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Encyclopædia Britannica;

OR, A

DICTIONARY

OF

ARTS and SCIENCES,

COMPILED UPON A NEW PLAN.

IN WHICH

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The various TECHNICAL TERMS, &c. are explained as they occur in the order of the Alphabet.

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By a SOCIETY of GENTLEMEN in SCOTLAND.

IN THREE VOLUMES.

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*

"LET KNOWLEDGE GROW FROM MORE TO MORE
AND THUS BE HUMAN LIFE ENRICHED."

ENCYCLOPÆDIA BRITANNICA

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ENCYCLOPÆDIA BRITANNICA

Volume 16

NAPOLEON I *TO* OZONOLYSIS

NAPOLEON I (1769–1821), emperor of the French from 1804 to 1814 and again for "the Hundred Days" in 1815, was born at Ajaccio in Corsica on Aug. 15, 1769, one year and three months after the cession of Corsica to France by the Genoese. He was the fourth child—and the second to survive infancy—of Carlo Buonaparte and his wife Letizia Ramolino (*see* BONAPARTE). His father's family was of ancient nobility. Tuscan in origin, it had emigrated to Corsica in the 16th century: Napoleon himself in his last years scoffed at the genealogy that flatterers and courtiers had concocted to make him descend from the 12th-century Buonapartes of Treviso and Bologna, whose line was extinct. In any case, Carlo Buonaparte was one of the delegates sent to Paris by the Corsican nobility.

A lawyer by profession, Carlo Buonaparte had married the beautiful and strong-willed Letizia Ramolino when she was only 14 years old; and they eventually had eight children to bring up in very difficult times. The French occupation of Corsica was resisted by a number of the inhabitants, led by Pasquale Paoli, and Carlo Buonaparte joined Paoli's party, taking his wife and family away with him lest the French should seize them as hostages. When Paoli had to flee, however, Carlo Buonaparte came to terms with the French. Winning the protection of the governor of Corsica, he was appointed assessor for the judicial district of Ajaccio in 1771. In 1778, moreover, through the influence of the governor's brother, he obtained the admission of his two eldest sons, Joseph and Napoleon, to the Collège d'Autun, to which he took them in Dec. 1778.

These events serve partly to explain Napoleon's character. A Corsican by birth, heredity and childhood associations, he continued for some time after his arrival in "continental" France to regard himself a foreigner; yet from the age of nine he was educated in France as other Frenchmen were, according to French methods and ideas. While Stendhal's tendency to account for Napoleon entirely in terms of his Tuscan and Corsican origins and to see in him a reincarnation of some 14th-century Italian *condottiere* is an overemphasis on one aspect of his character, it must be remembered that Napoleon shared neither the traditions nor prejudices of his new country: remaining a Corsican in temperament, he was first and foremost, through the education he received and the books that he read, a man of the 18th century.

Napoleon received his education at three schools: at Autun, where he stayed only three months; at the military college of Brienne, where he attended for five years; and finally at the military academy in Paris, where his studies lasted only one year. It was during Napoleon's year in Paris that his father died at Montpellier—where he had gone for treatment of a stomach cancer—on Feb. 24, 1785, leaving his family in straitened circumstances. Napoleon, although not the eldest son, wanted to do all that he could to help his mother, and at the age of 16 he was acting as the head of the family. On Sept. 1, 1785, he completed his studies at the military academy in Paris, where he ranked 42nd in a class of 51. He was made second lieutenant of artillery in the regiment of La Fère, then garrisoned at Valence.

The regiment of La Fère was a kind of training school for young artillery officers. Napoleon continued his education there, reading much, in particular the fashionable works on strategy and tactics by such writers as the comte J. A. H. de Guibert. He also wrote his own *Lettres sur la Corse,* in which he reveals his feeling for his native island. He went back to Corsica in Sept. 1786 and did not rejoin his regiment, then in barracks at Auxerre, until June 15, 1788. By that time the agitation that was to culminate in the French Revolution had already begun. A reader of Voltaire and of Rousseau, Napoleon believed that a political change was indispensable; but he seems not to have seen any need for radical social reforms, as his environment would not have brought him into contact with the labouring population.

THE REVOLUTIONARY PERIOD, 1789–99

In 1789 the Constituent Assembly (*see* FRANCE: *History;* FRENCH REVOLUTION) allowed Paoli to return to Corsica. As soon as Napoleon learned of this, he asked for leave to join him and obtained it in September. He joined Paoli's group with enthusiasm, but Paoli had no sympathy for the young man, whom he considered to be a "foreigner." Disappointed, Napoleon returned to France in Feb. 1791. On April 1 he was appointed first lieutenant to the 4th regiment of artillery, garrisoned at Valence. He at once joined the Jacobin club there and soon became its president, making speeches against nobles, monks and bishops. On Sept. 2, 1791, he got leave to go back to Corsica again for three

BIBLIOTHÈQUE NATIONALE, PARIS

"NAPOLEON I, EMPEROR OF THE FRENCH," ENGRAVING BY SOULANGE TEISSIER FROM THE PAINTING BY JACQUES LOUIS DAVID. IN THE MUSÉE DE LA MALMAISON, NEAR PARIS

months. He was elected lieutenant colonel in the national guard, but he fell out completely with Paoli, its commander in chief. Corsican political quarrels made him forget the date when his leave expired, and on Jan. 1, 1792, he was listed as a deserter. In April France declared war against Austria (*see* FRENCH REVOLUTIONARY WARS) and his offense was forgiven. Going to Paris in May, Napoleon was an indignant witness of the attack on the royal palace of the Tuileries on June 20. He also saw the insurrection of Aug. 10, but attributed its success to Louis XVI's incompetence.

Napoleon was promoted to the rank of captain but did not rejoin his regiment, returning instead to Corsica on Oct. 10, 1792, on the pretext of escorting his sister Élisa home. Paoli was now exercising dictatorial powers on the island and preparing to separate Corsica from France. Napoleon joined the Corsican Jacobins who opposed this policy: he wanted Corsica to be involved with France in the coming struggle. On Feb. 23, 1793, he occupied the little island of San Stefano, belonging to the kingdom of Sardinia-Piedmont (at war with France since September). Paoli ordered the evacuation of this island, but the Convention in Paris decided on the arrest of Paoli, and civil war broke out in Corsica (April 1793). Paoli had the Buonaparte family condemned to "perpetual execration and infamy," whereupon they all fled to France (June).

Toulon (1793).—Napoleon Bonaparte, as he may henceforth be called (though the family did not drop the spelling Buonaparte till after 1796), rejoined his regiment at Nice. He was given the task of collecting supplies of munitions in the Rhone valley for the army of Italy. During this mission he witnessed the struggles at Marseilles and at Avignon between the Jacobin supporters of the Convention and the "federalists" who, with royalist backing, were against it. In his *Souper de Beaucaire,* written at this time, he argued vigorously for united action by all republicans rallied round the Jacobins and the Convention. At the end of Aug. 1793 the Convention's troops under J. F. Carteaux (a former painter) had taken Marseilles but were halted before Toulon, where the royalists had called in British forces. As the commander of the Convention's artillery had been wounded, the commissioner to the army, A. C. Saliceti, a Corsican deputy and a friend of Napoleon's family, got the post for Bonaparte (Sept. 17); and Bonaparte was promoted *chef de bataillon* on Sept. 29 and adjutant general, head of brigade, on Oct. 7. His relations with Carteaux were not cordial, but he was soon on better terms with Carteaux's successors, A. Doppet and, in particular, J. F. Dugommier, who took command of the army on Nov. 16. Thenceforward Bonaparte could take active charge of the bombardment of the British positions. He received a bayonet wound on Dec. 16. On Dec. 17 the British troops, harassed by Bonaparte's artillery, evacuated Toulon; on Dec. 19 the French entered the town; and on Dec. 22 Bonaparte was promoted brigadier general in recognition of his decisive part in the capture of the town. Augustin Robespierre, the commissioner to the army, wrote to his brother Maximilien praising the "transcendent merit" of the young republican officer. On Feb. 7, 1794, Bonaparte was appointed commandant of the artillery in the army of Italy. He took part in the operations round Nice.

The Thermidorian Interval (1794–95).—Robespierre fell from power in Paris on 9 Thermidor (*i.e.,* July 27, 1794). When the news reached Nice, the *représentants en mission* to the army, regarding Bonaparte as a protégé of Robespierre's, had him arrested on a charge of conspiracy and treason (Aug. 6). He was freed on Sept. 14 but was not restored to his command. In March 1795 he was offered the command of the artillery in the army of the West, but he refused this post, which seemed to hold no future for him, and went to Paris to justify himself. Life was difficult for him on half pay, though he was carrying on an affair with Désirée Clary, daughter of a rich Marseilles businessman and sister of the Julie Clary who had just married his elder brother Joseph. Yet he was unable to obtain a satisfactory command, as he was feared for his intense ambition and for his relations with the "Montagnards" (the more radical members of the Convention). He then considered offering his services to Turkey.

The Coup of Vendémiaire.—Bonaparte was still in Paris in 1795 when the Convention, on the eve of its dispersal, submitted the new Constitution of the Year III to a referendum, together with decrees according to which two-thirds of the members of the Convention were to be re-elected to the new legislative assemblies. The royalists, hoping that they would soon be able to restore the monarchy, rose in revolt to prevent these measures from being put into effect. Barras, entrusted with full powers by the Convention, was unwilling to rely on the existing commander of the troops of the interior, Gen. J. F. de Menou, a weak man suspected of dealings with the royalists. He therefore had Bonaparte appointed second-in-command, as he knew of his services at Toulon and of his present lack of employment in Paris. Thus it was Napoleon who directed the defense, positioned the artillery and shot down the columns of rebels who were marching against the Convention (13 Vendémiaire, Year IV; Oct. 5, 1795). Having saved the Convention and the republic, he was derisively called "Général Vendémiaire" by his opponents.

After the rising of Vendémiaire, Bonaparte kept his place as commander of the army of the interior. Consequently he was henceforth aware of every political development in France. He also became the respected adviser on military matters to the new government, the Directory. Lastly, he came to know an attractive Creole, Joséphine Tascher de La Pagerie, the widow of Gen. Alexandre de Beauharnais (guillotined during the Terror), the mother of two children and a woman of many love affairs.

The Italian Campaign of 1796–97.—From every point of view, a new life was opening for Bonaparte. He began to observe the activities of the left-wing group directed by François Babeuf and by an Italian whom he had known in Corsica, P. M. Buonarroti. This group, which met at the Panthéon, wanted a new revolution to install a communist regime. On the instructions of the Directory, Bonaparte closed the Panthéon club (Feb. 28, 1796). Having thus proved his loyalty to the regime, he was appointed commander in chief of the army of Italy (March 2), a post that

he had been soliciting for several weeks so that he could personally conduct part of the plan of campaign adopted by the Directory on his advice. He married Joséphine on March 9 and left for the army two days later.

Arriving at his headquarters at Savona, Bonaparte found that his army, which on paper consisted of 43,000 men, in fact numbered scarcely 30,000 men available for service; and even these were ill-fed, ill-paid, ill-equipped and ill-shod. On March 28, 1796, he made his first proclamation to his troops: "Soldiers, you are naked, badly fed. . . . Rich provinces and great towns will be in your power, and in them you will find honour, glory, wealth. Soldiers of Italy, will you be wanting in courage and steadfastness?" He took the offensive on April 12 and, after the victories of Montenotte, Dego, Millesimo and Mondovi, defeated successively the Austrian and the Sardinian armies, separated them and marched on Turin. King Victor Amadeus III of Sardinia asked for an armistice, which was signed at Cherasco on April 28 and converted into a peace treaty in Paris on May 15: Nice and Savoy, which had been occupied by the French since 1792, were annexed to France. Bonaparte went on against the Austrians and occupied Milan, but was held up at Mantua. While his army was besieging this great fortress, he signed armistices with Ferdinand, duke of Parma, on May 9, with Ercole III, duke of Modena, on May 17, and finally with Pope Pius VI on June 23.

At the same time Bonaparte took an interest in the political organization of Italy. A plan for the "republicanization" of Italy by a group of Italian "patriots" led by Buonarroti had to be shelved when Buonarroti was arrested for complicity in Babeuf's conspiracy against the Directory. Thereafter Napoleon, without discarding the Italian "patriots" altogether, restricted their freedom of action. He set up a republican regime in Lombardy, but kept a close watch on its leaders; and in Oct. 1796 he created the Cispadane republic by merging Modena and Reggio nell'Emilia with the papal states occupied by the French army (that is to say, Bologna and Ferrara). Finally he sent an expedition from Livorno to recover Corsica, which the British had evacuated.

Austrian armies advanced four times from the Alps to relieve Mantua. Each time Napoleon defeated them—not always without risk to his own army. After the last Austrian defeat, at Rivoli (Jan. 14, 1797), Mantua capitulated. Bonaparte then forced the pope to sign peace at Tolentino (Feb. 19). Next, at the head of all his forces, he marched on Vienna. He was about 60 mi. from that capital when the Austrians sued for an armistice. By the preliminaries of peace, signed at Leoben on April 18, Austria ceded the southern Netherlands to France and recognized the Lombard republic, but received in exchange some territory that had belonged to the old republic of Venice, which was partitioned between Austria, France and Lombardy. In the six months preceding the final conclusion of peace Napoleon concerned himself mainly with political problems. The Lombard and Cispadane republics, with the Valtellina and some of the formerly Venetian territory, were united to form the Cisalpine republic; the republic of Genoa was reorganized on democratic principles as the Ligurian republic; and Jacobin propaganda was encouraged in Venetia. Some Italian patriots hoped that these developments would soon lead to the formation of a single and indivisible "Italian republic," modeled on the French.

The Coup of Fructidor and Campo Formio.—Meanwhile Bonaparte was also watching events in France. He was uneasy at the successes of the royalists in the elections in the spring of 1797 and advised the Directory to oppose them, if necessary, by force. When an attempted *coup d'état* by the Directory against the royalists failed (July 1797), Bonaparte made his army vote "addresses" hostile to the royalists and sent Pierre Augereau, one of his generals, to Paris, together with several officers and men "on leave." Augereau's successful *coup d'état* of 18 Fructidor (Sept. 4, 1797) eliminated the royalists' friends from the government and from the legislative councils and enhanced Bonaparte's prestige. Thus Bonaparte could conclude the peace treaty of Campo Formio with Austria as he thought best (Oct. 17). The Directory was displeased by this treaty because it ceded Venice to the Austrians and did not secure the left bank of the Rhine for France; but it raised Bonaparte's popularity to its peak, as he had restored peace on the continent after five years of war.

The Egyptian Campaign (1798–99).—The war at sea, against the British, continued. The directors, who wanted to launch an invasion of the British Isles, naturally appointed Bonaparte to command the army assembled for this purpose along the Channel. After a rapid inspection (Feb. 1798) he announced that the operation could not be undertaken until France had command of the sea. Instead he suggested that France should strike at the sources of Great Britain's wealth by occupying Egypt and threatening the route to India. This proposal, seconded by Talleyrand, the minister for foreign affairs, was accepted by the directors, who were glad to get rid of their ambitious young general.

The expedition, thanks to some fortunate coincidences, was at first a great success: Malta, the great fortress of the Knights Hospitalers of St. John of Jerusalem, was occupied on June 10, 1798, Alexandria taken by storm on July 1, and all the delta of the Nile rapidly overrun. On Aug. 1, however, the French squadron at anchor in Aboukir bay was completely destroyed by Adm. Horatio Nelson's fleet in the battle of the Nile, so that Napoleon found himself confined to the land that he had conquered. He proceeded to establish western political institutions, administration and technical skills in Egypt; but Turkey, nominally suzerain over Egypt, declared war on France in September. To prevent a Turkish invasion of Egypt and also perhaps to attempt a return to France by way of Anatolia, Bonaparte marched into Syria (Palestine) in Feb. 1799. His progress northwest was halted at Acre, where the British admiral Sir William Sidney Smith and the French émigré A. Le Picard de Phélippeaux (who had been at Brienne with Napoleon) withstood a siege. In May 1799 Bonaparte began a disastrous retreat to Egypt.

The Coup of Brumaire.—The battle of the Nile showed to Europe that Bonaparte was not invincible, and Great Britain, Austria, Russia and Turkey formed a new coalition against France. The French armies in Italy were defeated in the spring of 1799 and had to abandon the greater part of the peninsula. These defeats led to disturbances in France itself. The *coup d'état* of 30 Prairial (June 18, 1799) expelled the men of moderate views from the Directory and brought into it men who were considered Jacobins. Yet the situation remained confused, and one of the new directors, Emmanuel Sieyès, was convinced that only military dictatorship could prevent a restoration of the monarchy: "I am looking for a sabre," he said. In the hope of demoralizing the French army in Egypt, Admiral Smith had the newspapers recording these events passed to Bonaparte. The latter did not take long to make up his mind: he would leave his army and return to France—in order to save the republic, of course, but also to take advantage of the new circumstances and to seize power. The Directory had in fact ordered his return, but he had not received the order, so that it was actually in disregard of his instructions that he left Egypt with a few companions on Aug. 22, 1799. Their two frigates tacked along the African coast and miraculously escaped interception by the British. Bonaparte landed at Fréjus on Oct. 9 and was in Paris on Oct. 14.

By this time André Masséna's victories in Switzerland and Guillaume Brune's in Holland (Sept.–Oct. 1799) had averted the danger of invasion, and the counterrevolutionary risings within France had more or less failed. A *coup d'état* could therefore no longer be justified by the need to save the republic. Sieyès, however, had not given up his projects, and now he had his "sabre." From the end of October he and Bonaparte were in league together planning the *coup d'état*, and on 18–19 Brumaire, Year VIII (Nov. 9–10, 1799), it was carried out: the directors were forced to resign, the members of the legislative councils were dispersed, and a new government, the consulate, was set up. The three consuls were Bonaparte and two of the directors who had resigned, Sieyès and Roger-Ducos. Henceforth Bonaparte was the master of France.

THE CONSULATE, 1799–1804

Bonaparte, now 30 years old, was thin, short and wore his hair cut close—the *petit tondu*, or "little crop-head," as he was called. Not much was known about his personality, but people had con-

fidence in a man who had always been victorious (the Nile and Acre were forgotten) and who had managed in 1797 to negotiate a brilliant treaty. He was expected to bring peace back, to end disorder and to consolidate the political and social "conquests" of the Revolution. He was indeed exceptionally intelligent, prompt to make decisions and indefatigably hardworking, but also insatiably ambitious, always pursuing greater and greater enterprises. He seemed to be the man of the Revolution because it was thanks to the Revolution that he had climbed, at so early an age, to the highest place in the state. He was not to forget it: but more than a man of the Revolution he was a man of the 18th century, the most enlightened of the enlightened despots, a true son of Voltaire. He did not believe in the sovereignty of the people, in the popular will, or in parliamentary debate. Yet he put his confidence more in reasoning than in reason and may be said to have preferred "men of talent"—mathematicians, jurists and statesmen, for instance, however cynical or mercenary they might be—to "technicians" in the true sense of the word. He believed that an enlightened and firm will could do anything if it had the support of bayonets; he despised and feared the masses; and, as for public opinion, he considered that he could mould and direct it as he pleased. He has been called the most "civilian" of generals, but essentially he never ceased to be a soldier: clothes and titles could make no difference.

The Constitution of the Year VIII.—Bonaparte imposed a military dictatorship on France, but its true character was at first disguised by the Constitution of the Year VIII (4 Nivôse; Dec. 25, 1799), drawn up by Sieyès. This constitution did not guarantee the "rights of man" or make any mention of "liberty, equality and fraternity," but it did reassure the partisans of the Revolution by proclaiming the irrevocability of the sale of national property and by upholding the legislation against the *émigrés*. It gave immense powers to the first consul, leaving only a nominal role to his two colleagues. The first consul, namely Bonaparte, was to appoint ministers, generals, civil servants, magistrates and the members of the *conseil d'état* and even had an overwhelming influence in the choice of members for the three legislative assemblies, the senate, the *corps législatif* and the tribunate, though these members were theoretically to be chosen by universal suffrage. Submitted to a plebiscite, the constitution won an overwhelming majority (Feb. 1800). It is true that the vote was not taken by secret ballot and that pressure was exerted in many ways, but it appeared that Bonaparte was brought to power by a vote of more than 3,000,000 against about 1,500.

The Administration.—The consulate's work of administrative reform, undertaken at Bonaparte's instigation, was to be more lasting than the constitution and so more important for France. At the head of the government was the *conseil d'état,* created by the first consul and often effectively presided over by him; it was to play an important part both as the source of the new legislation and as an administrative tribunal. At the head of the administration of the *départements* were the prefects, who carried on the tradition of the intendants of the *ancien régime,* supervising the application of the laws and acting as the instruments of centralization. The judicial system was profoundly changed: whereas hitherto, from the beginning of the Revolution, judges had been elected, henceforth magistrates were to be nominated by the government, their independence however being assured by their irremovability from office. The police organization was greatly strengthened. The financial administration was considerably improved: instead of the municipalities, special functionaries were entrusted with the collecting of direct taxes; the franc was stabilized (*franc de Germinal*); and the Banque de France was created. Education was transformed into a major public service; secondary education was given a semi-military organization, and the university faculties were re-established. Primary education, however, was still neglected.

The Concordat.—Bonaparte shared Voltaire's belief that the people needed a religion. Personally, he was indifferent to religion: in Egypt he had said that he wanted to become a Muslim. Yet he considered that religious peace had to be restored to France. As early as 1796, when he was concluding the armistice in Italy with Pope Pius VI, he had tried to persuade the pope to retract his briefs against the French priests who had accepted the Civil Constitution of the Clergy. Pius VII, who succeeded Pius VI in March 1800, was more accommodating than his predecessor, and negotiations were opened with him in September. Ten months later a concordat was signed reconciling the Church and the Revolution. The pope recognized the French republic and called for the resignation of all former bishops; new prelates were to be designated by the first consul and instituted by the pope; and the sale of the property of the clergy was officially recognized by Rome. The concordat in fact admitted freedom of worship and the lay character of the state. In order, however, to induce the numerous ex-revolutionaries in the government to accept the concordat, the first consul appended to it the "Organic articles," which stipulated that papal acts should not be published in France or catechisms drawn up without the state's authorization.

The Code.—The codification of the civil law, first undertaken in 1790, was at last completed under the consulate. The code promulgated on March 21, 1804, and later known as the Code Napoléon (*q.v.*), gave permanent form to the great gains of the Revolution, individual liberty, freedom of work, freedom of conscience, the lay character of the state and equality before the law; but at the same time it protected landed property, gave greater liberty to employers and showed little concern for employees. It granted only limited legal rights to women, but maintained divorce.

Military Organization.—The army received the most careful attention. The first consul retained in outline the system instituted by the Revolution: recruitment by forced conscription, but with the possibility of replacement by substitutes; the mixing of the conscripts with old soldiers; and the eligibility of all for promotion to the highest ranks. Nevertheless the creation of the academy of St. Cyr, to produce infantry officers, made it easier for the sons of bourgeois families to pursue a military career. Moreover, the École Polytechnique, founded by the Convention, was militarized in order to provide officers for the artillery and engineers. Yet Bonaparte was not concerned about introducing new technical inventions into his army: he stopped the construction of military balloons, which had been started in 1793; and he sent home the American engineer Robert Fulton, who had come to suggest a steamship and a submarine for the French fleet. To win his battles he put his trust in the "legs of his soldiers": his basic strategic idea was a fast-moving army.

The Campaign of Marengo and the Peace of Lunéville (1800–01).—The first consul spent the winter and spring of 1799–1800 reorganizing the army and preparing for an attack on Austria (Russia had become estranged from the coalition against France). With his usual quick assessment of the situation he saw the strategic importance of Switzerland, from which he would be free to outflank the Austrian armies either in Germany or in Italy as he might see fit. His past successes made him choose Italy. Taking his army across the Great St. Bernard pass before the snow had melted, he appeared unexpectedly behind the Austrian army which was besieging Genoa. The battle of Marengo (June 14, 1800) gave the French command of the Po valley as far as the Adige; and in December another French army, led by Moreau, defeated the Austrians at Hohenlinden in Germany. Austria was forced to sign the peace of Lunéville on Feb. 9, 1801, whereby France's right to the "natural frontiers" which Julius Caesar had given to Gaul, namely the Rhine, the Alps and the Pyrenees, was recognized.

The Peace of Amiens (1802).—Great Britain alone remained at war with France. Bonaparte again began to prepare an invasion, as in 1798, but without great conviction. He preferred to stimulate Russian animosity against Great Britain and had persuaded the Russian emperor Paul I to form a "League of Armed Neutrality" with Sweden, Denmark and Prussia (Dec. 1800). The assassination of Paul in March 1801 and Nelson's bombardment of Copenhagen ruined this calculation, but Great Britain was tired of the struggle, and William Pitt, the prime minister, had already resigned. Preliminaries of peace, concluded in London on Oct. 1, 1801, put an end to hostilities and peace was signed at Amiens on March 25, 1802.

The Life Consulate.—General peace was re-established in

MANSELL COLLECTION, LONDON

"BONAPARTE CROSSING MONT SAINT BERNARD," BY JACQUES LOUIS DAVID, 1800. IN THE MUSÉE DE VERSAILLES

Europe for the first time in ten years. The first consul's prestige increased still more; and his friends—at his suggestion—proposed that a "token of national gratitude" should be offered to him. In May 1802 it was decided that the French people should give their opinion through a referendum, under the same conditions as in 1800, on the following question: "Shall Napoleon Bonaparte be consul for life?" In August an overwhelming majority of 3,500,000 votes against less than 10,000 granted him the prolongation of his consulate; and he also received the right to designate his successor.

The Failure of the General Pacification.—Bonaparte's conception of international peace did not coincide with that of the British government. For the British the terms of the treaty of Amiens represented an absolute limit beyond which they could under no circumstances agree to go: they even hoped, when they got the chance, to take back some of the concessions they had been forced to make. For Napoleon Bonaparte, on the other hand, the treaty of Amiens marked the starting point for a new French ascendancy. First of all, from the economic point of view, he meant to reserve half of Europe as a market for France and, to the indignation of British merchants, refused to lower customs duties. Then, from the naval point of view, he intended to revive France's expansion overseas, to recover San Domingo (which had rebelled), to occupy Louisiana (ceded to France by Spain in 1800), perhaps to reconquer Egypt and at any rate to extend French influence in the Mediterranean, in the Levant and in the Indian ocean. Finally, on the continent of Europe, he advanced beyond France's natural frontiers, incorporating Piedmont in France, intervening in Switzerland to restore order and taking a hand in the affairs of Germany, where princes dispossessed of territory on the Rhine under the peace of Lunéville were to be compensated with shares of the secularized ecclesiastical states.

Great Britain was alarmed by this expansion of France in peacetime and found it scarcely tolerable that one state should possess all the coastline of the continent from Genoa to Antwerp. However, the immediate occasion of Franco-British rupture was the problem of Malta. According to the treaty of Amiens, the British, who had taken the island on the collapse of the French occupation, should have restored it to the Knights Hospitalers; but the British, on the pretext that the French had not yet evacuated certain Neapolitan ports, refused to leave the island. Franco-British relations became strained, and in May 1803 the British declared war.

Cadoudal, Pichegru and the Duc d'Enghien.—The peace settlement had brought about the life consulate; the return of war was to stimulate the formation of the empire. The British government, which would have been glad to see Bonaparte deposed or removed by assassination, renewed its subsidies to the French royalists, who resumed their agitation and plotting. The most notable conspiracy was hatched by a young Chouan, Georges Cadoudal, and by a former republican general, Charles Pichegru, who had been deported from France after the *coup d'état* of 18 Fructidor but had escaped from Guiana and taken refuge in England. The police soon got wind of the conspiracy and arrested Pichegru on Feb. 29, 1804, and Cadoudal on March 9. Bonaparte decided to react vigorously enough to deter his opponents from any more such attempts. The police believed that the real head of the conspiracy was the young duc d'Enghien who was residing in the duchy of Baden, a few miles across the frontier. Accordingly, with the agreement of Talleyrand and the police chief Joseph Fouché, Bonaparte had the duc kidnaped on neutral soil and brought to Vincennes, where he was tried and shot (March 21). This action provoked a resurgence of opposition in the old aristocracy but enhanced the influence of Fouché.

THE EMPIRE, 1804–14

In the hope of consolidating his own position, Fouché now suggested to Bonaparte that the best way to discourage conspiracy would be to transform the life consulate into a hereditary empire, as the existence of an heir would remove all hope of changing the regime by assassination. Bonaparte readily accepted the suggestion. The senate, prompted by Fouché, then proposed a hereditary succession, and the tribunate expressed the wish that Bonaparte should be proclaimed hereditary emperor of the French. The empire was proclaimed on May 18, 1804, and a plebiscite approved the change.

The Institutions of the Empire.—Though there was little change in the organization of the government of France, Napoleon as emperor set himself to bring back a number of institutions similar to those of the *ancien régime*. In the first place he wanted to be consecrated—but by the pope himself, so that his coronation should be even more impressive than that of the kings. Pius VII agreed to come to Paris, and the ceremony, which seemed equally outrageous to royalists and to the old soldiers of the Revolution, took place in Notre Dame on Dec. 2, 1804. At the last moment, the emperor took the crown from the pope and set it on his own head himself. The imperial regime moreover had its symbols and titles. The Roman eagle was placed above the tricolor flag and was shown, together with the golden bees, in the coat of arms of the new dynasty. Princely titles were brought back for the members of Napoleon's family in 1804, and an imperial nobility was created in 1808. As opposition was still lively, Napoleon intensified his propaganda and imposed an increasingly strict censorship on the press. A dictatorial regime allowed him to carry on his wars for years without worrying about French public opinion.

Having been president of the Italian republic (as the Cisalpine was renamed) since Jan. 1802, Napoleon in March 1805 was proclaimed king of Italy. He was crowned in Milan on May 26.

The Projected Invasion of England: Trafalgar.—From 1803 to 1805 Napoleon had only the British to fight (*see* NAPOLEONIC WARS); and again France could hope for victory only by landing an army in the British Isles, while the British could defeat Napoleon only by forming a continental coalition against him. Napoleon began to prepare an invasion again, but with greater conviction this time and on a larger scale: he gathered nearly 2,000 ships between Brest and Antwerp and concentrated his "Grande Armée" in the camp at Boulogne (1803). Even so, the problem was the same as in 1798: to cross the Channel, the French had to have control of the sea. Still far inferior to the British navy, the French fleet needed the help of the Spanish;

and even then the two fleets together could not hope to defeat more than one of the British squadrons. Spain was induced to declare war on Great Britain in Dec. 1804, and it was decided that French and Spanish squadrons, massed in the Antilles, should lure a British squadron into these waters and defeat it, thus making the balance roughly equal between the Franco-Spanish navy and the British: a battle in the entrance to the Channel could then be engaged with some chance of success. The plan failed: the French squadron from the Mediterranean, under Adm. Pierre de Villeneuve, found itself alone at the appointed meeting place in the Antilles. Pursued by Nelson and not daring to attack him, it turned back toward Europe and took refuge in Cadiz on July 18, 1805; there the British blockaded it. Accused of cowardice by the angry Napoleon, Villeneuve resolved to run the blockade, with the support of a Spanish squadron, in order to reach Toulon; but on Oct. 21, 1805, he was attacked by Nelson off Cape Trafalgar. Nelson was killed in the battle, but the Franco-Spanish fleet was totally destroyed. The British had won a decisive victory, which eliminated the danger of invasion and gave them complete freedom of movement at sea.

The Victories in Europe (1805–07).—By this time, after two years of effort, the British had managed to organize a new continental coalition, in which Austria, Russia, Sweden and Naples were grouped against France. On July 24, 1805, three months before Trafalgar, Napoleon had ordered the Grande Armée from Boulogne to the Danube (thus even if the French had won at Trafalgar, the battle would not have been followed by the invasion of England). In the week preceding Trafalgar, the Grande Armée won an outstanding victory over the Austrian general Karl Mack, whose army surrendered at Ulm on Oct. 20; and on Nov. 13 Napoleon entered Vienna. On Dec. 2, 1805, he defeated the combined Austrian and Russian armies in the battle of Austerlitz, the greatest victory of his career. By the peace of Pressburg (Bratislava; Dec. 26, 1805) Austria renounced all influence in Italy and ceded Venetia and Dalmatia to Napoleon, as well as extensive territory in Germany to his protégés Bavaria, Württemberg and Baden. The French then proceeded to dethrone the Bourbons in the kingdom of Naples, which was bestowed on Napoleon's brother Joseph. In July 1806 the Confederation of the Rhine was founded—soon to embrace all western Germany in a union under French protection.

In Sept. 1806 Prussia entered the war against France; but on Oct. 14 the Prussian armies were defeated at Jena and at Auerstädt. The Russians put up a better resistance at Eylau (Feb. 8, 1807), but were routed at Friedland (June 14). In Warsaw, Napoleon fell in love with a Polish lady, Countess Marie Walewska (née Laczynska; 1786–1817), by whom he had a son, Alexandre Walewski.

Tilsit.—The Russian emperor Alexander I could still have gone on with the struggle, but was tired of the alliance with the British. He met Napoleon at Tilsit, in northern Prussia near the Russian frontier, on a raft anchored in the middle of the Niemen river. Three treaties were signed there: a Franco-Russian peace treaty (July 7, 1807), whereby Alexander consented to Napoleon's plans for Germany and Italy and ceded the Ionian Islands to France; a secret treaty of alliance between France and Russia (also July 7); and a Franco-Prussian peace treaty (July 9), whereby the Polish provinces were detached from the kingdom of Prussia to form the duchy of Warsaw. The two emperors thus shared the domination of Europe, Napoleon taking the west and Alexander the east; and Alexander even made a vague promise to attack, by land, the British possessions in India.

The Continental System.—As Napoleon could no longer think of invading England, he tried to induce capitulation by stifling the British economy. His idea was to produce artificially a state of overproduction in Great Britain by means of a continental blockade which would close the whole of Europe to British products: merchandise from the factories would accumulate in the English docks, the factories would soon have to be shut down, and then the unemployed workmen would rise against the government and force it to sue for peace. The decrees of Berlin (Nov. 21, 1806) and of Milan (Dec. 17, 1807) organized the continental system (*q.v.*): they forbade all trade with the British Isles, ordered the confiscation of all goods coming from English factories or from the British colonies and condemned as fair prize not only every British ship, but also every ship which had touched the coasts of England or its colonies or had merely allowed a British vessel to visit it.

Portuguese and Spanish Resistance (1808).—For the blockade to succeed, it had to be enforced rigorously throughout Europe; but from the beginning one country showed itself reluctant to comply. This was England's old ally Portugal, for whom the blockade meant commercial ruin. Napoleon decided to break down Portuguese opposition by force. Charles IV of Spain willingly let the French troops cross his kingdom and they occupied Lisbon; but the prolonged presence of Napoleon's soldiers in the north of Spain exasperated the inhabitants, who accused the king and his minister Godoy of treason. When insurrection broke out, Charles IV abdicated in favour of his son Ferdinand but then appealed to Napoleon for reinstatement. Seeing the opportunity to rid Europe of its last Bourbon rulers, Napoleon summoned the Spanish royal family to Bayonne in April 1808 and obtained the abdication of both Charles and Ferdinand (May 5 and 6); they were interned in Talleyrand's château of Valençay. The people of Madrid, however, had already risen against the French occupying troops on May 2; the rising was bloodily suppressed, but insurrection soon spread across the whole country, as the Spaniards would not accept Joseph Bonaparte as king. Gen. Pierre Dupont's army corps, sent to suppress the revolt in Andalusia, was forced to capitulate at Bailen in July; and this sensational blow to Napoleon's prestige was followed by another in August, when Andoche Junot's corps in Portugal capitulated to the British under the convention of Cintra. The Iberian peninsula, now up in arms, was henceforth to be a bridgehead on the continent for the British, and under the energetic Arthur Wellesley (later duke of Wellington), in command from 1809, the Anglo-Spanish-Portuguese forces were to achieve decisive successes (*see* PENINSULAR WAR).

Erfurt (1808) and Austria's War of 1809.—At the congress of Erfurt (Sept.–Oct. 1808), where Napoleon assembled a great concourse of princes to impress the Russian emperor, he could not extract from Alexander the definite promises to help that he required. Alexander's refusal, furthermore, was partly prompted by Talleyrand, who was already beginning to betray his master.

In 1809, however, with most of the Grande Armée thrown into Spain, Napoleon seemed on the point of overcoming the revolt. Then, in April 1809, Austria launched an attack in Bavaria in the hope of rousing all Germany against the French. Napoleon had to recall some of his forces from Spain, and Vienna fell again to the French on May 12. After their bloody defeat at Wagram (July 6), the Austrians obtained an armistice (July 12); and by the peace of Vienna in October, Napoleon took the Illyrian provinces from Austria, thus stopping a gap in the continental system.

Napoleon's Zenith.—The year 1810 was that of Napoleon's zenith, despite some failures in Spain and Portugal. He considered himself Charlemagne's heir. He repudiated Joséphine, who had not given him a child, so that he could marry the archduchess Marie Louise, daughter of the Austrian emperor Francis I; and the birth of a son, the king of Rome, in March 1811 seemed to assure the destiny of the empire. This empire, now at its greatest extent, included not only the Illyrian provinces but also Etruria, some of the papal states, Holland and the German states bordering the North sea. Around the empire proper there was a ring of vassal states ruled over by the emperor's relatives: the kingdom of Westphalia (Jérôme Bonaparte); the kingdom of Spain (Joseph Bonaparte); the kingdom of Italy (with Eugène de Beauharnais, Joséphine's son, as viceroy); the kingdom of Naples (Joachim Murat, Napoleon's brother-in-law); and the principality of Lucca and Piombino (Félix Baciocchi, another brother-in-law). Finally other territories were closely bound to the empire by treaties: the Swiss confederation, of which Napoleon was the mediator; the Confederation of the Rhine; and the duchy of Warsaw. Even Austria seemed bound to France by Napoleon's marriage to Marie Louise.

The political map of Europe, which had been so complicated

before 1796, was now greatly simplified. At the same time the frontiers did not coincide either with geographical features or with "nationalities." Whatever he may later have said, Napoleon while he was in power was not interested in realizing either German or Italian unity. Yet by reducing the number of states, by pushing the frontiers about, by amalgamating populations and by propagating institutions like those which the Revolution and nationalism had created in France, he prepared the ground for German and Italian unification. National feeling in Europe, stirred by French ideas and by contact with Frenchmen, gave rise in turn to the first resistance against French domination. From 1809 onward Spanish guerrillas, supported by British troops, were consistently successful in the peninsula, harassing the French and keeping them constantly on the move; and the national *Cortes*, convened at Cadiz by the insurrectionary element in Sept. 1810, promulgated in March 1812 a constitution inspired jointly by the ideas of the French Revolution of 1789 and by British institutions.

The Disaster in Russia (1812).—Since the congress of Erfurt the Russian emperor had shown himself less and less inclined to implement the treaty of Tilsit. In the spring of 1812, therefore, in order to intimidate him, Napoleon massed his forces in Poland; they amounted to about 453,000 men, drawn from every region of the empire and even including contingents extorted from Prussia and from Austria. After some last attempts at agreement, this Grande Armée began to cross the Niemen in the last week of June. The Russians retreated, scorching the earth behind them. Delayed in its advance by the difficulty of getting supplies, Napoleon's army did not reach the approaches to Moscow till the beginning of September. The Russian commander in chief, M. I. Kutuzov, engaged it at Borodino on Sept. 7: the fight was savage, bloody and indecisive, but on Sept. 14 Napoleon entered Moscow, which the Russians had abandoned. On that same day, a huge fire broke out, which destroyed the greater part of the town. Moreover, contrary to Napoleon's expectations, Alexander refused to treat with him. Withdrawal was necessary, and the premature onset of winter made it disastrous. After the difficult crossing of the Berezina in November, fewer than 10,000 men fit for combat remained with Napoleon's main force.

This catastrophe stirred all the peoples of Europe to withstand Napoleon's domination. In Germany the news let loose an outbreak of anti-French demonstrations which Prussia, having carefully prepared them, was ready to exploit. The Prussian troops, under Gen. Hans Yorck von Wartenburg, deserted the Grande Armée (Dec. 1812) and turned against the French. Following the Prussian example, the Austrians also withdrew their troops and adopted an increasingly hostile attitude. In Italy the people were moving away from Napoleon, and the "patriots" looked either to Eugène de Beauharnais or to Murat for the unification of the peninsula.

Even in France, signs of discontent with the regime were becoming more frequent. Talleyrand and Fouché were acting treacherously. In Paris a malcontent general, C. F. de Malet, nearly succeeded in carrying out a *coup d'état* when he announced, on Oct. 23, 1812, that Napoleon had died in Russia. This incident was a major factor in Napoleon's decision to hasten back to France ahead of the Grande Armée. Arriving in Paris on Dec. 18, he proceeded to stiffen the dictatorship, to raise money by various expedients and to levy new troops.

The Battle of Leipzig.—In 1813, therefore, the forces arrayed against France were no longer armies of mercenaries but nations fighting for their freedom as the French had fought for theirs in 1792 and 1793; and the French themselves, for all their courage, had lost their former enthusiasm. The emperor's ideal was no longer that of the nation.

In May 1813 Napoleon won some successes against the Russians and Prussians in Saxony and Lusatia (battles of Lützen and Bautzen) but his decimated army needed reinforcement and reorganization, and the armed mediation of Austria induced him to agree to an armistice, during which a congress was to meet at Prague under Metternich's presidency. Austria, the arbiter of the situation, proposed very honourable conditions: the French empire was to return to its natural limits; the duchy of Warsaw and the Confederation of the Rhine were to be dissolved; and Prussia was to return to its frontiers of 1805. Napoleon made the mistake of hesitating too long, and the congress had closed (Aug. 10) before his reply arrived. Austria declared war.

The French were now in a worse situation than in the spring. The numerical superiority of the allies was increasing every day, as one German contingent after another left Napoleon to go over to the other side. The greatest cataclysm of the Napoleonic era was the battle of Leipzig or "battle of the Nations" (Oct. 16–19, 1813), in which the Grande Armée was torn to shreds.

The reverse of the French degenerated fast into collapse. The French armies in Spain, forced to retreat, had been defeated at Vittoria (June 21, 1813); and by October the British were attacking their defenses north of the Pyrenees. In Italy the Austrians took the offensive, crossed the Adige and occupied Romagna. Murat, now openly a traitor to the emperor who had made him king of Naples, entered into negotiations with the Viennese court. The Dutch and the Belgians demonstrated against Napoleon.

Downfall and Abdication (1814).—In Jan. 1814 France was being attacked on all its frontiers. The allies cleverly announced that they were fighting not against the French people, but against Napoleon alone, since he had rejected the terms offered at Frankfurt (Nov. 1813), whereby the French would have preserved their "natural frontiers." The extraordinary feats of strategy which the emperor achieved during the first three months of 1814 with the army of young conscripts were not enough: he could neither defeat the allies, with their overwhelming numerical superiority, nor arouse the majority of French people from their resentful torpor. The *corps législatif* and the senate, formerly so docile, were now asking for peace and for civil and political liberties.

The treaty of Chaumont, signed on March 9, 1814, by Austria, Russia, Prussia and Great Britain, was a general pact such as France's enemies had failed to concert since 1793: the signatories bound themselves together for 20 years, undertook not to negotiate separately and promised to continue the struggle till Napoleon should have been overthrown. They then marshaled their forces and marched resolutely on Paris. They were at the gates of Paris on March 30, while Napoleon had moved east so that he could attack their rear guard. The Parisian authorities, no longer overawed by the emperor, lost no time in treating with the allies. The senate instituted a provisional government, with Talleyrand as president; he proclaimed the deposition of the emperor and, without consulting the French people, addressed himself to Louis XVIII, whose restoration the British alone were favouring.

Napoleon had been at Vitré when he learned of the advance on Paris. He had then ordered his army to turn westward again, but had only reached Fontainebleau when he heard that Paris had capitulated. He wanted to organize a new line of resistance south of the capital, but on April 4, 1814, a majority of his marshals explained to him that his troops, worn out and demoralized, could hold out no longer. Marshal Ney ended the discussion by advising the emperor to abdicate. Napoleon at first refused to follow this suggestion, but in the night of April 4–5 he learned that Marmont, in command of his vanguard, had just gone over to the enemy with a whole army corps. Fontainebleau was no longer protected, and on April 6 Napoleon abdicated.

By the treaty of Fontainebleau (April 11) the allies assigned the Mediterranean island of Elba to Napoleon as his place of residence, with full sovereignty over it; he was allowed to take there a corps of 400 volunteers and was granted a personal income of 2,000,000 francs, to be provided by Louis XVIII, as well as other financial provisions; also, he retained the title of emperor. The empress Marie Louise was to have the Italian duchies of Parma, Piacenza and Guastalla. After unsuccessfully trying to poison himself, Napoleon spoke his farewell to his "Old Guard," gathered in the courtyard of the "Cheval Blanc" on April 20. After a hazardous journey, during which he narrowly escaped assassination, he arrived at Elba on May 4.

ELBA AND THE HUNDRED DAYS, 1814–15

The island of Elba, on which Napoleon was to live and reign, was only a few square miles in size. "I want from now on to live

like a justice of the peace," he declared. But he was only 45 and in the full possession of his faculties. Could a man of such energy and imagination resign himself so easily to defeat?

In France, moreover, the Bourbon Restoration was soon exposed to criticism. Though in 1814 the majority of the French people were tired of the emperor, they had expressed no wish for the return of the Bourbons and were in any case strongly attached to the essential achievements of the Revolution; and Louis XVIII had come back "in the baggage train of the foreigners" with the last surviving *émigrés* who had "learnt nothing and forgotten nothing" and whose influence seemed to threaten most of the Revolution's achievements. The apathy of April 1814 quickly gave way to mistrust. Old hatreds were revived, resistance organized and conspiracies formed.

From Elba, Napoleon kept a close watch on the continent. He knew that some of the diplomats at Vienna, where a congress was deciding the fate of Europe, considered Elba too close to France and to Italy and wanted to banish him to a distant island in the Atlantic. Also he accused Austria of preventing Marie Louise and his son from coming to join him (in fact she had taken a lover and had no intention of going to live with her husband). Finally the French government refused to carry out the financial clauses of the treaty of Fontainebleau, so that Napoleon was in danger of being reduced to penury.

The Hundred Days.—All these considerations drove Napoleon to action. Decisive as ever, he returned to France like a thunderbolt: on March 1, 1815, he landed in the Gulf of Juan with a detachment of his guard. As he crossed the Alps, the republican peasants rallied round him, and at Laffrey, near Grenoble, he captivated the soldiers dispatched to arrest him. Thenceforward "the eagle flew from steeple to steeple until it reached the towers of Notre Dame." On March 20 he was in Paris.

Napoleon was brought back to power rather as one who embodied the spirit of the Revolution than as the emperor who had fallen a year before. To maintain himself and to rally the mass of Frenchmen to his cause he should have allied himself steadfastly with the Jacobins; but this he did not dare. Unable to escape from the *bourgeoisie* whose preponderance he himself had assured and who feared above all else a revival of the socialist experiments of 1793 and 1794, he could only set up a political regime scarcely distinguishable from that of Louis XVIII. Enthusiasm ebbed fast, and the Napoleonic adventure seemed a dead end. When the *Acte additionnel* which modified the imperial constitution was submitted to a plebiscite, only about 1,500,000 citizens voted—a small majority.

Napoleon mustered an army to oppose the allied troops massing on the frontiers. With it he marched into Belgium and defeated the Prussians at Ligny on June 16, 1815. Two days later, at Waterloo, he met the British under Wellington, the victor of the Peninsular War. A savage battle followed. Napoleon was in sight of victory when the Prussians under Blücher arrived to reinforce the British. "Victory changed sides" and soon, despite the heroism of the Old Guard, Napoleon was overthrown. (*See* WATERLOO CAMPAIGN.)

The Second Abdication.—Back in Paris, Napoleon was forced to abdicate by the legislative chambers: he did so, in favour of his son, Napoleon II, on June 22, 1815. On July 3 he was at Rochefort, intending to take ship for the United States, but a British squadron prevented any French vessel from leaving the port. Napoleon then decided to appeal to the British government for protection. Capt. F. L. Maitland, in command of the "Bellerophon," one of the blockading ships, told him that his request might be granted; and on July 13, Napoleon wrote his famous letter to the British prince regent (later George IV):

> Royal Highness,
> A prey to the factions which divide my country and to the hostility of the greatest powers of Europe, I have ended my political career, and I am going, like Themistocles, to seat myself at the hearth of the British people. I put myself under the protection of its laws, which I ask from Your Royal Highness, as from the most powerful, the most constant, and the most generous of my enemies.

Having apprised Maitland of his decision on July 14, Napoleon boarded the "Bellerophon" in the morning of July 15, 1815. The allies were agreed on one point: Napoleon was not to go back to Elba. Nor did they like the idea of his going off to America. It would have suited them if he had fallen a victim to the "white terror" or if Louis XVIII had had him summarily tried and executed. Great Britain had no choice but to send him to detention in a far-off island. On July 30, 1815, the British government announced that General Bonaparte could not be allowed to retain the means of disturbing the peace of the continent again; that the island of St. Helena had been chosen for his residence; and that its position would allow him to be treated with much greater indulgence than would be possible elsewhere, in view of the precautions that had to be taken to guard his person. Napoleon protested eloquently: "I appeal to history!"

ST. HELENA, 1815–21

When the "Bellerophon" reached Plymouth, Napoleon was transferred to the "Northumberland," which on Aug. 10, 1815, set sail for St. Helena. Meanwhile, France was paying heavily for the escapade of the Hundred Days. The second treaty of Paris (Nov. 1815) deprived the French of some frontier districts which had belonged to them even before the Revolutionary Wars, as well as of the part of Savoy which had been left to France in 1814. A "white terror" more violent than ever was let loose throughout the country, and the counterrevolutionaries came to power, where they were to remain for 15 years.

On Sunday, Oct. 15, 1815, the "Northumberland" dropped anchor off St. Helena. Napoleon disembarked with those followers who were voluntarily accompanying him into captivity: Gen. Bertrand, grand marshal of the palace, and his wife; the comte de Montholon, aide-de-camp, and his wife; Gen. Gourgaud; Las Cases, the former chamberlain; and several servants, including the valet Louis Marchand. They were all settled in The Briars, the property of an Englishman, William Balcombe, since the great house of Longwood was not yet ready for them. On Dec. 10, however, they moved to Longwood, though work on the house was still to go on throughout Napoleon's captivity.

Napoleon settled down to a life of routine. He got up late, breakfasting about 10 A.M., but seldom went out. He was free to go anywhere on the island so long as he was accompanied by an English officer, but he soon refused to comply with this condition and so shut himself up in the grounds of Longwood. He wrote and talked much. At first Las Cases acted as his secretary, compiling what was later to be the *Mémorial de Sainte-Hélène* (first published in 1823). From 7 to 8 P.M. Napoleon had dinner, after which a part of the evening was spent in reading aloud—Napoleon liked to hear the classics. Then they played cards, a favourite game being "reversis." About midnight Napoleon went to bed. Some of his time was devoted to learning English, and he eventually took to reading English newspapers; but he also had a large number of French books sent from Europe, which he read attentively and annotated.

St. Helena has a healthful climate, and Napoleon's food was good, carefully prepared and plentiful. The deterioration of his health in exile must have been due, in part at least, to inactivity. The man who for 20 years had played so great a role in the world and who had marched north, south, east and west across Europe could hardly be expected to endure the monotony of existence on a little island, aggravated by the reclusion that he had voluntarily imposed on himself. He had also more intimate reasons for unhappiness: Marie Louise sent no word to him, and he may have learned of her liaison with the Austrian officer appointed to watch over her, Graf A. A. von Neipperg (whom she eventually married in secret without waiting for Napoleon's death); nor did he have any news of his son, the former king of Rome, who was now living in Vienna with the title of duke of Reichstadt. Finally, though the severity of Sir Hudson Lowe has been much exaggerated, it is certain that this "jailer," who arrived as governor of St. Helena in April 1816, did nothing to make Napoleon's life easier. Napoleon from the start disliked him as the former commander of the Corsican rangers, a band of volunteers recruited by the British in the recent wars and largely composed of enemies of the Bonaparte

family. Obsessed by his responsibilities and always anxious to carry out his instructions exactly, Lowe came into conflict with Las Cases, whom he saw as Napoleon's confidant, as early as Nov. 1816: he had him arrested and expelled. Thenceforward relations between the governor and Napoleon were limited strictly to those stipulated by the regulations.

Napoleon showed the first signs of illness at the end of 1817; he seems to have had an ulcer or a cancer of the stomach. The Irish doctor Barry O'Meara, having asked in vain for a change in the conditions under which Napoleon lived, was dismissed; so also was his successor John Stokoe, who was likewise thought to be well-disposed toward Napoleon. The undistinguished Corsican doctor who took their place, C. F. Antommarchi, prescribed a treatment that could do nothing to cure his patient. It is uncertain, however, whether Napoleon's disease was curable at all, even by 20th-century methods.

From the beginning of 1821 the illness became rapidly worse. From March, Napoleon was confined to bed. In April he dictated his last will: "I wish my ashes to rest on the banks of the Seine, in the midst of that French people which I have loved so much. . . . I die before my time, killed by the English oligarchy and its hired assassins." On May 5 he spoke a few coherent phrases: "My God . . . The French nation . . . my son . . . head of the army. . . ." He died at 5:49 P.M. on that day, not yet 52 years old. His body was dressed in his favourite uniform, that of the Chasseurs de la Garde, covered by the gray overcoat that he had worn at Marengo. The funeral was conducted simply, but with due propriety, in the Rupert valley where Napoleon had sometimes walked, beside a stream in which two willows were reflected. The stone covering his tomb bore no name, only the words *"Ci-gît"* ("Here lies").

THE NAPOLEONIC LEGEND

Napoleon's fall had set loose a torrent of hostile books designed to sully the great man's reputation. One of the least violent of these was Chateaubriand's pamphlet *De Buonaparte, des Bourbons, et de la nécessité de se rallier à nos princes légitimes* (1814). But this literature soon died down, while the task of defending

GIRAUDON, PARIS

TOMB OF NAPOLEON, HOTEL DES INVALIDES, PARIS

Napoleon was taken up. Byron had published his "Ode to Napoleon Buonaparte" as early as 1814; Heine wrote his ballad "Die Grenadiere"; and in 1817 Stendhal began his *Vie de Napoléon.* At the same time the emperor's most faithful supporters were working together, talking about him and distributing reminders of him, engravings, etc. They idealized his life ("What a novel my life is!" he himself had said) and began to create the Napoleonic legend.

As soon as the emperor was dead, the legend grew rapidly. Memoirs, notes and narratives by those who had followed him into exile contributed substantially to it. In 1822 Dr. O'Meara, in London, published *Napoleon in Exile, or A Voice from Saint Helena;* in 1823 Montholon and Gourgaud began to publish the *Mémoires pour servir à l'histoire de France sous Napoléon, écrits à Sainte-Hélène,* while Las Cases, in his famous *Mémorial,* presented the emperor as a republican opposed to war who had fought only when Europe forced him to fight in defense of freedom; and in 1825 Antommarchi published his *Derniers momens de Napoléon.* Thereafter the number of books in Napoleon's honour increased continually; the year 1827 saw Victor Hugo's "Ode à la Colonne," the completion of A. J. F. Fain's series of recollections of the years 1812–14, the 28 volumes of the *Victoires et conquêtes des Français,* Walter Scott's *Life of Napoleon Buonaparte* and the first volume of J. Marquet de Montbreton de Norvins' *Histoire de Napoléon.* Neither police action nor prosecutions could prevent books, pictures and objects reminiscent of the imperial saga from multiplying in France.

After the July revolution (1830), when thousands of tricolor flags had appeared in windows, Louis Philippe's government had not only to tolerate the growth of the legend but even to promote it: in 1833 the statue of Napoleon was put back on the top of the column in the Place Vendôme in Paris; and in 1840 the king's son François, prince de Joinville, was sent in a warship to fetch the emperor's remains from St. Helena to the banks of the Seine in accordance with his last wishes. A magnificent funeral was held in Paris on Dec. 14, 1840, and Napoleon's body was conveyed, through the Arc de Triomphe in the Place de l'Étoile, to entombment under the dome of the Invalides.

Napoleon's nephew Louis Napoléon (*see* NAPOLEON III) exploited the legend in order to seize power in France. Though his attempts at Strasbourg in 1836 and at Boulogne in 1840 were failures, it was chiefly thanks to the growth of the legend that he won election to the presidency of the second republic, with an overwhelming majority, in 1848 and was able to carry out the *coup d'état* of Dec. 2, 1851, and to make himself emperor in 1852.

The disastrous end of the second empire in 1870 damaged the Napoleonic legend and gave rise to a new anti-Napoleonic literature, best represented by Hippolyte Taine's *Origines de la France contemporaine* (1876–94). World Wars I and II, however, together with the experience of the 20th-century dictatorships, made it possible to judge Napoleon more fairly. Any comparison with Stalin or Hitler, for instance, can only be to Napoleon's advantage. He was tolerant; he released the Jews from the ghettoes; and he showed respect for human life. Brought up on the *Encyclopédie* and on the writings of the *philosophes* of the Enlightenment, he was always above all, as has already been said, a man of the 18th century, the last of the "enlightened despots."

Conclusions.—One of the gravest accusations made against Napoleon is that he was the "Corsican ogre" who sacrificed millions of men to his ambition. Precise calculations show that the Napoleonic Wars of 1804–15 cost France itself about 500,000 men; *i.e.,* about one-sixtieth of the population. The loss of these young men, furthermore, seems to have had a notably adverse effect on the birth rate.

The social structure of France changed little under the empire. It remained roughly what the Revolution had made it: a great mass of peasants (75%), half of them being the working owners of their farms or sharecroppers, the other half having too little land for their own subsistence and hiring themselves out as labourers. Industry, stimulated by the war and the continental system, made remarkable progress in northern and eastern France, whence exports could be sent to central Europe; but it declined in

the south and west because of the closing of the Mediterranean and the Atlantic. The great migrations from rural areas toward industry in the towns began only after 1815. The nobility, hard hit by the Revolution, would probably have declined more swiftly if Napoleon had not restored it; but it could never recover its former privileges, and its attempt to reassert itself politically after 1815 came to nothing.

Above all, Napoleon left durable institutions, the "granite masses" on which modern France has been built up: the administrative system of the prefects, the Code Napoléon, the judicial system, the Banque de France and the financial organization, the university and the military academies. He made a lasting mark on the history of France—and of the world.

See also references under "Napoleon I" in the Index.

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NAPOLEON II: *see* REICHSTADT, NAPOLÉON FRANÇOIS JOSEPH CHARLES, DUKE OF.

NAPOLEON III (1808–1873), emperor of the French from 1852 to 1870, was born in Paris on April 20, 1808, the third son of the emperor Napoleon I's brother Louis Bonaparte, king of Holland from 1806 to 1810, and his wife Hortense de Beauharnais (*see* BONAPARTE; HORTENSE; the doubts cast on his paternity have never been substantiated). He was originally named Charles Louis Napoléon, the form LOUIS NAPOLEON coming into use after the death in 1831 of his brother Napoléon Louis (his parents' eldest son, Napoléon Charles, had died in 1807). His youth was largely spent in exile, since on the downfall of Napoleon I in 1815 all the Bonapartes had to flee from France; and he was brought up by his mother in Germany, Switzerland and Italy. His education was rather unsystematic and fragmentary: he attended the *Gymnasium* at Augsburg for a time (where he is said to have ranked fourth in a class of 94); he received private tutoring first from the abbé Bertrand and then from Philippe Le Bas, the son of a Jacobin regicide; and finally he was given military training in the Swiss army. His earliest ambition was to be a soldier like his uncle, but later he turned increasingly to politics, for which he had real gifts. As early as Dec. 1830 he was plotting a revolution in Rome that was to have proclaimed the duke of Reichstadt, Napoleon I's only son, as king of Rome and himself as regent. In 1831 he took part in the rising in Umbria directed against the tyranny and obscurantism of the papal government; his hope of "liberating Italy" dates from his earliest years.

The Napoleonic Propaganda, Strasbourg and Boulogne.—The death of his brother in 1831 and that of the duke of Reichstadt in 1832 made Louis Napoleon heir to his uncle's claims, since neither his father nor his uncles Joseph and Lucien wished to pursue them. Henceforth he gave all his energies to winning the throne of France, with a solid persistence and a faith in his destiny that defied all adversity, including mockery by his family for his vain ambitions. His prospects were actually not at all hopeless. He had first of all the advantage of the growing "Napoleonic legend," which was obtaining an increasing hold on French minds. Napoleon I's tyranny was being forgotten or glossed over as the memory of it grew dimmer, and instead his "glory," which contrasted so strikingly with the timidity and dullness of the *bourgeois* monarchy of Louis Philippe, was lauded nostalgically. Louis Napoleon moreover was an able propagandist, who saw clearly where his strength lay. In his pamphlet *Rêveries politiques* (1832) he declared that only an emperor could give France the desired glory, though he took care to point out, in the constitution which he outlined, that his aim would be to combine this glory with liberty. In 1836 he published a *Manuel d'artillerie*, which he distributed widely in the hope of drawing attention to himself and of proving that his military knowledge fitted him for the role of restorer of the empire. His multivolume work on the history of artillery (written with Col. Ildefonse Favé) was published during the years 1846–71.

The characteristic that distinguishes Louis Napoleon's early propaganda from his later work is his interest in and concentration on the army. He hoped at first to achieve his aims by a military *coup d'état*. On Oct. 30, 1836, accordingly, at 6 A.M., he presented himself before the garrison of Strasbourg in Napoleonic uniform

and invited the 4th artillery regiment, whose colonel (Claude Nicolas Vaudrey) he had previously won over, to follow him and revive the empire. He was acclaimed with shouts of *Vive l'Empereur*, but other portions of the garrison hesitated, some troops suspected that the revolt was a hoax, and within two hours Louis Napoleon was arrested. The king, Louis Philippe, anxious to conceal the fact that he had a rival, silently deported him to the United States without trial or fuss.

Louis Napoleon returned to Europe almost at once, in the spring of 1837, and resumed his plotting in Switzerland. Expelled from there as a result of pressure by the French government, he went to England. In London he became well-known as a man of fashion and formed a wide acquaintance in social and political circles: everywhere he struck people by the confidence with which he asserted that he would one day be emperor of France. In 1839 he brought out a booklet, *Des idées napoléoniennes* or *The Napoleonic Idea*, published in both French and English, in which he described his aims and political ambitions once more, though now in fuller detail. The Napoleonic idea was, he declared, the system which reconciled liberty and order, the conquests of the Revolution with the requirements of order, the principle of equality with that of a hierarchy based upon merit. Only a Napoleonic emperor, he declared, could provide a government strong enough for military achievement, for drastic social reforms and for economic improvements and yet rule according to the wishes of the people. He laid particular stress on his determination to be not a tyrant but the founder of liberty in France.

The broadening appeal of Louis Napoleon's propaganda can be seen in his looking beyond the army; but he still seemed to place his hopes on a military *coup d'état;* and in 1840, the year of the return of Napoleon I's "ashes" to France, he made one last attempt. On Aug. 6 he landed near Boulogne with about 50 followers and appealed to the garrison to rise in rebellion behind him. He was rebuffed and, together with all his party, arrested. This time he was brought to trial; and, as might be expected, he used the opportunity to advertise his claims: "I stand before you," he declared, "as the representative of a principle, a cause, a defeat. The principle is the sovereignty of the people; the cause is that of the empire; the defeat is Waterloo." Few could equal his gift for inventing striking formulas and he made some stir; but he was all the same sentenced to life imprisonment. He was incarcerated in the 13th-century fortress of Ham, but was nevertheless leniently treated; he was allowed servants and visitors and an uncensored correspondence and so could maintain his morale. He undertook studies designed to fit him for his throne; and he continued his propaganda. The most notable piece that he published in this period was an essay on *L'Extinction du paupérisme* (1844) which gave him some reputation in left-wing and working-class circles. He refused an offer of release conditional on his renouncing his political ambitions; but instead, on May 26, 1846, escaped dramatically from his prison disguised as a labourer.

The Presidency of the Second Republic.—Back in London, Louis Napoleon appears to have realized the importance of winning popular support; and so when the revolution of 1848 offered him new opportunities in France, he waited patiently for that support to mount. His friends (without his consent) put him up as a candidate for the national assembly, and in June he was triumphantly elected in four *départements;* but with masterly restraint he resigned his seat and waited till the tide should mount still higher in his favour. In the election of Sept. 1848 he was victorious in five *départements:* this time he took his seat, but was careful to refrain from revealing his grandiose ambitions and stressed his loyalty to the republic.

It was only at the end of the year 1848, when the parties in power had lost much of their credit and had shown aptitude only for squabbling among themselves and none for effecting improvements in the lot of the ordinary man, that Louis Napoleon stood for the presidency. The magic of his name gave him an overwhelming victory in the elections of Dec. 1848: he won 5,434,226 votes against Louis Eugène Cavaignac's 1,448,107, and A. A. Ledru-Rollin's 370,119. It will be noticed that his opponents were republicans; the royalists had decided to back him. It is usually stated that they did so because they thought him an easy tool, who would prepare the way for a royalist restoration when they were ready for it: but this is only partly true. Most of them backed him because they saw that he was bound to win, being the only candidate who was known to the peasants. Nevertheless, Louis Napoleon did come into office as an ally of the conservatives; he still had no political party of his own; and ministries and parliament continued therefore to be monopolized by men hostile to his ambitions.

The republican constitution made Louis Napoleon president for four years and did not allow him to be re-elected. He tried to arrange a revision of the constitution to enable him to remain for ten years; but though the royalists, split between Legitimists and Orleanists, could not agree among themselves on a king to replace him, they grew increasingly frightened by his rising prestige and power and refused to extend his term of office. Had they been willing to compromise, he might have been content with the presidency and perhaps never have become emperor. As it was, the hostility between him and the royalists mounted. Foreseeing a trial of strength, president and parliament each worked to win control of the army, and in the political sphere the president sought to gain a march over parliament by posing as the champion of the underdog. He demanded that parliament restore the vote to the 3,000,000 electors of the poorer classes whom it had disfranchised and thus increased his popularity. Finally, when it was clear that there was deadlock between them, Louis Napoleon on Dec. 2, 1851, declared parliament dissolved, arrested its principal leaders and about 20,000 of his enemies in a most efficiently executed *coup d'état* and appealed to the nation. In the plebiscite of Dec. 20 he was voted dictatorial powers for ten years by nearly 7,500,000 votes, with fewer than 650,000 votes cast against him.

The Second Empire Inaugurated.—In Nov. 1852 the president held another plebiscite and was elected emperor of the French; and on Dec. 2, 1852, he assumed the title of Napoleon III (Napoleon II was Napoleon I's son, technically assumed to have reigned in 1815). In Jan. 1853 he married the beautiful Spanish countess Eugénie (*q.v.*) de Montijo. Thus was inaugurated the brilliant and tragic period known as the second empire.

Foreign Policy.—When Napoleon III was preparing the ground for his assumption of the imperial dignity he declared that "the empire meant peace"; and to a certain extent this was not simply designed to lull the fears of Europe but expressed a genuine hope. His ambition in foreign affairs was to make his country a great power once more, on the same level as 50 years earlier, when France had been the champion of oppressed peoples and the redresser of European wrongs. It was one of his fundamental beliefs that the principle of nationalities was the most powerful driving force in 19th-century Europe, inexorable as well as just, and he wished to lead the powers in redrawing the map of the continent in accordance with it. In this way he would at the same time wipe out the memory of Waterloo and the humiliations imposed by the Congress of Vienna and peacefully extend the influence of France, for he was confident that the new states which he hoped to call into being (Poland, Italy, Germany, Rumania, Mexico) would be, as it were, satellites of their benefactor. In his long period of exile he had studied Napoleon I's career with the purpose of discovering what it was that ruined that great man; and one of his explanations was that Napoleon I had fought Great Britain. Napoleon III determined to avoid repeating this mistake; and his personal inclinations in any case urged him to ally himself with Great Britain, the leading liberal power, against the tyrannies of Austria and Russia. It is certain that he had no wish to renew his uncle's long and ruinous wars: he would try to achieve what Napoleon I had failed to do but he would seek to do it peacefully by political cunning, persuasion and alliances. He was not simply a French nationalist, but a genuinely altruistic idealist: there is no question of his projecting territorial conquests for France by aggressive war, but he did hope that his good services to the world would not go unrewarded and that the new map of Europe would be made to "balance" by an extension of French territory on the eastern borders as "compensation." The view (which some German historians have argued) that Napoleon III pursued France's traditional

policy of seeking conquests on the Rhine is unsubstantiated. On the contrary, he pursued a policy that was in many ways a departure from French traditions, and this undoubted fact played its part in bringing about his downfall.

It was probably his hesitation between idealism and self-interest that made Napoleon III's foreign policy almost uniformly unsuccessful. None of his projects ever worked out quite as he planned it and nearly all left him entangled in knots for which he had only himself to blame. The Crimean War (*q.v.*) of 1854–56 was his first and only entirely successful adventure. In conjunction with Great Britain, his favourite ally, he halted Russian expansion toward the Mediterranean (which some say he wished to make his special sphere of influence), paved the way for Rumanian independence and in one stroke appeared to win both clerical and liberal applause, for he both defended the Holy Places and destroyed the might of tsarist Russia. The Congress of Paris (1856), at which the peace terms were agreed, seemed to restore France to the leading position in Europe.

The emperor's success was short-lived. When he turned to the task of liberating Italy he met the first really serious difficulties of his reign, difficulties that were soon to multiply. He hoped that he could find a solution to the Italian problem which would be universally acceptable but he failed to please anyone entirely. On April 24, 1859, he declared war on Austria (after a carefully hatched secret intrigue with Cavour, prime minister of Sardinia-Piedmont, designed to make Austria technically the aggressor). His aim was to expel Austria from Italy and to establish an Italian confederation of four states under the presidency of Pope Pius IX. However, no sooner had he won a few victories than, horrified by the bloodshed (which he now saw for the first time) and frightened by Prussian military preparations on the Rhine, he suddenly signed preliminaries of peace with Austria at Villafranca in July. The Italian national movement slipped entirely out of his control and he eventually found himself confronted with a united Italian monarchy very different from the weak federation that he had planned. This new Italy was dissatisfied because neither Rome nor Venice was included; the pope and the French clericals were alienated because Napoleon had allowed the annexation of the papal states to the kingdom; and finally, when Napoleon received Nice and Savoy from Sardinia-Piedmont as a reward for his assistance, he lost the goodwill of Great Britain (*see* ITALIAN INDEPENDENCE, WARS OF; ITALY: *History*).

His grandiose plans for a new "Latin empire" in Mexico under the Austrian archduke Maximilian involved Napoleon in still further difficulties (1862–67): the invasion of the country proved much harder than he had foreseen; when it was at length accomplished the hostility of the United States compelled him to withdraw (1866–67); and finally Maximilian was executed by the Mexicans and his whole regime overthrown.

In Germany likewise Napoleon involved himself in humiliating contradictions. He personally favoured some unification of Germany, as he favoured unification of Italy, and he was consequently benevolently neutral when Prussia declared war on Austria in 1866 (*see* SEVEN WEEKS' WAR). He hoped that these two powers would exhaust themselves in a long struggle and that he would then be able to intervene as mediator and impose a settlement. Prussia's rapid victories found him so unprepared that (as had already happened in Italy) he found himself quite unable to keep up with events. He feebly asked Prussia for "compensations" on the Rhine, only to be rebuffed; and so began the hostility that was to culminate in the Franco-German War.

Napoleon's foreign policy is thus one of repeated disappointments, but also one which was primarily responsible for the reshaping of Europe on nationalistic lines. It should not be forgotten too that it was he who annexed Cochin China to France (1862) and so laid the basis of his country's subsequent expansion and empire in the far east; and that he so stimulated French naval development in the new fields of steam-propelled and ironclad ships that Great Britain's traditional supremacy on the seas seemed for a time to be seriously challenged. He was lucky here in having able advisers—the marquis Justin de Chasseloup-Laubat, minister of the navy and colonies, and Stanislas Dupuy de Lôme, the naval architect—who played really decisive and useful roles. He failed to use his foreign ministers so successfully: he repeatedly changed them, acted behind their backs and thus increased the confusion of his policy.

Domestic Policy.—"The Napoleonic Idea," wrote the future emperor in his youth, "is not an idea of war, but a social, industrial, commercial, humanitarian idea." The second empire coincided with the beginnings of the industrial revolution in France, and Napoleon, inspired by Saint-Simonian doctrines, distinguished himself both from the preceding and from the succeeding regimes in working actively to assist and accelerate this change. He gave great impetus to the foundation of institutions of credit, the construction of railways, the holding of industrial exhibitions, the draining and reclamation of waste land and the extension of public works, of which the rebuilding of Paris remains a surviving monument. Inspired by the example of Great Britain, he introduced a considerable amount of free trade with the Anglo-French commercial agreement of 1860 (the "Cobden treaty") despite much opposition, in the hope that it would encourage the modernization of industry. It was under his reign and with his encouragement that the effective organization of the working class began; and in 1864 combination for strikes was made legal. Though economic circumstances were to a considerable extent independent of him, there is no doubt that he contributed to making his reign one of remarkable and almost unprecedented prosperity. It was long remembered as such; and this gave considerable strength to the Bonapartist cause after 1870. Still, Napoleon had his disappointments in this sphere too. He said "I alone have busied myself with the workers"; but the workers turned socialist all the same. The industrialists whom he sought to stimulate gave him no thanks for increasing the competition that they had to meet because of his policy of free trade. Here again his dreams of progress involved difficulties he had not foreseen.

It was in his constitutional policy that Napoleon came nearest to success. The regime that he established in 1852 was highly authoritarian: it concentrated all important powers in the emperor and gave him a free hand in appointing the ministers and officials who ran the country. The legislature, though still elected by universal suffrage, had its rights drastically curtailed: it could not initiate bills, it could amend them only to a limited extent and its debates were published in censored form. Political activity in the country was virtually brought to an end, and opposition could be expressed only indirectly under heavy disguise in literary journals. However, in the first years of the empire this dictatorial regime was probably generally popular among a majority of the people, since the disorders of the republic and the fear of anarchy and socialism had produced a reaction in favour of strong government. It has often been stated that Napoleon maintained himself in office by force: Karl Marx, for example, declared that his principles were not liberty, equality and fraternity but "cavalry, infantry and artillery." Yet the peasants, who formed the bulk of the electorate, cared little for politics and were quite happy to vote as directed by Napoleon's agents, the prefects and the mayors; in return they obtained what they wanted most, namely material prosperity and improvements in the condition of their daily lives, subsidies for their village schools, roads and railways.

This system worked well enough in the 1850s, but began to collapse in the second decade of the reign. The "red menace" of 1852 was forgotten, the opposition parties revived and found ready weapons in the mistakes and hesitations of the government. The Italian war of 1859 ended Napoleon's alliance with the Catholics, who now took the lead in opposition, and they were joined by the manufacturers incensed by the free trade treaty. Napoleon met this challenge in an interesting and original way, which speaks well for his political acumen. He believed that it is "always public opinion which wins the last victory." "March at the head of the ideas of your century," he declared, "and these ideas follow you and support you. March behind them, and they drag you after them. March against them, and they overthrow you." He determined, therefore, that he would yield to the growing demand for liberty by granting it voluntarily while he still could, so as to capture the leadership of the new trend in public opinion. On

Nov. 24, 1860, he issued a decree increasing the powers of the legislature; and after further concessions from 1867 he invited the leader of the liberal opposition in parliament, Émile Ollivier, to form a responsible ministry at the end of 1869. Thus was his dictatorship transformed into a constitutional monarchy, and on May 8, 1870, the "Liberal empire" was approved in a plebiscite by an overwhelming vote of 7,359,000.

Napoleon seemed to have given his regime a new lease of life, for he had completely disarmed the majority of the opposition by granting most of their demands. The Liberal empire has been criticized for not being a real parliamentary democracy, and many historians have claimed that it was either consciously or unconsciously a sham, whose inherent contradictions inevitably caused its rapid collapse. There are grounds however for believing that Napoleon was trying to establish not parliamentary government but a form of "representative government" with a definite doctrine behind it; and that his Liberal empire was an original and worthwhile experiment which might have succeeded had the Franco-German War not destroyed it in its infancy.

Deposition and Exile.—The international situation appeared to be very calm when suddenly on July 2, 1870, it was revealed that the Spaniards had invited a German prince, Leopold of Hohenzollern-Sigmaringen, to be their king. This was taken to be a threat to the security of France, and the king of Prussia, William I, was asked to stop the prince's candidature and then—fatal mistake—to promise that he would never allow it to be revived. His refusal, turned into an insult by Bismarck, caused the French chamber on July 15 to vote for war against Prussia, which was declared on July 19 (*see* FRANCO-GERMAN WAR). Though ill with a disease of the bladder to the point of hardly being able to move, Napoleon took command of his troops and, largely through his prolonged hesitation, was quickly defeated and surrounded at Sedan. He surrendered on Sept. 2, and the third republic was proclaimed in Paris on Sept. 4.

Napoleon III, on being released by the Germans, withdrew to England and lived in Camden Place, Chislehurst. Later, he projected a return to France, in the hope that his presence would lead to a rising for his restoration to the throne; but the preliminary operation that he underwent to cure his incapacitating disease was unsuccessful. He died at Chislehurst on Jan. 9, 1873; and the early death of his only son, Napoleon Eugène Louis, prince imperial (1856–79), deprived Bonapartism of whatever chance it had of returning victorious to France.

One of the most enigmatic and controversial rulers of the 19th century, Napoleon III was long regarded as a mere tyrant or adventurer, an impostor with good intentions, perhaps, but with none of Napoleon I's outstanding ability. Later, however, when the personal animosities aroused by his reign had died down, his political significance and achievement could be better appreciated. His writings were published in collected editions, four volumes (1854–56) and five volumes (1856–69), supplemented by his *Histoire de Jules César*, three volumes (1865–66), and by the *Oeuvres posthumes* (1873).

See also references under "Napoleon III" in the Index.

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NAPOLEON, a round game of cards (known colloquially as "nap"). Any number may play. The cards rank as at whist, and five are dealt to each player. The deal being completed, the player to the dealer's left looks at his hand and declares how many tricks he would play to win against all the rest, the usual rule being that more than one must be declared; in default of declaring he says "I pass," and the next player has a similar option of either declaring to make more tricks or passing, and so on all round. A declaration of five tricks is called "going nap." The player who declares to make most has to try to make them, and the others, but without consultation, to prevent him. The declaring hand has the first lead, and the first card he leads makes the trump suit. The players, in rotation, must follow suit if able.

If the declarer succeeds in making at least the number of tricks he stood for he wins whatever stakes are played for; if not he loses. If the player declaring nap wins he receives double stakes all round; if he loses he only pays single stakes all round. Sometimes, however, a player is allowed to go "Wellington" over "nap," and even "Blücher" over "Wellington." In these cases the caller of "Wellington" wins four times the stake and loses twice the stake, the caller of "Blücher" receives six times and loses three times the stake. Sometimes a player is allowed to declare *misère, i.e.*, no tricks. This ranks, as a declaration, between three and four, but the player pays a double stake on three, if he wins a trick, and receives a single on three if he takes none.

NAPOLEONIC WARS. An account of the wars of the European powers between 1792 and Nov. 1799, when Napoleon Bonaparte overthrew the Directory and assumed control of French affairs, will be found under FRENCH REVOLUTIONARY WARS. The present article is concerned with the warfare that continued, except during the uneasy peace of Amiens (1802–03), till Napoleon's first abdication (1814) and is arranged as follows:

When the *coup d'état* of Brumaire (Nov. 1799) brought Napoleon Bonaparte to power, the second coalition against France was beginning to break up. In Holland, a capitulation had been signed for the withdrawal of the Anglo-Russian expeditionary force; and though the Russo-Austrian forces in Italy had won a series of victories, the course of the campaign in Switzerland had reflected growing differences between Austria and Russia. Yet despite Russia's subsequent abandonment of the common cause and France's recovery of control over Holland and Switzerland, the British government paid no serious attention to Bonaparte's proposals for peace in Dec. 1799, since on the one hand the regime in France had yet to prove itself and on the other it was expected that the Austrians would make further gains.

I. THE DEFEAT OF AUSTRIA, 1800–01

Though Bonaparte had to embark on the campaigns of 1800 with inadequate forces and funds, the weaknesses of allied strategy went far to offset the disadvantages under which he laboured. Austria had decided on an equal division of its strength by maintaining armies of approximately 100,000 men in both the German and Italian theatres. Instead of reinforcing Austrian strength in northern Italy, where there was most hope of success, the British government spent its efforts in limited and isolated enterprises, among them an expedition of 6,000 men to capture Belle-Île and another of 5,000 to join the 6,000 already in Minorca. When in June these two forces were diverted to co-operate with the Austrians they arrived off the Italian coast too late to be of use.

Bonaparte's plan was to treat Italy as a secondary theatre and to seek a decisive victory in Germany. It proved impossible to increase Moreau's army of the Rhine to more than 120,000, too small a margin of superiority to guarantee the success required. Nevertheless, Bonaparte was busy with the creation of an army of reserve which was to be concentrated around Dijon and was destined to act under his command in Italy: until he had engaged this force in the south he would be able, should the need arise, to take it to Moreau's assistance. In Italy, Masséna's 30,000–40,000 outnumbered troops were to receive the Austrians in the Apennines and in Alpes-Maritimes until the army of reserve, marching to the south of the army of the Rhine, should cross the Alps, fall upon the Austrians' lines of communication, cut off their retreat from Piedmont and bring them to battle. Bonaparte had hoped that Moreau would mass the army of the Rhine in Switzerland and cross the river at Schaffhausen to turn the Austrian left in strength and obtain a decisive victory before dispatching some of his army to join the force descending on the rear of the Austrians in Italy. Moreau, however, preferred to think in terms of crossing the Rhine at intervals over a distance of 60 mi. and encountering the Austrians before he had concentrated his own forces.

1. The Marengo Campaign.—Moreau did not begin his offensive until April 25, 1800, when Bonaparte was issuing the preliminary orders for the crossing of the Alps by the army of reserve. The urgency of the situation in the south, where Masséna was besieged in Genoa on April 21 and L. G. Suchet had fallen back to the line of the Var, made it necessary to send the army of reserve, now en route for Geneva, over a pass further to the west than had been originally intended. An ill-provisioned force of 35,000 men and 40 cannon began the passage of the Great St. Bernard on the night of May 14–15 and completed it on May 25. Moreau, who had been asked to send 25,000 men via the St. Gotthard, released 15,000, but only 10,000 of them joined Bonaparte's army on June 1, a day before the French occupied Milan and its extensive magazines. When Masséna surrendered Genoa on June 4 and sent his forces to join Suchet's, Bonaparte's presence in the rear of the Austrians had robbed their success of significance. The collapse of the Austrian offensive enabled Suchet's troops to inflict serious losses in what fast became the Austrian rear as Michael Melas turned to meet the army of reserve. A number of oversights in the execution of Bonaparte's fundamentally sound strategy just before the battle of Marengo on June 14 came close to causing his destruction, for they enabled Melas to concentrate 30,000 men and more than 100 guns for an attack on Bonaparte's 22,000 and 14 guns. Bonaparte had had to yield ground when Desaix, responding to a hurried summons, returned to assault the Austrian vanguard with 6,000 men and 6 or 8 cannon. F. É. Kellermann's cavalry charge against the Austrian flank completed the transformation of near defeat into a victory, but Desaix was killed. (*See* MARENGO, BATTLE OF.)

On June 15, 1800, Melas concluded a capitulation: the Austrians were to evacuate northern Italy west of the Mincio, though remaining in Tuscany and the papal Legations; they received free passage of their troops to Mantua. While Bonaparte lacked the strength in Italy to impose more stringent terms, the Holy Roman emperor Francis II contracted a fresh agreement with Great Britain on June 20. Malta, which Bonaparte had offered to the Russian emperor Paul I three months before, fell to the British in September.

2. The Danube Campaign and Hohenlinden.—Moreau's principal columns, having reached the Rhine at Strasbourg, Breisach and Basel and completed the crossing on May 1, 1800, advanced along the south bank of the Danube. On May 3, C. J. Lecourbe took Stockach, while Moreau defeated Paul Kray at Engen. After a further reverse at Messkirch, the Austrians withdrew, to reach Ulm on May 11. Having lost his advantage in numbers at this point through the dispatch of the contingent to Italy, Moreau rejected a direct attack on the strong positions at Ulm in favour of a turning movement on the right. On June 19 he forced the passage of the Danube between Höchstädt and Donauwörth, thereby compelling Kray to evacuate Ulm. The French entered Munich nine days later and had pushed Kray's demoralized army back upon the Inn before hostilities were suspended, on July 15, by the armistice of Parsdorf.

At the end of the armistice both sides had armies of approximately 100,000 between the Danube and the Tirol. While a Franco-Dutch force of 16,000 from the Main protected Moreau's left wing, 20,000 Austrians in the Tirol covered his opponent's left flank. The Austrians forestalled Moreau's impending offensive on the Inn by launching theirs on Nov. 27, 1800. Moreau withdrew to muster his dispersed forces to meet an attempt to outflank him, and in the battle of Hohenlinden (Dec. 3) the mobility of the French enabled him to rout the Austrian columns, which lost 14,000 men and 80 cannon. Many thousands more were taken prisoner in a vigorous pursuit. By the armistice of Steyr (Dec. 25) the Austrians agreed to negotiate for peace without Great Britain.

In Italy the French, in contravention of the armistice, had occupied Tuscany in Oct. 1800 on the grounds of British activity at Livorno. On the Mincio front Macdonald arrived from Chur (by a bold crossing of the Splügen pass) with 14,000 men to strengthen Brune, who then forced the crossing against the outnumbered Austrians late in December. Having abandoned the Adige (Jan. 1, 1801) and the Brenta (Jan. 11), the Austrians were ready to sign the armistice of Treviso (Jan. 15).

3. The Peace of Lunéville and the Italian Settlement.—The Franco-Austrian peace of Lunéville was signed on Feb. 9, 1801. For the most part it repeated the treaty of Campo Formio (1797). The French frontier was to be advanced to the Rhine, with the proviso that the rulers thus dispossessed should be compensated from ecclesiastical territory in Germany; compensation was also to be found for the Habsburg grand duke Ferdinand III of Tuscany, who was also to be dispossessed; and the Dutch, Helvetic, Cisalpine and Ligurian republics were recognized by Austria.

The Neapolitans, who had meanwhile invaded Tuscany, were driven back by Murat's force of 26,000; and the armistice of Foligno (Feb. 18, 1801), whereby they agreed to evacuate the papal states, was followed by the peace of Florence (March 28), whereby Naples lost little territory but undertook to exclude British and Turkish trade. In accordance with the treaty of Aranjuez of March 21, 1801, between Bonaparte and Charles IV of Spain (who in Oct. 1800 had restored Louisiana to France), Tuscany was erected into the kingdom of Etruria for Charles IV's son-in-law, Louis of Bourbon-Parma; and Parma, to which the latter renounced his claim as heir apparent, passed under French administration. Abandoned by the Austrians, Charles Emmanuel IV of Sardinia could do nothing against the continuing French occupation of Piedmont.

II. GREAT BRITAIN, FRANCE AND THE NEUTRALS, 1800–02

The British, in pursuit of their primarily maritime, colonial and commercial interests in the wars, might claim to be serving the common cause and had moreover applied their profits to subsidizing the continental armies, but had adopted means that offended neutral states and former allies alike. Through the blockade, the British could virtually dictate the terms of European sea trade: granting licences for merchant shipping to enter the ports of France and France's associates, they admitted neutrals only when there were not enough British ships to carry all the colonial produce of which they now controlled the sources. Moreover, the British maintained that a neutral flag did not cover an enemy's goods; that these might be seized when destined for a port only blockaded on paper; that iron, hemp, timber, pitch and corn were at all times contraband of war; and that neutral ships were liable to search even when under convoy.

1. The League of Armed Neutrality.—Offended by the British capture of Malta after Bonaparte had presented the island to him, the Russian emperor Paul, in Nov. 1800 placed an embargo on British ships in Russian ports; and on Dec. 16 Russia, Sweden and Denmark renewed that League of Armed Neutrality which they had first made in 1780, during the American Revolution. The Danes occupied Hamburg, which had become the main entrepôt for Anglo-German trade after the French invasion of Holland, while the Prussians, who joined the league on Dec. 18, invaded Hanover.

Germany and the Baltic had witnessed much of the expansion of British trade during the previous decade of war, British exports to Bremen and Hamburg having risen 600% between 1792 and 1800. The closing of the Baltic and of the German ports and rivers thus struck the most damaging blow at Great Britain's commerce and war economy. Furthermore, the Baltic and Germany also supplied most of the materials for British shipbuilding and were the main source of the imports of grain, supplying 5%–16% of British consumption. As the harvests of 1799 and 1800 were poor, the interruption in shipments was soon felt in a bread shortage.

The assassination of the emperor Paul (March 1801) removed the chief author of the league at a moment when its members had to reckon with British reprisals. A fleet including 18 ships of the line under Sir Hyde Parker had left Yarmouth for the Baltic on March 12; and on April 2 Nelson led a vanguard of 12 battleships and the frigates into Copenhagen harbour. The shore batteries opened fire; but, despite orders to retire and the grounding of three battleships, he continued the action till he had overcome the stubborn resistance of the vessels and hulks anchored there. The Danes agreed to an armistice and made peace on May 28; Sweden had already done so on May 18, and an Anglo-Russian convention followed on June 17. The league was thus dissolved and its forces withdrawn from Hanover, Hamburg and Lübeck; in return the British modified their maritime claims. The new Russian emperor, Alexander I, moreover gave up the demand for Malta.

2. The Anglo-Turkish Conquest of Egypt.—British sea power made possible a further success in the course of the year 1801: the defeat of the army that Bonaparte had left in Egypt in 1799. An expeditionary force of 18,000 under Sir Ralph Abercromby was landed at Aboukir (Abu Qir) in March, the Turks sent 25,000 to the theatre, 6,000 sepoys from India arrived via the Red sea, and the 13,000 French in Cairo surrendered on June 28 and the 5,000 in Alexandria on Aug. 30. Nelson's attack on the flotilla at Boulogne, however, met with failure (Aug. 15–16).

III. THE INTERVAL OF PEACE, 1802–03

Meanwhile the British economy was suffering from severe strain. Gold payments rose steeply in 1800 and 1801, for in addition to disbursing £5,600,000 in subsidies and £2,800,000 in their own military expenses in Europe during these two years, the British spent an estimated £19,000,000 on grain imports, though only once since 1793 had these last exceeded £2,000,000 per annum. The price of wheat had risen to 156*s.* per quarter by March 1, 1801. It fell to 129*s.* in June and to 75*s.* in December.

1. The Peace of Amiens.—The British government had opened negotiations with France on Feb. 21, 1801. Pitt, whose place as prime minister had been taken by Henry Addington, approved of this overture not so much because of the collapse of Austria as because of the danger presented by the League of Armed Neutrality. The preliminaries having been concluded on Oct. 1, 1801, the peace of Amiens was signed on March 27, 1802. Notwithstanding their reverses overseas, the French recovered all their colonies. The British kept Ceylon (taken from the Dutch) and Trinidad (taken from the Spaniards), but restored Minorca to Spain and Cochin, the Cape of Good Hope and the Spice islands (Moluccas) to Holland. France agreed to the evacuation of Naples and the papal states and to the return of Egypt to Turkey. The British undertook to leave Malta within three months: the island was to be handed back to the Order of St. John of Jerusalem, and until the Order could assume its government was to be garrisoned by 2,000 Neapolitan troops, with its neutrality guaranteed by the powers. It was agreed that "an adequate compensation" should be found in Germany for the prince of Orange, William V, who had lost his position in the Netherlands. Though Bonaparte had already ignored his undertaking in the treaty of Lunéville to observe the independence of the neighbouring republics, the treaty of Amiens made no reference to nonintervention in their affairs; and when later the British government complained that French troops remained in Holland and northern Italy in violation of the treaty of Lunéville, Bonaparte replied that this was the business of the signatories to that treaty and that he desired "the treaty of Amiens and nothing but that." France had asked for British recognition of the Italian republics, but in the absence of compensation for the king of Sardinia this was withheld.

2. Redispositions in Europe.—Representatives of the Cisalpine republic, summoned to Lyons at the end of 1801 to remodel their constitution, invited Bonaparte in Jan. 1802 to accept the presidency of the republic, which was henceforth to be known as the Italian republic. Similar arrangements were subsequently made in the Ligurian republic and in Lucca; and Piedmont was brought under direct French rule in Sept. 1802.

In Germany the compensation of the rulers dispossessed by the French was settled by the *Reichsdeputationshauptanschluss* of Feb. 1803. French and, to a lesser extent, Russian influence marked the negotiations by which the ecclesiastical principalities and all but six of the imperial cities were distributed among the displaced princes and the larger German states. The church in Germany lost nearly 2,500,000 subjects; Prussia gained nearly 400,000; Bavaria's losses on the left bank of the Rhine were more than compensated by the acquisition of bishoprics and imperial cities to the east; Württemberg, Baden, Hesse-Kassel and Salzburg became electorates. Austria gained some territory but was in effect weakened, since the new settlement not only left the *Reich* feebler but also lessened the emperor's voice in its affairs.

The coming of peace accelerated Bonaparte's reorganization of French institutions and overhaul of governmental machinery; and his achievement in this field provided the model for countries under French occupation during the following decade.

IV. ECONOMIC ASPECTS OF THE WARS

France had a population of 27,350,000 in 1801 as opposed to Great Britain's 10,942,146 and had gained much territory in the warfare since 1792; but a significant advance in economic strength was to enable Great Britain to wage war against this formidable adversary and to achieve the "miracles of credit" whereby foreign military assistance could be subsidized. The French, whose manufactures progressed less dramatically than the British and whose seaborne trade had been strangled, found it impossible to raise funds commensurate with their aggressive policy in Europe, so that Napoleon had to rely on the spoils of conquest to supplement the deficiencies of French finance.

Many of the figures for British overseas trade during the period represent official values based on a scale of prices current in the 1690s, regardless of market value. Useful only for comparison, the official scale shows that exports rose from £20,000,000 in 1790 to £53,500,000 in 1814, increasing by 75% between 1790 and 1801 and by 51% between 1801 and 1814. The total expendi-

ture of the British government in 1793 was £30,590,000, of which war services amounted to £10,340,000 (nearly twice the figure for peacetime); in 1814 these sums had increased to £163,790,000 and £69,070,000 respectively. The steep rise in national income made this possible both by providing immediate revenue and by supplying the funds from which investors lent to the state, whose debts rose from £230,000,000 at the beginning of 1793 to £507,000,000 in 1802 and to £900,000,000 in 1815. For the period as a whole, 35% of the addition to the country's expenditure caused by the war was met from current revenue, and between 1802 and 1813 the proportion of total net governmental income derived from borrowing was never more than 54.7%.

Great Britain had superior banking services, could suspend payments in gold at home and raise heavy loans and was preponderant in the European money market. France by contrast was financially hampered by a national economy and financial machinery ill-constituted to produce government credit, by the virtual impossibility of inflating the metallic currency and by potential investors' lack of confidence in the regime. The deliberate obscurity of Napoleon's budgetary system makes it difficult to ascertain the exact state of government finances. Among the privy funds that he amassed were (1) the *trésor de l'armée*, formed by Austrian and Prussian war contributions and estimated to have furnished 743,000,000 francs between 1805 and 1810; and (2) the *domaine extraordinaire* of Jan. 1810, largely composed of the territories which Napoleon had retained in the satellite states. These hidden sources of income met some part of French expenditure, and foreign states made further contributions of money as well as troops and supplies, but the disparity between French and British financial resources remains clear. In 1813, when French expenditure was in the region of £40,000,000, the British government was able to borrow £105,000,000 of the £174,000,000 that it spent.

Napoleon's economic ideas owed much to the outmoded mercantilist school. He hoped to destroy Great Britain's capacity to make war by closing the European markets to British trade. Yet when at last he was in a position to do so the military strength whereby he had enforced his will on Europe was so strained that the continental powers could break the boycott prematurely and resume hostilities against his widely dispersed armies.

Imported grain provided no more than 5% of Great Britain's consumption in normal years and is estimated never to have exceeded 16%, though in such periods as 1800–01 and 1811–12 home production of grain fell short of normal demand by 40%. There is no evidence that Napoleon ever considered withholding grain from Great Britain in an attempt to force withdrawal from the war: when he did suspend shipments, as in 1811–12, it was because grain was scarce in Europe. At other times his mercantilist views led him to export French grain to Great Britain, provided that France received cash, not goods, in return.

For the mercantile marine France had had more than 2,000 ships employed in European and colonial trade by 1792 but possessed only 200 ships of 200 tons or more by 1800, while British strength rose by one-third in ten years to number 19,772 vessels (2,037,000 tons) in 1802 and was to reach 21,869 ships (2,447,831 tons) in 1815. Maritime supremacy enabled the British to dominate the colonial reexport trade (coffee, tea, sugar, spices, cotton and dyes) to the great advantage of their national economy.

V. FRENCH AND BRITISH ARMED FORCES

1. Napoleon's Army and Method of Warfare.—In France the law of 10 Fructidor year VI (Sept. 5, 1798), had replaced the levies of the Revolution by a regular method of conscription which, with a few modifications, remained in force until 1815. Of the 5,692,164 men belonging to the 18 classes affected by this law, 2,716,567 were called up and 2,022,201 actually incorporated in the army. Troops levied in the 12 years 1800–11, of whom slightly more than 75% came from areas French in 1792, accounted for no more than 50% of those mobilized between 1798 and 1815.

Between the peace of Lunéville and the campaign of 1805 Napoleon formed the best of the armies that he was to lead: approximately half of its effectives had already seen active service; and there had been ample opportunity to absorb recruits into it and to accustom it to maneuvers en masse. No changes were made in tactics or battle formation (the infantry continued to use the *règlement* of 1791): it was by the overall organization of his army and the direction of its movements that Napoleon brought a new form to warfare with the campaign in 1805, in which for the first time 200,000 men employed in divisions and corps were coordinated to a single purpose under one leader. In 1800 the practice had been adopted of forming groups of several divisions under the command of a senior general, but it was with the formation of the *armée des Côtes*, or Coastal army, on the Channel coast that Napoleon introduced the army corps as the definitive basis of army organization. Each corps was given a separate staff and administrative services and was composed ordinarily of three infantry divisions and a division of light cavalry. Separate from the army corps was the cavalry reserve of two divisions of cuirassiers (heavy cavalry) and three or four divisions of dragoons, each with a mobile battery of horse artillery.

The organization of an appropriate general staff, transport, artillery and rear services was also undertaken. Napoleon's possession of a general staff, however, did not imply the circumstances associated with the term in later usage. Its chief, Berthier, and the rest of its personnel were required not to think or to act independently but to communicate effectively between Napoleon and his corps commanders. There was no real training for staff work, and the staff officers were chosen haphazardly, as Napoleon reserved the control of a campaign to himself (though he allowed his corps commanders much freedom in the execution of his orders). He was content to employ largely second-rate men who were not always adequate to the parts allotted to them under his supervision and who were to show still more serious deficiencies when they became theatre commanders.

Since he lacked the means to provide for more systematic methods, Napoleon's campaigns had to yield prompt and decisive results. The virtual abandonment of traditional lines of communication in favour of an independent "line of operations" directed against the enemy army and based on a convenient centre for immediate rear services, together with the reduction of supply trains to a minimum, conferred great strategic benefits so long as victory was soon obtained. The system, however, was not amenable to prolonged campaigning or to the conduct of a successful retreat, in which the army would quickly exhaust its supplies, since its customary measures of pillage and forced requisition were less efficient than the more normal organized raising of supplies for payment. Nor could the system be easily applied in comparatively unproductive areas or over great distances: perfected in western Europe and in northern Italy, it was far less practicable in the east.

Napoleon did not prescribe the infantry formations to be used by his corps commanders, whose varying combinations were often ineffective and wasteful of manpower, especially in the frontal attacks that he favoured in his later battles. He made no attempt of any consequence to introduce the two-rank firing that the British used to such advantage against opponents whose ranks were at least three deep. He put great emphasis on his cavalry, which screened the movements of army corps, intervened at crucial moments in battle and conducted the vigorous pursuits so profitable after a victorious engagement. With a remarkable grasp of the strategic implications of a situation, Napoleon was preeminent in disposing his army corps to discover the whereabouts of enemy forces, to head them off from retreat, to obstruct their concentration and to bring them to battle. Mobility and the careful dispersal of semi-independent army corps so as to control an extensive area were often decisive factors in Napoleon's campaigns.

2. British Military and Naval Strength.—The British regular army had been employed predominantly in colonial warfare, for which it had been freed by calling up the militia to supplement home defense; but even so the demand for men had outrun the supply of volunteers, and in July 1799 the government had begun paying a bounty to militiamen who would volunteer for service with the regular army. The strength of the latter was reduced to 95,800 after the peace of Amiens. Inevitably the British attached primary importance to their navy. In 1803, whereas the

French had 23 ships of the line and 25 frigates and could call upon the Dutch republic's 15 capital ships (of which, however, only 5 were in commission), the British had 34 ships of the line and 86 frigates in service and 77 of the line and 49 frigates in reserve; and at the close of the war the British had 240 ships of the line and 317 frigates against the French 103 and 55.

VI. THE THIRD AND FOURTH COALITIONS, 1803–07

1. The British Rupture of the Peace.—Among the causes of the rupture of the peace of Amiens was Napoleon's refusal to make a trade treaty with Great Britain. Excluded from France and the countries under French control, the British merchants and manufacturers found peace no more profitable than war. The British government, having shown its good faith by abolishing the wartime income tax and by considerably reducing naval and military expenditure, found ample pretexts for dissatisfaction in Napoleon's uncompromising treatment of the dependent territories; and the provocative report by Gen. H. F. B. Sébastiani, published in the *Moniteur* of Jan. 30, 1803, which declared that 6,000 men could reconquer Egypt, gave fresh cause for dispute. Claiming that the treaty of Amiens was not being carried out, Addington's government decided to retain Malta in defiance of the treaty, thus supplying the technical *casus belli*. To obtain an initial advantage, Great Britain declared war on May 18, 1803.

The French thereupon occupied Hanover and Naples, closing Hamburg and Bremen to British trade but failing to occupy Sicily. Both Hanover and Naples, together with Holland, were charged with the support of their French garrisons, 78,000 strong. The French treasury drew on the revenues of northern Italy, received yearly subsidies of 84,000,000 francs from Spain and Portugal and obtained $11,250,000 outright from the sale of Louisiana to the United States in May 1803. Spanish subsidies to France led Great Britain in Oct. 1804 to seize bullion ships en route for Spain, thus provoking the hostilities which lasted until 1808.

At the end of 1803 Napoleon gave the title *armée d'Angleterre*, or army of England, to his forces assembled around Boulogne. Later, when he had successfully turned this army against the continental powers, he could claim that such had been his original purpose. He had, however, made extensive preparations for the invasion of England, and the army maintained on the Channel coast numbered more than 100,000. At first he envisaged a crossing of the Channel en masse, to be completed before British naval forces had time to intervene against his lightly armed invasion craft; but it soon became apparent that there could be no question of getting the invasion fleet to sea quickly enough for that. The Channel therefore had first to be cleared of British warships, and Napoleon prescribed a policy for the French fleet which he hoped would draw British naval strength away from home waters.

2. The Formation of the Third Coalition.—Napoleon seems not to have felt apprehensive at the prospect of a third coalition against France, for he pursued courses which could only encourage its formation. In June 1804, shortly after Pitt had replaced Addington, the British government, which had been considering the terms on which to seek an alliance with Russia and Sweden, received proposals for an Anglo-Russian agreement. Austria could at first respond to Russian overtures only by accepting the promise (Nov. 1804) of Russian help against a French attack; Sweden signed an alliance with Great Britain in Dec. 1804 and with Russia early in 1805; but it was not until April 11, 1805, that Great Britain and Russia provisionally concluded a treaty envisaging a European league to compel France to evacuate Italy and Hanover, to restore independence to Holland and Switzerland and to reinstate the king of Sardinia in Piedmont. The British offered an annual subsidy of £1,250,000 for every 100,000 troops that their allies employed in the field.

The French empire had been proclaimed in May 1804 and Napoleon had been crowned emperor in December. He had next accepted the transformation of the Italian republic into the kingdom of Italy, with himself as king, in March 1805; and soon afterward Liguria was annexed to the French empire. The Holy Roman emperor Francis II, who in view of the diminution of Habsburg influence in Germany had already assumed the additional style of emperor of Austria, as Francis I, in Aug. 1804, was now so much affronted by Napoleon's actions in Italy that on Aug. 9, 1805, he adhered to the Anglo-Russian alliance, which had been finally ratified on July 28.

Napoleon was not without support against this coalition: Bavaria (which joined France on Aug. 25, 1805), Baden (Sept. 5) and Württemberg (Oct. 5) were normally opposed to Austria, and their desire to absorb adjacent Habsburg domains encouraged them to range themselves with France. Moreover, Prussia's neutrality favoured the French by blocking the route that a Russo-Swedish force, accompanied by a British contingent, could have taken from Stralsund to attack the French in northern Germany and the Netherlands; and Prussian coolness toward the coalition later delayed the march of Russian armies to support the Austrians in Bavaria.

3. Ulm, Austerlitz and the Peace of Pressburg.—The Austrians, who had hesitated to join the coalition, now rushed into hostilities with such speed that they enabled Napoleon to deal with their main army before the Russians had come to their support. Employing heavily superior forces under the archduke Charles in northern Italy against Masséna (who was to conduct a defensive campaign on the Adige) and keeping a further 25,000 under the archduke John in the Tirol, they prejudiced their chance of success in the main theatre of war, Bavaria. On Sept. 8, 1805, fewer than 80,000 Austrians under Karl Mack crossed the Inn, whereupon the much smaller Bavarian army withdrew safely northward to Würzburg. Though Napoleon had begun to move 176,000 men toward central Europe in the last days of August, Mack did not even wait for the first Russian army to join him; and while respect for Prussia's neutrality delayed the arrival of the second Russian army till November, Bernadotte's Frenchmen from Hanover marched southward across Prussian Ansbach without Prussia's permission.

Napoleon's first orders had directed the French forces in Hanover on Würzburg, Marmont's corps in Holland on Mainz and the army of England, henceforth renamed the Grande Armée, on lower Alsace; but when he learned that Mack was in the Black Forest, he swung his own army to its left, reaching the Rhine in the former Palatinate and passing through Württemberg and Franconia in columns which converged on Mack's rear. Mack had grouped his forces around Ulm and awoke too late to his danger. Napoleon's forces began crossing the Danube around Donauwörth, 50 mi. downstream from Ulm, on Oct. 7, 1805. Uncertain of the Austrians' latest positions, Napoleon now extended his front along the Lech river, detaching one corps toward Munich to contain the Russians should they appear. Despite bad weather, shortage of supplies and clumsiness on the part of some of Napoleon's subordinates in the course of Mack's encirclement, the mass of Mack's army was taken prisoner at or soon after his capitulation at Ulm, concluded on Oct. 20. So vigorous was the pursuit of the escaping units of Austrians that only one division joined the Russians under Kutuzov, who reached the Inn in mid-October with fewer than 40,000 men and who now retired as Napoleon advanced. Leaving Ney to drive the archduke John from the Tirol, Napoleon entered Vienna on Nov. 13. The archduke Charles, having gained some ground on Masséna in Italy, was recalled to Austria, but came too late to defend Vienna and withdrew into Hungary.

Murat had gained the passage of the Danube near Vienna by a subterfuge, and the French continued to pursue the Russians, who fell back to Olmütz (Olomouc). Napoleon was constrained to suspend his advance at Brünn (Brno), since Kutuzov had been joined by the second Russian army. Moreover, Frederick William III of Prussia, indignant at Bernadotte's violation of Prussian neutrality, was now threatening to intervene in favour of the allies and could have settled the issue if he had promptly sent his army of 180,000 men into the struggle. Great Britain, however, had been offended at Prussia's desire to occupy Hanover and so had not offered money for Prussian or other North German forces; and British coolness, together with the influence of the pro-French party in Berlin and Napoleon's procrastination of discussions with the Prussian envoy, Christian Haugwitz, kept Prussia out of the

field while Napoleon settled accounts with Russia and Austria. In the battle of Austerlitz (*q.v.*), on Dec. 2, 1805, the allies lost approximately 26,000 of their 87,000 men and 180 guns, and the French between 7,000 and 8,000 of their 73,000 men. Francis of Austria signed an armistice with Napoleon on Dec. 6, and Alexander withdrew his broken army to Russia under a truce.

The peace treaty between France and Austria was signed at Pressburg (Bratislava) on Dec. 26, 1805. Austria had to cede Venetia, Istria and Dalmatia to Napoleon as king of Italy; Tirol, Vorarlberg and several smaller territories to Bavaria, whose elector, Maximilian Joseph, was now to be recognized as a king; and other territories to Württemberg and to Baden, which became a kingdom and a grand duchy respectively. Würzburg was ceded by Bavaria to Ferdinand of Salzburg (the former grand duke of Tuscany), who in turn ceded Salzburg to Francis of Austria.

4. Trafalgar and Italy.—The war at sea culminated in the battle of Trafalgar (*q.v.*), on Oct. 21, 1805. On Sept. 14, Napoleon had instructed Adm. de Villeneuve at Cadiz to enter the Mediterranean and to hold some of the coalition's forces in Italy by attacking Naples while the French army marched to the Danube. On Oct. 19–20, Villeneuve left harbour with 33 ships of the line, his Spanish vessels mingled with the French. Then Nelson came up with him off Cape Trafalgar, with 27 ships. The French and Spanish lost 19 ships on the day of the battle, and 4 more were captured early in November; the British lost none in the battle or in the storm which followed, sinking many of their prizes. Nelson and 448 British were killed; wounded brought their total casualties up to 1,690. French and Spanish casualties numbered about 4,400 killed, 2,500 wounded and 7,000 captured. The immediate result was to frustrate French plans for a diversion against Naples, and there could be no return to plans for an invasion of England.

The Anglo-Russian force that landed at Naples in Nov. 1805 arrived long after Napoleon had withdrawn his troops from the south to strengthen his defenses on the Mincio and too late to affect the outcome of the year's campaigns. The Neapolitans welcomed it and joined the coalition; but the French army forced the allies to withdraw to Corfu and to Sicily (though Reggio, on the mainland, remained in British hands till Feb. 17, 1808); and Napoleon's brother Joseph was proclaimed king of Naples on March 30, 1806, in place of the Bourbon Ferdinand IV (whose deposition Napoleon had announced in Dec. 1805). With the occupation of the papal states the whole of Italy was under French control.

5. Hanover and the Confederation of the Rhine.—In Vienna on Dec. 15, 1805, Napoleon and Haugwitz had drafted the treaty of Schönbrunn whereby Prussia was to enter into an offensive-defensive alliance with France, to cede Neuchâtel, Cleves and Ansbach and to acquire Hanover. The Prussian government, wishing simply to occupy Hanover till peace should have been made, did not ratify this treaty, but was soon forced, under the treaty of Paris (Feb. 15, 1806), to annex Hanover outright and to close the Prussian as well as the Hanoverian ports to British commerce. Great Britain consequently declared war on Prussia (April 21) and seized 250 Prussian ships in British harbours.

Having thus embroiled Prussia with Great Britain, Napoleon obstructed the plan for a confederation, under Prussian leadership, to include Saxony and other states of northern Germany. He set up his brother Louis, however, as king of Holland (June 1806) and then proceeded to form the Confederation of the Rhine in July, embracing Bavaria, Württemberg, Baden, Aschaffenburg, Hesse-Darmstadt, Nassau, Berg and several smaller states of western Germany, with himself as its protector. When these confederates announced that the ancient *Reich* had ceased to exist, Francis of Austria acquiesced by renouncing his title of Holy Roman emperor (Aug. 1806). Negotiations had meanwhile been proceeding between the belligerents, but Charles James Fox's ministry, which had taken office in Great Britain after Pitt's death (Jan. 1806), made no more progress with Napoleon than did the Russians.

6. The Russo-Prussian Alliance.—The hardening of anti-French feeling in Berlin put an end to an uneasy stalemate, and Russia and Prussia signed a secret defensive alliançe against France in July 1806. Napoleon, however, still discounted the notion that Prussia might go to war against him: he was preparing to honour his undertaking to withdraw French forces from Germany even when Prussia, on Aug. 9, had ordered partial mobilization. Growing tension in Prussia and the stronger tone of Russian diplomacy soon made him change his mind. On Sept. 5, 1806, a day before the Prussians opened the North Sea ports to the British, he instructed his forces in the triangle Coblenz, Constance and Passau to regroup farther north between Frankfurt and Amberg.

Prussia had chosen to go to war with France in far less favourable circumstances than those which had obtained in 1805: the French were now within easy reach of the frontier, the Austrians could no longer intervene, the Russians were behind the Vistula. Furthermore, the Prussian army had little light infantry, poor artillery and only cumbersome supply trains and had not yet adopted the divisional system. In the face of Napoleon's army corps, the Prussians took the field in three armies commanded by elderly men. The first and fundamental mistake of the Prussian high command was to come forward, instead of withdrawing to form a line along the Elbe and awaiting the arrival of the Russians.

7. The Campaign of Jena and Auerstädt.—Having won the support of the elector Frederick Augustus of Saxony, the Prussians marched into Saxon territory on Sept. 13, 1806. The news reached Paris five days later, and on Sept. 19 Napoleon ordered the concentration of the Grande Armée, by the beginning of October, along the Main as far as Bamberg and thence to the south. At Mainz on Sept. 29 he learned that the Prussians were still between Eisenach and Hildburghausen in front of the Thuringer Wald and roughly at right angles with the Main. This news suggested that he had time to enter Saxony so as to appear in the rear of their left flank. Having reached Würzburg on Oct. 2, he closed up his forces; and on Oct. 5 he gave orders for the march to the northeast: in three columns, his corps were to cross the Frankenwald and debouch on the upper Saale at Saalfeld, Schleiz and Hof. On Oct. 9 a Saxon division was attacked at Schleiz; on Oct. 10 a Prussian detachment was routed at Saalfeld; Hof was occupied without opposition. While Napoleon continued his advance toward Gera, the Prussian army under Prince Friedrich von Hohenlohe retired northward to Kahla, 20 mi. to the west of Napoleon's objective.

The engagement of Saalfeld at last convinced the Prussians that they might be cut off from the Elbe, and they decided to concentrate their forces, under King Frederick William and Charles William Ferdinand of Brunswick, at Weimar. When the French forces reached the Saale (Oct. 12, 1806), Napoleon ceased his march to the northeast and moved his forces to the left to close in on the river line. As Hohenlohe retreated from Kahla to Jena, Napoleon swung his right wing northwestward to gain the Saale and march up its right bank, while the main body of the French was directed to cross the river between Kahla and Jena and then to advance on the mass of the Prussian forces. By the evening of Oct. 12 Napoleon's main advance guard had made contact with the outposts left at Jena by Hohenlohe and Davout was at Naumburg, 20 mi. downstream, within easy reach of the roads from Weimar along the left bank of the Saale via Auerstädt and Freiburg toward the Elbe. The movements of the following day and the separate defeats of the Prussian forces on Oct. 14 are described in the articles JENA, BATTLE OF; AUERSTÄDT, BATTLE OF. The Prussians lost 22,000 killed and wounded in the two battles and 18,000 prisoners. The most famous pursuit of the Napoleonic period began on Oct. 15 and ended with the capitulation at Ratkau, near Lübeck, on Nov. 7, of Blücher's detachment. Of the Prussian army, only 15,000 men under Anton Wilhelm von Lestocq escaped to East Prussia. Together with 120,000 prisoners, vast quantities of matériel had been taken: one month's campaigning had destroyed the Prussian war machine.

The price of such defeat was severe. Pending the final settlement a war contribution of 160,000,000 fr. and extensive requisitions throughout northern Germany were exacted. Napoleon's immediate demands were for all Prussian territory west of the Elbe except Magdeburg and the Altmark, but the rapid collapse of Prus-

sia, the Russian advance into Prussian Poland (Oct. 23, 1806) and the disclosure of the Russo-Prussian alliance soon led him to offer an armistice instead of a peace treaty. On Nov. 10 he announced that he would occupy Berlin until a general settlement had been made, including the restoration by the British of the colonies seized from the French and their allies. Frederick William preferred to remain in the allied camp. Meanwhile the French had occupied Brunswick and Hesse-Kassel; and Würzburg had joined the Confederation of the Rhine in September. The peace of Posen (Poznan), between France and Saxony was concluded on Dec. 11, 1806, bringing Saxony into the Confederation of the Rhine and giving its elector, Frederick Augustus, the title of king.

8. The Winter Campaign of 1806–07: Eylau.—From Berlin the French advanced into Poland. Behind the Vistula were Lestocq's Prussians and 55,000 Russians under Bennigsen, who had occupied Warsaw and the right bank and was awaiting a further Russian army of 35,000 men under F. W. von Buxhöwden. On Nov. 28, 1806, Bennigsen abandoned Warsaw without resistance to Murat, whom Napoleon had sent ahead with Davout, followed by Lannes and Augereau. As the three remaining French corps became available, Napoleon directed Ney's and Bernadotte's toward Thorn (Torún) and Soult's between Thorn and Warsaw. At Berlin, on Nov. 19, Napoleon had informed a Polish deputation that he sympathized with their desire for the restoration of Poland; but though he was ready to recruit Polish assistance, he did not contemplate a thoroughgoing revival of the Polish state, which would have aroused further Russian enmity and Austrian opposition.

Bennigsen withdrew his forces to the Narew, principally around Pultusk, and was reinforced by Buxhöwden. On Dec. 18, 1806, Napoleon himself reached Warsaw. After some indecisive engagements between Dec. 22 and Dec. 29 he gave up all hope of an effective pursuit of the retreating Russians and ordered his army into winter quarters. The combined Russian and Prussian forces had numbered about 115,000, of whom about 20,000 had been killed, wounded and captured; the French had suffered approximately 5,000 casualties. Weather, terrain and poor communications robbed the French of their mobility and Napoleon was handicapped by the unfamiliar difficulty of feeding an army in an unfertile area whose resources the Russians had already exhausted.

Most of the French army was grouped in front of Warsaw. On the extreme left one corps was placed before Elbing (Elblag); another at Neidenburg (Nidzica) linked the force at Elbing with the mass of the army; and outposts were established along the Passarge (Pasleka), then along the Omulew and as far south as the Bug. Ney, who had been ordered to push the Prussians northward late in Dec. 1806, so exceeded his instructions that his troops had not reached winter quarters when Bennigsen advanced against the French left wing in the last days of Jan. 1807. On Jan. 25 Bernadotte concentrated his corps at Mohrungen (Morag), 8 mi. W. of the Passarge, where he repulsed the numerically superior Russian advance guard before withdrawing southward toward Osterode (Ostroda). Anxious to appear in the rear of his enemy, Napoleon marched northward along the right bank of the Alle (Lyna) with three corps. He came up with the Russians, who had retreated to the north between the Passarge and the Alle, at Göttkendorf (Gutkowo) on Feb. 3, but night fell before a battle could be fought, and by morning the Russians had decamped, abandoning their magazines on the Alle. The French continued their pursuit, and on Feb. 7 their forward troops attacked the Russian rearguard outside Eylau, occupying the town that night. The battle of Eylau was fought on the following day, Feb. 8, 1807. The Russians suffered 25,000 casualties and were able to retreat in good order; the French, having had 28,000 casualties and being unable to pursue the Russians, fell back into winter quarters along the Passarge.

9. Great Britain and the Fourth Coalition.—Though he had more than 600,000 men under arms in Europe altogether, Napoleon had barely 150,000 available for the war in East Prussia, and of those only 100,000 could be used for the decisive operations of summer 1807 (50,000 remained in Poland, protecting lines of communications and covering the 30,000 Russians disposed along the Narew). To the north, in East Prussia, there were 24,000 Prussians and 85,000 Russians by June 1807, and more Russian troops were expected. The allies, however, were not well placed to profit from the dispersal of Napoleon's forces. While Russia was handicapped by having undertaken war against Persia (1804) and Turkey (1806), Great Britain's practice of piecemeal warfare overseas precluded the dispatch of a strong expedition to help the eastern allies.

The progress of the campaign in East Prussia was obscured for the British by developments in South America. On June 27, 1806, a squadron under Sir Home Popham, with 1,600 troops, had captured Buenos Aires; and though the Spaniards had recovered the place in August the prospect of opening up new markets was so attractive to the British that a second expedition of 7,800 men under Sir John Whitelocke was sent out. Landing near Buenos Aires on June 28, 1807, it suffered such heavy losses in the assault on the city's defenses that the project had to be abandoned. Failure had also overtaken the 6,000 troops sent from Sicily to Alexandria in March and the naval squadron dispatched in February to assist the Russians by attacking Constantinople.

It was not until April 26, 1807, that Russia and Prussia concluded the convention of Bartenstein (Bartoszyce), by which they undertook to make no separate peace treaties and to free Germany and Italy. The British proposed to grant Prussia a subsidy of £1,000,000 and to send an expeditionary force to Stralsund to join 16,000 Swedes in opposing the French, who had occupied Swedish Pomerania. Sweden, however, had signed an armistice with the French on April 18, and this truce lasted till July 3. When 8,000 British troops under W. S. Cathcart disembarked at Rügen in mid-July, the Russians and Prussians, farther to the east, had already been defeated. The fourth coalition had come into being too late.

10. Friedland.—Soon after the suspension of the winter campaign, Napoleon issued orders for the siege of Danzig. The investment began on March 12, 1807, and the town was surrendered on May 26, offering a valuable base for operations. The French army had left winter quarters early in May to assemble behind the Passarge. On June 5 the Russians appeared before the French left wing. As Bennigsen's opening moves traversed the French front, Napoleon grouped his forces.

On June 8, 1807, an encounter with 10,000 Russians suggested that the mass of the Russian army was around Guttstadt (Dobre Miasto), on which Napoleon proceeded to march and where on June 9 he dislodged the Russian rearguard. The Russians retreated to Heilsberg (Lidzbark Warminski) on the Alle, where they had prepared an entrenched camp, 35 mi. S. of Königsberg and 27 mi. S. W. of Friedland. Heavy fighting took place before Heilsberg on June 10, in which the French had the advantage. Next day Napoleon brought up the rest of his forces, trusting that the threat to their lines of retreat would make the Russians withdraw—as they did late in the evening. Bennigsen crossed to the right bank of the Alle, while Napoleon, anticipating that he would soon reappear on the left bank, headed north toward Eylau to place himself between the Russians on the Alle and the Prussians in front of Königsberg. On June 13 the French were massed close to Eylau, with strong detachments pushed forward in the direction of both Königsberg and Friedland. That evening it was learned that the Russians had crossed the Alle at Friedland, which Lannes had already been instructed to occupy next day. The battle of Friedland (*q.v.*), on June 14, ended with the crushing defeat of the Russians, who suffered 25,000 casualties. Meanwhile the corps detached to keep the Prussians away from the battlefield had driven Lestocq into Königsberg, which he abandoned on June 16, withdrawing his forces to join Bennigsen at Tilsit. Napoleon reached the Niemen on June 19 and found the Russians ready for an armistice.

11. The Treaties of Tilsit.—A variety of political motives, as well as his reverses in the field, prompted Alexander to make peace; among them were his dissatisfaction with Great Britain and his belief that a French invasion of Russia would stimulate opposition to his regime. Yet Napoleon had not the means to con-

template an early invasion of Russia and had resolved, should Alexander remain in the war, to maintain his forces on the Niemen and to await the eventual reappearance of the enemy army.

Alexander was ready to accept not only peace, but an alliance with France. He hoped to acquire the greater part of Turkey's Balkan possessions, though Constantinople itself was not to fall to his share. Furthermore, an understanding with France and hostility toward Great Britain would give him the opportunity to pose as an arbiter of European affairs in common with Napoleon and to preserve Russia's Polish lands. Though Napoleon would not agree to restore Prussia's western territories in exchange for the cession of Polish provinces to Saxony and excluded Frederick William from the Franco-Russian negotiations and from the secret alliance signed at Tilsit on July 7, 1807, Russia lost nothing in the peace treaty of the same day.

The settlement between France and Prussia (July 9, 1807) furnished the spoils of the recent campaigns. Prussia was reduced to half its former population, losing all possessions west of the Elbe and almost all the territory gained in the three partitions of Poland. Danzig was to be a free city, garrisoned by the French, and Prussia was to be occupied by French forces till a heavy war indemnity had been paid. Further, Prussia agreed to close its ports to British trade and, if necessary, to join Russia and France in war against Great Britain.

The ceded territory west of the Elbe was distributed mostly between Murat's grand duchy of Berg and the new kingdom of Westphalia (created for Jérôme Bonaparte in Aug. 1807 and including also Brunswick and Hesse-Kassel); but East Frisia went to Holland, and some other lands were left at Napoleon's disposal. The bulk of the Polish provinces, with a population of 2,000,000, were made into the duchy of Warsaw for the king of Saxony, with a French garrison. Westphalia entered the Confederation of the Rhine, into which Mecklenburg and Oldenburg followed in 1808.

VII. THE CONTINENTAL SYSTEM AND THE BLOCKADE, 1807–11

Napoleon's Berlin decree of Nov. 21, 1806, had already declared that the British Isles were under blockade and that "no ship which comes directly from England or the English colonies . . . shall . . . enter any of our harbours." The secret Franco-Russian alliance of Tilsit furthered his scheme for economic warfare against Great Britain, since the co-operation of Russia should permit the complete closure of the Baltic to British shipping and hasten Austrian participation in the continental system. Alexander undertook to support France against the British if they did not consent by Nov. 1, 1807, to acknowledge the complete freedom of the seas and to return the conquests made since 1805: if they refused, France and Russia would "summon the three courts of Copenhagen, Stockholm and Lisbon to close their ports to the British and declare war."

1. The Coercion of Europe.—Soon informed of the Franco-Russian agreement, the British government tried to prevent Denmark from joining Napoleon's continental system. On July 26, 1807, Adm. James Gambier sailed for Copenhagen with a massive fleet, and his junction with W. S. Cathcart's troops, evacuated from Swedish Pomerania, enabled him to land 27,000 men near Copenhagen on Aug. 16: the Danes were offered an alliance and told that in any case they must surrender their fleet for the duration of the war. Rejection of this ultimatum led to the bombardment of Copenhagen (Sept. 2–5), and the Danes capitulated on Sept. 7. The British withdrew with 18 Danish ships of the line and many smaller vessels. Denmark signed an alliance with France on Oct. 30, 1807.

On July 19, 1807, Napoleon informed the Portuguese that they must join the continental system; ten days later he ordered the concentration around Bayonne of 20,000 troops under Junot. The Portuguese tried to placate both belligerents by proposing to refuse to confiscate British goods, but to close their ports and to go through the motions of making war on Great Britain; but neither side would accept such a policy. In mid-October the French troops set out for Portugal, marching through Spain. The Franco-Spanish convention of Fontainebleau (Oct. 27) regulated a partition of Portugal: the northwest, with Oporto, should go to the house of Bourbon-Parma in return for the cession of Etruria to France; Algarve and Alemtejo (Alentejo) were to go to Manuel de Godoy, the Spanish court's favourite; the rest was to be at Napoleon's disposition. On Nov. 30, Junot's vanguard reached Lisbon, whence the Portuguese royal family had embarked for Brazil with a British escort. On the pretext of supporting Junot in Portugal, Napoleon was organizing three more army corps for Spain.

In Italy, Tuscany (Etruria) was annexed to the French empire in pursuance of the convention of Fontainebleau; Parma was also formally incorporated into the empire; and the papal Marches were added to the kingdom of Italy in April 1808, to extend French surveillance of the Adriatic coast. Russia declared war on Great Britain on Oct. 31, 1807, and Prussia followed suit on Dec. 1, apologizing secretly to the British government for its action, as also did Austria, which had joined the continental system in October and was forced to announce a state of hostilities with Great Britain early in 1808.

Russia, having begun to mass forces on the Finnish frontier in Nov. 1807, invaded Swedish Finland, with Danish support, on Feb. 21, 1808. The British granted Sweden a subsidy of £1,200,000, but the nature of King Gustavus IV's plans made it impossible to find a basis for common military action, and the 12,000 troops under Sir John Moore, sent to Göteborg in May 1808, returned without having landed. British shipping, however, continued to supply Swedish markets and to engage in contraband trade with the other Baltic countries.

2. The Orders in Council and Napoleon's Decrees of 1807.—The British further retaliated to the Berlin decree and the Tilsit agreement by the orders in council of Nov. 11, 18 and 25 and of Dec. 18, 1807, which prescribed that any port closed to the British was to be regarded as under blockade and that, under pain of confiscation, any neutral vessel sailing to or from such ports was to put in at a British port to obtain a licence to trade with the enemy and to pay customs duties (now increased to 20%–30%) on its cargo. By taxing neutral, principally American, trade with enemy colonies, the orders favoured the interests of British merchants and planters, who had been complaining of foreign competition. As far as was practicable, the continent of Europe was to receive its commerce through Great Britain; and up to the point where British shipping capacity proved insufficient, the licence system ensured that this trade was carried in British vessels.

Since in practice the Berlin decree did not prevent neutral vessels from bringing British cargoes into French-held ports, Napoleon intensified his measures by the decree of Fontainebleau (Oct. 13, 1807) and the two decrees of Milan (Nov. 23 and Dec. 17). The decrees of Oct. 13 and Nov. 23 classed all colonial produce as British unless carrying a certificate of origin, while that of Dec. 17 declared that "all ships which had submitted to the British [orders in council] were denationalized, and good and lawful prize; and every ship sailing from or to Great Britain or any of its colonies . . . was good and lawful prize."

The effect of the French and British regulations was to leave the neutrals with the prospect of being taken as prizes at sea by the British or in port by the French. On Dec. 22, 1807, the United States imposed an embargo on belligerents adopting measures against neutral shipping, a decision which favoured France and damaged British interests, since the French conducted their trade in neutral ships. The U.S. embargo was unpopular with many sections of U.S. opinion and was not completely effective, despite further legislation in 1808 and the Enforcement act of Jan. 9, 1809; but it contributed to the crisis which overtook Great Britain in 1808.

3. The Spanish Insurrection and Erfurt (1808).—French troops had installed themselves in Burgos, Pamplona and Barcelona by the end of Feb. 1808. Murat left Burgos for Madrid on March 15, but his approach provoked riots in the capital, which led to Godoy's imprisonment and to the enforced abdication of Charles IV in favour of his son, Ferdinand VII, on March 19, four days before Murat's arrival. Charles and Ferdinand were summoned to Bayonne, where on May 10 Napoleon obliged them to resign the kingdom to his brother Joseph. Meanwhile more seri-

ous rioting in Madrid (May 2) was followed by nationalist insurrections throughout Spain. Joseph entered Madrid on July 20 but soon had to retire beyond the Ebro. For an account of the ensuing operations in Spain and Portugal, *see* PENINSULAR WAR.

From the first the war in Spain affected France's relations with the eastern powers. The Franco-Russian entente was disliked in Russian governing circles, and they felt further dissatisfaction at Napoleon's treatment of Prussia and at his proposals for the division of Turkish territories. Napoleon was now anxious to enlist Russian support to guard against Austrian and German moves while the bulk of his forces were engaged in Spain. Having concluded a convention with Prussia whereby the French were to evacuate Prussian territory except certain strong points on the Oder (Sept. 8), Napoleon on Sept. 27, 1808, met Alexander at Erfurt. His concessions failed to impress Alexander, who refused to put any effective pressure on Austria; but at least the treaty of Erfurt (Oct. 12) renewed the Tilsit alliance, and Napoleon could now expect to be free to concentrate on Spain. The Grande Armée was dissolved, two corps alone remaining in Germany under Davout.

When Napoleon, at Vitoria, on Nov. 6, 1808, took over command of the 70,000 French in Spain north of the Ebro, the only solidly constituted force opposing him was that of the 20,000 British under Sir John Moore, reinforced by 13,000 infantry disembarked at La Coruna on Oct. 26; and within a month Napoleon had occupied Madrid. Moore resolved (Dec. 6) to assist the Spanish by moving with 26,000 men against the communications of the still dispersed French forces; but on Dec. 23 he received news of a French concentration against him and next day he began his retreat. Having given up his direction of operations on Jan. 3, Napoleon left Valladolid for Paris a fortnight later, to face the danger from Austria (*see* below). His brief experience of Spanish warfare had shown him some of its difficulties, and he left Spain unsubdued, but he was not prepared to abandon his enterprise.

4. Effects of Economic Warfare.—The opening of Spain, Portugal and South America to British trade helped to offset the drop in Great Britain's exports to Europe. Whereas Great Britain's exports to northern Europe in "real" (as opposed to official) values fell from £16,600,000 in 1805 to £5,400,000 in 1808 and recovered only to £14,500,000 in 1809, sales to America outside the United States for the same years rose from £8,500,000 to £18,100,000 and to £19,800,000. Much of the increase in South American business was financed by credit, and the default of the Spanish colonies was among the causes of the economic crisis of 1811.

A parallel development in shipments to the Mediterranean offset the damage done by Jefferson's measures in North America. While shipments to the United States fell by £6,300,000 between 1805 and 1808, those to the Mediterranean grew fourfold to £6,800,000. The effect of U.S. measures against British commerce was greatly eased in 1809, for while the Non-Intercourse law of March 1809 maintained the prohibitions on trade with belligerents, it did not include the Iberian peninsula and Scandinavia, and U.S. ships were able to make their way to nonneutral ports. British exports to the United States had fallen to £5,300,000 in 1808; for 1809 they were £7,460,000.

The continental blockade, however, was already capable of creating substantial strategic difficulties for Great Britain. Imports of grain from Europe sank from 114,000 tons in 1807 to 14,000 tons in 1808, so that the price of wheat, as little as 66*s.* a quarter in 1807, averaged 94*s.* 5*d.* in 1809 and 103*s.* in 1810. It is in this context that the shortsightedness of Napoleon's determinedly mercantilist policy in selling surplus French and allied corn in 1809 and 1810 is most striking.

The effects of the blockade were keenly felt in France and the continental states as well as in Great Britain. European consumers had food enough but missed amenities such as coffee and sugar; cotton manufacturers soon found themselves cut off from their raw materials as well as from competition; and capital was lacking to create new enterprises to offset the absence of British manufactures. French ports and their merchants were hard hit, and difficulties of transportation arose from the greatly increased use of land routes for continental trade. Between 1806 and 1808, when British exports fell by approximately 13%, those of the French empire declined by 27%—to remain at the same level in 1809, when the volume of British foreign trade rose by more than 33%. French customs receipts, 60,600,000 fr. in 1807, were only 11,600,000 in 1809.

5. The French System of Licences.—To increase revenue and to dispose of surplus agricultural production, Napoleon in April 1809 issued licences as a temporary measure, permitting the export of alcohol and foodstuffs in exchange for wood, flax, iron and quinine, or cash; but the concessions were so limited that the licences taken up during the next 14 months represented only 3% of French exports for 1809.

A decree of July 25, 1810, imposed the licence system on all foreign trade; and one of Aug. 5 laid duties of 40%–50% on colonial goods. The entry of colonial goods was conditional on the export of goods of at least equivalent value. British manufactures, however, could not be brought in. Finally, the decree of Fontainebleau of Oct. 10, 1810, prescribed sentences of ten years' imprisonment and branding for the smuggling of British manufactures and up to four years for the importation of unlicensed colonial goods. All goods illegally imported were subject to confiscation; colonial produce was to be sold by the state and manufactured goods were to be publicly destroyed. These measures precipitated the crisis of 1811 on the continent.

Through the decrees of 1810 the French state, in effect, took over the contraband trade, whose costs were commuted into the new customs tariffs. Licences given under the decree of July 25 were restricted at first to trade in French ships, and the modest trade permitted could hardly offset the overall effects of the continental system. Customs receipts increased to nearly 106,000,000 fr. between Aug. 1810 and Dec. 1811. By Nov. 25, 1811, however, only 494 of the new licences had been issued to cover imports worth 27,000,000 fr. and exports worth 45,000,000; and many "exports" were dummies, later jettisoned, to warrant the landing of imports.

6. The Annexations of 1809–10.—Apart from the cessions imposed upon defeated Austria under the peace of Vienna (*see* below), Napoleon extended the frontiers of the French empire in 1809–10 in order to make his continental system more effective. On May 17, 1809, he annexed what had been left of the papal states; and on July 6 Pius VII, who had excommunicated Napoleon, was taken from Rome as a prisoner. On Jan. 3, 1810, Zeeland was annexed and the Dutch provinces between the Scheldt and the Rhine were occupied, before the outright annexation of Holland on July 9. Finally, in Dec. 1810 Napoleon annexed not only Valais but also all northwestern Germany between the Low Countries and the western Baltic, including Hamburg, Bremen, Lübeck, part of Berg, part of Westphalia, Arenberg, Salm and—least happily of all, because its ruling dynasty was closely connected with Russia—Oldenburg.

7. The Crisis of 1811.—The "real" value of Great Britain's exports and reexports, £51,100,000 in 1805 and £49,700,000 in 1808, reached £62,200,000 in 1810. For that reason the slump of 1811, when they fell to £43,900,000, was the more severely felt. Napoleon's recent measures against British commerce with the continent had contributed to this decline, but the crisis was due rather more to the effects of the war itself in encouraging the overrapid development of non-European trade and the growth of inflation. Moreover, financial instability had been increased by speculation. Thus the difficulties of 1811 were general. Though the British suffered more from the slump in trade than did their economically less-developed neighbours, the crisis overtook both Europe and the new world. Popular discontent in Great Britain was exacerbated by the rise in the cost of bread, caused partly by the poor harvests of 1809 and 1810. Economic opinion urged a return to the gold standard, but this would have depressed the economy still further and curtailed Great Britain's contribution to the war in Europe. By its determination to sustain the war, the British government did much to overcome the crisis: having spent £44,200,000 on war services and borrowed £22,500,000 in 1809, it spent £50,200,000 on the services and raised £23,500,000 in 1811

and increased its borrowings by 50% in 1812.

Both France and Great Britain relaxed their commercial measures against each other in Nov. 1811: the British allowed the export of cotton and quinine and admitted French and allied traders; the French permitted the entry of the colonial goods hitherto forbidden—cotton, sugar, coffee, tea, dyes, etc.—and granted licences for trade.

From Nov. 1810 Napoleon had relaxed the Berlin and Milan decrees in respect of U.S. shipping; and in Feb. 1811 President Madison asked the British government to revoke the orders in council. After much delay the British agreed (April 21, 1812), provided that Napoleon had freed American trade from all restrictions. This was confirmed and, finally, on June 23, 1812, the orders in council were revoked—but too late, since the United States had declared war on June 18 (*see* War of 1812). By this time, however, the British contraband trade with Germany was reviving; and after the complete opening of Swedish and Russian ports and an increase in South American trade, exports of British produce and manufactures reached £41,700,000 in 1812 (as opposed to £32,900,000 in 1811), while the volume of reexports rose by more than 50%.

VIII. AUSTRIA'S WAR OF 1809

To Austria the involvement of the French army in Spain offered an opportunity to restore the rights of the Habsburgs in Germany and Italy and to put an end to the growing fear of new French demands. Moreover, though Austria did not intend to sponsor German nationalism, the possibility of identifying the house of Habsburg and its traditions with the struggle to set central Europe free from French domination engendered a degree of exaltation in preparing for war and a kind of popular enthusiasm hitherto unprecedented. Though the reforms undertaken after 1805 had left the Austrian regime unchanged in fundamentals, while the financial condition had continued to deteriorate, the army had been considerably improved. Provision was made for the raising of reserves for regiments of the line. The Landwehr, established on June 9, 1808, was to furnish about 200,000 men, but their value was restricted to providing limited reinforcements for regular units. The military reformers adopted some measure of skirmishing tactics in 1807 and raised 23,000 light infantrymen in Sept. 1808. At the same time, the cavalry and the artillery were reorganized, so that in 1809 there were 36,000 horsemen and 760 guns in the field. A return was made to the requisition systems in order to supplement the previously cumbrous supply trains; and the corps system was adopted, but only in principle.

The threat of Russian intervention could have deterred Austria from aggression, but though Alexander was pledged to help France if Austria eventually declared war, he yet refused to coerce Austria. While they met with little enthusiasm from Great Britain and got no heavy British subsidy to defray the cost of their mobilization, the Austrians could still count on a substantial effort to distract Napoleon: the British cabinet had agreed on the necessity to intervene in Europe and was considering whether to strengthen the British forces in Portugal, to send an expedition to the Netherlands or to make a diversion in the Baltic.

News of Austrian preparations for war prompted Napoleon to return to Paris from Spain in Jan. 1809. The threat to his regime was greater than any that had emerged since 1805, and his difficulties were reflected in the high proportion of young recruits and foreign troops in the forces that he hurriedly assembled. The conscription class of 1809 had been summoned in Jan. 1808; a further draft of 20,000 had been taken from each of the classes of 1806–09 in September; and 80,000 of the class of 1810 were called up in December. German contingents furnished nearly one-third of the striking force of 174,000 which assembled on the Danube in mid-April 1809. The *garde*, recalled from Spain to stiffen the new army, had still to come up.

For the Austrians, the archduke John was to lead 47,000 against Eugène de Beauharnais in northern Italy; 10,000 were to go to the Tirol and 7,000 to Dalmatia; and 35,000, under the archduke Ferdinand, were to guard Galicia against J. A. Poniatowski's 19,000 Poles and the dangers of a popular rising. The principal effort, however, was to be along the Danube, where the archduke Charles was to have 190,000 men at his disposition. Charles had first planned to move from Bohemia to place his army between the assembling French forces and attack Davout's 60,000 troops around Regensburg on the Danube; but eventually, declining to leave Vienna uncovered, he sent the bulk of his forces via Linz to take the offensive south of the Danube. Though this course involved delay and diminished his advantage, it promised substantial success provided that he struck promptly.

1. Landshut and Eckmühl.—Launching his offensive before the French completed their concentration, Charles entered Bavaria at Braunau, on the Inn, on April 9, 1809. If he had moved quickly he might have surprised the French at Neustadt on the Danube in the middle of their concentration; but he did not reach their outposts on the Isar till April 15. With him, around Landshut, were 126,000 troops, another 49,000 having been sent up the north bank of the Danube from Passau to a position 30 mi. N. of Regensburg. Commanding in Napoleon's absence, Berthier failed to withdraw Davout from Regensburg, with the result that his forces, dangerously far apart, risked an early defeat in detail, since on April 16 Charles's forward troops had only 15 mi. to march to reach the Danube 20 mi. upstream from Regensburg. Farther up the Danube, Berthier had 33,000 troops around Ingolstadt and 16,000 between Neuburg and Donauwörth, while to the south, along the Lech as far as Augsburg, there were 20,000 under Oudinot. Masséna's force of 40,000, scattered over the area Augsburg-Ulm-Landsberg, had not completed its assembly.

Napoleon arrived at Donauwörth early on April 27, 1809, while Lefebvre's three divisions were still falling back from the Isar before Charles's columns. As the Austrians appeared to be heading northward from Landshut to Regensburg and the Danube, Napoleon formed the plan for using Davout to hold their front while Masséna came up on their rear to cut them off from Landshut. Davout left the Regensburg area to march along the right bank of the Danube in front of the enemy early on April 19: with 47,000 men, he ran no great risks unless he were attacked at once and by the mass of the enemy; and in that case there were 46,000 troops around Neustadt to come to his assistance. In the event, Charles's two eastern columns did not encounter the French as they concluded their advance, and the third, left-hand column was easily contained at Teugen by Davout's rear guard as his vanguard joined Lefebvre's forces at Abensberg. On the same day, April 19, Masséna's advance, on the French right, brought him to a point 30 mi. W. of Landshut, where Johann von Hiller was in command of the two remaining Austrian columns. Napoleon, mistaking Hiller's forces for the mass of the Austrian army, then pressed Masséna to reach the Isar and take Landshut, supposing that, if a large proportion of the Austrian forces were caught in the triangle whose apex was the Isar-Danube confluence and whose sides ran down to Regensburg and Landshut, Charles would be forced either to stand and fight or to attempt escape by crossing the Danube at Straubing or Regensburg. Lannes was given command of the centre of the French front, where he was placed to deliver a blow to the flank of the Austrians at Abensberg on April 20, as they were pushed back toward Landshut by Lefebvre and Davout. On April 21, the 40,000 Austrians around Landshut were threatened by forces of 94,000 converging from the north under Lannes and Vandamme and from the west under Masséna. Masséna however entered Landshut too late to take the Austrians in reverse, and Hiller withdrew toward the Inn. The Austrians suffered more than 9,000 casualties around Landshut and in the retreat and lost 30 cannon and much of their transport.

Regensburg capitulated to the Austrians on April 20, 1809. Reinforced by the two corps sent originally to the north of the Danube, Charles next decided to attack Davout and Lefebvre, who found themselves heavily outnumbered; but on April 22, before he could outflank Davout's left, his own left wing was attacked by Davout at Eggmühl. Napoleon's arrival on his rear compelled Charles to retreat, and during the night the Austrians crossed the Danube unpursued.

A week's operations had cost Austria 30,000 casualties and split the archduke's forces into two groups. Though both groups

were able to retire toward Vienna, north of which their reunited army numbered 130,000 by mid-May, the Austrian reverse confirmed Frederick William in his preference for keeping Prussia neutral. He had, however, thought of joining Austria; and several Prussian officers, headed by Ferdinand von Schill, started a patriotic rising of their own on April 28, 1809, in the hope of encouraging him to intervene against the French.

2. Aspern-Essling.—As Charles withdrew northward into Bohemia, Napoleon advanced on Vienna with the intention of achieving a decision before the Austrian forces in Italy and the Tirol could intervene. Thus the main French army followed Hiller toward Linz, leaving Davout and Bernadotte to observe Charles. To the south Lefebvre advanced via Munich to the Salzach and the Tirol. After a fierce engagement at Ebelsberg on the Traun (May 3, 1809) Hiller reached the Danube and the archduke's army. The French entered Vienna on May 12, but found the bridges broken and Charles's army massed on the left bank of the swollen Danube. To come to grips with the Austrians, Napoleon decided to attempt a crossing a little below Vienna, where islands split the river into smaller channels. His advance guard, sent across on the night of May 20–21, was attacked between the villages of Aspern and Essling; and after more French forces had crossed they were repulsed on May 22 with at least 20,000 casualties, the Austrians losing 23,000. This reverse, the battle of Aspern-Essling (*q.v.*), not only compromised Napoleon's immediate military situation, but lessened his standing in the eyes of Europe. The Tirolese, who had risen in favour of the Habsburgs against Bavarian rule in April but had appeared to be quelled by Lefebvre's arrival in Innsbruck on May 19, retook Innsbruck a week after Aspern-Essling and remained in the field for six more months (*see* HOFER, ANDREAS).

3. The Austrian Campaign in Poland.—In April 1809 the Russian emperor Alexander resumed his war with the Turks. For two months he made no move against Austria except to issue a belated declaration of war (May 5), though he maintained a large force on the Galician border; and when he did intervene in Galicia it was with an eye to his own interests, not to Napoleon's. The archduke Ferdinand had crossed the Pilica on April 17 to reach Warsaw on April 23; and Poniatowski retired to the right bank of the Vistula until the Russians should come up. Ferdinand next advanced down the left bank, but could not cross at Plock or at Torun. Meanwhile Poniatowski assumed the offensive up the river, taking Lublin and Sandomierz in mid-May; but the Russians, entering Galicia in early June, failed to co-operate with him. Ferdinand, returning southward, thus made good his escape.

4. The Southern Fronts.—Defeating Eugène de Beauharnais before the Tagliamento on April 16, 1809, the archduke John had driven the French back to the Adige before the news of Landshut and Eckmühl obliged him to retire. With his forces still too widely dispersed, he withdrew before Eugène across Carinthia and Styria into Hungary and arrived at Körmend on the upper Raab river on June 1. Retiring next to Raab (Győr), he was defeated there on June 14; and though he crossed the Danube next day and reached Bratislava on June 23, he rejoined the archduke Charles several hours too late to take part in the battle of Wagram, whereas Eugène had joined Napoleon beforehand. Far to the west, in Styria around Graz, Ignaz Gyulai continued till June 29 to maneuver against Marmont, who had taken the offensive against the Austrians in Croatia and had been at Laibach by June 3.

5. Wagram.—By the beginning of July 1809 Napoleon had assembled approximately 180,000 men and 488 cannon on the isle of Löbau and in its environs on the right bank of the Danube east of Vienna. On the left bank Charles had about 136,000 men and 414 guns. After a number of diversions along the river, the French army began its passage, below Essling, at 9 P.M. on July 4. Charles withdrew to a strong position six miles north of the Danube above Deutsch Wagram and Aderklaa, from which for two days he strongly resisted French attacks. On July 6, however, he was forced to retreat. In this battle of Wagram the Austrians had given a good account of themselves, while the performance of the French reflected the inferiority of their army to the veteran force that Napoleon had wasted since 1805. Charles retired northward to the Thaya (Dyje), with his forces well in hand, and the French proved slow to develop their pursuit. On July 12, after a last engagement at Znaim (Znojmo), Napoleon was willing to grant an armistice. The Austrians who had entered Saxony and put King Frederick Augustus to flight retraced their steps.

6. The Walcheren Expedition of the British.—The British had decided in May 1809 that they would intervene in the Low Countries. On July 28, an expedition of 39,200 men, the largest that had ever been sent to the continent, sailed for the Scheldt estuary, supported by a fleet of 35 ships of the line, 23 frigates and 350 transports. Its incompetent commander, the 2nd earl of Chatham (John Pitt), instead of marching directly on Antwerp, which might have fallen, wasted precious time on Walcheren Island before Flushing, which he occupied on Aug. 16. Half of his force returned to England during the first week of September, by which time almost 11,000 men had contracted fever. The rest remained to garrison Walcheren till they were taken off in December. Of the expedition's 4,044 dead, only 106 had been lost in action.

7. The Peace of Vienna (Schönbrunn).—Late in July 1809 the Russian emperor asked Napoleon for an undertaking that Poland as a whole would not be reestablished: he could countenance the transfer of much of Galicia to the duchy of Warsaw, but not any arrangement prejudicial to Russia's position in Poland. Both he and Napoleon saw how damaging to Franco-Polish relations it would be if Napoleon complied with this request; but in any case Alexander's conduct since the outbreak of war in April had already shown that Tilsit and Erfurt were to be regarded as establishing a truce rather than an alliance between France and Russia. The war party in Austria drew fresh strength from the deterioration of the Franco-Russian entente, so that the peace negotiations, which opened in the middle of August, proceeded slowly. When Napoleon finally offered part of Galicia and an assurance on Poland to Alexander, the latter on Sept. 1 told the Austrians that he was not prepared to support them in continuing the war.

The peace of Vienna, signed at Schönbrunn on Oct. 14, 1809, was a costly settlement of what had been, militarily, Austria's least unsuccessful war against Napoleon. The Innviertel and the province of Salzburg had to be ceded to Bavaria; part of Croatia, Fiume, Istria and Trieste, most of Carinthia and Carniola went to Napoleon; West Galicia (the Polish territory acquired by Austria in 1795, with Cracow and Lublin) passed to the duchy of Warsaw; and in the east the Tarnopol area was assigned to Russia. Francis of Austria thus lost 3,500,000 subjects and all his coastal possessions. Austria had also to pay an indemnity of 85,000,000 fr. and to reduce the army to 150,000 men.

IX. FRANCE AND NORTHERN EUROPE, 1809–12

Gustavus IV of Sweden abdicated in March 1809. His uncle, who succeeded him as Charles XIII, made peace with Russia by the treaty of Fredrikshamn of Sept. 17, ceding Finland. Sweden next made peace with France by the treaty of Paris of Jan. 6, 1810, and joined the continental system (officially at least). When Bernadotte was chosen heir to the Swedish crown (*see* CHARLES XIV John), Napoleon obtained a declaration of war by Sweden against Great Britain (Nov. 17). This had no effect, and Bernadotte soon told Alexander that he would remain independent of French influence and loyal to the treaty of Fredrikshamn.

Franco-Russian relations were exacerbated early in 1810 when Napoleon's betrothal to the Austrian archduchess Marie Louise was announced before Alexander had declared his mother's refusal of Napoleon's overtures for a marriage alliance with the Russian imperial family. If the suggestion had been unwelcome, the denouement was slighting, and the growth of French influence in Vienna increased Alexander's impatience of French tutelage. The difficulties occasioned to Russia by the continental system, together with Napoleon's own example in permitting relaxation of his commercial measures where French interests were involved, prompted Alexander to issue the ukase of Dec. 31, 1810, forbidding some imports by land (whose provenance was the French empire and the satellite states) and doubling the duty on some French merchan-

dise, and to open his ports to neutral shipping and British goods. Before this, Napoleon had taken the unmistakably hostile course of annexing Oldenburg. Thenceforward France and Russia both prepared for war.

Early in 1811 Napoleon had only the 50,000 troops of the duchy of Warsaw and the 45,000 French garrisoned in Germany to protect his eastern frontier. The Russians could soon put 240,000 men in the field, and Alexander concluded that if the Poles would join him, together with the 50,000 Prussians who could, he believed, then also join him without risk, he "could advance to the Oder without striking a blow." This plan was dropped when the Poles refused to change sides despite Alexander's offer to reconstitute Poland; but Napoleon remained on the alert in the spring of 1811, and by Aug. 16 he was discussing the general plan of a Russian campaign to begin in June 1812.

In Dec. 1811 Napoleon secured Austria's informal agreement to furnish 30,000 men for his campaign against Russia; and by a treaty of Feb. 24, 1812, Frederick William of Prussia, to the dismay of Prussian patriots, consented to the occupation of his country by the Grande Armée on its way to Russia and undertook to provide supplies and materials to it (the cost to be set against the balance of the Tilsit indemnity) and also to send and maintain at full strength a contingent of 20,000 men. Both Austria and Prussia, however, informed Alexander that they would make no serious effort in the forthcoming campaign.

Napoleon offended Bernadotte by opposing the latter's plan for the annexation of Norway to Sweden and by occupying Swedish Pomerania (Jan. 1812) in reprisal for Sweden's failure to exclude colonial goods. Bernadotte therefore sought alliance with Russia; and by the agreement of April 5–9, 1812, it was arranged that the Swedes should invade Germany when the French were deeply enough engaged in Russia and that the Russians should later help the Swedes to annex Norway. On May 28 Russia made peace with Turkey.

X. THE RUSSIAN CAMPAIGN, 1812

For the campaign of 1812 Napoleon summoned the largest army that Europe had ever seen. He also made unprecedented efforts to assemble supplies and transport, but these preparations were quite insufficient for an advance with such disproportionate forces far into Russia. He wrongly supposed that the campaign would be ended within 30 days. Late in February the various elements of the Grande Armée set out on the long journeys which were to bring them to the frontier along Niemen in June.

1. The Invasion of Russia.—The main French army began to cross the Niemen into Russia on June 24, 1812. The total invading force then numbered approximately 453,000; but about 612,000 were to enter Russia during the campaign, and little more than 200,000 of them were French. The non-French contingents were destined for employment in secondary tasks; the spearhead of the invasion force was composed of French troops. Napoleon divided his forces into armies, commanding the principal one himself and providing two auxiliary armies to protect the flanks and rear of his striking force. With him on the Niemen were 227,000 men; next on his right Eugène led 80,000; on the right wing at Grodno were Jérôme with 76,000 and, beyond him, K. P. Schwarzenberg's Austrian contingent of nearly 30,000, charged with the observation of the southernmost of the dispersed Russian forces; and on the extreme French left were Macdonald and Yorck with the Prusso-Polish force of 40,000.

Behind the Niemen the Russian commander Barclay de Tolly's army numbered 118,000. Bagration commanded approximately 35,000 and several thousand Cossacks behind the Bug, while A. P. Tormasov, who was observing Schwarzenberg, led about 40,000. In the north P. Kh. Wittgenstein was advancing westward with 25,000 to defend the Dvina. For reserves, the Russians could call on recruits under training and Cossack and militia formations; but as these were not at once available the Russian command decided to retreat before Napoleon's greatly superior forces.

A forced march brought the French to Vilna on June 28, 1812, but by then Barclay had moved toward the fortified camp of Drissa on the Dvina; and Bagration, against whom Jérôme was making a lengthy march from the south in difficult conditions, avoided Davout's attempt to cut his line of retreat by a thrust through Minsk with two divisions and was able to cross the Dnieper (July 25). Barclay meanwhile had abandoned Drissa and withdrawn first to Vitebsk (July 23), then to Smolensk, where Bagration joined him on Aug. 3, bringing their combined forces to 110,000.

Napoleon, whose march from Vilna to Vitebsk had failed to separate the two Russian armies, now turned southeastward, crossing the Dnieper in the night of Aug. 13–14, 1812. On Aug. 14 an engagement at Krasnoe (Krasny) left Barclay in no doubt of his intentions. The French appeared, 180,000 strong, before Smolensk on Aug. 16 and, despite the resistance of Barclay's rear guard, entered the suburbs next day. Early on Aug. 18 the Russians withdrew, having destroyed the bridges and fired the town; and though their rear guard was defeated by Ney and Murat at Valutina on Aug. 19, the mass of their army eluded pursuit. The French lost nearly 15,000 killed and wounded in the actions of Aug. 16–19.

Meanwhile on Aug. 17, 1812, Gouvion-Saint-Cyr replaced Oudinot on Napoleon's left flank and defeated Wittgenstein at Polotsk. A few days later Schwarzenberg won a success at Gorodechno; but though the French extreme left flank in this sector had been able to contain Tormasov, P. V. Chichagov's approach from the south threatened to double the Russian numbers there. Napoleon halted at Smolensk till Aug. 25, summoning Victor's corps to Smolensk to protect his lines of communication and ordering Augereau's from Germany to Vilna.

Prolonged and rapid marching and commissariat problems, not combat, had already taken heavy toll of Napoleon's strength. If the failure of the transport columns to supply the marching troops reduced the effectiveness of the infantry, the cavalry, so essential to his methods of warfare, were particularly vulnerable: forage was lacking for the 300,000 horses, and disease and excessive work increased their death rate.

Fruitful though Barclay's cautious methods had been, he was replaced by the veteran Kutuzov on Aug. 17, 1812. The new commander was determined to fight a major battle before abandoning Moscow. The French arrived before his positions around the village of Borodino on Sept. 5. The next day was spent in concentrating the army, reconnaissance and preparations; and the inconclusive battle of Borodino (*q.v.*) was fought on Sept. 7. The Russians fell back southeastward to the Nara river, and Napoleon entered Moscow with 95,000 men on Sept. 14. That night the city was fired, partly at least by the Russians themselves.

2. The Retreat from Moscow.—The Russians refused to come to terms; and both military and political dangers could be foreseen if the French were to winter in Moscow. After waiting for a month, Napoleon began his retreat, his army now 110,000 strong, on Oct. 19, 1812. His first intention was to retire via Kaluga and thus to make a long detour through more fertile and unexhausted territory before regaining Smolensk, but after the successful combat of Maloyaroslavets (Oct. 24), where he found Kutuzov in his path, he decided to return by the direct route.

At Vyazma, on Nov. 12, 1812, Napoleon's forces had already fallen to 55,000 men. It was not until Nov. 6 that the first snowstorm overtook the army, to be followed by alternate thaws and frosts till early December, when bitter cold set in. Thus the large majority of Napoleon's losses occurred before the first snowfall. On leaving Smolensk, which had been ravaged in August and was now virtually destitute of supplies, the French found Kutuzov threatening their path at Krasnoe. Kutuzov however declined to bring on a general engagement, and in the intermittent fighting that ensued (Nov. 15–17) the main French forces secured their retreat. Ney, trapped with the rear guard on Nov. 18, was able to escape, with heavy losses, only by crossing the unreliable ice on the Dnieper.

The Grande Armée now numbered 8,000 combatants and 40,000 stragglers. Victor's corps, 15,000 men, who had gone northwestward from Smolensk, and Oudinot's, fewer still, rejoined the army west of Orsha; in their rear Wittgenstein had crossed the Dvina. The French approached the Berezina only to learn that the vital bridge at Borisov had been captured by Chichagov, whom Schwarzenberg had failed to pursue on his march from the south. Ou-

dinot's corps took Borisov, but the Russians burned the bridge before they withdrew. During the night of Nov. 25–26, 1812, two bridges were constructed upstream at Studyanka while a feint to the south distracted the Russians' attention. Oudinot's 7,000 men crossed on Nov. 26, the main body of the army next day. On Nov. 28 the rear guard under Victor held off Wittgenstein's attacks along the east bank while Chichagov's assaults on the west bank were contained by the rest of the army. At 9 A.M. on Nov. 29 Victor's men fired the bridges. From Smorgoni the French continued their march, now in extreme cold, to Vilna (Dec. 9) and thence to Kovno, where a few broken thousands crossed the Niemen to find refuge at Königsberg. A further 40,000 men in isolated detachments subsequently made their way to the Vistula. From the north, Macdonald's corps retired with 16,000 men; in the south, Schwarzenberg and J. L. E. Reynier fell back to the Bug with 40,000. The exhausted Russians, their own forces reduced to 40,000, suspended their advance at the Vistula. Their casualties had also been extremely high: fewer than 30% of the troops who began the pursuit at Maloyaroslavets reached Vilna.

When the remnant of his army was 60 mi. E. of Vilna, on Dec. 5, 1812, Napoleon had handed the command over to Murat and had hastened on ahead in order to reach Paris before the news of his disaster. It is estimated that of the 612,000 combatants who entered Russia only 112,000 returned to the frontier: 100,000 are thought to have been killed in action, 200,000 to have died from other causes, 50,000 to have been left sick in hospitals, 50,000 to have deserted and 100,000 to have been taken as prisoners of war. The French themselves lost 70,000 in action and 120,000 wounded, as against the non-French contingents' 30,000 and 60,000. Russian casualties have been set at 200,000 killed, 50,000 dispersed or deserting and 150,000 wounded.

The dissolution of the Grande Armée meant that the French army could no longer absorb new recruits into well-established formations. Nor could it find trained men and horses on a scale to replace the magnificent cavalry arm destroyed in Russia.

XI. THE CAMPAIGN OF 1813

It was not immediately certain that the Russians would carry the war into Germany. Alexander, however, intended to exploit his new opportunities and resolved to continue his advance. Napoleon hoped, mistakenly, that Austria and Prussia would send reinforcements to assist Murat in maintaining a front until he himself returned with a new army.

1. Prussia's Change of Side.—Prussian resistance to Napoleon was precipitated by the initiative of Yorck, commander of the Prussian contingent under Macdonald. Instead of marching as Macdonald's rear guard, Yorck chose to sign his own convention of neutrality with the Russians at Tauroggen on Dec. 30, 1812, which allowed them to occupy the Prussian territory between Königsberg and Memel so that Macdonald had to continue his retreat to Danzig. On the other wing of the French front, Schwarzenberg signed an armistice on Jan. 30, 1813, and withdrew southward with his Austrian troops, exposing Reynier's corps in its retreat to the Oder. The Poles offered no resistance to the Russian advance, which stood at the Niemen on Jan. 13, reached the Vistula on Jan. 18 and gained Warsaw on Feb. 7.

King Frederick William's first reaction to Yorck's convention of Tauroggen was to declare it the act of "an insubordinate soldier." Gaining confidence, however, he decided to join the patriotic advocates of resistance to France and to capture a leading role in the German War of Liberation. Meanwhile, the exiled statesman Karl vom und zum Stein, whom Frederick William had dismissed from the Prussian government in 1808 and who was known as a spokesman of the anti-French movement in Germany, was installed by the Russians as provisional governor in Königsberg, where the estates of East Prussia met to call for the formation of a Landwehr. Frederick William agreed on Feb. 3 to an appeal for volunteers; and within another week he had abolished exemption from military service.

After negotiation and the use of some pressure on Frederick William, Alexander concluded an alliance with him at Kalisz on Feb. 28, 1813, by which he undertook not to make peace until the kingdom of Prussia had been restored to an area and population equivalent to what it had had before Tilsit, though almost all the territory gained in the second and third partitions of Poland was to be renounced. On March 16 Prussia declared war on Napoleon; and on March 19 Alexander and Frederick William issued a proclamation declaring the Confederation of the Rhine to be dissolved and summoning its rulers to change sides or forfeit their states.

Prussian support was essential to Alexander's plans, since the Russian field army numbered only 64,000 at the end of March 1813, whereas Prussia had 61,500 ready for campaign, 28,000 in garrison and 32,000 in Pomerania and in East Prussia and would have the Landwehr available for service in August. The practical results of Prussian enthusiasm for the German national movement in 1813 have been subject to some exaggeration: it furnished 22,000 volunteers between March and May, while the Landwehr contributed more than 120,000 men, to supply half of the Prussian effectives in the autumn campaign.

Eugène, who had replaced Murat in command of the French forces on Jan. 16, 1813, retreated from Poznan on Feb. 12 and paused only briefly on the Oder (Feb. 18–22) before falling back on Berlin. On March 4, he withdrew from Berlin to defend the line of the upper Elbe, exposing Hamburg, which was captured by Russian cavalry on March 18, and abandoning Dresden, the Saxon capital, where Blücher and his Prussians arrived on March 27.

In April 1813 the British offered subsidies to Frederick William on condition that Hanover, which Prussia had undertaken to forgo, was enlarged and that Prussia would agree with Russia not to make peace without Great Britain's consent. Acceding to the Russo-Swedish agreement of 1812, the British not only assigned Norway to Bernadotte (treaty of Stockholm, March 3, 1813), but allotted him Guadeloupe into the bargain and £1,000,000 toward the cost of the contingent of 24,000 with which he landed in Pomerania on May 18.

2. The Austrian Attempt at Mediation.—Austria was the least prepared of the major European powers for immediate hostilities against France. Metternich distrusted Alexander's designs in Poland and in the Turkish states and was reluctant to assist the aggrandisement of Prussia. On the other hand alliance with France would leave Austria to the mercy of the allies if Napoleon were defeated but would not ensure adequate recompense if he won. In April 1813 Metternich asked Napoleon to agree to the return of Illyria, to the partition of the duchy of Warsaw and to the dissolution of the Confederation of the Rhine, informing him that Austria was about to take up armed mediation and would intervene against the side which failed to agree with its proposals. Austria had guaranteed the integrity of the kingdom of Saxony, and on April 26 King Frederick Augustus undertook to join forces with Austria in the event of war. Metternich was also seeking support from Bavaria, whose loyalty to France was uncertain.

3. The New French Army.—Though the Austrian field army was to number 194,000 by Aug. 1813, only one-third of that number was available during the early months of the year. Napoleon's new levies, hastily raised on his return from Russia, lacked training and experience; and though cannon, muskets, munitions and wagons were found, he had few horses, so that there were only 7,000–8,000 cavalrymen fit to campaign by April 1813. In Sept. 1812 a levy of 137,000 men had been made from the class of 1813; and on Jan. 11, 1813, Napoleon called up the class of 1814 in a contingent of 150,000 men and raised a further 100,000 from the classes of 1809–12. Instead of winding up his Spanish affairs, he withdrew 27,000 troops from the peninsula, leaving more than 150,000 in Spain. In Jan. 1813 the incorporation into the active army of 22 regiments of the *premier ban* of the *garde nationale* provided about 85,000 men for the line. In April he mobilized another 90,000 men of the 1814 class and a further 80,000 of the classes of 1807–12 serving with the *garde nationale*. When he left Paris for the front on April 15 the Russian army in Germany numbered 110,000 men, of whom 30,000 were cavalry, and the Prussian 80,000 men; against them, Napoleon had 226,000 troops and 457 guns.

4. Lützen (Gross-Görschen) and Bautzen.—Napoleon had divided his forces into two armies: the army of the Main under his own command; and the army of the Elbe led by Eugène. In the

last days of April 1813 Napoleon reached the Saale with 140,000 men, of whom only 7,500 were cavalry, and 372 guns. Napoleon proposed first to march on Leipzig, outflanking his enemy, then to turn southward to drive the allies against the Erzgebirge mountains. Late on April 30 the army of the Elbe (62,000) was around Merseburg and the army of the Main along the Saale west of Weissenfels, while the allied troops under Wittgenstein (64,000 infantry, 24,000 cavalry and 552 guns) were grouped south of Leipzig, almost at right angles to the French line of operations.

On May 1, 1813, Napoleon entered Lützen; the army of the Elbe had moved from Merseburg to Schladebach and the leading corps of the army of the Main from Weissenfels to Lützen, while the *garde* advanced to Weissenfels and the two rear corps closed up on Naumburg and Stössen. During the next day Ney was to remain at Lützen, to protect both the movement of the army of the Elbe on Leipzig and the approach of the rearward corps of his own army of the Main as they came up to Lützen. Ney disposed his troops rather carelessly and failed to reckon sufficiently with the danger of an allied attack. Wittgenstein was thus prompted to attempt to detach the flank guard under Ney, split the enemy forces and drive the army of the Elbe back upon the Elster river.

On May 2, 1813, the allies opened their cannonade at Gross-Görschen near Kaja, taking Ney's corps by surprise as Napoleon was superintending the attack on Leipzig. Napoleon ordered his troops to concentrate at Kaja instead of continuing their approach to Leipzig (now in French hands) and reestablished his front while waiting for Bertrand to intervene on the allied left flank and for Macdonald to cut the enemy's retreat to the Elster. Both came slowly to the battlefield and the struggle ended at nightfall. Covered by his numerous cavalry, which prevented pursuit, Wittgenstein retired in good order. The French had purchased their inconclusive victory at a cost of about 20,000 killed, wounded and captured; the allies had lost 12,000. However, the retreat of the allies caused Frederick Augustus of Saxony to abandon them, and his army now joined the French.

On May 3, 1813, Ney was instructed to move northeastward on Torgau and Wittenberg while the army of the Elbe followed the allied retreat on Dresden. From Dresden the Russians continued their retreat to the Spree, the Prussians bearing northward before rejoining their allies at Bautzen. In the north 30,000 under F. W. von Bülow were to cover Berlin. On May 8 Napoleon entered Dresden, where he spent over a week in reorganizing his forces and establishing a base of operations against the main allied army and Berlin. Eugène was sent to Italy and the armies of the Main and Elbe were divided between Napoleon and Ney.

On May 18, 1813, Napoleon set out for Bautzen to seek a decisive battle. Having first ordered Ney to send two of his corps toward Berlin, he subsequently countermanded this order and summoned all Ney's forces to Bautzen, but the new instructions arrived too late to ensure the necessary concentration of strength. The allies had assembled 96,000 men on the Spree around Bautzen; and Napoleon was determined to engage them by a preliminary attack on May 20—to be completed when Ney should arrive from the north next day to attack their flank and rear, cutting their lines of communication and pushing them toward the Erzgebirge. On May 20 the preliminary attack was successful; but on May 21 Ney, who reached Preititz with more than 40,000 in hand, allowed himself to be drawn into an inconclusive encounter with the allies' right wing. The restricted extent of Ney's outflanking movement and the heavy superiority of their cavalry allowed the allies to escape once more when they began their retreat eastward at 4 P.M. French casualties were about 20,000 men, the allies' half as many.

Having crossed the Katzbach on May 26, 1813, the allies turned southward with the intention of safeguarding Silesia. On June 1 they reached Schweidnitz (Swidnica) and the French occupied Breslau. In the north, Davout's troops had retaken Hamburg on May 30.

5. The Armistice and the Reichenbach Treaties.—Though the French had paid heavily for their partial victories, Napoleon still enjoyed a numerical advantage, and the allies were materially in poor condition; yet on June 1, 1813, he proposed an armistice which was accepted on June 4 by the Russians at Pläswitz and by the Prussians at Poischwitz and was extended subsequently from June 20 to Aug. 10 for an unrealistic discussion of peace terms at Prague. The Prussian Landwehr and the Austrian army had not yet entered the field, but the French offensive had spent its force. Napoleon had lost 25,000 more men than the allies; his army lacked ammunition and supplies and was exhausted by continual marching (the number of sick had risen to 30,000); and above all he was short of cavalry. He counted on matching the allies' increase in strength during an armistice and on putting sufficient cavalry into the field to secure a decision.

At Reichenbach (modern Pol. Dzierzoniow), in Silesia, British plenipotentiaries signed a treaty with Frederick William on June 14, 1813, and another with Alexander on June 15. It was agreed that Hanover should be restored and enlarged, that Prussia's territories should be made equivalent to those of 1806 and that the three powers should not treat separately with Napoleon. Great Britain was to provide £2,000,000 toward the support of the 240,000 men in the Russian and Prussian field armies. There followed, on June 27, a third treaty of Reichenbach, between Austria, Russia and Prussia, whereby the Austrians undertook to enter the war if Napoleon did not accept their terms. These terms, together with their allies' still more exacting demands, included the disappearance of the duchy of Warsaw, the Confederation of the Rhine and the German annexations and the surrender of Holland, Italy, Spain and Illyria. The news of Wellington's crushing victory at Vitoria, in the Peninsular War, strengthened the allies' morale considerably. By July 5 Castlereagh, the British foreign secretary, was ready to adopt the continental powers' conditions for peace, to demand Sicily for the Bourbons and to seek the allies' acknowledgement of Bernadotte's claims. The armistice ended on Aug. 10. Austria declared war two days later. The treaty of Teplitz (Sept. 9) confirmed the Austro-Russo-Prussian alliance.

6. Dispositions for the Autumn Campaign.—Despite Austria's entry into the war, Napoleon had virtually kept pace with the allies' increase in strength, for he now commanded 442,000 men of whom more than 40,000 were cavalry, excluding the 26,000 men in garrisons on the Elbe, and 1,284 guns. The Russians began the autumn campaign with 184,000, the Prussians, whose Landwehr was becoming available for service, with 162,000; the Austrians contributed 127,000, the Swedes 23,000 and the Anglo-German contingent 9,000: in all more than 500,000 men and 1,380 guns. Napoleon had only 43,000 men in reserve, however, while the allies' reserves and besieging forces numbered 143,000 without counting the 112,000 troops dispersed in fortress duty.

After considerable discussion the allies decided to divide their forces into three armies: the army of Bohemia under Schwarzenberg (accompanied by Alexander and Frederick William), consisting of 127,000 Austrians, together with 82,000 Russians and half as many Prussians; the army of Silesia under Blücher, a Russo-Prussian force of more than 100,000; and the army of the North under Bernadotte, comprising the Swedish contingent, 73,000 Prussians and a Russian detachment, in all 125,000 men. The first army would advance on Dresden up the western bank of the Elbe and the third on Wittenberg, protecting Berlin, while the second would assist either the first or the third as the course of events should demand. It was agreed that the allies should avoid battle with Napoleon and attack his subordinates.

Napoleon's autumn campaign of 1813 was the worst conceived and most disastrous of his career. He was determined to relate his strategy to the fortresses which his forces occupied, thus reducing his scope for movement; and though there were good reasons for his decision to defend the line of the Elbe, it also posed difficulties which he failed to resolve. In the first place, it required the retention of Dresden as his principal base of operations. Yet if he moved the bulk of his forces northward to join Davout from Hamburg and J. B. Girard from Magdeburg in attacking the army of the North, he would loosen his grip on the king of Saxony and allow the army of Bohemia and the army of Silesia to unite before Dresden. As he decided to concentrate against the latter two armies, Oudinot was left exposed in the north to contain Bernadotte's much superior forces. With the deduction of Davout's 40,000 at Hamburg and the garrisons along the Elbe, Napoleon

greatly reduced both his capacity to maneuver and the number of troops immediately available for the field.

7. Dresden.—Napoleon did not know that the allies had decided to increase the army of Bohemia to 250,000 men, and he resumed operations intending to stand on the defensive in the south, with his base at Dresden, till the allies should show their hand, and to seek a decision in the north, where Oudinot (with 70,000) and Davout from Hamburg would converge upon Berlin. At Bautzen, on Aug. 17, 1813, he learned that 40,000 Russians from the army of Silesia were marching to Bohemia. He proposed to deal first with Blücher and then with the armies of Bohemia and of the North. Blücher having advanced toward Löwenberg on the Bober (Lwowek Slaski on the Bobrawa), Napoleon crossed the river on Aug. 21 only to find that Blücher had retreated. Returning to Görlitz, he learned on Aug. 23 that the advance of the army of Bohemia had obliged Gouvion-Saint-Cyr to fall back on Dresden. Leaving Macdonald with 75,000 men to hold Blücher east of the Bober, Napoleon set off westward in haste, at the same time ordering Vandamme to march to Stolpen, where he intended to assemble the remainder of his forces on Aug. 25 so that they could appear en masse at Pirna in Schwarzenberg's rear. He himself arrived at Stolpen on Aug. 25; but so dangerous was the situation at Dresden that he instructed the bulk of his forces to proceed directly on the city while Vandamme continued alone to Pirna. At 10 A.M. on Aug. 26, the *garde* entered Dresden, having marched 90 mi. in 72 hours. Schwarzenberg, who had meant to launch his attack at 4 P.M., now decided to retire, but too late to prevent the beginning of the engagement. Though Napoleon led only 70,000 men against an enemy twice that number, he succeeded in pushing his opponents back before nightfall; he was joined late that night by Marmont and Victor's corps. The battle was resumed at 6 A.M. on Aug. 27, the French driving back Schwarzenberg's right and overwhelming his left. At 4 P.M. the allies withdrew in disorder, though their retreat was not heavily pressed; they had lost 10,000 men killed and wounded, more than 13,000 captured and 26 guns. The French began their pursuit early on Aug. 28, but the less effectively because Napoleon became ill and retired to Dresden. Illness and the shortcomings of his corps commanders deprived him of the full reward of his last major victory.

A succession of reverses soon destroyed the effect of Dresden. On Aug. 23, 1813, Oudinot had been defeated by Bülow at Grossbeeren, with the loss of 3,000 men, and retired behind the Elbe. On the evening of Aug. 28 news reached Dresden of Macdonald's rout by Blücher on the Katzbach (Aug. 26), in which the French had lost nearly 20,000 men and more than 100 guns. Vandamme, pressing on toward Teplitz with 38,000 men to intercept the retreating army of Bohemia, became separated from his colleagues and on Aug. 30 was surrounded at Kulm; he lost about 15,000 men in a rout that destroyed his corps as an organized force.

8. The Allies' Convergence.—Napoleon, still anxious to reach Berlin, replaced Oudinot by Ney, whom he sent to hold Bernadotte away from the Elbe. On Sept. 3, 1813, he left Dresden to rally Macdonald's army, which he led forward to Hochkirch—again to find that Blücher had ordered a retreat to the Neisse. Schwarzenberg, having approached Dresden once more (Sept. 5), retired to Teplitz when Napoleon turned south. Ney crossed the Elbe to be completely defeated at Dennewitz on Sept. 6, where he lost about 22,000 men and 53 cannon. Bernadotte, whose Swedes had been absent from both Grossbeeren and Dennewitz, continued to maneuver along the right bank of the Elbe.

At Pirna, where on Sept. 18 he had finally rejected a plan to attack the army of Bohemia, Napoleon was wrongly informed that Bernadotte had crossed the Elbe at Rosslau. Returning to Dresden on Sept. 21, he reinforced Macdonald on Aug. 22 to push Blücher on to his prepared positions near Bautzen. More false news of Bernadotte's arrival on the Elbe at Wartenburg then caused him to evacuate all areas east of the river save for the bridgeheads in French hands. Blücher now decided to join Bernadotte, who arrived before Wartenburg on Sept. 24, while Schwarzenberg's army, 180,000 strong, left the Dresden area to march on Leipzig, arriving around Chemnitz on Sept. 26. Blücher defeated Bertrand's 14,000 at Wartenburg a week later and completed his crossing of the Elbe next day (Oct. 4), when Bernadotte led 76,000 across at Rosslau, pushing Ney before him. Napoleon resolved to take advantage of the allies' deliberate advance: against them, and operating on interior lines, he disposed of 250,000 men. On Oct. 2 he sent Murat to Freiberg to take command of 45,000 men to resist Schwarzenberg's march on Leipzig. On Oct. 5 he ordered Gouvion to retain Dresden with 40,000 while he attempted to defeat Blücher and Bernadotte with the rest of his forces. Prudently, on Oct. 7 he instructed Gouvion to evacuate Dresden, but he countermanded the order on the same day. Marching 50 mi. in two days, he had assembled 150,000 men around Wurzen, east of Leipzig, on Oct. 8, with whom he proposed to attack Blücher at Düben; but Blücher, covered by the Saale, retreated to join Bernadotte's army near Halle on Oct. 10.

9. Leipzig.—Prevented by the advance of the army of Bohemia from pursuing Bernadotte and Blücher, Napoleon planned to attack it when Schwarzenberg had committed it to an engagement in the Leipzig area. On Oct. 14, 1813, he ordered his troops to Leipzig. Had Napoleon been able to concentrate his forces on that day, Schwarzenberg would have been exposed to defeat on the Elster and Pleisse rivers to the south; but early on Oct. 16 Napoleon was still waiting for Macdonald, and at 9 A.M. Schwarzenberg opened his attack on the heights of Wachau. The battle of Leipzig (*q.v.*), or Battle of the Nations, was begun. When it ended, with the French withdrawal in the early hours of Oct. 19, the allies had lost approximately 55,000 men; French killed and wounded have been estimated at 38,000 men but the total French losses were about 60,000 men, with 325 guns and enormous quantities of matériel.

Napoleon's principal forces crossed the Saale at Weissenfels on Oct. 20, 1813, and halted at Erfurt from Oct. 23 to Oct. 26. Meanwhile Bavaria had concluded an armistice with the allies on Sept. 17 and joined the coalition, by the treaty of Ried, on Oct. 8. At the end of October 30,000 Bavarians under Karl Philipp Wrede blocked Napoleon's path at Hanau; but they met with heavy defeat and lost 9,250 men. Marching via Frankfurt, the French crossed the Rhine at Mainz (Nov. 2–4), their numbers now reduced to 70,000 men and 35,000 stragglers, among whom typhus had appeared; 120,000 more remained beleaguered in the German fortresses. For the second year in succession Napoleon had lost an army.

XII. THE CAMPAIGN OF FRANCE, 1814

At Frankfurt on Nov. 9, 1813, Metternich, with the reluctant approval of Russia and Prussia, offered peace on the basis of France's "natural frontiers," the Rhine, the Alps and the Pyrenees; but he stipulated prompt acceptance, since the allies did not intend to delay operations. When Caulaincourt, Napoleon's new foreign minister, delivered his assent on Dec. 2 the allies had already withdrawn their proposal.

Castlereagh arrived in Basel on Jan. 18, 1814, prepared to offer subsidies to the value of £5,000,000 to the allies; to demand the restoration of Spain and Portugal and compensation for the Bourbons of Naples; and to abandon some of Great Britain's colonial conquests in return for the establishment of a Dutch barrier. He wanted to unite Belgium with Holland so as to block French expansion and was ready to advocate the extension of Prussia's frontiers to the west. His ability and, even more, the strength of his position permitted him to intervene between Alexander and Metternich, so as to bridge divisions growing between Russia and Prussia on the one hand and Austria on the other.

By the end of Dec. 1813 Napoleon had only 60,000 troops to defend the Rhine frontier and a further 30,000 ready for early operations, while the allies were about to invade France with their three armies: that of the North via the Low Countries; that of Silesia, still under Blücher, between Coblenz and Mannheim; and that of Bohemia, still under Schwarzenberg, via Switzerland, the Jura and Langres. In the north, Bernadotte remained to contain Davout at Hamburg, leaving 20,000 men under Bülow in Holland and 50,000 with Ferdinand von Wintzingerode around Wesel. Blücher had 50,000 men at Mainz and Schwarzenberg 180,000 around Basel.

In Italy, Eugène was to conduct a defensive campaign with 50,-

000 against 75,000 Austrians. Soult with 60,000 men strove to halt Wellington's advance with greater forces from Spain. Murat, as king of Naples, had already entered into negotiations with the Austrians and on Jan. 11, 1814, he concluded an alliance by which he was to furnish them with 30,000 men. Bernadotte's arrival in Holstein obliged Frederick VI of Denmark to cede Norway to Sweden on Jan. 14 (in exchange for an indemnity in Germany) and Heligoland to Great Britain. In mid-Nov. 1813 Lebrun evacuated Amsterdam, and rebels at The Hague demanded the return of the house of Orange to the Netherlands.

1. Brienne and La Rothière.—After crossing the Rhine on Dec. 31, 1813, Blücher crossed the Marne at St. Dizier on Jan. 25, 1814. On that date Schwarzenberg's forces stood 150,000 strong between Langres and Bar-sur-Aube, 30 mi. S.W. of Blücher's position. Napoleon meanwhile had assembled the corps of Marmont, Victor and Ney, in all 41,000 men, around Vitry-le-François, 20 mi. N.W. of St. Dizier; 20,000 more were under Mortier, in the neighbourhood of Troyes; and Macdonald and Sébastiani, with 10,000–11,000, were en route from Mézières to Ste. Menehould. Learning that Blücher was approaching the Aube with his forces dispersed, Napoleon advanced rapidly toward 25,000 of Blücher's army around St. Dizier and pursued him to Brienne. Here the French had slightly the better of the piecemeal engagement on Jan. 29, in which both sides lost about 3,000 men, but Napoleon failed to prevent Blücher's junction with Schwarzenberg's right wing.

At La Rothière 85,000 men and 200 guns commanded by Blücher attacked Napoleon's 45,000 men and 128 guns on Feb. 1, 1814. The French held out till nightfall and made their retreat along the snow-covered banks of the Aube; they had lost more than 6,000 men (of whom 2,000 were captured) and 60 guns. The allied casualties were of similar size. Next day the allies agreed at Brienne that they should separate, Blücher marching via Châlons-sur-Marne to Meaux, Schwarzenberg via Troyes toward Bar-sur-Seine and Sens. By Feb. 3 Napoleon had 70,000 men between Troyes and Arcis-sur-Aube, and Macdonald had reached Châlons.

2. Champaubert, Montmirail, Château-Thierry and Vauchamps.—Leaving about 40,000 men to contain Schwarzenberg, Napoleon marched against Blücher's left flank. On Feb. 7, 1814, he was at Nogent-sur-Seine while Macdonald was retreating on Épernay and Blücher advancing toward Paris. Having ordered Marmont to occupy Sézanne, Napoleon himself arrived late on Feb. 9, determined to stake all on a last offensive with his heavily inferior forces of 30,000 men. The day before, Blücher's main column had been extended over 44 mi., while Yorck's corps was more than 12 mi. to the north of his line of advance. At Champaubert on Feb. 10, Marmont and Ney routed one of Blücher's corps, an isolated force of 4,000 Russians, of whom only 1,600 escaped. The French now lay across Blücher's line of march, as Blücher had reached Vertus, east of Champaubert, with the rearmost troops, while his leading corps, under F. G. von der Osten-Sacken, was to the west beyond Montmirail. Leaving Marmont to observe Blücher, Napoleon took 18,000 men and hurried to Montmirail, where he defeated Osten-Sacken's 18,000 Russians on Feb. 11, before Yorck (who had been awaiting Macdonald's appearance along the Château-Thierry road) could join battle to extricate them. The allies lost nearly 4,000, the French half as many.

Pursuing Yorck's force and the remains of Osten-Sacken's to Château-Thierry (Feb. 12, 1814) the French drove them with fresh losses across the Marne, whence Mortier was instructed to press their withdrawal northward. Napoleon left Château-Thierry late on Feb. 13 to overtake the troops already sent back to support Marmont, who was trying to hold Blücher off at Vauchamps. Attacking on Feb. 14 and again that night at Étoges, as Blücher retreated, the French inflicted 6,000 casualties as against their own 600. In the four days between Champaubert and Vauchamps, Blücher's army of 56,000 had been scattered by Napoleon's 30,000 and suffered losses of more than 16,000 against 4,000 French. Blücher, however, rallied his divisions around Châlons, where by Feb. 18, his reinforced army numbered more than 50,000. Napoleon had spent himself and his troops to achieve only a postponement of defeat.

3. Schwarzenberg's Advance and Retreat.—Schwarzenberg meanwhile, finding Troyes evacuated by the French, had remained there resting his army (Feb. 7–10, 1814). He then advanced in two columns, one to the bridge over the Seine at Bray, the other toward Fontainebleau. Leaving Mortier and Marmont on Blücher's front, Napoleon set off with the *garde* on Feb. 15 to attack Schwarzenberg. Having joined Oudinot and Victor at Guignes, he issued orders at 1 A.M. on Feb. 17 for a general advance. On Feb. 18 he defeated a rearguard of 10,000 men on the north bank of the Seine opposite Montereau, capturing a vital crossing-point and 3,400 men. Pursued by the French, Schwarzenberg began to withdraw to Troyes, while Blücher marched to Méry-sur-Seine to reunite on Feb. 21 with the army of Bohemia. Schwarzenberg now abandoned his plans for a joint battle with Napoleon in his alarm at Augereau's advance with 28,000 men from the south against his communications. Yet after detaching troops to meet this threat he still had 90,000, who with Blücher's 50,000 gave the allies 140,000 with whom to oppose Napoleon's 75,000, exclusive of Mortier and Marmont's troops to the north. Declining to join Schwarzenberg in his retreat on Langres, Blücher turned north toward Reims to join Bülow and Wintzingerode. On Feb. 23 Bülow's and three Russian corps were detached from Bernadotte's command and assigned to Blücher, who now became strong enough to campaign on his own—the more easily because Schwarzenberg's movements had carried Napoleon first south and then east of the Seine.

4. The Congress of Châtillon and the Treaty of Chaumont.—On Feb. 5, 1814, the allies had opened the congress of Châtillon(-sur-Seine); and on Feb. 7 they demanded that the French should return to the frontiers of 1792. Napoleon, who after the battle of La Rothière had given Caulaincourt a free hand in his negotiations, soon rejected this demand; but on Feb. 17 negotiations were resumed with Caulaincourt. Napoleon's success at Montmirail had led him to demand the Rhine and the Alps as the frontiers of France; and the Austrians, who had sought an armistice on Feb. 17, sought one again on Feb. 24. By the treaty of Chaumont (March 9), however, thanks largely to Castlereagh's intervention, Great Britain, Russia, Austria and Prussia undertook to continue the war till France accepted the old frontiers and acknowledged the independence of the German states, Holland, Switzerland and Spain; to this end each power would maintain 150,000 men in the field and the British would pay subsidies of £5,000,000. The four powers also agreed on a 20-year defensive alliance to meet any later attempt at expansion by France.

5. The Operations on the Aisne.—At Troyes, which he reoccupied on Feb. 24, 1814, Napoleon learned of Blücher's move toward the Marne and Aisne with 60,000 men, against whom Mortier and Marmont had only 18,000. Leaving 42,000 with Macdonald and Oudinot to observe Schwarzenberg, Napoleon sent Ney, Victor and J. T. Arrighi northward to attack Blücher's rear and, on Feb. 27, went himself to Arcis-sur-Aube, whence by advancing toward Fismes, he threatened to cut off Blücher's retreat across the Aisne. Blücher therefore halted his offensive against Marmont and Mortier at the Ourcq on March 1 and withdrew northeastward to join Bülow and Wintzingerode, who were attacking Soissons. The sudden capitulation of Soissons on March 3 eased Blücher's movement and he continued his march on Laon. Safely behind the Aisne, he regrouped his army, which Bülow and Wintzingerode's reinforcements brought up to 110,000 men. Napoleon moved after him with 35,000 followed by 14,000 with Mortier and Marmont, crossing the Aisne at Berry-au-Bac. A confused and bloody encounter with Blücher's flank guard of 30,000 at Craonne on March 7 ended with Blücher's retreat to Laon, both sides having lost approximately 6,000 men. Dividing his forces into two columns, Napoleon was unsuccessful in his attack from the south on March 9; and that night Marmont's corps was surprised and broken up by the allies' cavalry, with a loss of 2,500 prisoners and 45 cannon (it was rallied only at Berry-au-Bac next day). This reverse would have been more extensive still had Blücher not fallen ill and had the Prussians not halted their pursuit. Withdrawing to Soissons, Napoleon next moved to Reims, where he fought a successful engagement against a Russian corps of 15,000.

6. The Allied Advance on Paris.—Meanwhile, Schwarzen-

berg had pushed Macdonald and Oudinot slowly before him toward Provins. Napoleon now marched from Reims to Méry-sur-Seine to attack his communications. Schwarzenberg withdrew to Troyes on the news of Napoleon's approach, and by March 19, 1814, his forces were between the Seine and the Aube. Napoleon crossed the Aube at Arcis with 16,000 men, and Schwarzenberg, with nearly twice as many, was pushed off the battlefield by nightfall of March 20; casualties were about 2,000 on either side. Next day Schwarzenberg resumed the attack with 100,000, and Napoleon had to retreat.

Not strong enough to stop either allied army, Napoleon resolved to move eastward to rally his garrisons in Lorraine and seek to provoke a general rising in order to throw himself against Schwarzenberg's rear. From St. Dizier his light troops moved along the Marne. Blücher marched southward via Châlons across the French rear to draw closer to Schwarzenberg; and at Sompuis on March 24, 1814, the allies determined to advance directly on Paris by parallel routes. Mortier and Marmont were soundly beaten at La Fère-Champenoise on March 25, losing 2,000 killed and wounded, 4,000 prisoners and 50 cannon. With only 12,000 men left, they could not halt the allies, who crossed the Marne at Meaux to reach Bondy on March 29. The garrison of Paris and the national guard brought Marmont and Mortier's forces to 42,000, and on March 30 they fought honourably before the outskirts of Paris, retiring slowly before the allies' 100,000. That night they concluded the city's capitulation. Napoleon hurried westward, reaching Troyes on March 29 and Fontainebleau next day.

7. The End of the War.—On March 31, 1814, the allies entered Paris, where they invited the inhabitants to decide on their future form of government. In the evening, however, the allied leaders determined not to make peace with Napoleon. The French senate on April 2 and the *corps législatif* on April 3 proclaimed the deposition of Napoleon; and on April 6 the senate called Louis XVIII to the throne, subject to his accepting a constitutional charter. At Fontainebleau, meanwhile, the marshals had refused to follow Napoleon in his demand for a last attempt at resistance with his 60,000 troops and had prevailed on him to abdicate in favour of his son. Then Marmont's decision to take his corps into the allied lines (night of April 4–5) uncovered Fontainebleau, and Napoleon agreed to abdicate both in his own name and in his son's. The treaty of Fontainebleau, which he accepted from the allies on April 13, assigned to him the sovereignty of Elba, the title of emperor and an annual stipend. On April 20, he bade farewell to his troops and set out for Elba.

Wellington's forces had already driven Soult from Spain into the south of France; and during February and March 1814 the French continued to retreat eastward from the Adour. At Toulouse on April 10, when the news of the cessation of hostilities had not yet reached the two commanders, Soult was again defeated. In Italy, Murat, having gone over to the Austrian side, had advanced from Naples to occupy Rome, Ancona and Bologna, obliging Eugène to retire from the Adige to the Mincio. In February he opened negotiations with Eugène, which continued intermittently until news was received of the allies' advance on Paris. Hostilities were ended a few days later by a convention (April 16) under which Eugène was to withdraw his forces from Italy.

The allies made peace with Louis XVIII's government by the treaty of Paris (May 30, 1814). They demanded no indemnity and even permitted the retention of nearly all the works of art that the French had taken as spoils of war, but the frontiers of 1792 were restored, except that Montbéliard and western Savoy were left to France (as well as Avignon and the Comtat-Venaissin, annexed in 1791). Overseas, France renounced Tobago, St. Lucia, Mauritius and Seychelles to Great Britain and San Domingo to Spain but regained the other colonies. Finally, France accepted in advance the allies' division of previous French conquests at the forthcoming congress of Vienna (*q.v.*). After the Hundred Days and the final defeat of Napoleon (*see* WATERLOO CAMPAIGN) the second treaty of Paris, signed on Nov. 20, 1815, was more stringent to France.

See further the historical section of the articles on the belligerent states; biographical articles on the sovereigns, statesmen, marshals and generals mentioned above; and references under "Napoleonic Wars" in the Index.

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NAPOLEONITE, or CORSITE, a gabbro showing orbicular, or spherical, structure from Santa Lucia di Tallano, Corsica. The rock when cut and polished makes a beautiful ornamental stone, examples of which are to be found in most petrographical museums. Although often referred to as a diorite, napoleonite in its mineral and chemical composition corresponds to a hornblende gabbro (*q.v.*). The spheroids or orbicules in napoleonite, remarkable for their uniformity in structure, range from ½ in. to 2 in. in diameter and are set in a matrix of variable grain size built up of green hornblende and cummingtonite (*see* AMPHIBOLE) and bytownite feldspar (*see* FELDSPAR: *The Plagioclases*).

The core of these structures consists of material mineralogically similar to the matrix but richer in feldspar; it is followed by a series of broad and narrow zones, respectively, of radiate plagioclase and green hornblende-cummingtonite intergrowths also radially arranged. Both the plagioclase of the core and of the broad zones is distinctly more calcic than that of the matrix. These relations are in accord with the concept that the orbicules developed in a crystallizing liquid and the structure itself has probably arisen by rhythmic crystallization.

Orbicular or spheroidal structures, though by no means common, have been found in the crystalline rocks of Sweden, Finland, the U.S.S.R. and North America. They have been closely studied by the petrologists of Finland and are there known as esboites. The mutual relations in composition and structure of orbicule and matrix in some of these rocks, especially those of Finland, have led to the opinion that the structures are metamorphic in origin, the orbicules developing in a solid or quasi-solid matrix which has in part been converted into a migmatite by metasomatic replacement.

See P. Eskola, "On the Esboitic Crystallization of Orbicular Rocks," *J. Geol.*, vol. xlvi, pp. 448–485 (1938). (C. E. T.)

NAPO-PASTAZA, former province in the Oriente region of Ecuador, east of the Andes mountains. With an area of 33,237 sq.mi., Napo-Pastaza was the largest province in Ecuador. However, it had a population in 1950 of only 25,425. The capital was Tena. In Jan. 1960 the province was divided into the two provinces of Napo (pop. [1962] 24,487) and Pastaza (13,840). *See* EL ORIENTE.

NAPO RIVER, a tributary of the Amazon river in South America. The Napo rises among the volcanoes of the Andes mountains in northern Ecuador and flows southeast to join the Amazon near Iquitos, a town in northeast Peru. Total length is 700 mi. *See* AMAZON.

NAPRAPATHY, a system of manipulative drugless treatment based on a theory that the cause of disease is connective tissue that has become shrunken as a result of injury. A shrunken

strand of connective tissue is called a ligatight and may occur in the spine, thorax, pelvis or elsewhere. It is claimed that such tissue can be corrected by naprapathic treatment, which aims at stretching the shrunken strands. Study of a set of charts showing types of ligatights and manipulations to correct them are held to be an important part of the practitioner's training. Naprapathy was founded in 1907 by Oakley Smith.

NARA, a *ken* (prefecture) in central Kii peninsula (western Honshū), Japan, east of Ōsaka. The total area of the prefecture is 1,426 sq.mi. Its southern and northeastern portions are mountainous, while its northwestern quarter is occupied by the Nara (Yamato) basin, the key lowland. The basin has most of the prefecture's population (825,941 in 1965), main cities, agricultural land and transportation facilities. It is separated from eastern Ōsaka by the Ikoma and Kongō mountains. The Nara basin is one of Japan's most densely settled and historic regions and has many famous temples, buildings and other remains from the past. However, it is being pulled increasingly into the commercial orbit of Ōsaka (less than one hour by electric train), to which it sends a daily stream of commuters, products of its intensive agriculture and a variety of simple cotton goods and handicrafts.

NARA, the capital and largest city of Nara prefecture, is 25 mi. from Ōsaka, in the hilly northeastern edge of the Nara basin. Pop. (1960) 134,577. During 75 years (710–784) it was Japan's capital

WERNER BISCHOF—MAGNUM

SCHOOLCHILDREN IN FRONT OF THE ENTRANCE TO THE TEMPLE OF KATSURA, NARA

and many of the striking artistic accomplishments (Buddhist temples, monasteries, sculpture) of that age are still preserved, grouped around the edge of the celebrated deer park. (*See* also JAPANESE SCULPTURE: *Nara [Tempyo] Period.*) Many artifacts have been preserved for 1,200 years in a log storehouse, the Shōsōin. These splendid remnants of early Japanese civilization attract more than 4,000,000 visitors annually. Besides tourism and administration, Nara is a leading commercial and educational centre and has some manufacturing. (J. D. EE.)

NARA (officially EASTERN NARA), an important water channel in Sind, West Pakistan, now utilized for the Eastern Nara canal (226 mi.), the largest of the Sukkur barrage canals. The upper part of the Nara river was a small channel through which spill water from the Indus, above Rohri, found its way to central and lower Sind. Skirting the sandhills throughout the Thar Parkar desert it discharged itself into the Puran, an old channel of the Indus, which 80 mi. farther south enters the Rann of Cutch. To ensure regular water supply it was connected in 1958–59 with the Indus at Rohri by the 12-mi.-long Nara supply channel. The Eastern Nara is also considered by some as the channel by which the Ghaggar or Hakra (now dry) flowed into the sea. Others believe it to be the old bed of the Indus or the Sutlej. (K. S. AD.)

NARAI (NARAIN), king of Siam from 1657 to 1688, is best known for his conduct of foreign relations. In 1664 he signed a treaty with the Dutch giving them commercial privileges in Siam, including extraterritoriality. He was unsuccessful in establishing a favourable basis for trade and goodwill with the British, and a series of incidents led to a declaration of war against the British East India company in 1687. He welcomed the first French Catholic missionaries to his shores in 1662, because he discovered they could build forts as well as churches. Through the good offices of the missionaries he exchanged political missions with popes and kings. He also engaged in useless, intermittent wars against traditional enemies in Burma, Cambodia and Chiangmai.

Narai's policies caused violent reactions on the part of the court and the people. The whole realm was filled with European-built forts garrisoned by European soldiers. The most powerful minister in the government was a romantic Greek trader, Constant Phaulkon. The missionaries overreached themselves in trying to convert the king to Catholicism and to spread their religion throughout the kingdom. When the king died, foreigners were dispossessed of power or driven out, and Siam remained in comparative seclusion from the west for more than a century thereafter. (C. A. B.)

NARAYAN, JAYAPRAKASH (1902–), Indian political leader and political theorist, was born on Oct. 11, 1902, in the Saran district of Bihar. He was educated locally and at universities in the United States, where he maintained himself by his own exertions and became a Marxist. He returned to India in 1929 and joined the Congress party. He was sentenced to a year's imprisonment in 1932 for participation in the civil disobedience movement. After his release he took a leading part in the formation of the Congress Socialist party, a left-wing group within the Congress party itself. He was imprisoned again in 1939, for opposition to the war effort, but subsequently made a dramatic escape and for a short time tried to organize violent resistance to the government before his recapture in 1943. After his release in 1946 he tried to persuade the Congress leaders to adopt a more militant policy and argued that political independence would be incomplete without a social revolution. In 1948 he left the Congress party, in company with most of the Socialists, and formed a separate Socialist party, which in 1952 merged with another left-wing group to become the Praja Socialist party. But he was becoming dissatisfied with party politics and in 1954 announced that he would devote his life exclusively to the *Bhoodan Yajna* (land-gift) movement (*see* BHAVE, VINOBA). His continuing interest in political problems, however, was revealed in 1959 when he argued for a "reconstruction of Indian polity" by means of a four-tier hierarchy of village, district, state and union councils resembling the "basic democracies" established in Pakistan by Pres. Ayub Khan, which he specifically praised. In April 1960 he organized an Afro-Asian convention in Delhi to protest against Chinese policy in Tibet as well as against the remains of colonialism elsewhere. (KE. A. B.)

NARAYANGANJ, a town in the Dacca district of East Pakistan, stands 8 mi. S.E. of Dacca on both banks of the Lakhya at its confluence with the Dhaleswari, just before the latter joins the Meghna. It has thus steamer connections with all the important inland ports as well as with Chittagong. Pop. (1961) 162,054 including 36,262 in the cantonment. Its good location as a riverport has made Narayanganj a collecting centre of hides and skins and a terminal market for jute. Together with Dacca (*q.v.*) it forms the greatest industrial region of East Pakistan, with the largest number of jute presses and jute and cotton mills. It also has manufacture of leather and footwear and glassworks. The making of underwear is a notable cottage industry.

The town is compact, built on raised low-lying land, with many spacious streets. Old buildings include Kadam Rasul (1801), a shrine built by Ghulam Mohammed of Tippera; two forts built by Isa Khan, one of the Bara Bhaiyas (12 landlords of Bengal), dur-

ing the reign of Akbar; and the Laxmi Narayan building, a Vishnu construction of the 12th century, after which the town is named. Modern buildings include the Dacca-Narayanganj chamber of commerce and industry, National and Grindlays bank, Co-operative house and Seth Tolaram college. There is also a municipal public library. The town has facilities for ship repairs.

(K. S. AD.)

NARBONNE, a city of France, ancient capital of Gallia Narbonensis and now capital of an *arrondissement* in the *département* of Aude, lying on a vine-growing plain 8 mi. (13 km.) from the Mediterranean, 34 mi. (55 km.) E. of Carcassonne. Pop. (1962) 30,388. The town has excellent rail services and is on two main roads. It has a subprefecture and courts of first instance and of commerce.

Surrounded by wide outer boulevards, Narbonne is divided into *bourg* and *cité* by the Robine canal, a branch of the Canal du Midi. Its old buildings include the basilica of St. Paul Serge (11th–14th centuries), a curious and early specimen of the Gothic style in the south, with a churchyard of the 4th century; the unfinished cathedral of St. Just (13th–14th centuries), which consists only of a choir (135 ft. high) flanked by two 234-ft. towers; the church of St. Sebastian, flamboyant Gothic (15th century); and the pure Renaissance-style House of the Three Wet-Nurses (16th century), so named because of the proportions of the three caryatids that support its cornice. Special notice must be taken of the Archbishops' palace, a collection of civil, military and religious buildings ranging from the high middle ages to the 18th century. A part of the palace is used as a town hall, but it shelters also two exceptional museums: the museum of Narbonne prehistory and antiquities and the museum of art and history, with important collections of paintings and ceramics. In the Lamourguier church is one of the world's greatest lapidary museums. Modern buildings include the technical college, and, in a park, the Palace of Arts, Sports and Work, enclosing an Olympic swimming pool, theatre, gymnasium and meeting rooms for workers.

Narbonne has a good trade in wines, salt and tartar. Its honey is renowned. The main industries are uranium and sulfur refining, alcohol distilling, oil milling and the making of wine casks and bricks and tiles.

Narbonne was the capital of the Volcae Tectosages. There the Romans in 118 B.C. founded their first colony in Gaul, Narbo Martius; they built great works to protect the city from inundation and to improve its port. The capital of Gallia Narbonensis, the seat of a proconsul and a station for the Roman fleet, Narbo Martius became the rival of Massilia (Marseilles); but the division of Gallia Narbonensis into two provinces reduced its importance. Alans, Suebi and Vandals each held the city until in 413 it was occupied by the Visigoths, whose capital it afterward became. In 719, after a siege of two years, it was captured and extended by the Saracens. Charlemagne made the city the capital of the duchy of Gothia, and divided it into three lordships—one for the bishop, another for a Frankish lord and a third for the Jews. In the 13th century the archbishopric was seized by the pope's legate, Arnaud Amaury, who took the title of viscount of Narbonne. Simon de Montfort, however, deprived him of this dignity, receiving from Philip Augustus the duchy of Narbonne along with the county of Toulouse. By his expulsion of the Jews Philip the Fair hastened the decay of the city; and about the same period the Aude, which had been diverted by the Romans to flow toward Narbonne, burst its banks, returned to its original bed, and the harbour was silted up. United to the French crown in 1507, Narbonne was enclosed by a new line of walls under Francis I; the last portions of its ramparts were demolished in 1870. The archbishopric was founded about the middle of the 3rd century, its first holder being Sergius Paulus; it was suppressed in 1790.

(HE. J.)

NARCISSUS (d. A.D. 54) was a freedman, who as *ab epistulis* to the Roman emperor Claudius I was responsible for bringing to his attention letters on every kind of subject from cities and officials throughout the empire, and doubtless for drafting replies. This household secretarial post had existed before but had had no political importance; by his influence over the malleable emperor, Narcissus raised himself to be one of the first ministers of state and also one of the richest men Rome had ever known. He was for a long time in league with Messallina (*q.v.*), but fear made him and other freedmen secretaries combine to secure her death (48). Claudius could not remain unmarried, but Narcissus backed the wrong candidate, Claudius' divorced wife Aelia Paetina; hence, on Claudius' marriage to Agrippina the younger, he lost influence to the financial secretary Pallas, who had supported her. His loyalty to Messallina's son Britannicus ensured his death on Nero's accession. It is often held that Narcissus' importance betokens the development of a centralized bureaucracy under Claudius, but the ancient evidence only represents him as a powerful favourite; it is so distorted by social prejudice that his talents and achievements cannot now be assessed.

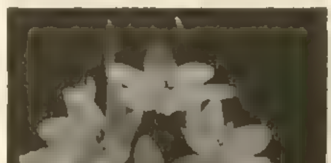
See M. P. Charlesworth in *Cambridge Ancient History,* vol. x, ch. 20, with bibliography (1934). (P. A. BR.)

NARCISSUS, in Greek mythology, son of the river-god Cephissus and the nymph Leiriope, distinguished for his beauty. The seer Tiresias told his mother that he would have a long life, provided he never looked upon his own features. His rejection of the love of the nymph Echo (*q.v.*) or of his lover Ameinias drew upon him the vengeance of the gods. Having fallen in love with his own reflection in the waters of a spring, he pined away (or killed himself), and the flower that bears his name sprang up where he died. According to Pausanias, Narcissus, to console himself for the death of a favourite twin sister, his exact counterpart, sat gazing into the spring to recall her features by his own.

It is a very plausible suggestion of Sir James Frazer in *The Golden Bough* that this story is to be connected with the widespread belief that it is unlucky, or even fatal, to see one's own reflection. This superstition existed in Greece.

Hence is derived the term narcissism, used in psychiatry, and especially psychoanalysis, for a morbid condition in which the subject is intensely interested in his own body.

NARCISSUS, a genus of bulbous plants belonging to the amaryllis family (Amaryllidaceae), native of central Europe and the Mediterranean region; one species, *N. tazetta,* extends through Asia to Japan. From some of these, by cultivation and hybridization, have arisen the numerous modern varieties used in gardens and as cut flowers. The plants have long narrow leaves springing from the bulb and a central scape bearing one or more generally large, white or yellow, drooping or inclined flowers. The flowers are regular; the perianth (calyx and corolla) springing from above the ovary is tubular below, with spreading segments and a central corona or cup; the six stamens are inserted within the tube. The most interesting feature botanically is the corona, which springs from the base of the flower segments and gives the special character to the flower. One classification of narcissuses includes 11 groups or divisions; of these the following five are of chief interest to the gardener:



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PAPER-WHITE NARCISSUS (NARCISSUS TAZETTA ALBA), ONE OF THE POLYANTHUS NARCISSUSES

1. The hoop petticoat narcissuses are from 4 to 12 in. in height and have grassy foliage and yellow or white flowers. These have the corona in the centre of the flower—very large in proportion to the other parts and much expanded, like a hoop petticoat. They are all regarded as varieties or forms of the common hoop petticoat, *N. bulbocodium*, which has comparatively large bright-yellow flowers.

2. A second group is that of the pseudo narcissuses, of which the common or wild daffodil, *N. pseudo-narcissus,* is the type. This species is found in woods and thickets in most parts of the

north of Europe and is naturalized in the U.S. Its leaves are about 1 ft. in length and 1 in. in breadth and have a blunt central ridge and flat edges. The stem, which is 8 to 18 in. long, bears a single flower. The flowers are large, yellow, scented and slightly drooping, with a corolla deeply cleft into six lobes, and a bell-shaped corona that is crisped at the margin; they appear in early spring. In this species the corona is also very large and prominent. (*See* DAFFODIL.)

3. Another group, with coronas of medium size, includes the fine and numerous varieties of *N. incomparabilis*, one of which has large, double flowers. *N. odorus*, known as the campernelle jonquil, has two to four uniform bright-yellow flowers and is considered a hybrid between *N. jonquilla* and *N. pseudo-narcissus*, although it is found wild in France and Spain.

4. The polyanthus or bunch narcissuses form another well-marked group, whose peculiarity of producing many flowers on the stem is indicated by the name. In these the corona is small and shallow as compared with the perianth. *N. tazetta* is the type of this group. They are general favourites among spring flowers. The Chinese sacred lily, or joss flower, and the paper-white narcissus, forced on a large scale by florists, are varieties of *N. tazetta*. The jonquil, *N. jonquilla*, with yellow flowers, a native of south Europe and Algeria, does well outside in a warm border but may also be grown in pots for early flowering.

5. In the poet's or pheasant's-eye narcissuses (*N. poeticus*) the perianth is large, spreading and conspicuous and the corona very small and shallow. These pheasant's-eye narcissuses, of which there are several well-marked varieties, blossom in succession from early spring to midspring, and all do well in the open borders as permanent hardy bulbs.

Narcissuses are best displayed in naturalized plantings but are also effective in more formal arrangements. Bulbs, available in early fall, should be planted as soon as they are received, so that they may root before cold weather arrives. They should be covered by soil as deep as one and one-half times their height. Narcissuses will thrive in a loamy soil enriched with rotted manure or bone meal, which should not touch the bulbs. After the plants flower, the leaves should be allowed to wither naturally; the bulbs depend upon the foliage for the manufacture of food materials necessary for the resumption of growth next season. *See* also FLOWER: *Commercial Flower Growing.*

BIBLIOGRAPHY.—For a scientific treatment of the genus, *see* J. G. Baker, *Handbook of Amaryllideae* (1888). *See* also E. A. Bowles, *Handbook of Narcissus* (1934); Royal Horticultural Society, *Dictionary of Gardening*, vol. iii (1951); the *American Daffodil Yearbook* (1947 *et seq.*); Norman Taylor (ed.), *Taylor's Encyclopedia of Gardening*, 4th ed. (1961).

NARCOTICS, a general term for substances that produce lethargy or stupor and the relief of pain. In a restricted sense, the term applies to opium (*q.v.*) or coca leaves or any compound, manufacture, salt or preparation thereof, even though their action is not narcotic. Prescriptions for these substances in most countries require that the prescribing physician be registered with the proper governmental agency (department of the treasury in the United States) and comply with the regulations furnished by that agency. *See* DRUG ADDICTION; NARCOTICS, LAWS RELATING TO.

(F. L. A.)

NARCOTICS, LAWS RELATING TO. Addiction to narcotic drugs began to be recognized as a social evil in the 19th century, and governments have sought to deal with it along three main lines: (1) control of sources of supply through international co-operation; (2) prohibition by criminal penalties; and (3) treatment of addicts by medical and public health authorities. The United States has been the foremost exponent of international controls, the United States and Nationalist China (Formosa) are prominent for the severity of their repressive laws, and the United Kingdom, followed by the Scandinavian countries, probably has had most success in the medical treatment of addicts. In nearly all countries, however, an attempt is made to balance the need for repressive legislation, on the one hand, and the medical treatment of addicts on the other; the balance varies according to local circumstances. England, for example, unlike the United States, has only a small number of drug addicts and no organized illicit traffic in narcotics; such differences should be kept in mind in appraising the legislation of the two countries.

International Controls.—The opium traffic in the far east was exploited by westerners in the 18th and 19th centuries. The Opium wars (1839–42, 1856–60) were fought to crush Chinese resistance to this exploitation. The United States, however, began to bar its nationals from the traffic by bilateral agreements as early as 1833, outlawed U.S. participation in the China traffic in 1881, and suppressed domestic manufacture of smoking opium by progressively higher taxation after 1890 and by outright prohibition in 1909. In 1909 Pres. Theodore Roosevelt convened a commission of 13 nations, which met in Shanghai to discuss the international problem, and these deliberations led to the Hague Opium convention of 1912.

The Hague convention required each adhering Power to control its production, importation and exportation of raw opium and coca leaves, as well as to regulate its own domestic manufacture, distribution and use, to confine the latter to legitimate medical purposes. Following World War I these objectives were pursued by the League of Nations (ratification of the 1919–20 peace treaties included automatic ratification of the 1912 convention), and there have been many international agreements since: the Geneva convention of 1925, attempting to set up a production quota system and creating a permanent central opium board to administer it; the Geneva agreement of 1925, proposing to bind the principal Asiatic producers of opium to establish government monopolies for easier control; the Geneva convention of 1931, extending the limitations on manufacture and distribution of drugs, and creating an international drug supervisory body to police them; the Bangkok agreement of 1931, calling for government monopolies of the retail sale of opium in Asiatic countries; the 1936 convention (with less than a score of adherents), calling for direct criminal sanctions to punish international trafficking; the protocol of 1946, bringing all prior agreements under the supervision of the United Nations and replacing the Opium Advisory committee of the League of Nations by the UN Commission on Narcotic Drugs; the protocol of 1948, providing machinery for the addition of new drugs to the controlled categories by action of the World Health organization; the protocol of 1953 (with more than 50 adherents), agreeing to drastic limitations on the cultivation of poppies; and the Single convention of 1961, codifying and extending the provisions of the numerous multilateral treaties.

Despite this array of international commitments, the contracting Powers have not co-operated effectively enough to stamp out production for addict consumption nor to curb illicit trafficking. Producing countries in the middle and far east continue to tolerate, if not encourage, lucrative drug industries within their borders; and consuming countries like the United States (which has no domestic production) continue to receive vast supplies via the smuggler and clandestine peddler. (*See* also OPIUM: *Opium Traffic.*)

United States.—By the start of the 20th century narcotic drugs were widely used in the United States. Eating opium and laudanum were sold everywhere. Respectable people suffered from the "opium sickness." Even children's medicines contained opiates, and the medical profession prescribed addicting drugs with little restraint. When heroin was introduced, in 1898, it was widely hailed as a nonaddicting substitute for morphine. In the early 1900s a number of states passed prescription laws. To aid in the enforcement of these laws and to provide the regulation required by the 1912 Hague convention, congress in 1914 passed the Harrison Narcotics act.

The Harrison act, still the basic U.S. drug statute, began as a simple tax measure. It imposed a stamp tax of 1¢ per ounce on opium and coca products and required all who handled them—importer, manufacturer, wholesaler, pharmacist and prescribing physician—to register, to keep records and to make use of special order and purchase forms. But the act also contained an ambiguous limitation: the physician was exempted from its requirements only in prescribing drugs "to a patient" and "in the course of his professional practice only."

Enforcement fell to the treasury department, which was also

charged, in 1919, with enforcement of the National Prohibition act; the department's new prohibition unit thereupon launched twin campaigns against drug users and alcohol drinkers. From the outset, though the Harrison act called merely for collection of the tax, registration was refused to sellers outside the medical profession, and even doctors and pharmacists who ministered to addicts were arrested and prosecuted. Public health facilities (narcotic drug clinics), established in many communities during the period 1918–23 to provide treatment for addicts, were closed. In a series of test cases, culminating in *U.S.* v. *Behrman* (1923), the U.S. supreme court interpreted the ambiguous exemption referred to above to mean that no doctor could lawfully prescribe or administer *any* narcotic drug to an addict, even in a good-faith attempt to cure the addiction or alleviate the symptoms of withdrawal. Though this decision was reversed in *U.S.* v. *Lindner* (1925), treasury enforcement policies have continued to rely on the *Behrman* interpretation.

Estimates of the number of persons addicted to narcotic drugs in the United States at the close of World War I range from 200,000 to 1,000,000 (the latter being the treasury department's official figure). It is certain that a great number, finding themselves cut off from all legitimate suppliers and medical assistance, simply cured themselves. But many turned to the underworld, to a hitherto unknown figure, the "dope peddler"; in doing so they became criminals themselves, creating the richest illicit drug market in the world and the most costly law enforcement problem of our times. In the heyday of bootlegging, there were twice as many federal convictions for drug offenses as for liquor law violations (in 1928, for instance, a federal prison census showed 2,529 prisoners out of a total of 7,138 to be Harrison act offenders); in the mid-1960s, with the addict population of the country estimated to be about 60,000, drug-law arrests by federal and local authorities remained above 20,000 per year. Over 15% of federal prisoners were serving time for drug-law offenses.

The Harrison act was amended by the Marihuana Tax act (1937), placing marihuana in the controlled category, and by the Boggs act (1951) and the Narcotic Control act of 1956. These acts greatly increased the penalties for drug-law violations, introducing mandatory minimum sentences and depriving offenders of the privileges of probation and parole afforded other federal prisoners. A person convicted of any drug-law offense must be imprisoned for at least 2 years (and up to 5, though the court may suspend the sentence for first offenders); on the second offense, the sentence must be 5 to 10 years, and for subsequent convictions the minimum is 10 years and the maximum 40. For offenses in the sale, transfer and smuggling categories, the prescribed sentence for a first offense (without suspension) is 5 to 10 years, and for subsequent convictions, 10 to 40 years. A discretionary fine, up to $20,000, may be imposed with any of the foregoing sentences. Heroin, estimated to constitute 90% of the illicit traffic, was directly outlawed by the 1956 act, and its sale by an adult to a minor was made punishable by life imprisonment or, if the jury so recommended, by death. A number of states have followed the federal pattern of penalties in their own drug statutes.

The United States thus is notable (along with Formosa, where most offenses involving drugs are punishable by summary execution) for the severity of its narcotic laws. But it should also be noted that two of the finest narcotic drug hospitals and research centres in the world are operated by the U.S. public health service, one at Lexington, Ky., opened in 1935 and one at Fort Worth, Tex., opened in 1938.

Great Britain.—Great Britain, also an adherent to the Hague convention of 1912, enacted its Dangerous Drugs act, with regulatory provisions strikingly similar to those contained in the Harrison act, in 1920. The first home office regulations contained a similar ambiguous exemption for the physician: he could possess and supply drugs only "so far as may be necessary for the practise or exercise of his said profession, function or employment, and in his capacity as a member of his said class." But in Great Britain the ambiguity was resolved by a medical commission. In 1926 the Rolleston committee, made up of eminent doctors appointed by the government, recommended that physicians should be permitted to prescribe morphine or heroin for addicts (1) in cure by gradual withdrawal; (2) when drugs cannot safely be discontinued because of the severity of withdrawal symptoms; and (3) when the patient "while capable of leading a useful and relatively normal life when a certain minimum dose is regularly administered, becomes incapable of this when the drug is entirely discontinued."

These standards have been accepted and observed in the United Kingdom since 1926. The police function concentrates upon aiding doctors by preventing forged prescriptions and detecting frauds, such as an addict's placing himself in the care of more than one physician at the same time. In 1961 the Interdepartmental Committee on Drug Addiction, headed by Sir Russell Brain, reported that it saw no need for further statutory controls. In the early 1960s there were about 15 convictions annually in the courts of the United Kingdom for offenses involving opium (with sentences up to six months and fines up to £100), and about 50 annually for offenses involving manufactured drugs such as morphine and heroin (with sentences up to two years and fines up to £100). Home office records of known addicts, believed to be highly accurate because of prescription checks, show a total addict population consistently below 500, in a population exceeding 50,000,000. There is no significant smuggling activity, and no illicit drug market, in the United Kingdom.

See also DRUG ADDICTION. (R. KI.)

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NARDI, JACOPO (1476–1563), Florentine statesman and historian, whose history of his native city throws light on contemporary events and personalities, was born in Florence in 1476. A republican and supporter of Savonarola, he occupied various official positions after the expulsion of the Medici in 1494. He continued in the public service after their return, but joined in the movement for their second expulsion in 1527 and was instrumental in defeating the Medicean troops under Cardinal Silvio Passerini. On the family's final reinstatement in 1530, Nardi was exiled. He lived most of the rest of his life in Venice. He died in March 1563.

Nardi's chief literary work was his *Istorie della Citta di Firenze*, published posthumously (1582). Based on the diary of Biagio Buonaccorsi, a companion of Machiavelli, it covers the period 1498 to 1538. It reflects Nardi's republican zeal, and his admiration for the religious ideals of Savonarola, and its style is sometimes heightened by sincere feeling. He was also the author of two comedies, and of a life of Antonio Giacomini (1567).

See L. Arbib's complete edition of Nardi's *Istorie* (1838–41); A. Pieralli, *La vita e le opere di Jacopo Nardi* (1901).

NARDINI, PIETRO (1722–1793), Italian violinist and composer, was born at Leghorn on April 12, 1722. He studied violin and composition at Leghorn and later became a pupil of G. Tartini at Padua. For 15 years he held an appointment as solo violinist at the court of Stuttgart. In 1767 he settled at Leghorn and was with Tartini during the latter's last illness. He became music director to the duke of Tuscany in 1770 and enjoyed great fame as a performer and composer. He died at Florence on May 7, 1793. Nardini is remembered as Tartini's most famous pupil; he himself had many distinguished pupils, among them the Englishman Thomas Linley the younger. His compositions for the violin, although not numerous, are melodious, eminently playable, and also have considerable value as technical studies. Several of his sonatas and six of his quartets were reprinted in modern editions.

See K. Pfäfflin, *Pietro Nardini* (1936). (CS. CH.)

NARES, SIR GEORGE STRONG (1831–1915), English admiral and arctic explorer, was born in Aberdeen on April 24, 1831. Educated at the Royal Naval college, he entered the navy in 1845. For some years he served in the Pacific, after which he was mate of the "Resolute" in the arctic expedition of 1852 in search of Sir John Franklin. After serving in the Crimea, he was engaged in the training of cadets and in survey work off the northeast coast of Australia and in the Mediterranean. While in command of the "Challenger" (1872–74) he explored the southern oceans as far as the Antarctic and undertook extensive geographic and oceanographic work. In 1874 he commanded the arctic expedition to reach the north pole in the "Alert" and the "Discovery." The spring voyages of 1875 through the pack ice were difficult, costly and ill-fated. He was elected fellow of the Royal society (1875), created knight commander of the Bath (1876) and awarded medals by the Royal Geographical society (1877) and the Geographical Society of Paris (1879). In 1878 he commanded the "Alert" in a survey of the Magellan straits. Retiring from active service in 1886, he continued in the service of the government, becoming a vice-admiral in 1892. He died at Surbiton, Surrey, on Jan. 15, 1915.

His publications were *Reports on Ocean Soundings and Temperature* (1874–75) and *Narrative of a Voyage to the Polar Sea During 1875–76*, two volumes (1878).

See *Report of the Proceedings of the Arctic Expedition of 1875–1876* (1876). (H. G. Kg.)

NARESUAN (Phra Naret), popularly known as the Black Prince, was king of Siam from 1590 to 1605. In his youth, his country was invaded and conquered by Burma and was exposed to repeated invasions from Cambodia. In 1571, when only 16 years of age, Prince Naresuan was made governor of the northern province of P'itsanulok. His rule was a chronicle of constant fighting, during which he displayed reckless courage and extraordinary military skill. In 1584 he renounced allegiance to Burma. He successfully defended the capital city of Ayuthia, and defeated the besieging Burmese forces by a combination of scorched earth and daring guerrilla tactics. He also drove out the Cambodians and thus had reassured Siamese independence by the time he mounted the throne. As king he devoted more time to the improvement of internal affairs. He conducted peaceful relations with Portuguese from Malacca and Spanish from Manila. Then he expanded his power over much of Burma and Malaya, and reduced Cambodia to vassalage. He re-established the prestige of Siam in the region between the Indian ocean and the borders of China. More than anyone else, the celebrated warrior hero was responsible for the greatness of Siam which dazzled the first East India merchants from the Netherlands and Elizabethan England. *See* also Thailand: *History*. (C. A. B.)

NARIÑO, southwesternmost department of the republic of Colombia, bounded by Ecuador on the south, the Pacific ocean on the west, and by the department of Cauca and the *comisaria* of Putumayo on the north and east. The *comisaria* of Putumayo was made a part of Nariño in 1953 and re-established as a *comisaria* in 1957. Area, 12,499 sq.mi. The population of Nariño (547,323 in 1951; [1961 est.] 613,640) is principally concentrated in the volcanic Andean highlands above 5,000 ft. Indian physical and cultural characteristics predominate but Spanish is the universal language. The densely settled *altiplano* of Túquerres-Ipiales on the Ecuador frontier is separated by the Patía river from that of Pasto, where Nariño's capital of that name is located. The economy of Nariño is based almost entirely on agriculture. Wheat, barley, beans and potatoes are the principal highland crops. Bananas are exported from the port of Tumaco, which handles large ocean-going vessels. A railroad from Tumaco ascends the Patía valley for 70 mi. to El Diviso. (Js. J. P.)

NARMADA (Narbada), a river of central India. It is sometimes regarded as the boundary between Hindustan or northern India and the Deccan or peninsular India. It rises near Amarkantak in the Maikala range in Madhya Pradesh and for the first 200 mi. of its course winds among the Mandla hills. Then at Jabalpur, passing through the Marble Rocks (noted dolomitic marble gorge, about 2 mi. long), it enters the structural trough between the Vindhya and Satpura ranges, and pursues a direct westerly course to the Gulf of Cambay. Its total course through Madhya Pradesh and Gujarat is 801 mi., and it flows into the sea in the district of Broach. It receives the drainage of the northern slopes of the Satpuras, but not that of the Vindhya tableland, the streams from which flow into the Ganges and Jumna. After entering Gujarat state, the river widens out in the fertile district of Broach, with an average breadth of ½ to 1 mi. Below Broach city it forms an estuary which is 13 mi. broad where it enters the Gulf of Cambay. The Narbada is nowhere utilized for irrigation, and navigation is confined to the lower section. In the rainy season boats of considerable size sail about 60 mi. above Broach city. In sanctity the Narbada ranks second to the Ganges among the rivers of India, and along its whole course are special places of pilgrimage such as Suklatirtha and Nemawar. The most meritorious act that a pilgrim can perform is to walk from the sea to the source of the river and back along the opposite bank. The valley of the Narbada has always been an important routeway between the Arabian sea and the Ganges valley. Its middle section is followed by the main railway from Bombay to Jabalpur on its way to Allahabad. (L. D. S.)

NARODNIKI (Populists), the adherents of a 19th-century socialist movement in Russia based on the idea that political propaganda among the peasantry would lead to the awakening of the masses and, through their influence, to the liberalization of the regime. Since Russia was a predominantly agricultural country the peasants represented the majority of the people (*narod*); hence the name of the movement, *narodnichestvo* or populism.

The movement arose among the Russian intelligentsia (*i.e.*, professional people, students and the so-called *raznochintsi* or intellectuals not belonging to the gentry) in the 1860s; it gained momentum in the 1870s and culminated in the assassination of the emperor Alexander II in 1881. It was enhanced by dissatisfaction with Alexander's land reforms of 1861, which, though liberating the peasants from serfdom, created unsatisfactory economic conditions for peasant agriculture by favouring the landowners in the partition of land and by imposing an involved system of collective compensation on the villages. At the same time the movement was influenced by western ideas; *e.g.*, those of Herbert Spencer, Auguste Comte and John Stuart Mill.

The Narodniki also embodied in their teachings a considerable amount of Communist ideology gathered from Karl Marx's works, accepting for instance his ideas of communal ownership and production, his dislike for private enterprise and his definition of surplus value. However, they modified two of Marx's fundamental principles, thus bringing upon themselves the criticism of orthodox Marxists. First, they believed in agrarian communism and disregarded the industrial proletariat, which in their days represented but a small minority of the population of Russia. Second, they adapted to their needs Marx's theory of historical development, according to which human society must progress inevitably from primitive communism to industrial capitalism and thence to the dictatorship of the proletariat. That, the Narodniki argued, would not apply to Russia, where peasant life was traditionally organized in the *mir* or village community. A successful change of regime would, in their view, allow Russia to skip the intermediate stages and pass straight from primitive communism to modern socialism. Thus, like so many Russian doctrines, populism embodied a messianic element reminiscent of certain teachings of the earlier Russian nationalist philosophers, the Slavophils, who also believed in the inherent virtues of the peasant commune. Yet an evolution of thought did take place. While the Slavophils idealized the *mir* as an ancient and peculiarly Slavonic institution, the Narodniki laid stress on social questions.

The economic theories of the Narodniki were vague. Unlike the Marxists, they did not distinguish between the various income groups of the peasantry and did not class the richer peasants as enemies of the people. The *mir* and the *artel* (a primitive village productive co-operative), they believed, would naturally evolve a system of production and distribution beneficial to the community.

On the political methods whereby reforms and the drafting of a constitution should be achieved, the Narodniki differed widely

among themselves. The moderates believed that propaganda among peasantry would undermine the tsarist regime and enforce a democratization of the government, but there was disagreement as to how this would take place. On the one hand M. A. Bakunin, the anarchist of the older generation of idealistic socialists, put his hopes into peasant risings the sheer force of which would, he believed, effect political changes; on the other, the moderate P. L. Lavrov (1823–1900) advocated propaganda among the people and the enlightenment of the illiterate peasantry, which would lead to gradual reforms. In opposition to both those theories the radical P. N. Tkachev (1844–85) preached a forcible overthrow of the tsarist regime followed by gradual education of the masses to communist standards: until such time as the people were enlightened enough to govern, Tkachev suggested the rule of an intellectual minority which would guide them to this goal. The Narodniki were predominantly atheist in their philosophical outlook and positivist in their method and claimed to accept only phenomena confirmed by experience.

The activities of the Narodniki developed in the late 1860s in a movement known as *khozhdenie v narod* ("going to the people") in the course of which young intelligentsia, dressed in peasant clothes, canvased rural regions, mainly those of the Volga, Don and Dnieper. This led to persecution, arrests and political trials, the most famous one of which was the "trial of the 193" (1878). The illiterate peasantry did not always respond to propaganda in the expected way and sometimes gave the dedicated intellectuals away to the police. This campaign and its outcome have been well described by Ivan Turgenev in his novels.

The Narodniki retaliated to persecution by acts of counter-violence and by the "execution" of *agents provocateurs*. In 1876 a secret organization, the *Zemlya i Volya* ("Land and Freedom"), was formed, and the Narodniki started switching over from peaceful propaganda to terrorist and conspiratorial activities.

Differences between moderates and radicals widened and, in 1879, at the Voronezh party meeting, the movement split. The moderates, G. V. Plekhanov and P. B. Axelrod (1850–1928), then formed the organization *Cherny Peredel* ("Black Redistribution") which, as the name indicates, aimed at a fairer distribution of land among the peasantry. The radicals, A. I. Zhelyabov (1850–81), A. D. Mikhailov (1855–84), Vera N. Figner and Sofia L. Perovskaya (1853–81), gathered around *Narodnaya Volya* ("People's Will"), a terrorist organization which set out to change the regime by violence. A series of political murders was arranged, culminating, on March 13 (N.S.), 1881, in the assassination of the emperor Alexander II, accompanied by the party's open letter to his successor demanding constitutional reforms.

This was the climax of the activities of the *Narodnaya Volya* organization, which thereafter deteriorated. The 20th-century Socialist Revolutionary party can be called the ideological descendant of the Narodniki. In the 1880s Plekhanov became the head of a Marxist group, *Osvobozhdenie Truda* ("Liberation of Labour"), and an outstanding theorist of Social Democratic thought.

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NARRA (ASANÁ), the local Philippine name applied to certain timber trees of the genus *Pterocarpus* of the pea family (Leguminosae), especially to *P. indicus*, also called India padauk. Narra wood is used for cabinet work; it is usually a red or rose colour, often variegated with yellow, and is hard and heavy. The trunk is surrounded (or, occasionally, supported) by huge buttresses extending outward and upward for 10 to 20 ft.; these are sometimes made into table tops, the pattern of the grain and the colouring being hardly equalled by any other timber. The wood cells contain a peculiar substance: a minute chip placed in a bottle of water soon gives an opalescent colour to the liquid. Narra wood is known also as Burmese rosewood, Andaman redwood and Kiabooca wood.

NARSES (*c.* 478–*c.* 573), Byzantine general, born in Persarmenia, was a eunuch who played an important role during Justinian I's reign. He became an official in the imperial household (*sacellarius*) which entailed command of the spatharocubiculars (a bodyguard of eunuchs), eventually rising to be grand chamberlain (*praepositus sacri cubiculi*). When the Nika riot broke out in Constantinople in 532, Narses was one of those who saved Justinian his throne in winning over the Blue political faction by lavish distribution of bribes and by timely military action. In 535 he was sent to Alexandria with troops to ensure the reestablishment of the imperial candidate Theodosius as patriarch and to quell disturbances which had arisen by reason of the election. In 538 he took part in Justinian's reconquest of Italy ostensibly to assist Belisarius. The two commanders, very different in character, found it difficult to co-operate and in 539 Narses was recalled to Constantinople. In the summer of 551 Narses was in charge of troops directed against barbarian raiders, mainly Huns, Gepids and Lombards, who were devastating the Balkans. On the resurgence of Ostrogoth power in Italy under Totila, Narses was made commander in chief in the autumn of 551, and in the following year opened a vigorous campaign. At the end of June in 552 he defeated Totila, who died of his wounds, and he entered Rome. During the following years scattered resistance by the Goths was crushed, and Franks and Alamans entering north Italy were subdued. Imperial control was gradually restored under Narses, who appears to have exercised both civil and military authority. He was recalled by Justin II in 567 and is said to have retaliated by inviting the Lombards to enter north Italy.

In appearance he was small and elegant, and as a eunuch could never be a candidate for the imperial throne, which may have been one reason for the continuous favour he enjoyed from Justinian. He was a devout man and during the empress Theodora's lifetime he seems to have inclined toward Monophysitism. Though apparently not a particularly cultivated man, he had moral and intellectual qualities. Astute, controlled, with excellent judgment, he served Justinian well, and his evil reputation for oppression and avarice in Italy during his later years should not obscure this.

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NARSIMHAPUR (NARSINGHPUR), is a town and district in the Jabalpur division of Madhya Pradesh, India. The town, headquarters of the district, lies on the Central railway 50 mi. W. of Jabalpur. Pop. (1961) 17,940. Once called Chhota Gadarwara, it was renamed Narsinghpur when a temple of Narsingh (the "man lion," an incarnation of Vishnu) was erected about 150 years ago. The river Singri divides the town into two parts, Kandeli on the east and Narsimhapur on the west. The chief trade is in timber.

NARSIMHAPUR DISTRICT (area 1,979 sq.mi.; pop. [1961], 412,406) is a narrow strip of fertile black alluvium between the Narmada (Narbada) river and the Satpura ranges. The Narmada, which marks its northern border, receives many tributaries from the south whose ravines are an ever-growing problem. Much of the district is forested and the remainder is under cultivation, the main crops being wheat, cotton, jowar millet and sesamum.

Narsimhapur once formed part of the territory of the Mandla Gond kings of Chauragarh, 20 mi. S.W. of Narsimhapur town. Later, the Bundelas of Orchha conquered Chauragarh and in 1781 the Gond dynasty was overthrown by the Marathas who were ousted by the British in 1818. (S. M. A.)

NARTHEX, in architecture, a long, narrow porch, usually colonnaded or arcaded, at the entrance of a church, sometimes alone, sometimes as the side of the atrium (*q.v.*) adjacent to the church façade. In the early days of Christianity it was the only portion of the church to which catechumens and penitents were admitted. Occasionally an additional vestibule exists within the church building proper. In this case, the inner vestibule is called the narthex and the outer porch an exonarthex. The narthex is common in basilican, Byzantine and some Romanesque churches, particularly in Italy; in the Gothic period its use had almost disappeared, but during the Renaissance it was again found, although its ritual usage had entirely died out and it had become a simple

porch or vestibule. *See* BASILICA; RELIGIOUS ARCHITECTURE.

NARVA, a river port of the Estonian Soviet Socialist Republic, U.S.S.R., situated on the Narva (Narova) river a few miles above its entry into Narva bay on the Gulf of Finland and 120 mi. E. of Tallinn on the Tallinn-Leningrad railway. With it is associated the nearby seaside resort of Narva-Joesuu. Its population, mostly Russian immigrants, was 27,600 in 1959.

The town is dominated by two medieval fortresses—Ivangorod on the east bank built by the Russians and Hermann fortress on the west bank founded by the Danes. In the 13th century a settlement developed under the protection of the Danish fortress and obtained city privileges. In 1346 the Danish king, Valdemar IV, sold Narva to the Teutonic knights whose stronghold it remained until its capture in 1558 by the Russians. In 1581 it was taken by the Swedes who lost it in 1704 when the Russian emperor, Peter the Great, took it from Charles XII by assault after having suffered a great defeat under its walls four years earlier. Narva remained under Russian rule until Estonia obtained independence in 1918–20; it was annexed by the U.S.S.R. with the rest of Estonia in 1940–41. During World War II it was occupied by the Germans (1941–44) and it suffered much from artillery fire when it was recaptured by the Soviets. In 1945 the suburb of Ivangorod (Jaanilinn) was incorporated into Leningrad *oblast* of the Russian Soviet Federated Socialist Republic.

Narva is an important textile centre, the site of the large Kreenholm mills. In 1955 a hydroelectric power station with a capacity of more than 100,000 kw. was completed on the Narva river. To the west at Soldina is a huge Baltic electric power station run by shale oil.

NARVÁEZ, PÁNFILO DE (*c.* 1480–1528), Spanish adventurer, was born at Valladolid. He helped Diego Velásquez in the reduction of Cuba and was put at the head of the force sent to the Aztec coast to compel Hernán Cortés to renounce his command. He was defeated by his compatriot and made prisoner (1520).

On his return to Spain Narváez obtained from Charles V a grant of land in Florida as far as the River of Palms. Landing near Tampa bay in April 1528, he struck inland with 300 of his followers and reached "Apalache" on June 25. Disillusioned in their hopes of fabulous wealth, they made for the coast, arriving in July at the Bahia de los Caballos, at or near St. Mark's. Having built rude boats, the much-reduced company sailed on Sept. 22 for Mexico, but the vessel that carried Narváez was destroyed in a storm. His lieutenant, Nuñez Cabeza de Vaca, and three others ultimately reached the Gulf of California by way of Texas. *See* FLORIDA.

NARVÁEZ, RAMÓN MARÍA (1800–1868), DUQUE DE VALENCIA, Spanish general and politician, a leading Conservative supporter of Isabella II, was born at Loja (Granada) on Aug. 5, 1800, of an illustrious Andalusian family. He joined the Guardias Valonas in 1815 and was one of the ablest of the regent María Cristina's military leaders during the first Carlist war. He rose to the rank of brigadier in 1836 and began his political career with election to the *Cortes* in 1838. An opponent of Gen. Baldomero Espartero (*q.v.*) and the Progresista party, Narváez led an unsuccessful rising at Seville in 1838 and had to flee, first to Gibraltar and then to France. There he plotted against Espartero, especially after María Cristina (*q.v.*) had been driven from the regency.

In 1843 he staged a successful *coup d'état* in Spain and the next year was asked to form a government. Narváez's first ministry was notable for the promulgation of the 1845 constitution and for the tax reforms of the finance minister, Alejandro Mon. The government fell early in 1846 and Narváez was replaced first by the marqués de Miraflores and then, after a brief return to office, by Francisco Istúriz, who offered him the post of ambassador to Naples. Narváez refused this appointment and went into exile, but Joaquín Pacheco's government made him ambassador to France, whence he returned in 1847 to head another ministry. The new administration (Oct. 1847–Jan. 1851) was Narváez's period of greatest achievements—including the suppression of a fresh Carlist rising and the execution of numerous public works. He retired from politics in 1851, but returned briefly to power in 1856–57, 1864–65 and 1866. He died in Madrid on April 23, 1868. He was created duque de Valencia in 1844.

See also SPAIN: *History: The Bourbon Dynasty.* (R. S. LL.)

NARVIK, an ice-free seaport on the Ofotfjord in the northern part of Nordland *fylke* (county), Norway, 110 mi. N.E. of Bodø. Pop. (1960) 13,219. The iron ore store and the railway divide the town into two districts: Frydenlund, with the slate church (1925), hospital, college and primary schools; and Oskarsborg, with the marketplace, market hall, Kongens gate (main street), town hall, technical schools and a cableway ascending 2,100 ft. above the town toward the top of the Fagernesfjell (4,186 ft.). A railway links Narvik with Kiruna and other places in Sweden. Narvik is connected with other parts of Norway by roads, coastal shipping and airlines. The main occupation of the inhabitants is the export of iron ore, brought from the Kiruna-Gällivare region in Sweden. The town dates from the 1880s (it was called Victoriahavn, 1887–98, in honour of the crown princess Victoria, wife of crown prince Gustavus, later Gustavus V, and of the princess royal Victoria of Great Britain, wife of Frederick III of Prussia), and developed after the construction of the Ofot railway (opened 1903), the most northerly in the world. During World War II the Germans seized Narvik on April 9, 1940. Two naval battles were fought there on April 10 and 13, 1940, and the port was captured on May 28 by a British-French expeditionary force which withdrew on June 9. (A. L. So.)

NARWHAL (NARWAL, NARWHALE), one of the toothed whales (*Monodon monoceros*) of the Arctic in which the left of the two teeth present (very rarely both) is developed in the male as a long unicornlike, forward-directed tusk (which may be in excess of nine feet), twisted in a left-handed spiral. The body, which reaches about 15 ft. in length, is gray, mottled with darker and lighter markings, and has no dorsal fin; the head is bluntly rounded in profile. The right tooth of the male, generally, and both teeth of the female, usually, remain unerupted in deep sockets in the skull. In young narwhals several small teeth are present but disappear soon after birth.

The narwhal is rarely found south of latitude 65° N.; it is gregarious and usually found in schools of 15 or 20, sometimes many more. Its food consists of squid and fishes, in the capture of which it appears to be in no way handicapped by its reduced dentition. Little is known of the biology of the narwhal. The use of the tusk to the animal is unknown and its value as ivory to man is not great because it contains a central cavity that precludes its use in the manufacture of anything but small articles. *See* also WHALE. (L. H. M.)

NARYN, a river and town in Soviet Central Asia. The river flows westward for 431 mi. (694 km.) from the Tien Shan to the Fergana valley where it joins the Syr-Darya. It crosses the Uzbek and Kirgiz Soviet Socialist Republics, and although the winters are cold it does not freeze and has a large hydroelectric potential. The first of a series of power stations to be built on the Naryn and its tributaries was completed near Uch-Kurgan on the border of the Uzbek S.S.R. in Nov. 1962, and generates 180,000 kw.

The town (pop. [1959] 15,000), in the Kirgiz S.S.R., was founded by the Russians as a fortified outpost in 1868. It lies at the point where the motor road from Frunze to the Torugart pass crosses the river, and is 110 mi. S. by road of the railway station at Rybachye. (G. E. WR.)

NARYSHKIN, a Russian family which gave its name to the faction contending for the Russian throne on behalf of Peter Alekseevich (later Peter I the Great) against the Miloslavskis, who represented the interests of Ivan Alekseevich (Ivan V).

The Naryshkins sprang into prominence and entered the closed circle of the Kremlin aristocracy with the marriage in 1671 of the tsar Alexis (*q.v.*), after the death of his first wife M. I. Miloslavskaya, to Natalia Kirillovna Naryshkina (1651–94). When, in 1672, Natalia gave birth to Peter, a sturdy child—unlike Alexis' two sons by Miloslavskaya, the sickly Fedor and the halfwitted Ivan—the fortunes of the Naryshkins rose and those of the Miloslavskis declined. In the next 20 years eight Naryshkins were to be elevated to the dignity of boyar. The actual leader

of the Naryshkin party was A. S. Matveev (*q.v.*): related to them through a niece of his by marriage, he had also been Natalia's guardian and brought about her marriage with Alexis.

On the accession of Miloslavskaya's elder son to the tsardom as Fedor III (*q.v.*) in 1676, the Miloslavskis regained their ascendancy and prevailed on the tsar to banish Matveev and his family. During his disgrace, Natalia won the support of many powerful families and some of the higher clergy, including the patriarch of Moscow, Ioakhim, who in 1682, on Fedor's death, proclaimed Peter tsar in accordance with the wish of the vestigial *zemski sobor* (land assembly). To mark the occasion, six Naryshkins were at once promoted grooms of the bedchamber (*spalniki*).

Meanwhile the discontented *streltsy* (musketeer troops) were threatening revolt, and the Miloslavskis deftly presented them with a collective scapegoat in the persons of the Naryshkins. From May 25 (new style; 15 old style), 1682, for a whole week, the *streltsy* wreaked death and destruction on the persons and possessions of their true and imaginary enemies. Among their victims were Matveev and three Naryshkins; a rumour circulated by the Miloslavskis had accused them of plotting to murder Peter's half brother Ivan, the *streltsy's* own candidate for the throne. On June 5 (N.S.), Ivan and Peter were proclaimed joint rulers, with Ivan's sister Sophia (*q.v.*) as regent. Natalia's father, Kiril Poluektovich Naryshkin (1623–91), and her brothers Lev Kirillovich (1664–1705) and Martemyan Kirillovich (1665–92) were all banished.

Time, however, was on the side of the Naryshkins. While Natalia, counseled by B. A. Golitsyn (*q.v.*), managed to hold her own, Peter was growing up. In the spring of 1689, thanks to V. V. Golitsyn's absence in the Crimea, the Naryshkins, including Lev (who had been allowed to return from exile), were able once more to seize the initiative. It was now their turn to expose a plot being hatched by the Moscow *streltsy*, whose commander, F. L. Shaklovity, was openly accused of conspiring to wipe out the Naryshkin family. Tension reached its climax in August, when Peter, hearing that the *streltsy* were after his blood, sought sanctuary in the Troitse-Sergiev monastery, where he was joined by the Naryshkins and growing numbers of his supporters. By the end of the first week in September, Sophia threw her hand in, leaving the Naryshkins, especially Lev and Natalia, and their adherents in control. In 1690 Lev Kirillovich was appointed head of the foreign office (*posolski prikaz*), a post which he occupied until 1702, though he had ceased to exercise any political influence by 1699.

See C. Bickford O'Brien, *Russia Under Two Tsars, 1682–1689* (1952). (L. R. Lr.)

NASBY, PETROLEUM V., pen name of David Ross Locke (1833–1888), U.S. humorous satirist of the Civil War period. He was born near Binghamton, N.Y., on Sept. 20, 1833. From an early age he worked for various newspapers in New York and Ohio. In 1861, as editor of the *Findlay* (Ohio) *Jeffersonian*, he published the first of many satirical letters purportedly written by one Petroleum Vesuvius Nasby. For over 20 years Locke contributed "Nasby Letters" to the *Toledo Blade*, which under his editorship gained national circulation. Many of the letters appeared also in book form.

An ardent Unionist and foe of slavery, Locke vigorously supported the Northern cause. His chief weapon was a heavy irony. He let his character Nasby, a "Copperhead," argue in favour of the Southern position; but because Nasby is stupid, illiterate, coarse and vicious, he damns the cause he favours. His reasoning is absurd, his grammar and spelling atrocious. Used for a serious end, such verbal fooling delighted Northern readers, including President Lincoln, who occasionally read Nasby letters to his cabinet. But topical satire and humour date quickly. Among the many humourists who flourished during and immediately after the Civil War, Locke, perhaps the most influential of his time, is today one of the least readable. He died on Feb. 15, 1888.

See Cyril Clemens, *Petroleum V. Nasby* (1936); Walter Blair, *Horse Sense in American Humor* (1942). (L. T. D.)

NASCIMENTO, FRANCISCO MANOEL DO (pseudonym, Filinto Elísio) (1734–1819), the last of the Portuguese neoclassical poets. He was born in Lisbon on Dec. 23, 1734, of humble and probably adulterous origin. He was educated by the Jesuits and ordained in 1754. Not long afterward he founded a literary society known as the *Grupo da Ribeira das Naus*. In 1768 he became tutor to the daughters of the marquis of Alorna and fell in love with one of them, the "Maria" of his poems. Disapproving of the low-born poet's affection for his daughter, the marquis may have been ultimately responsible for Nascimento's being denounced to the Inquisition in June 1778. He succeeded in escaping to France, however, and there, except for some four years in The Hague during the revolutionary Terror, he remained, living by translations and by taking private pupils. But when he died, in Paris on Feb. 25, 1819, it was recognized that Portugal had lost its foremost poet.

The themes of Nascimento's poetry, which is usually in blank verse, polished, robust but often overladen with archaisms, range from denunciations of the tyranny of the aristocracy, the Inquisition and the hierarchy, coupled with praise of liberty and patriotism, to homely evocations of the joys of life in his native land and laments on the poverty and loneliness of exile. His demonstration of the flexibility and richness of the Portuguese language, his choice of themes and his translations of such works as Wieland's *Oberon* and Chateaubriand's *Les Martyrs* influenced the romantic writers. For portrait *see* article Portuguese Literature.

Bibliography.—*Obras completas de Filinto Elísio*, 22 vol. (1836–40); a useful selection is that edited by J. P. Tavares (1941). *See* also J. M. Pereira de Silva, *Filinto Elísio e a sua época* (1891); T. Braga, *Filinto Elísio* (1901). (N. J. L.)

NASEBY, BATTLE OF, was fought on June 14, 1645, about 20 mi. S. of Leicester, between the parliamentarian army and the royalists under Prince Rupert; it largely decided the first phase of the English Civil War (*see* Civil War, English). Sir Thomas Fairfax, commander in chief of the parliamentarian New Model army that had been formed earlier in 1645, had ultimately been given a free hand on strategy and had made up his mind to attack the main royalist army whose headquarters were at Oxford. Oxford had long been under siege. To relieve the pressure the royalist army broke out and stormed Leicester on May 30, but afterward Charles I was uncertain what to do next and his army lingered at Daventry, in Northamptonshire, collecting supplies. Fairfax advanced to Kislingbury, 8 mi. E. of Daventry, on June 12. On June 14 the king's council of war decided it must accept a battle.

The two armies drew up and faced each other on a one-mile front. The royalist army was deployed along a ridge called Dust hill, the parliamentarian army on another ridge half a mile away; between them lay a valley known as Broad Moor, lying about a mile north of Naseby. Prince Rupert had approximately 10,000 men under his command; the parliamentarians about 14,000. Rupert himself commanded the cavalry on the royalist right, Lord Astley the infantry in the centre and Sir Marmaduke Langdale the cavalry on the left. Facing them were, respectively, the parliamentarian cavalry under Commissary General Henry Ireton, the infantry under Maj. Gen. Philip Skippon and the cavalry on the right under Fairfax and Lieut. Gen. Oliver Cromwell. In spite of his inferior numbers Rupert attacked all along the line. He himself drove back the horse on Ireton's left but then made the mistake of engaging in a wild pursuit; Ireton himself harassed the royalist infantry but soon was wounded and taken prisoner. Meanwhile on the right Fairfax' first line of horse repulsed the royalists. Fairfax himself then went to rally the infantry in the centre and handed over the cavalry command to Cromwell. Unlike Rupert, Cromwell successfully regrouped his troopers and was thus able to go to the help of the parliamentarian foot, who were hard pressed in the centre where Skippon had been wounded. At this stage Charles I, who had a small reserve in hand, wanted to commit it to redress the course of the battle, but was prevented from doing so, and in the confusion the opportunity was missed. By the time Rupert and his men returned from attacking the parliamentarian baggage train near Naseby village, the battle was

virtually over. The parliamentarians claimed to have killed between 400 and 1,000 men, to have taken 4,500 prisoners, and to have captured arms for 8,000 men, while themselves losing only 150 men.

The inferiority of the royalists in numbers and in morale after three years of war chiefly explains the victory. But Rupert's inability to keep his troopers in check, which contrasted with Cromwell's fine discipline of his cavalry, contributed notably to the royalist defeat. The attacks on the royalist infantry's flanks by Ireton and by Cromwell had saved the weakened parliamentarian centre. Fairfax, unlike Rupert, exerted considerable control over the course of the battle and, together with Cromwell, deserved the triumph.

See Austin Woolrych, ***Battles of the English Civil War*** (1961). (M. P. A.)

NASH, JOHN (1752–1835), English architect best known as architect to the prince regent, later George IV, was born in London, son of an engineer and millwright. Starting his career in the office of the architect Sir Robert Taylor, Nash remained there for about ten years. In 1778 he set up in business as architect and builder but in 1783 became bankrupt through speculation and moved to make a fresh start in Carmarthen. Various moderate commissions followed, including jails at Carmarthen, Cardigan and Hereford. He became well established as a country-house architect, designing freely in adaptations of the classical, Gothic and picturesque "cottage orné" styles. Surviving examples of his houses include Llanayron, Cardiganshire; Southgate grove, Middlesex; Sundridge park, Kent; Blaise hamlet, near Bristol; and Cronkhill, Shropshire.

In about 1796 he returned to London and soon entered into informal partnership with Humphrey Repton, the landscape gardener. From the time of his marriage in 1798, Nash seems to have acquired the patronage of the prince regent and also a reasonable fortune, enabling him to remodel and live in a town house, 29 Dover street, and to build himself East Cowes castle, Isle of Wight, in semi-baronial manner.

His major work, begun in 1811, was the development of Regent's park and Regent street as a residential area, linked by a new street to Carlton house and the centre of Georgian London. It incorporated the Regent's canal, churches, artisans' houses, shops and arcades as well as the layout of many of the surrounding streets. Regent street with its well-known Quadrant and colonnades, the latter demolished in 1848, was finished in about 1825 by which date Nash had also built the circular porticoed Church of All Souls, Langham place. These schemes of town planning with their appreciation of the picturesque and skilful use of urban composition on a large scale still provide many of London's most charming features such as Park Village East, Park crescent and Carlton House terrace.

From 1813 to 1815 Nash held the post of deputy surveyor general; he had also become the prince regent's personal architect in which capacity he extended and greatly altered the Royal pavilion, Brighton (1815–23), in a fanciful "Hindoo" style at enormous total cost of about £160,000. In 1821 instructions were given that Buckingham house should be rebuilt as a royal palace, again regardless of expense. The king, however, died in 1830 and Nash's work at Buckingham palace was never completed as he shared his master's unpopularity and was dismissed. Subsequently, in 1831, he was required to answer an inquiry into the expenditure and alleged defects of the building. He died at Cowes on May 13, 1835.

See J. N. Summerson, ***John Nash*** (1935). (E. C. D.)

NASH, PAUL (1889–1946), English painter appointed an official war artist in both World Wars I and II, was born in London on May 11, 1889, and studied at the Slade school, London. In 1914 he enlisted in the artists' rifles and his 1918 exhibition of paintings portrayed with abstract detachment shattered war landscapes, such as "Menin Road" (Imperial War museum, London). There followed seascapes ("Wall Against the Sea," Carnegie institute, Pittsburgh) and landscapes ("Oxenbridge," Birmingham art gallery, Eng.) of distinguished design and cool, vibrating colours; and book illustrations and wood engravings. In the 1930s his paintings developed freer design and richer colour, together with a symbolic, "fourth-dimensional" vision influenced by surrealism. One of his best-known paintings of World War II was "Totes Meer" ("Dead Sea," Tate gallery, London). Later paintings reveal his imaginative poetic symbolism; *e.g.*, "November Moon" (Fitzwilliam museum, Cambridge, Eng.) and "Solstice of the Sunflower" (National gallery, Ottawa). Nash died at Boscombe, Hampshire, on July 11, 1946.

See Paul Nash, ***Outline*** (1949); M. Eates (ed.), ***Paul Nash*** (1948). (M. T. N.)

NASH, RICHARD (1674–1762), first of the great dandies of England, known as BEAU NASH, and also as "Monarch of Bath and Tunbridge Wells." He was born of upper-middle-class Welsh parents on Oct. 18, 1674, at Swansea, where his father, reduced by Cromwell's wars, was operating a bottle factory. Young Nash, after Carmarthen grammar school and a year at Jesus college, Oxford, bought his way into the guards as an ensign. Introduced thereby to London society, he "put his whole intellect into a bow." When army pay proved insufficient he entered at 20 the Inner Temple, less to study law than "the art of living without money." Over the gaming tables Nash rounded his manner. The epicures dubbed him "the Count" and the benchers chose him master of the revels on the accession, singly, of William III in 1695. Capt. (afterward Sir) John Vanbrugh, to depict a beau, modeled from Nash the title part of the comedy *Aesop* (1697).

When Queen Anne passed a month at Bath, she drew thither the nobility, who in turn attracted gamblers, among them, in 1705, Beau Nash. He gained the patronage of the manager, Captain Webster, who was soon afterward killed by a duelist. Bath corporation thereupon elected Nash master of ceremonies. He elevated the standard of manners by forbidding swords, boots and aprons in assemblies; he regulated chair-men; he fixed charges for lodgings. Improving Bath itself, he built roads, promoted assembly rooms and founded a mineral-water hospital with 108 beds for the poor. In 1715 the Beau began opening the season in Tunbridge Wells and controlled the resort from 1735, when its manageress died. Three years later he entertained the prince of Wales at Bath. Nash wore a large white three-cornered cocked hat, dressed elaborately and traveled in royal manner in a coach-and-six. Lord Chesterfield said many in the ballroom took the gold-laced master, at a distance, for "a gilt garland." Unmarried, he was egoistic and flippant, though openhanded, and excelled as a mediator. After 1745 antigambling laws ruined his livelihood. Nash died at Bath on Feb. 3, 1762, a threadbare pensioner, but was buried with pomp in Bath abbey.

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NASHE (NASH), **THOMAS** (1567–1601?), English pamphleteer, poet and dramatist, was born in 1567 at Lowestoft, Suffolk, the son of a Herefordshire minister. In 1581 or 1582 he matriculated at St. John's college, Cambridge. About 1588 he left Cambridge and went to London, where he became associated with Robert Greene and other professional authors. His first appearance in print was his preface to Greene's *Menaphon* (1589), though he probably wrote *The anatomie of absurditie* (1589) earlier. Both works reveal the recent university graduate: a fervid but traditional espousal of literary standards, violent hostility to popular literature, a conventional misogynic attitude and a style tainted by euphuism. The learning is pretentious and the tone often arrogant and sometimes coarse: "I will persecute those idiots and their heires unto the third generation, that have made Art bankerout of her ornaments, and sent Poetry a begging up and downe the Countrey."

In 1589 and 1590 he evidently became a paid hack of the episcopacy in the Marprelate controversy (*q.v.*), and matched wits with the unidentified, but enormously clever, "Martin." Almost all the replies to Martin have variously been assigned to Nashe, but the only one that has been convincingly attributed is *An Almond for a Parrat* (1590). He wrote the preface to Thomas Newman's unauthorized edition of Sir Philip Sidney's *Astrophel and Stella* (1591). Though Nashe penned an extravagant, servile

dedication to Sidney's sister, the countess of Pembroke, the book was withdrawn and reissued in the same year without Nashe's foreword.

Pierce Penilesse his supplication to the divell (1592) revealed Nashe's artistic strengths and weaknesses. Purged of euphuistic affectations, his prose had become a combination of colloquial diction and idiosyncratic coined compounds ideal for controversy and for his eccentric discussion of the seven deadly sins. But verbal facility was frequently an end in itself; Nashe rambled, inserting whatever came to mind, and failed to impose a consistent structure upon his material. In a digression he attacked Richard Harvey and thus added to Greene's diatribe against the Harveys in *A quip for an upstart courtier* (1592) a passage which Greene deleted before his death on Sept. 3, 1592. After Gabriel Harvey (*q.v.*) had assailed both Greene and Nashe in *Four Letters and certaine sonnets* (1592), in *Strange newes* (1592), Nashe defended, but not too strenuously, the memory of his friend and heaped further abuse upon the Harvey family. Then, in the foreword to *Christs teares over Jerusalem* (1593), he indicated willingness to end the dispute, but when Harvey, who was probably unaware of the proposal, printed *Pierces supererogation* (1593), Nashe withdrew the preface in the second edition, and wittily burlesqued his opponent in *Have with you to Saffron-Walden* (1596). Thomas Middleton, writing in 1604, was probably most accurate when he termed this controversy "but the running a tilt of wits in booksellers' shops on both sides of John of Paul's churchyard." For in 1592 and 1593 Harvey was in the employ of John Wolfe, who printed his pamphlets, and, if Harvey is to be credited, Nashe was as early as 1593 a hack in the printing establishment of John Danter. The flyting was officially terminated in 1599, when the archbishop of Canterbury ordered "that all Nasshes bookes and Doctor Harveyes bookes be taken wheresoever they maye be found and that none of theire books bee ever printed hereafter."

Apparently Nashe wrote *Strange newes* while he was living in late 1592 and early 1593 at the home of Sir George Carey, who dramatically relieved for the moment his oppressive poverty. *Christs teares over Jerusalem* and *The Terrors of the Night* (1593) were dedicated to members of the Carey family. In the former Nashe ominously warned his countrymen during one of the worst plagues that unless they reformed London would suffer the fate of Jerusalem, and so strenuously condemned the greed of London merchants that he was forced to cancel the offending passage. *The Terrors of the Night* was a discursive, sometimes bewildering, attack on demonology. Both works were medieval in their attitudes and almost puritanical in their moral indictments.

Pierce Penilesse excepted, Nashe's most successful works were his masque, *Summers last Will and Testament* (1592, publ. 1600), his novel *The unfortunate traveller, or, The life of Jacke Wilton* (1594) and *Nashes lenten stuffe* (1599). *The unfortunate traveller* has brilliant sections, including the romance of the earl of Surrey and Geraldine, but it is marred by Nashe's lack of artistic control and by his repellent fascination with cruelty and violence. *Lenten stuffe*, purportedly a panegyric of red herrings, contained a charming description of Yarmouth, Norfolk, and a serio-comic treatment of Hero and Leander.

By his share in a lost stage comedy entitled *The Isle of Dogs* (1597) and labeled seditious, Nashe offended the authorities. Exactly what punishment he received is unknown, but Ben Jonson and others were temporarily imprisoned. In the remaining years of his life Nashe apparently retired from London to Yarmouth. He died in 1600 or 1601. Nashe was the first of the English prose eccentrics, an extraordinary inventer of verbal hybrids, and, according to C. S. Lewis, "the supreme master of literary *sansculottisme*." (C. S. Lewis, *English Literature in the Sixteenth Century*, Oxford University Press, London, 1954.) Unfortunately he neither had time because of financial need nor the temperament necessary to realize fully his undoubted talents.

The Works were edited by R. B. McKerrow, five volumes (1904–10; revised edition by F. P. Wilson, 1958).

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NASHUA, a city of New Hampshire, U.S., is located on the Merrimack and Nashua rivers 40 mi. N.W. of Boston, Mass.; the seat of Hillsboro county. It has extensive manufacturing. With the post-World War II withdrawal of textiles the city developed a diversified industrial base through the Nashua-New Hampshire foundation, which includes shoes, paper products, electronics, chemicals, office equipment, millwork, plastics, greeting cards, asbestos products and machinery for the manufacture of plastic and paper.

The site was originally part of Massachusetts province but the 1741 boundary settlement placed it in New Hampshire. This led to local resentment and a five-year delay in applying for a charter as Dunstable, N.H. In 1803 the village of Indian Head, across the Nashua river, took the name of Nashua (believed to have been derived from a local Indian tribe). The two settlements joined in 1837 as Nashua. The northern section withdrew, as Nashville, in 1842 over a dispute in locating the town hall. They were reunited under a city charter in 1853.

Nashua is the site of Rivier, a Roman Catholic college for women, founded in 1933. The city early attracted Irish immigrants to the textile mills, followed by large numbers of French Canadians. The latter still form the major ethnic group, although Lithuanian, Polish and Greek immigrants subsequently contributed to the cosmopolitan character of the community. For comparative population figures *see* table in New Hampshire: *Population*. (L. F. R.)

NASHVILLE, capital city of Tennessee, U.S., and seat of Davidson county, is situated on the Cumberland river in the north central portion of the middle Tennessee basin. Pop. (1960) 170,874. (For comparative population figures *see* table in Tennessee: *Population*.)

History.—The first English settlement in Tennessee west of the Allegheny mountains, the city was founded in 1779 by settlers from eastern Tennessee under the leadership of James Robertson and John Donelson. The site of the city had been occupied much earlier by French traders, who operated a trading post near the present downtown area, and before that by the Shawnee Indians. It was originally named Fort Nashborough, for Gen. Francis Nash of North Carolina, and in 1784 took its present name.

One of the prime movers behind the settlement of Fort Nashborough was Richard Henderson, a North Carolina jurist, who in 1775 acquired most of middle Tennessee and Kentucky in the famous Transylvania purchase from the Cherokee Indians. He also is credited with having written the Cumberland Compact, the articles of self-government adopted by the settlers, which contained the first known provision in the United States for recall of elected officials (*see* Tennessee: *History*). Henderson's settlement was under frequent Indian attack in its early years and for a while these attacks seemed likely to destroy the infant colony. But with the end of the American Revolution many new settlers arrived increasing the population and treaties of peace were soon signed with the formerly hostile Indians.

The city grew rapidly in the first half of the 19th century and soon became a thriving trade centre for the entire middle Tennessee area. Radiating from the city like the spokes of a wheel was an extensive system of turnpikes over which the produce of the surrounding area was brought to the city's Cumberland river docks. Nashville's commercial importance was further enhanced in the 1850s when it acquired railroad connections with major commercial cities to the north and south. The city also became a political centre of the state. In 1826, just two years before Andrew Jackson became president of the United States, Nashville was selected as temporary capital of the state; in 1843 it became the permanent capital.

Its transportation facilities and strategic location made Nashville an important city in the campaigns of the American Civil War. It was occupied by Federal troops in Feb. 1862, shortly after the capture of Ft. Donelson, the Confederacy's key defense position on the Cumberland river. Nashville was under Federal

military control for the remainder of the war and from March 3, 1862, to March 1865 it was the seat of government for Military Governor Andrew Johnson. It also was a major supply base for Federal operations in the lower South. Its warehouses and railroads played an important part in Gen. William T. Sherman's 1864 campaign against Atlanta.

The last major battle of the Civil War took place at Nashville a few months after the fall of Atlanta. Confederate Gen. John B. Hood moved back into Tennessee in an effort to cut Sherman's supply lines and perhaps threaten Cincinnati and other northern cities. After suffering heavy losses in the battle of Franklin (Nov. 30, 1864), Hood advanced to the southern outskirts of Nashville, about 15 mi. N. of Franklin and there established defensive lines across the railroad tracks leading south. On Dec. 15, 1864, the Union army, commanded by Gen. George H. Thomas, marched out against Hood and overwhelmingly defeated the badly outnumbered Confederates. On the following day the Union victory was made complete and the Confederate army retreated in near disorder into Alabama.

Since Nashville had been occupied early in the war and without a fight, the city suffered less physical destruction than most occupied southern cities. Union warehousing and supply operations were not without economic benefit to the city and the many Federal soldiers who remained in Nashville after the war helped promote its economic recovery. Nashville resumed and improved its position as a leading investment and commercial centre and by the turn of the century was also becoming an important manufacturing centre in the state. Its continuing industrial development was greatly accelerated in the 20th century by the availability of cheap electric power from the Tennessee Valley authority and from the Cumberland river dams of the U.S. army corps of engineers.

Population and Government.—In 1960 the Nashville standard metropolitan statistical area (SMSA), consisting of Davidson county, had a population of 399,743. In 1963 the SMSA was enlarged to include Sumner and Wilson counties, bringing its population (based on the 1960 census) to 463,628.

Prior to April 1, 1963, government of the city was by a mayor and council, while most residents of Davidson county outside the city were governed by a county judge and county court. A few areas in the suburbs were incorporated as separate cities under varying forms of city government. For many years the city had been slow to expand its boundaries. On June 29, 1962, however, a new metropolitan form of government, to replace the separate city and county governments, was adopted in a special election. The validity of this new form of government was subsequently affirmed by the state supreme court on Oct. 5, 1962, and put into effect on April 1, 1963. During the following year a planned and orderly consolidation of city and county functions was effected. While these changes were being made, the city was also engaged in ambitious and progressive programs of urban renewal, slum clearance, improved street lighting, expansion of airport facilities and other civic improvements.

As was the case with other Tennessee cities, Nashville was for many years grossly underrepresented in the state legislature. The U.S. supreme court decided in *Baker* v. *Carr* (1962) that the state's legislative apportionment was a proper subject for review by federal courts, resulting in legislation giving greater representation to Nashville and other urban areas (*see* TENNESSEE: *Government*).

Commerce, Industry and Transportation.—Nashville has a well diversified economy. Investment firms and insurance firms are both important. There are more than 500 manufacturing plants but no single one is a dominant element in the city's economy. The largest industrial plant is one producing dacron and cellophane at Old Hickory, a suburban industrial city built as an explosives centre during World War I. Other major industries produce shoes, major parts for airplanes, vacuum bottles and lunch kits, river transport equipment and paper bags. Important additions to the city's industrial development include a glass plant and a rubber plant.

Nashville is widely known as a religious centre. It is the site of the national headquarters of several boards and agencies of the Methodist Church, the Sunday School board of the Southern Baptist convention and the international headquarters of the Disciples of Christ Historical society. The Methodist Publishing House is said to be the largest religious publishing house in the world and is one of the few major publishers that operates its own printing plant; its interdenominational magazine *The Upper Room* is claimed to be the world's most widely used devotional guide, being printed in over 30 languages. This publishing house is only one of a large number that make printing and publishing one of the city's major industries. The Southern Baptist convention also operates a publishing house.

During the second quarter of the 20th century the city became widely known as an entertainment centre, largely through its "country music" industry. Regular radio broadcasts of the "Grand Ole Opry" began in 1925 and national network broadcasts in 1939; it consistently attracted capacity audiences to its performances in historic Ryman auditorium. Country music is also the mainstay of a very large recording industry.

Nashville is served by several airlines, two railroads and more than 40 motor-freight lines, several of which have their home offices in the city. It is the major river port on the Cumberland.

Education.—Vanderbilt, a private university founded in 1873, ranks as one of the nation's leading universities; it has schools of liberal arts, medicine, law, religion, engineering, nursing and graduate studies. On adjoining campuses are George Peabody College for Teachers (private), founded as Davidson academy in 1785, and Scarritt College for Christian Workers, a Methodist senior college and graduate school chartered in 1924. Nearby is Belmont college, established in 1951 by the Tennessee Baptist convention on the historic property formerly occupied by Ward-Belmont college, now defunct; farther south is David Lipscomb college, founded in 1891 and affiliated with the Churches of Christ. In the west portion of the city are Fisk university, established in 1865 and affiliated with the American Missionary association, and, on an adjoining campus, Meharry Medical college (Methodist), founded in 1876. Still farther west is Tennessee Agricultural and Industrial State university, established in 1912. The city also has two highly regarded private preparatory schools, Harpeth Hall (for girls) and Montgomery Bell academy (for boys). Well-known private schools in nearby outlying towns are Battle Ground academy in Franklin, Castle Heights Military academy in Lebanon and Columbia Military academy in Columbia, all for boys.

Parks and Recreation.—Nashville's park system includes more than 30 city parks. The best known is Centennial park, which occupies 132 ac. of the state centennial exposition grounds and features the world's only full-scale reproduction of the Parthenon. Edwin Warner park and Percy Warner park, adjoining each other in the southwestern portion of the county near the city's Fine Arts Center and Botanical Gardens, contain 2,665 ac. of hilly land of great natural beauty. These parks contain scenic roads, picnic and play areas, hiking and riding trails and a municipal golf course. Old Hickory lake, a 22,500-ac. impoundment of the Cumberland river, is another major recreational area.

The area's best-known historic site is The Hermitage, the home of Andrew Jackson. It annually attracts thousands of visitors, many of whom also visit Belle Meade, a famous 19th-century plantation home and thoroughbred nursery; Traveler's Rest, the home of Jackson's close friend and business associate, John Overton; and Ft. Nashborough, a reconstruction of the fort around which the city developed. (W. T. A.)

NASI, JOSEPH (1520?–1579), Jewish statesman and financier, who rose to a position of power in Turkey under the sultans Suleiman the Magnificent and Selim II. Of Marrano descent, Nasi was born in Portugal and baptized under the Christian name of João Miguez. He moved to Antwerp in 1536 with his aunt Doña Gracia Nasi, wife of the banker Francisco Mendes. There he gained a thorough knowledge of commercial and financial affairs in the service of the house of Mendes. In 1554 Nasi settled at Istanbul, declared himself to be a Jew and married his cousin Reyna, the daughter of Doña Gracia. He soon attained high favour with Sultan Suleiman and his son Selim. At Tiberias in Palestine—the town and seven neighbouring villages were granted to him by the sultan in 1561—he strove to establish a community

of Jewish refugees from Europe. Five years later, in 1566, Selim II, having just ascended the Ottoman throne, made him duke of Naxos. His influence, hostile to Venice, contributed not a little to the decision made at the Porte in 1571 to attempt the conquest of Cyprus. After the death of Selim II in 1574 Nasi found himself excluded from an effective role in public affairs. The last years of his life were spent in virtual retirement at his villa of Belvedere near Galata. He died there on Aug. 2, 1579.

See C. Roth, *The House of Nasi, the Duke of Naxos* (1948).

(V. J. P.)

NASIK, a town and district in the Bombay division of Maharashtra, India. The town, headquarters of the district, lies on the Godavari river, 6 mi. from the Central railway and 110 mi. N.E. of Bombay. Pop. (1961) 131,103. It is a place of Hindu pilgrimage because of the sanctity of the Godavari river and the belief that Rama, the legendary hero of the epic *Ramayana,* lived there for a time with his wife Sita and his brother Lakshman. The town lies mainly on the right (south) bank of the river; Panchavati, the quarter on the left bank, has several temples. The river banks are lined with ghats (stepped bathing places). The town has an arts and science college, affiliated to Poona university, and is the seat of an Anglican bishop. Brass- and copperware, especially statues, caskets, chains and lamps, are manufactured. Interesting places include the *Dasahara* maidan (open space), the Jain Chambhar caves and Pandu Lena, a group of Buddhist caves (1st century B.C.–6th century A.D.).

NASIK DISTRICT, with the exception of a few villages in the west, is on a plateau 1,300–2,000 ft. above sea level. Area 6,020 sq.mi. Pop. (1961) 1,855,246. The west is hilly and intersected by ravines; the east is open, fertile and well cultivated. The Sahyadri range stretches north-south, the watershed formed by the Chandor range running east-west. All streams south of this watershed join the eastward-flowing Godavari; north of it the Girna and its tributary the Mosam join the westward-flowing Tapti. The Kadva canal (1874), the Girna left-bank canal (1909) and the Godavari right- and left-bank canals (1911) irrigate about 87,000 ac. At Gangapur, 8 mi. W. of Nasik, an earthen dam (built 1949–54) irrigates about 45,000 ac. The chief crops are bajra, jowar, pulses, oilseeds, cotton, sugarcane, guavas, potatoes, peanuts and betel nuts. Manufactures include cotton and silk textiles, gold and silver thread and copper, brass and silver vessels. At Ravalgaon is a sugar factory and there are railway workshops at Igatpuri and Manmad. Places of interest include the Govindeshwar temple at Sinnar, the Ankai and Tringalwadi caves near Igatpuri, the Jogeshwar temple in Baglan, and numerous hill forts. Other larger towns include Malegaon, Yeola and the military station Deolali. (M. R. P.)

NASIR AD-DIN (NASR AD-DIN) (1831–1896), shah of Persia from 1848 to 1896, was born probably at Teheran on July 17, 1831. Although not the eldest son of his father, Mohammed Shah, he was, through his mother's influence, made heir apparent. Serious disturbances which broke out on his accession in 1848 were quelled mainly through the efforts of his extremely capable and honest chief minister, Mirza Taqi Khan. Thereafter some much-needed reforms were introduced. These reforms, however, made Taqi Khan many enemies, and he was hated by the queen-mother, who had great influence over the young shah. The consequence was that Taqi Khan was disgraced and finally murdered. In 1853 the shah himself narrowly escaped death at the hands of three fanatical Babis (*see* BABISM). Although in general kindly and humane, Nasir ad-Din thereupon embarked on a fierce persecution of the Babis.

Being unable to regain any of the territory lost to Russia in the two disastrous wars which were waged in the reign of Fath Ali Shah, Nasir ad-Din endeavoured to seek some compensation for these losses by seizing Herat in 1856. Great Britain thereupon declared war on Persia, forcing the shah to relinquish Herat and to recognize the kingdom of Afghanistan.

Although imbued at first with liberal ideas through the influence of Taqi Khan, the shah subsequently became opposed to reforms. Nevertheless, he ruled his country firmly and well for the greater part of his reign. It can indeed be said that he was the best sovereign of the Qajar line. He curbed the excessive power of the mullahs by the gradual reassertion of the civil authority and by the introduction of the lay administration of religious properties; and despite his fear of reforms, he took certain measures which resulted in the partial opening up and modernization of the country. Telegraph and postal services were introduced; the construction of roads practicable for wheeled traffic was begun; and education on modern lines was initiated by the establishment, in 1851, of the *Dar al-Funun* (École Polytechnique) in Teheran, where modern scientific ideas and European languages could be studied.

Nasir ad-Din visited Europe in 1873, 1878 and 1889; he kept diaries of these visits which were published in Persian and English. The shah became unpopular in his later years because of his refusal to yield to the increasing demands for reforms and of his granting extensive concessionary rights to foreigners in return for lavish payments most of which went into his own pocket. He was assassinated at Teheran by a fanatic on May 1, 1896. *See* also IRAN: *Administration and Social Conditions;* PERSIAN HISTORY: *Qajar Dynasty.*

See G. N. Curzon, *Persia and the Persian Question,* vol. i, pp. 391–412 (1892); J. Feuvrier, *Trois Ans à la cour de Perse,* 2nd ed. (1906).

(L. Lo.)

NASIR-I KHUSRAU (1004–1088), Persian poet, theologian and religious propagandist, whose later life and work were influenced by his conversion to Isma'ilism, was born near Balkh (in Afghan Turkestan) of a Shi'ite family. He served in the Saljuq government of Khorasan before resigning to make the pilgrimage to Mecca. Continuing his journey into Palestine and Egypt, he was impressed by the splendour of Fatimid rule in Cairo and it was as an ardent Isma'ili convert that he returned to Balkh in 1053. His vigorous advocacy of that heresy obliged him soon to flee to the mountains of Badakhshan (northwest Hindu Kush), where he ended his days. His poems of a didactic and devotional character consist mainly of long odes considered to be of high literary quality; he is also credited with two moralizing sequences, the *Sa'adat-nama* and the *Raushana'i-nama.* His most celebrated prose work is the *Safar-nama,* a diary describing his journey. It is a most valuable record of the scenes and events which he witnessed. He also wrote more than a dozen treatises expounding the doctrines of the Isma'ilis, among them the *Jami' al-hikmatain,* in which he attempted a harmony between theology and philosophy. Nasir-i Khusrau's style is straightforward and vigorous. In his verse he displays great technical virtuosity, while his prose is remarkable for the richness of its philosophical vocabulary.

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NASIRIYAH (AN NASIRIYAH), a town of southern Iraq, capital of the *liwa'* (province) of the same name, about 110 mi. N.W. of Basra. Pop. (1957) 39,060. A bridging point and local market situated on the north bank of the Euphrates, Nasiriyah was founded about 1870 by Nasir Sadun Pasha, then paramount sheikh of the Muntafiq confederation, who became an Ottoman official and furthered Midhat Pasha's policy of reducing nomadism in Iraq. The town, surrounded by a mud wall and numerous bunds to prevent flooding, is built mainly of brick (mostly sun-dried), with relatively broad streets. About three-quarters of the population are Shi'ah Muslims, and there is a community of Sabians engaged in silverworking, boatbuilding and carpentry, together with a few Persians and Kurds.

NASIRIYAH LIWA', formerly named after the Muntafiq tribe, lies between Diwaniyah *liwa'* on the west and Basra *liwa'* on the east. Area 5,580 sq.mi. Pop. (1957) 455,644. Though relatively small in size, it is one of the most densely populated regions in Iraq owing to the relative abundance of cultivated land and the presence of many nomads and semisettled pastoralists. Wheat, barley and dates are grown, and there is an important rice area in the extreme southeast extending from the head of Lake Hammar. The sheep-herding nomads play a greater part in local economic life than they do in many other riverine areas of Iraq. Corresponding

closely in boundaries with the Ottoman sanjak of Muntafiq, which with Basra and Amarah formed the old *vilayet* of Basra, Nasiriyah *liwa'* is the lowest portion of the Euphrates valley before the river spreads out into the extremely shallow and marshy Lake Hammar. The ruins of Larsa, Ur, Erech, Eridu and Lagash are all found in this region. (W. B. Fr.)

NASMYTH, ALEXANDER (1758–1840), Scottish portrait and landscape painter, was born in Edinburgh on Sept. 9, 1758. His work attracted the attention of the portrait painter Allan Ramsay, who took him to London and employed him upon the subordinate portions of his portraits. Nasmyth returned to Edinburgh in 1778, and was soon largely patronized as a portrait painter. He also assisted Patrick Miller of Dalswinton, as draftsman, in his mechanical researches and experiments. Miller advanced him money to go to Italy in 1782, where he remained two years. On his return he painted the portrait of Robert Burns now in the Scottish National Portrait gallery. Although they are little known, some of his portraits, and in particular the conversation pieces he executed in the 1780s and 1790s, are of considerable interest. Nasmyth's pronounced Liberal opinions gave offense to many of his aristocratic patrons, and led to the diminution of his practice as a portraitist. In his later years, accordingly, he worked mainly at landscapes. His subjects are carefully finished and coloured, but are wanting in boldness and freedom. He also designed sets for the theatre and worked as an architect. He invented the "bow-and-string" bridge and is known for his designs for the Dean bridge, Edinburgh, and the graceful circular temple covering St. Bernard's well. Nasmyth died in Edinburgh on April 10, 1840.

NASMYTH, JAMES (1808–1890), Scottish engineer and inventor of the steam hammer, was born in Edinburgh on Aug. 19, 1808, the youngest son of Alexander Nasmyth (*q.v.*). He started his own business in Manchester in 1834, and in a few years was at the head of the prosperous Bridgewater foundry at Patricroft, near Manchester. The invention of the steam hammer was actually made in 1839, when a drawing of the device appeared in his notebook, or "scheme-book," as he called it, in that year. Nasmyth designed the steam hammer to meet the difficulty experienced by the builders of the "Great Britain" steamship in finding a firm that would undertake to forge the 30-in.-diameter paddle wheel shaft originally designed for that vessel, but he did not construct the machine until 1843. He did much to improve machine tools and devised many new appliances—the shaping machine ("Nasmyth steam-arm"), a nut-milling machine, steam pile driver, and hydraulic machinery. He died in London on May 7, 1890.

His autobiography was edited by Samuel Smiles (1883).

NASRIDS, the last of the Muslim dynasties of Spain, ruled in Granada from 1238 to 1492 (*see* Granada, Kingdom of). The family rose to power in the turmoil which followed the defeat of the Almohads at the battle of Las Navas de Tolosa in 1212. The first Nasrid ruler, Mohammed I (d. 1273), became a tributary vassal of King Ferdinand III of Castile and assisted him at the capture of Seville in 1248. He started the construction of the Alhambra (*q.v.*) and laid the basis of Granada's prosperity by welcoming refugees from Seville, Valencia and Murcia. His successors were weakened by dynastic and factional strife: in two and a half centuries there were 20 Nasrid rulers. Most of them died violently; several were expelled and restored two or three times. The dynasty wavered between submission to Castile and dependence on their Marinid kinsmen of Fès, whose mercenaries often dictated the political fortunes of Granada. The African alliance proved disastrous, leading, for example, to the defeat of Yusuf I (1333–54) at Río Salado (1340) by Alfonso XI. After two centuries of internal disorder and border warfare, in which the Christians had taken a series of key positions (notably Gibraltar in 1462), Nasrid rule was finally doomed by Mulay Hasan (Abu-l-Hasan Ali) (1466–82), who renewed hostilities against Castile and at the same time plunged his subjects into civil war by opposing the succession of his legitimate heir, Boabdil (*q.v.*).

NASSAU, the capital of the Bahamas, is a port on the northeastern coast of New Providence Island. Founded on the site of the village of Charles Towne, it was not until 1690 that it took its present name and not until 1729 that the city was laid out. (*See also* Bahamas.) Pop. (1963) 80,907.

The temperate climate (average temperature November–May, 23° C. [74° F.], June–October, 28° C. [82° F.]), beautiful scenery and fine beaches make Nassau one of the chief pleasure resorts of the world. The city proper covers a comparatively small area but the residential districts extend for a considerable distance along the coast. From Bennett's hill, a ridge south of the city, there is a view not only of the city and harbour but also of almost the whole island. The water tower, a conspicuous landmark on the ridge, is the source of the city's water supply. Below the tower is Ft. Fincastle (1793), one of several built during the 18th century when Nassau was fortified. On Mt. Fitzwilliam above the city is the imposing white building of Government house; in the middle of a long flight of steps in front of it stands a statue of Christopher Columbus. On George street, which leads downhill to the town, stands Christ Church Anglican cathedral. The city's centre is Rawson square with the law courts and chief government buildings; Christ Church cathedral and the public library are nearby. The main shopping and business street is Bay street, which also has the public market (1901). Bay street runs parallel with the harbour front. Offshore, at the eastern end of the harbour, are the marine gardens, where glass-bottomed boats are available for sight-seeing. The natural vegetation of Nassau is exceedingly beautiful, the scarlet poinciana tree flowering from May to September and the poinsettia at Christmastime, and the purple bougainvillea growing profusely along the hedgerows. In the Ardastra gardens along Bay street to the west of the city are many rare tropical plants.

The harbour, which is sheltered by Hog Island, accommodates vessels of 24-ft. draft. There are no important industries on the island, but products including sisal, sponges, citrus fruits, tomatoes and pineapples are exported.

Nassau is easily reached by sea or air. From the airport at Windsor field there is regular service to airports in the U.S., Great Britain and elsewhere. There is also local service to other islands in the Bahamas.

See W. W. Cartwright (ed.), *Pocket Guide to Nassau,* 8th ed. (1954); *Historic Forts of Nassau* (1932).

NASSAU, a historic territory of western Germany, corresponding under the Federal Republic of Germany to the westernmost part of the *Land* Hesse (*q.v.*) together with the district of Montabaur in the *Land* Rhineland-Palatinate. In its consolidated form (1816–66) as a sovereign duchy, Nassau had an area of 1,830 sq.mi., being divided approximately into halves by the Lahn river and bounded south by the Main, southwest by the Rhine, northwest and north by parts of Prussia's Rhine province and Prussian Westphalia and east by parts of Grand-Ducal Hesse, by Prussian Wetzlar, by Hesse-Homburg and by Frankfurt am Main. South of the Lahn are the Taunus mountains; north is the barren Westerwald. Thickly wooded, Nassau has valleys rich in grain and fruit, notable vineyards, numerous spas and deposits of iron, lead, copper, silver and malachite.

History.—In Roman times the south of the country was inhabited by the Germanic Mattiaci. During the great migrations, it was occupied by the Alamanni. The Franks, having annexed the north, overran the south in the reign of Clovis; and in the 6th–7th centuries Christianity was introduced. Before 1128 the counts of Laurenburg, of the local nobility, built a castle overlooking the Lahn near the town of Nassau; and Walram (d. 1198) took the title of count of Nassau. His grandsons divided their inheritance in 1255: Walram II took the south, with Weilburg, Idstein and Wiesbaden; Otto I took the north, with Dillenburg and Siegen.

Walramian Nassau.—Walram II's son Adolf (*q.v.*) was German king from 1292 to 1298. His descendants, however, continually partitioned their lands. Nassau-Weilburg, separated from Nassau-Idstein-Wiesbaden in 1355, became a princely countship of the *Reich* in 1366 and acquired Saarbrücken and also Commercy (in Lorraine) in 1381, but was split into Weilburg and Saarbrücken branches from 1442 to 1574 and again in 1574 and 1594. After the reversion of the whole Walramian inheritance to Weilburg (1605) new partitions in 1629 and 1651 divided it between three lines,

Weilburg, Idstein and Saarbrücken-Usingen. The last named was subdivided into branches of its own from 1659 to 1728 and from 1735 to 1797, but had the Idstein succession from 1722.

When the lands west of the Rhine were ceded to France (1801), Nassau-Weilburg and Nassau-Usingen made common cause and won substantial compensation in 1803 (*see* GERMANY: *History*). Entering Napoleon's Confederation of the Rhine and making some cessions to Berg in 1806, Walramian Nassau received further territory (notably at the expense of Ottonian Nassau) and became a duchy. It was maintained as a sovereign duchy by the congress of Vienna; and the extinction of the Usingen line in 1816 made William of Weilburg (1792–1839) sole duke of Nassau. His successor Adolf (1817–1905) took Austria's side in the Seven Weeks' War; and on Oct. 3, 1866, Nassau was annexed by Prussia—to form the bulk of the Wiesbaden district of the province of Hesse-Nassau.

Ottonian Nassau.—Otto I's descendants also indulged in partitions and subdivisions: Dillenburg and Hadamar (1290–1394); Dillenburg-Dillenburg and Dillenburg-Beilstein (1343–1561); and Dillenburg-Dillenburg and Dillenburg-Breda (1516–44). It was by legacy from the Breda branch that William of Nassau-Dillenburg became prince of Orange (*see* ORANGE, HOUSE OF; WILLIAM I the Silent). The sons of his brother John VI of Nassau-Dillenburg (d. 1606) effected a fourfold partition of their patrimony, but the branch of Nassau-Dietz eventually reaccumulated it as the others died out (Nassau-Hadamar in 1711, Nassau-Dillenburg in 1739, Nassau-Siegen in 1743). Having lost their German possessions in 1806, the Ottonians in 1815 received Luxembourg in compensation. They also had the kingdom of the Netherlands. When their male line died out in 1890, Luxembourg passed to their distant Walramian cousin Adolf.

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NASSER, GAMAL ABD-AL- (1918–), Egyptian army officer and political leader, became the president of Egypt in 1956. He was born at Beni Mor in Asyut province, upper Egypt, on Jan. 15, 1918, the son of a post-office civil servant, and was educated in Cairo at a secondary school and at the military college to which, after a period of normal military duties, he was appointed a lecturer in 1942. Intensely patriotic and politically active, Nasser formed a group of young officers dedicated to the cause of Egyptian nationalism. By 1945 a substantial group of "free officers" formed a secret organization around Nasser. The Palestine war of 1948–49, in which Nasser narrowly escaped death from a chest wound, did much to harden their bitterness and determination. After the war the organization of the free officers was tightened, and underground propaganda against the regime was undertaken. In July 1952 the coup was executed that led to the deposition of King Faruk (*q.v.*). Although from the outset real power rested in the hands of the Revolutionary Command Council of 11 officers controlled by Nasser (by this time a lieutenant colonel), Maj. Gen. Mohammed Naguib (*q.v.*) was at first put forward as the leader of the military regime. In 1953 Naguib was named prime minister and president of the new republic with Nasser as deputy prime minister and minister of the interior. In 1954, however, Naguib was deprived of his titles, and Nasser, escaping unhurt from an attempt on his life in Alexandria, emerged as prime minister and the real ruler of Egypt. In June 1956 he was elected president.

Nasser, like most of the other cadets who joined the military college with him in 1936, had sprung from the *fellah* middle class, the native Egyptians of the provincial towns. What he and they wanted was not only the effective independence of the country but good, uncorrupt government in the hands of people like themselves. Something of their aims at this time may be learned from Nasser's published writings and speeches (including his *Philosophy of the Revolution*, 1954).

Although at first inexperienced in the problems of power, Nasser soon became not only a national but an international figure. His first major success was the negotiation of the agreement for the withdrawal of British troops from the Suez canal zone (1954). His


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NASSER

nationalization of the Suez Canal Company (July 26, 1956), following withdrawal of Western promises of aid in building the Aswan High Dam, was interrupted, but only briefly, by the Suez conflict of that year (*see* SUEZ CANAL), from which Nasser emerged with great prestige throughout the Arab world. One consequence of this prestige was the Syrian-Egyptian union of February 1958 which led to the creation of the first United Arab Republic (U.A.R.), of which Nasser was the president. This federation to which Yemen had become affiliated, collapsed in 1961 with Syria's secession, but following military coups in Iraq (February 1963) and in Syria (March 1963) a draft constitution, subject to referendum, for a second (tripartite) U.A.R. federation was signed in Cairo on April 17, 1963 (*see* UNITED ARAB REPUBLIC). Nasser's aspirations toward leadership of the Arab world were strongly based on the resources, political stability, and social and economic progress of Egypt. Among Arabs, he became the principal symbol of modernization without loss of identity, and of government in the interests of the people. His leadership was repeatedly challenged —by the Syrian Baath Party, by the rulers of Saudi Arabia and Jordan from time to time, and in 1964 by Pres. Habib Bourguiba of Tunisia—but it remained strong.

Other main features of Nasser's regime have been his hostility toward Israel (*q.v.*); anticolonialism; support for the nonaligned nations; occasional moves toward leadership among the emerging African nations; and the use of Cairo radio for the dissemination of political propaganda. In the Yemeni civil war which broke out in 1962, he gave strong military support to the Republican Party.

In Egypt he remained strong and provided government which inspired more continuing confidence than could be felt in most major developing countries. The problems were very great, not the least being a sharply rising population, but the standard of living improved perceptibly though slowly. Opposition, not easily expressed, showed itself principally through the Muslim Brotherhood, which was twice severely repressed. The Aswan Dam, the first stage of which was completed in 1964, was important not only economically but as a symbol of what Egypt under Nasser was trying to achieve and as some indication that these purposes were consistently pursued and capable of a large measure of fulfillment. *See* also EGYPT: *History*.

See Jean and Simonne Lacouture, *Egypt in Transition,* Eng. trans. by F. Scarfe (1958); Tom Little, *Egypt* (1958). (H. S. D.)

NAST, THOMAS (1840–1902), U.S. cartoonist, best known for his attack on the political machine of William M. Tweed (*q.v.*) in New York city in the 1870s, was born in Landau, Ger., on Sept. 27, 1840. He was brought to New York city by his mother in 1846. He studied art there with Theodore Kaufmann and at the National Academy of Design, at the age of 15 became a draftsman for *Frank Leslie's Illustrated Newspaper,* at 19 for *Harper's Weekly,* at 20 went to England for the *New York Illustrated News* and in the same year went to Italy to cover Garibaldi for *The Illustrated London News* and U.S. publications. His cartoon, "After the Battle" (1862), attacked Northerners opposed to pushing the Civil War vigorously. This and other cartoons published in *Harper's Weekly* during the Civil War led President Lincoln to call him "our best recruiting sergeant." Nast's cartoon campaign against Tweed was climaxed when a caricature of him led to his identification and arrest in Vigo, Spain, in 1876. Originally a Republican, Nast turned first to the Mugwumps because of his advocacy of civil service reform and his distrust of James G. Blaine and in 1884 to the Democrats; in 1892 he returned to the Republicans. Having lost nearly all his money in the failure of the brokerage house of Grant and Ward in 1884, he was appointed consul general at Guayaquil, Ecuador, by Pres. Theodore

Roosevelt in 1902, and he died there on Dec. 7 of the same year.

Nast did some painting in oil and book illustrations, but his fame rests on his caricatures and political cartoons. From his pen came the Democratic party's donkey, the Republican party's elephant, and Tammany Hall's tiger.

See A. B. Paine, *Thomas Nast: His Period and His Pictures* (1904).
(D. H. W.)

NASTURTIUM, the common name for soft-stemmed flowering plants of the genus *Tropaeolum,* only a few of the 50 species constituting the family Tropaeolaceae being cultivated as ornamentals, and the generic name sometimes used for certain aquatic crucifers (*see* WATER CRESS).

The garden nasturtium or Indian cress (*T. majus*), like others of the genus, is native to South America; it is a perennial climber in Peru, but in cultivation is treated as a hardy annual. It climbs by means of the long stalk of the peltate leaf which is sensitive to contact like a tendril. The irregular flowers have five sepals united at the base, the dorsal one produced into a spur; of the five petals the two upper are slightly different and stand rather apart from the lower three; the eight stamens are unequal and the pistil consists of three carpels which form a fleshy fruit. The pungent leaves are sometimes eaten in salads, and the young green fruits are pickled in vinegar as a substitute for capers. The dwarf variety known as Tom Thumb (*T. m. nanum*), is an excellent bedding or border flower, growing about one foot high. Other fine annual tropaeolums are *T. peltophorum,* with long spurred orange-red flowers, and *T. minus,* a kind of miniature *T. majus* with yellow, scarlet and crimson varieties. *T. peregrinum* is the well-known canarybird flower. A fine nasturtium with brilliant scarlet blossoms is *T. speciosum* from Chile; it has tuberous roots, as have also such perennials as *T. polyphyllum* and *T. pentaphyllum. T. tuberosum,* the anu, is grown in the Andean highlands for its edible tubers.

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NASTURTIUM (TROPAEOLUM MAJUS)

Garden nasturtiums are easily grown from seed, which is sown in a warm, sunny location after the danger of frost is past. They are quick growing and, if planted in too rich soil, may produce an abundance of foliage at the expense of blossoms. Cuttings made in autumn provide potted plants for winter blooms indoors.

See also TROPAEOLACEAE.

NATAL, the smallest of the four provinces of the Republic of South Africa, has an area of 33,578 sq.mi., or 7.11% of the area of the Republic. This area includes Zululand and Tongaland (*qq.v.*), which lie between the Tugela river and the Portuguese East African (Mozambique) border, together occupying 10,362 sq.mi. The province is bounded on the west by the Drakensberg escarpment, on the south partly by the upper Umzimkulu river and the Mtamvuna river. The northern boundary lies for most of its distance along the Pongola river, along the crest of the Lebombo range as far north as Usutu *poort,* along the Usutu river to its confluence with the Ingwavuma and from there to the 13th beacon along the boundary line with Portuguese East Africa, on the coast, 5 mi. N. of the inlet to Kosi bay. The provincial capital is Pietermaritzburg.

PHYSICAL GEOGRAPHY

Landforms.—The province lies in the eastern marginal area of the Republic of South Africa. Most of its surface is formed of beds belonging to the four series of the Karroo system, which in the coastal region have been folded to form the Natal monocline. Pre-Karroo formations (Archean granite, Table Mountain Sandstone, etc.) have been exposed along most of the monoclinal axis, except in a small area to the north of the Tugela river where the Karroo beds are still intact. In the lower Tugela basin the axis has been dislocated by a number of east-trending faults. In Zululand the flat coastal plain is covered by marine Tertiary beds forming the southern extremity of the great Mozambique plain.

Steeply graded rivers have worked powerfully on the different rocks to produce the present surface features, and headwater erosion of the largest of these rivers into the Stormberg basaltic lavas has carved out the prominent Drakensberg mountains (*q.v.*). Such deep river erosion has left high interfluvial spurs trending eastward from the plateau edge. Where strong sheets of dolerite have resisted erosion, wide open basins have been formed in the interior above such rock barriers. Two of these basins which occupy a considerable area are the Ladysmith basin on the upper Tugela river and the Newcastle-Utrecht basin on the upper Buffalo river. In general three surface divisions can be recognized: a coastal zone rising to between about 1,500 and 2,000 ft.; a midland zone on the interfluvial spurs rising to about 3,500–4,000 ft., and a high veld area from about 4,000 ft. up to the foot of the Drakensberg escarpment.

Climate.—Atmospheric temperature is related closely to altitude. Mean temperatures in July are highest in the coastal belt, where they exceed 15° C. (60° F.), and lowest on the high veld, where they are between 7° and 10° C. (45° and 50° F.). In January the mean monthly temperatures of the coastal belt to the north of Durban exceed 24° C. (75° F.), and in the interior basins and in Zululand the mean maximums generally exceed 29° C. (85° F.). Temperatures often exceed 32° C. (90° F.) when berg winds blow from the plateau. Frost is rare in the coastal belt except in July, when light frosts may occur in valley bottoms. In the high veld area the duration of the frost period extends from about the middle of May to the middle of September.

Natal lies wholly in the region of predominantly summer rainfall, but the coastal belt receives in general rather more than 30% of its annual rainfall in the winter half-year. From the coast to the midlands the mean annual rainfall decreases from about 40 in. to about 30 in., but increases with altitude to about 40 in. in the high veld areas. On the Drakensberg the precipitation is estimated to be over 60 in. The reliability of the annual rainfall over the province as a whole is between 80% and 90%. An important feature of the midland zone is the frequency of mist so that certain parts of the zone are known as the mist belt and are well suited to afforestation, especially of wattles.

Vegetation.—The coastal belt of subtropical forest or dense evergreen bush extends for 6 to 20 mi. from the coast. This is succeeded inland by more open bush or savanna which passes, in the southern part of the province, into remnant patches of temperate forest. Lying at an altitude of between about 3,000 and

BURTON HOLMES FROM EWING GALLOWAY

VALLEY OF A THOUSAND HILLS, A REMARKABLE CRUMPLED FORMATION NEAR PIETERMARITZBURG

4,000 ft., this zone marks the position of the mist belt. At higher altitudes the dominant vegetal type is tall "sour" grass. The lower valleys in the south and most of the low country in the north are areas of thornbush (*Acacia savanna*).

Animal Life.—Natal contains many distinctive southern species as well as tropical African species and may be considered as a corridor in which southern and northern fauna have intermingled. Tropical forms in the northern part of the province include the tsetse fly, which formerly infested Zululand as far south as the Umfolozi river, the tree-nesting tailor-ant (*Oecophylla smaragdina*), the tiger fish (*Hydrocyon vittatus*), the ghost frog (*Chiromantis zerampelina*), the white rhinoceros, the black rhinoceros, and of the antelopes the nyala and the suni. This tropical corridor has also been the passageway to the south of many east African birds such as the hornbills, louries and trogons, and the tropical barbets and parrots.

Most of the game is preserved in the provincial reserves. In Zululand the Hluhluwe game reserve (57,000 ac.) and the Umfolozi game reserve (72,000 ac.) have white and black rhinoceros, kudu, impala, waterbuck, wildebeest, zebra, buffalo and many other animals. In the Drakensberg, the Giant's Castle game reserve contains over 1,500 head of eland besides numerous oribi, klipspringer, grysbok, reedbuck and other antelopes. In the Nkuzi game reserve in Zululand among many other antelopes are the inyala and the suni. In the extreme north of Zululand, near the confluence of the Usutu and the Ingwavuma (Ngwavuma) rivers, the Ndumu game reserve, with its freshwater pans, contains many hippopotamuses, crocodiles and numerous waterfowl, as well as the suni antelope. Along the Zululand coast are several parks and nature reserves where a great variety of birds, fish and game are protected. (J. H. Wn.)

HISTORY

In 1497 the Portuguese Vasco da Gama, on his voyage to India, sighted the bluff at the entrance to the present harbour of Durban on Christmas day and so named the country Terra Natalis. Neither then nor subsequently did the Portuguese settle or claim Natal. The nearest Portuguese settlement was 296 mi. farther north at Delagoa bay, which offered safer anchorage and a more convenient entrepôt for trade. It was, then, from shipwrecked mariners that the first tales of the Natal coast reached Portugal. King Sebastian of Portugal in 1575 commissioned Manuel de Mesquita Perestrelo to survey the South African coast and mark points for safe anchorage in storms, for these had already taken heavy toll of the merchantmen. In 1593 the wreck of the Portuguese "Santo Alberto" north of the Great Kei river left a party of 285 stranded on the shore. This group, instead of pushing north along the coast to Delagoa bay, a route already notorious for its perils, used compass and sextant to "navigate" an inland route which took them through the heart of Natal Zululand and Tongaland to Lourenço Marques. These were the first Europeans known to have penetrated to the interior of Natal.

By the 17th century English, French and Dutch challenged the Portuguese monopoly of the Indian ocean, but for Natal the story was still one of wrecks and disasters rather than of trade and settlement. In 1685 the survivors of the English slaver "Good Hope" left a small company complete with guns in a shanty fort on the bluff. The following year the Dutch trader "Stavenisse" was wrecked farther south. The survivors were joined by English from the bluff and from another English vessel, the "Bonaventura." They built a boat and sailed with a cargo of ivory to Cape Town.

In 1689 Simon van der Stel dispatched thence the "Noord" to open up trade in ivory and secure the bay of Natal. The bay was duly purchased, but the wreck of the "Noord" on the return voyage and the repudiation of the sale by the natives made the venture abortive. In 1721 another venture was made by Gov. Maurits Pasques de Chavonnes to place a settlement during the Dutch attempt to hold Delagoa bay. Both moves were abandoned in 1730. The coast was difficult and for practical purposes the hinterland of Natal was terra incognita. There was no obvious source of wealth to be tapped. For yet another century Natal was to lie off the beaten track of European adventurers. (*See* also Cape of Good Hope.)

Within Natal the Nguni branch of the Bantu seems to have settled early in the 16th century, Zulu (reputed dates 1627–1709) being but the least of many founders of tribes. A. T. Bryant in his book *Olden Times in Zululand and Natal* (1929) estimated that about 50 separate clans inhabited Natal proper at the opening of the 19th century and hazarded the calculation that at least 78,000 and probably 100,000 natives were technically aboriginals in Natal. North of the borders of modern Natal, the Tembu-Tongas seem to have acted as middlemen between the Portuguese traders and the natives in Zululand and Natal. They are credited with introducing maize (corn), yams, peanuts and, legend has it, cats into Natal. Throughout the hinterland, which of course had as yet no political boundaries, there were the petty wars about land and cattle common to all primitive societies, but no major cataclysms. The first attempt at a paramountcy was made (1807–1818) by Dingiswayo. He was chief of the Mtetwa (Umtetwa), northeast of the Tugela river. He opened up trade with Delagoa bay by exchanging oxen and tusks for blankets and beads. Until his defeat and death at the hands of Zwide, chief of the Ndwandwes (Undwandwes), in 1818 he established a rough suzerainty which Shaka (Chaka) of the Zulus was to usurp (*see* Zululand). Already before Shaka crossed the Tugela in 1818, refugee tribes from Zululand headed by the Tembus and Cunus had hacked a way through the coastal tribes of Natal. Thereafter the Zulu impis (warrior regiments) first of Shaka and then of Dingaan (Dingane) completed the dispersal and destruction which was to mislead both Boer and Briton into thinking Natal was uninhabited. Those who had not been murdered or conscripted either hid or fled. From 1821 onward all the area between the Umzimkulu and the Umzimvubu rivers was in chaos. Ncapaai of the Ama-Baxa tribe (1826–44) forged some of the exiled tribes into a massive army of about 3,000 warriors. He defied both the pressure from Natal to the north and from Pondoland to the south until his destruction by Faku, chief of the Amapondo (Pondo), in 1844. Three prime factors, then, provide clues to the policy of early European settlement in Natal: fear of Zulu military power; the myth that Natal was uninhabited; and the chaos beyond the Umzimkulu which threatened both Natal and Cape province.

First British Settlement, 1824.—One consequence of the occupation of the Cape by Britain in 1806 was the attempt to map the east coast for naval purposes. Throughout 1822 and 1823 Capt. W. F. Owen of the Royal Navy laboured at this task. Merchants and traders, already speculating in the coastal trade, followed in his track. Two former naval lieutenants, F. G. Farewell and J. S. King, arranged with Owen to finish the survey of the port of Natal and St. Lucia bay. Farewell and King failed to land at St. Lucia bay, but a renewed attempt farther south brought them triumphantly across the bar of what is now Durban harbour. The following year Farewell with H. F. Fynn and others returned to the port of Natal to found a trading station and open up negotiations with Shaka at his Bulawayo (Zululand) kraal. Chiefly because of the courage, tact and medical skill of Fynn, Shaka rewarded Farewell's party by signing a treaty (Aug. 1824) ceding the port of Natal and about 50 mi. of coastline to a depth of 100 mi. inland. This was never revoked, but Shaka seems to have regarded the traders as in some sort his vassals or subchieftains for in 1826 they were virtually conscripted into Shaka's war with the Ndwandwes. Both Shaka and Dingaan protested against shelter given to refugees from royal wrath. Shaka did not hesitate to make peremptory demands, as for instance in 1828 when he was infuriated because his ambassadors to George IV had returned empty handed from Port Elizabeth; equally because they had forgotten the Macassar oil he ordered. John Cane was compelled to set out for the Cape to purchase the oil and dared not defy. While the Cape authorities unfairly blamed the traders for the tribal upheavals, the traders themselves led a precarious existence. King died of dysentery in 1828. Farewell was murdered by Nqueto and the Kwabis in 1829 in no man's land. In 1831 Fynn and his group narrowly escaped with their lives when Dingaan raided Port Natal, and the following year Fynn withdrew to Grahamstown.

It seems clear that both Shaka and, more particularly, Dingaan and their indunas (headmen) were perturbed by European diffusion, especially after the opening of the land route through Pondoland. Jacob the interpreter, a Kaffir former convict (shot in 1832), combined distorted pictures of European power and greed with the self-claimed power to prophesy that the coming of traders and white missionaries spelled doom to the natives, and it is inconceivable that Matiwana, who was murdered by Dingaan in 1829, can have failed to report his disastrous encounter with Col. H. Somerset at Baziya Mount. In 1832 Andrew Smith arrived from the Cape to report on Natal. In 1834 a *commissie* (committee) trek arrived from the Eastern province directed by Piet Uys. They made contact with the Zulus by shouting across the Tugela and reported that Natal was vacant and available for settlement.

The European settlers at Port Natal reiterated the demand first made by King in 1826 that Natal should be taken over as a colony. In 1834 the merchants at Cape Town petitioned to the same end, while in Britain there was some mercantile support for the move. In Natal the settlers backed their demands by laying out a municipality which in 1835 they called Durban after the then governor of the Cape, Sir Benjamin D'Urban. But in the Cape the renewal of frontier war and in Britain the reluctance of the colonial office to undertake wider commitments militated against intervention. One step was essayed. Capt. A. F. Gardiner had gone to Natal as a missionary and had secured from Dingaan (May 1835) a treaty ceding the southern half of Natal, on condition that refugees were handed back to Dingaan. He also secured the appointment of the Rev. F. Owen at Dingaan's kraal at Umgungundhlovu. With this behind him he secured in 1837 magisterial authority at Durban from the Cape. But without troops or police, he had no effective control in Natal where the traders, hunters and gunrunners wanted protection without control. For this reason the traders welcomed Piet Retief, the advance envoy of the trekkers who had crossed the passes of the northern Drakensberg in the late summer of 1837.

The Voortrekkers in Natal.—The settlers welcomed Retief and guided him to Dingaan's court. Dingaan promised Retief virtually the whole of Natal provided he first recovered cattle stolen from the Zulus by Sikonyela in Basutoland. This Retief rapidly achieved by a mixture of subterfuge and force so expeditious that together with the news of the defeat of Dingaan's kinsman Mzilikazi at the Marico river (Nov. 1837) it alarmed Dingaan and the indunas. The deed of cession was duly signed and witnessed but it was sealed with Retief's blood: Piet Retief and more than 60 followers who were all unarmed being massacred on the spot (Feb. 1838). From Umgungundhlovu Zulu impis sped to exterminate the scattered laagers along the Bushmans and Blaauwkrantz rivers. Loss of life was appalling. The English from Durban hastened to the rescue with their native levies but were overwhelmed. Save for a few stalwarts the survivors embarked from Natal on the brig "Comet."

Undeterred by the murder of Retief and the death of Gert Maritz the following September, the trekkers, reinforced by timely supplies brought up by Andries Pretorius from Graaff-Reinet, simultaneously pursued two ends—the defeat of Zulu military dominance and the organization of a government in Natal in touch with trekkers west of the Drakensberg. In Dec. 1838 the Boers under the supreme command of Pretorius defeated the Zulus at the battle of the Blood river and destroyed more than 3,000 of Dingaan's army. H. Jervis, the British agent, mediated a peace in May 1839, but it was broken by both sides and Dingaan was finally defeated by the trekkers in alliance with his brother Panda (Mpande) at Magongo in Jan. 1840 and fled to his death in Swaziland. Panda made valuable concessions to the allies of his treachery. He ceded a coastal belt from the Black Umfolozi river to the entrance to St. Lucia bay, undertook to withdraw behind the Tugela and rule in the newly defined Zululand as the vassal of the new republic with its capital at Pietermaritzburg. Even before the territorial position had been secured, a constitution had been drafted. The *volksraad* (elected legislature) was to meet four times a year at the capital, leaving a *commissie raad* (town committee) to function during the long recesses. Landdrosts (magistrates) were appointed at Pietermaritzburg, Weenen and Congella and 12 field cornets were elected. Financial stringency, acute after Capt. T. C. Smith took control of the port, lack of permanent trained officials, personal quarrels between the leaders, the difficulty of keeping touch with the adjunct *raads* at Winburg and Potchefstroom, all made progress toward effective administration difficult, but not necessarily impossible. What sabotaged the structure of the republic was the influx of natives returning to Natal to resettle the lands they had abandoned to the Zulus. The attempt of the trekkers to meet the crisis by their subjection and expulsion probably decided the British to intervene.

British Annexation of Natal, 1843.—Even before the trek, various groups in Britain and in the Cape had pressed for the annexation of the port of Natal. By 1838 there were clear grounds for decisive action. There were signs of coal in Natal which made Durban, in the days of steamships, a possible coaling point; there was anxiety about French colonial projects when it was discovered that J. A. Smellekamp, self-appointed political agent who visited the new republic in 1842, was financed in Paris; there was official as well as humanitarian concern that the "apprentices" scheduled for release at the end of 1838 should in fact be released; there was the ambiguity caused by the claim of jurisdiction to latitude 25° S. in the Cape of Good Hope Punishment act, together with the British refusal to admit that allegiance and therefore obedience could be discarded; there was above all the growing realization that disturbances in the Cape were in part the consequence of upheavals in Natal. At first British policy was dangerous by reason of its uncertainty. The Whig government was on its last legs by 1839 and fell in Sept. 1841. Between 1839 and 1846 there were five different secretaries of state for war and colonies. Though permanent officials like James (afterward Sir James) Stephen exercised great influence, decisions at cabinet level had always to reckon with parliament. The slowly forming convictions as to what was the right policy were tempered by practical politics and the already heavy drain on Britain's financial resources. In the circumstances, with changing fronts in South Africa and changing fronts at Whitehall, it was difficult for policy to crystallize. Between Dec. 1838 and Dec. 1839 Durban had been reoccupied and held. The military crisis over, the order came to withdraw the British forces from Durban in Dec. 1839. The republican flag was thereupon hoisted. But at the end of 1840 the Natalians sent a commando against Ncapaai, who with his Bushmen allies had raided republican cattle. This disturbed local opinion because of the scale of the plunder, which included "apprentices" taken in defiance of the Punishment act. It also alarmed Faku, chief of the Amapondo, to reassure whom, in Jan. 1841, Captain T. C. Smith was sent with a small force to the Umgazi river. Hitherto the colonial office had toyed with the proposal of Pretorius that the republic should be officially recognized. But in Dec. 1841 came the news that in August the *raad*, harrassed by the unceasing flow of native refugees, had decided to evict them and settle them in the disputed territories between the Mtamvuna and the Umzimvubu, the tinderbox of conflict. To avert this, in May 1842 Smith was ordered to reoccupy Durban. His leisurely advance gave the republicans time to organize, and Smith was besieged so closely at the port that only the heroic ride of Dick King to Grahamstown for reinforcements averted disaster. Col. A. J. Cloete rushed up reinforcements by sea and resistance collapsed. In June the republicans submitted. One year later Henry Cloete (brother of A. J. Cloete) arrived as special commissioner and thenceforward though the *raad*, shorn of its more virile members, continued to function until Oct. 1845, in theory the administration was British, the land settlement was liable to revision and the principle of legal equality was pronounced. In Aug. 1843 Panda, all claim to European suzerainty being tacitly dropped by Britain, accepted the Tugela river as his frontier and confirmed the cession of St. Lucia bay. This fixed the northern boundary of Natal. To the south, the Umzimkulu was fixed as the boundary and beyond it Faku, having disposed of Ncapaai, was given treaty status and recognized as ruler between the Umzimkulu and the Umtata rivers. When it is recalled that in Dec. 1843 similar treaty status had been given to Adam Kok and Moshesh across the Orange river,

the annexation of Natal to the Cape appears not merely as it obviously was, in part a commercial, in part a humanitarian, move but also as part of a constructive, if abortive, effort to give new stability to frontiers distorted by the Great Trek. On the maintenance of stability combined with flexibility, the well-being of all in southern Africa depended.

In this respect, when the War of the Ax broke out in the Cape in 1846, the annexation proved to have been a wise insurance. Partly because, theoretically, the colonial office would allow no distinction between black and white, and pendant on that a revision of the land settlement was considered necessary, many trekkers withdrew from Natal. It is estimated that by the beginning of 1847 the number of Boer families had shrunk to less than 100. The largest immigration project was that launched by J. C. Byrne who during 1849–51 brought out 2,500 emigrants from Britain.

From Annexation to Responsible Government in 1893.—Though from 1845 onward Natal had a local administration, until 1856 it was substantially an adjunct of the Cape. In 1856 it was given its own legislative council of 4 official members and 12 elected representatives. As the settlers increased, they sought to establish control over the executive by securing more complete control over the revenue. There were two chief bones of contention. In 1856 the crown stipulated that £5,000 annually should be set aside for native development. This was challenged on the constitutional ground that the legislature had incomplete control over expenditure. Secondly, Theophilus (later Sir Theophilus) Shepstone (*q.v.*), first as diplomatic agent, then as secretary of native affairs, was a permanent official and tended to move without consultation with either government or legislature. Overemphasis on the niceties of constitutional theory reached their climax during the depression which coincided with the lieutenant governorship of R. W. Keate (1867–72). Economic crisis, constitutional deadlock, uneasiness in the native areas, the threatened repercussions of the Langalibalele affair (*see* below) resulted in the dramatic intervention of the colonial office which sent out Sir Garnet Wolseley in 1875 to stiffen official control. By dint of "drowning the constitution in champagne and sherry" he added, for a five-year period, eight more official members to the legislature. Between 1845 and 1877 Shepstone built up the Natal pattern of native administration. His influence was at its height when, in 1849, by ordinance, the lieutenant governor was made supreme chief and Shepstone his chief induna. Natal was geographically isolated from the rest of South Africa, the European population was small and its resources slight. Across the Tugela was the powerful Zulu monarchy and within Natal the Europeans were hopelessly outnumbered. Merely to have preserved peace during the crucial period of Natal's growth was a major development. When in 1849 a hut tax of 7*s.* was imposed on the natives, Shepstone supervised its collection. For years the hut tax was the most stable revenue of the colony. During 1851–54 Shepstone sought leave to draw off the natives to districts south of the Umzimkulu and to create, as the trader John Dunn was to do in Zululand, a quasi monarchy. This was vetoed by the colonial office. Instead, he settled about 80,000 natives in fixed locations in Natal, leaving about 50,000 as squatters on crownlands or on private property. In 1864, largely at his instigation, the Native Land trust was created with control over more than 2,000,000 ac. of land. In the same year provision was made for educated natives to apply for exemption from native law. Little attempt was made nor indeed, with deficiency of men and money, could be made, to civilize the tribes, though by the end of the century 188 mission schools were subsidized. Measure of Shepstone's achievement was given when, in 1873, Langalibalele, chief of the Hlubi tribe, settled at the foot of the Drakensberg and rebelled rather than hand in for registration the firearms his young men had earned in Kimberley. In the existing state of tension in South Africa, the revolt was probably intended to touch off a general rising. Its prompt suppression by Sir Benjamin Pine without a ripple of revolt in the rest of Natal is comment enough on the effectiveness of the Shepstone system at that stage of Natal's economic development.

As the European population of Natal in the 1870s was little more than 20,000, the Natalians sought not so much land as a reliable labour supply. Various crops had been sampled; tobacco, indigo, cotton and tea in addition to staple farm products had been tried and found wanting. The future of the colony seemed to turn on the coastal belt which in the late 1850s was found suitable for sugar cane. Many natives, acclimatized to the uplands, could not adapt themselves to the malaria-ridden coastal belt. Most had all they needed without work. In 1860, therefore, and, save for the period 1866–74, without interruption until 1911, coolie labour was recruited in India on a five-year indenture with the option of settling on the expiration of the contract. At the same time free immigrants began to arrive in numbers.

The prosperity of the Natal sugar industry as well as the development of market gardening was substantially due to Indian labour. On the eve of the union in 1910 there were 65,917 free Indians and 42,777 were still under indenture.

Until the 1870s Natal remained relatively isolated from the rest of South Africa. The Drakensberg, though not insurmountable, was a formidable barrier. Across the Tugela lay Zululand and to the south (though Alfred county beyond the Umzimkulu was added to Natal in 1865) lay Pondoland and Griqualand East, both potential storm centres. Communications by sea were not easy. Repeated attempts to make the harbour safe had failed and the coast was often the scene of wrecks until the harbour mouth was narrowed and dredged. Economic impetus was, though, sharply felt in the 1870s and 1880s. The opening of the Kimberley diamond fields (1870) made transportation a profitable venture. The coming of railways facilitated the development of the Natal coal fields and railways in their turn were indebted to the development of the coal mines as well as to the opening of the Witwatersrand gold fields in 1886. By the 1890s Natal had a key role to play in the making of a new South Africa.

From 1875 to 1880, moreover, Natal had been the hub of political crisis. The annexation of the Transvaal (*q.v.*) by Shepstone on the instruction of the earl of Carnarvon, secretary of state for colonies, in 1877 and the Zulu War of 1879 (*see* ZULULAND) were prelude to the first Transvaal War of 1880–81 which was fought and extinguished in the Laing's Nek pass and over the Drakensberg at Majuba (Feb. 1881). The crisis made the Natalians acutely aware of the South African position as a whole and H. Escombe and John (afterward Sir John) Robinson began to press for responsible government. Robinson in particular pressed for a federal union, which, Carnarvon's project having ended so disastrously, he argued should next originate with South Africa. Zululand, after abortive experiments, was annexed to the crown in 1887 and the sensitivity of the foreign office as well as the colonial office to the vulnerability of the South African coast line was shown in the sealing off of the coast by annexation. In 1884 St. Lucia bay was annexed, in 1884 Port St. Johns, in 1885 Galekaland, in 1886 Bomvanaland, in 1894 Pondoland and in 1895 Tongaland.

Economic development and greater security necessarily reacted on internal politics. The retirement of Shepstone in 1877 saw the beginning of a transitional phase in native policy. In 1875 a native high court of three judges had been established, thus separating the judicial from the administrative powers of the secretary for native affairs. A commission was appointed to draw up a code of native law (1878), but in practice magistrates in each district had a wide margin of discretion. There was a growing interest in native administration not altogether then divorced from land hunger and desire to tap more effectively the labour and fiscal potentialities of the natives. Native affairs were more exposed to the exigencies of politics. Codification of native law tended to give rigidity to a tribal structure that economic changes were beginning to undermine.

In 1893 the increase in European colonization and settled development, greater prosperity and, it seems, conviction that the economic prosperity of Natal turned on forging links with the Transvaal, brought to a successful conclusion the demands for responsible government in Natal. The first prime minister was Sir John Robinson (1893–97). He had been a member of the legislative council since 1863 and had represented Natal at the London conference on federation (1876) and at the jubilee celebra-

tions of 1887. In 1888 he had represented Natal at the South African customs conference and had declined to commit Natal to agreements which would have sacrificed the advantages of its geographical proximity to the Rand. In the three years that followed the customs agreement between the Cape and the Orange Free State and the extension of the Cape railway system to Pretoria, Natal revenues shrank by 50% and the colony was crippled by £250,000 interest charges on debt incurred to improve railways and harbours. Natalians tended unwarrantably to blame a non-responsible administration for failure to press Natal's economic interest. The popular response to Robinson's renewed agitation for responsible government was due to popular conviction that the colony's future depended on the exploitation of the Rand market which was only 130 mi. from the Natal border. One reason for this belief was that Natal was still a crown colony, so that obliquely the Natal railway was a "crown" railway, the extension of which was prohibited by the Transvaal after it had reached Charlestown near the border in 1891. Certainly the conclusion of a railway agreement with the Transvaal (Feb. 1894) followed hard on the heels of the establishment of responsible government. In Oct. 1895 the new line was completed to Pretoria.

Economic forces had proven a basic community of interests between the South African states, a conclusion endorsed in Natal which belatedly in 1898 concluded customs agreements with the Cape and Orange Free State. In the same way the native problem was even more clearly an interstate problem, once the mines at the Rand became dependent on migratory native labour. Two things ruptured the approach to a common South African point of view. One was the cultural revival of Afrikaner nationalism which fixed its political hopes on the republics; the other was the gross and inexcusable blunder of the Jameson raid (Dec. 1895; *see* TRANSVAAL). Thus, though in 1897 Natal, as befitted its new status, assumed responsibility for Tongaland and Zululand, the necessary readjustments had hardly been made when, in Oct. 1899, the South African War struck at the foundations of South African co-operation. Natal was invaded by the Boers but the defense of Ladysmith, as well as the reinforcements hurried from overseas through the port of Durban, prevented the colony from being overrun. Natalians played an important part both in the civil and the military organization of the war. On its conclusion the districts of Vryheid, Utrecht and parts of Wakkerstroom were reattached to Natal. Utrecht, settled and founded by Boers in 1848, had been enlarged by agreements with Panda in 1861. While in 1884, also at the expense of Zululand, Vryheid had been founded and, with frontiers cut off from the sea by the British annexation of St. Lucia bay, had, to the exasperation of Natal, been recognized *faute de mieux* by Britain in 1884. Natal had made considerable efforts and sacrifices during the war and though it is arguable that as a colony its interests had on occasion either been ignored or even subordinated to those of the Cape and to the shifting trends of British colonial policy, its territory had been doubled since 1897 and then coincided with the boundaries envisaged by the trekkers.

Peace of Vereeniging to the Union of South Africa, 1910.—The peace of Vereeniging which ended the South African War was followed by the grant first of representative and then of responsible government in the Transvaal and the Orange River colony. This made the problem of evolving some kind of economic and political co-ordination as urgent as it had been before the war. Natal statesmen played a prominent part in the intercolonial conferences which preceded the union. In 1906 the Bambata rebellion was a sharp reminder that more was at stake than railway rates and customs. Responsible government in Natal had brought with it a tendency to subordinate native affairs to the exigencies of party politics, while the rapid development of commerce and industry brought natives more sharply up against European notions of contract reflected in the Masters and Servants regulations. The migration of native labourers first to Kimberley, then to the Rand or, nearer home, to the coal fields of Natal was unsettling. First locusts, then rinderpest, then war had dislocated agriculture. Squatters' rents had gone up, the cost of living, even at Zulu levels, was rising and the poll tax of £1 a head imposed on all males, native and European, over the age of 18 was, though theoretically it treated all races equally, resented by the natives on whom it placed a disproportionate burden. There had been, too, much anti-white agitation. When, therefore, the attempt to collect the tax led to the killing of two European policemen at Byrnetown, there were signs and fears of a general rising. The arrested natives were tried and sentenced by court-martial, but Lord Elgin, secretary of state in the Campbell-Bannerman ministry, ordered stay of execution. The Natal protest that this was a violation of the rights of self-governing colonies received commonwealth support and Lord Elgin gave way. More serious was the threatened spread of the revolt through the attempt of Bambata to rouse Zululand. In less than six months the revolt was isolated and suppressed, but isolated events convinced Natalians that Dinizulu was implicated. He was arrested in Dec. 1907 and thanks to the skilled advocacy of W. P. Schreiner he was acquitted of most of the charges levied against him. The revolt had been promptly handled and Natal had received the active support of the other South African colonies. It is to the credit of Natal that the revolt caused some heart searching. A special commission was appointed in Aug. 1906 to inquire into the whole position and more than 5,500 natives attended and 901 native statements were recorded in the schedule attached to the report. Its analysis recognized the defects in native administration, in particular the loss of personal contact, the increased and often confusing regulations (there had been 48 new regulations since 1893) and the subordination of native affairs to political pressures. One sentence in particular was long to be pertinent: "As we can neither assimilate or destroy them, political forethought and commonsense alike call for a settlement of the question on a broad, enlightened permanent basis." It seems fairly certain that Natal's approach to the union was coloured by the experiences of 1906. The need for union on economic grounds was clear. The advantage of a strong front in view alike of the Indian and the native question was also clear, but Natal was sceptical of Cape liberalism quite as much as of Transvaal nationalism and strove vainly in the National convention which preceded union to substitute federation for an incorporating union. Natal was the only colony which held a referendum on the question of union. It was accepted by 11,121 votes to 3,701. For the subsequent history of Natal, *see* SOUTH AFRICA, REPUBLIC OF: *History*. (W. A. ML.)

POPULATION, ADMINISTRATION AND ECONOMY

Population.—In 1960 the population of Natal was 2,979,920, comprising 340,235 whites, 2,199,578 Bantu (a term that has officially replaced "native" or "African"), 394,854 Asians and 45,253 Coloureds. Of these, 85% of the whites, 85% of the Coloureds, 78% of the Asians and 18% of the Bantu were urban dwellers. It is thus clear that in Natal the whites, Asians and Coloureds are preponderantly urban; the Bantu preponderantly rural. Of the rural Bantu in 1951 about 366,000 were on white farms, 31,000 on farms of Asians and Coloureds and 90,000 on other farms and agricultural holdings. About 955,000 lived in Bantu areas consisting mainly of homelands, Trust land, mission stations, tribally owned farms and crown land. In the homelands, covering 11,211 sq.mi., the Bantu population was 925,610, giving a mean density of 83 to the square mile, but densities varied from about 50 in northern Zululand and Tongaland to about 140 in the southern coastal zone. The chief towns are Durban (pop. [1960] 681,492) and Pietermaritzburg (128,598) (*qq.v.*).

Administration.—The relationship of the provinces to the central government is described under SOUTH AFRICA, REPUBLIC OF. The Natal provincial council's responsibilities include provincial hospitals, certain municipal powers, shop hours, loans to municipalities and health committees, entertainment duty, water supply, education and teachers' pensions. The main items of its revenue are personal, income and company taxes, automobile registration fees and taxes, hospital receipts, totalizator and entertainment taxes. In addition there are considerable subsidies from the central government and a smaller amount from the department of transport for national roads. The main items of expenditure are education, hospitals and health services, roads, bridges, etc., and national roads. For purposes of administration

the province is divided into 44 magisterial districts.

Public Health.—The Natal provincial administration controls 20 hospitals and hospital advisory boards, and representatives of various interests are appointed to assist with the control of these hospitals, which are maintained solely at public expense. Many institutions not controlled by government authorities also receive financial assistance from provincial funds.

Education.—There are more than 160 primary and intermediate schools for whites, most of which are maintained by the state or are state-aided. Secondary and high schools are also similarly maintained. For Asians and Coloureds there are nearly 300 primary and intermediate schools, and some secondary and high schools. There are also several private schools. Bantu schools number more than 1,400. The University of Natal (founded 1909 as a constituent college of the University of South Africa, assuming university status in 1949), the chief institution of higher education in the province, is located partly in Pietermaritzburg and partly in Durban. Students include whites, Asians, Coloureds and Bantu.

The Economy.—*Agriculture.*—By far the most valuable crop is sugar cane, which is grown on the coastal lowlands and forms one of the principal agricultural products of the country. Maize (corn) is grown mainly in the uplands; the total yearly crop is approximately 2,000,000 bags (of 200 lb. each), the most productive districts being Estcourt, Newcastle, New Hanover, Bergville and Utrecht. Some of the best yields in South Africa are obtained in the midlands, where the average yields are five–six bags to the acre; on some farms seven–eight bags are usual. Except for kafir corn (kafir or sorghum), which is grown mainly on Bantu lands, the only other important crop is cotton, which does well under irrigation in the Ngotshe district, where production averages about 3,000,000 to 4,000,000 lb. per year, and in the Lower Umfolozi district, with about 1,000,000 lb. Pastoral farming is practised mainly in the midland and highland areas, where most of the cattle are pastured. The Bantu herds outnumber those of the whites by about 90%. Sheep are raised in the greatest number in the high veld districts of Utrecht, Klip River and Newcastle.

Mining and Industry.—Coal production is the most important mining activity. Derived from the middle Ecca beds of the Karroo system, the Natal coals include some of the best types in South Africa and, because of the great intrusions of dolerite, there are large deposits of anthracite. Most of the coal and anthracite produced (about 5,000,000 tons a year) comes from two coalfields: the Klip River field centred on Glencoe, including Newcastle and Dundee, and the northern Natal field, with Vryheid as its main producing centre. In the coastal zone titanium is mined at Isipingo, the production being about 30 tons a day. The production of ilmenite, zircon (for ceramics) and rutile was also beginning in the mid-20th century in the south coastal areas.

Almost all manufacturing industry takes place in the Durban and Pinetown industrial area. Products include textiles, soap, rubber, cigarettes, fertilizers, paint, clothing and furniture. Other establishments include a ferromanganese plant at Cato Ridge, a rayon factory at Umkomaas, an oil refinery at Wentworth, a cotton factory at New Germany and a textile factory at Pinetown. At Pietermaritzburg is the tanning extract factory—probably the largest in the world. A further industrial area has been laid out at Mountain Rise, while at Howick is a notable rubber factory, at Ladysmith cotton factories and at Empangeni, in Zululand, a pineapple cannery.

Power is provided by the Electricity Supply commission's Natal Southern and Natal Central undertakings, of which the Congella (Durban) and Umgeni power stations and the Colenso undertaking operate together.

An important marine industry is whaling, producing annually products to the value of about R. 6,000,000. To meet the industrial developments, improvements in Durban harbour have included rail and road access to the Island View oil sites and new precooling and cargo sheds.

Communications.—Natal has a network of communications including 1,539 mi. of railway line and 503 mi. of bituminous surface main roads. Durban (*q.v.*) is South Africa's most important harbour and Ladysmith is a main rail junction. The Louis Botha National airport is near Durban.

See also references under "Natal" in the Index. (J. H. Wn.)

NATAL, chief city and capital of the state of Rio Grande do Norte, Brazil. It is located a little more than 5° S. of the equator, on the right bank of the Rio Potengí about 2 mi. above the river's mouth. Pop. (1961) 154,276. Natal is connected by rail with the interior of the state and southward to João Pessoa, Recife and Maceió. Its chief overland connections, however, are by all-weather gravel highways which reach all the major points in the northeast of Brazil and extend southward to Rio de Janeiro. During World War II, Natal was a stage in the ferry route over which planes from the U.S. were flown to Africa and southeast Asia. Natal is also the port through which the products of the state are sent to other parts of Brazil. The chief products are cotton, sugar, salt and hides. In the city there are plants for the manufacture of cotton textiles and for the refining of salt. The city was founded by the Portuguese in 1599. (P. E. J.)

NATCHEZ, a Muskogean-speaking tribe formerly living in nine villages on the east side of lower Mississippi river between the Yazoo and Pearl rivers, near the site of the present city of Natchez, Miss. Early in the 18th century when the French first established themselves in what was later called the Natchez district, the tribe numbered perhaps 6,000. Relations with the French were at first friendly, and under Jean Baptiste Le Moyne, sieur de Bienville, governor of Louisiana, Ft. Rosalie was built on the site of the present city of Natchez. In 1723 the Natchez were nearly conquered by the French, and an unsuccessful uprising of the Natchez in 1728 was followed in Nov. 1729 by the massacre of more than 200 Frenchmen and the destruction of Ft. Rosalie. In the war that followed the French enlisted the aid of the Choctaw tribe, drove the Natchez from their villages and scattered them. More than 400 Natchez were captured and sold into the West Indian slave trade; the remainder took refuge with the Chickasaw, and later with the Creek and Cherokee. A few Natchez lived in northeastern Oklahoma in the 1960s.

The Natchez, allied in general culture to other Muskogean tribes, were primarily agricultural, highly developed in the arts, and exerted considerable influence on neighbouring tribes before their dispersal. They had developed a sun worship with which was related a perpetual fire of oak bark in a temple. The fire, as well as all fires in the villages, was allowed to die once a year on the eve of the harvest festival and was renewed at dawn on the festival day by a high priest who made fire by rubbing two sticks together. All the village fires were then made anew from this fire. The women then bore in the first maize, some of which was offered at the temple and some of which was ground and baked into bread for a ceremony at sunset. The ceremony was followed by general feasting.

The remarkable Natchez caste system classified men as suns, nobles, honoured people and commoners (or stinkards). The tribal chief (the Great Sun) and heads of the villages claimed descent from the sun; and there were both male and female suns, each supposedly descended from a male and female who had come out of the sun. The system was matrilineal and exogamic. Male and female suns could not marry each other. Male suns married stinkard wives and their children were honoured people. Sun women married stinkard husbands and their children were rated suns. The Great Sun had the power of life and death over all the others and was followed in death by his spouses, attendants and voluntary victims. The succeeding tribal chief was the son of the Great Sun's sister or closest female relation.

See H. B. Cushman, ***History of Choctaw, Chickasaw and Natchez Indians*** (1961).

NATCHEZ, a city of Mississippi, U.S., is located on the Mississippi river near the southern boundary of the state; the seat of Adams county. Founded by France as an outpost bastion of empire, Natchez has been part of the struggle for colonial mastery in North America and is symbolic of the south with its rich ante-bellum cotton culture, post-Civil War decline and modern industrialization.

The oldest settlement on the Mississippi river, the site was

selected in 1700 as one of a series of military posts designed to halt British westward penetration, with actual settlement occurring in 1716. Surviving a massacre by Natchez Indians in 1729, one of the bloodiest in American history, the settlement passed to the British in 1763 at the conclusion of the French and Indian War. Becoming Great Britain's chief outpost on the Mississippi, Natchez was a haven for Loyalists driven from the revolting colonies during the early stages of the American Revolution until, in 1779, the town was captured by Spain. Spanish cession occurred in 1795, and with occupation by the United States in 1798 Natchez became the first incorporated town (1803) and the first capital of the Territory (1798–1802) of Mississippi. It was also the southern terminus of the famed Natchez Trace, the overland link between Natchez and Nashville, Tenn. As the old southwest was settled, Natchez burgeoned as the commercial and cultural centre of a vast and rich cotton-producing area. At the outbreak of the American Civil War it was the largest and wealthiest city in Mississippi.

Following a decline after the Civil War, modern Natchez has capitalized upon its natural resources, industrial potential, and historic legacy to become again one of Mississippi's leading cities. Transportation facilities include river, railway, highway and airline systems. A $40,000,000 bridge spans the Mississippi at Natchez. Timber, petroleum and natural gas reserves have attracted major manufacturers of rubber, wood, paper and textile products as well as producers of petroleum and natural gas.

Possessing a legacy of the cotton barons' magnificent homes, sunken roads, an infamous though long extirpated river front section named "Natchez-Under-the-Hill" and a culture ranging from the supreme elegance of the "Cotton kingdom" to the lawlessness of the early river front, Natchez has become the stereotype of the ante-bellum south. The annual Natchez pilgrimage, held during March and featuring homes and pageants of those days, attracts visitors from throughout the United States. Many novels and motion pictures have their setting in the city.

The city contains several parks, the largest of which was once part of Auburn and Sunnyside plantations; also three hospitals, the Fisk public library and Natchez college, a Negro Baptist junior college opened in 1885. For comparative population figures *see* table in MISSISSIPPI: *Population.* (P. F. WA.)

NATHAN, GEORGE JEAN (1882–1958), U.S. author, editor and drama critic, of whom, at the time of his death, the *New York Times* reported ". . . no other American critic of the period had so greatly raised the standards of play producers or so determinedly elevated the tastes of play goers." He was born Feb. 14, 1882, in Fort Wayne, Ind., son of Charles and Ella (Nirdlinger) Nathan. He graduated from Cornell university, Ithaca, N.Y., in 1904 and joined the staff of the *New York Herald.* Beginning in 1906, he was at various times drama critic for numerous magazines and newspapers, but his name is particularly associated with *Smart Set,* of which he was co-editor (1914–23) with H. L. Mencken, and with the *American Mercury,* which, also with Mencken, he helped to found (1924). As a critic Nathan championed the plays of Ibsen, Strindberg, Shaw, O'Neill, O'Casey and Saroyan. He published his *Theatre Book of the Year* annually from 1943 through 1951, as well as more than 30 volumes of lively essays on theatrical and other subjects.

Nathan married the actress Julie Haydon in 1955. He died in New York city on April 8, 1958. (B. HT.)

NATHANAEL, one of the first disciples of Christ, "an Israelite . . . in whom there is no guile" (John i, 47). He was an inhabitant of Cana in Galilee (John xxi, 2), but is otherwise unknown. Though Nathanael was one of the first disciples, his name does not appear in the apostle lists. A 9th-century Syrian tradition identified him with Bartholomew—so Isho'dad of Merv, Elias of Damascus and others. (*See* BARTHOLOMEW, SAINT.) This identification was adopted by Rupert of Deutz in the 12th century and became common from that time on in the Western Church; it is commonly accepted by modern biblical scholars. The name means "God has given." (J. A. FI.)

NATHANYA (NETANYA), a town of Israel situated on the coastal plain of Sharon, 25 mi. N. of Tel Aviv-Jaffa. Founded in 1928 as an agricultural village of smallholders, it was named after Nathan Straus, a well-known U.S. philanthropist. Pop. (1961) 41,267. It became a popular bathing resort for the region, and British forces had a big rest camp there in World War II. Many diamond cutters and polishers from the Netherlands and Belgium were settled in a suburb to carry on the diamond industry, and other important industries (textiles, chemicals, paper products, food processing) have been developed. The Goldmunz Museum of Modern Art is in the southern part of the town. The park by the sea includes an open-air theatre. There is good road and railway communication with Tel Aviv-Jaffa. (No. B.)

NATICK, a city of Massachusetts, U.S., 18 mi. W.S.W. of Boston, is situated on the southeast end of Lake Cochituate. The area was granted to John Eliot (*q.v.*) in 1650 as a plantation where he could carry on his mission work and establish a school of higher education for the most capable Indian converts; Natick was its original Indian name. Eliot published his Indian Bible in 1663, a copy of which the town possesses. The Indians held the land in common until 1719 and prevailed until 1762. Incorporation as a town took place in 1781. Modern Natick serves in a dual capacity as a suburban residential community and as a growing industrial town. Of special interest is the research and engineering centre of the U.S. army quartermaster research and development command. For comparative population figures *see* table in MASSACHUSETTS: *Population.* (M. E. L.)

NATION, CARRY AMELIA (née MOORE) (1846–1911), U.S. temperance advocate, was born in Garrard county, Ky., Nov. 25, 1846. In 1867 she married Charles Gloyd, an alcoholic; their brief unhappy life together prompted her later career of saloon-smashing in Kansas. With a few hymn-singing women, or alone, she would march into a saloon, sing, pray, hurl vituperations at all "rummies" present and smash the fixtures and the stock with hatchets. This crusade, most violent in the 1890s, led to scattered temporary efforts at law enforcement. After this period of "hatchetation" of "joints"—her words—she lectured in many states, in Canada and Great Britain, usually under her own management. For a while she also spoke between acts of carnivals and burlesque shows.

BROWN BROTHERS

CARRY NATION

The fact that her first husband had been an active member of a fraternal order as well as an alcoholic led her to fight such organizations along with saloons, and she added to her list of things to be destroyed tobacco, foreign foods, corsets, skirts of improper length and paintings of the sort often found in barrooms. She was an advocate of women's suffrage, but neither the national movement for suffrage nor that for temperance gave her much support. Her second husband, David Nation, divorced her in 1901 on grounds of desertion after a marriage of 23 years. She died June 9, 1911. Her autobiography, *The Use and Need of the Life of Carry A. Nation* (1904), is a hodgepodge of disorder. (G. BN.)

NATIONAL ACADEMY OF SCIENCES–NATIONAL RESEARCH COUNCIL. The academy, a nongovernmental U.S. organization of scientists, was established March 3, 1863, by act of Congress to serve as an official adviser to the government, upon request, in all matters of science and technology. The National Research Council was established by the academy in 1916. The academy and the council were unified after World War II and came to be known as the National Academy of Sciences–National Research Council (NAS–NRC, or Academy–Research Council).

Among the first tasks assigned to the academy were those dealing with weights, measures, and coinage, magnetic deviation and bottom-fouling in iron ships, wind and current charts and sailing

directions, materials for the manufacture of coins, the prevention of counterfeiting, and the establishment of metric standards for the states. Later, the academy was asked to advise on plans for observing the transits of Venus in 1874 and 1882. In 1871 it prepared instructions for the scientific activities of the expedition which sailed toward the North Pole, in 1873 for the exploration of the Yellowstone, and in 1902 for the exploration of the Philippines. In 1878 the academy made recommendations that resulted in the creation of the U.S. Geological Survey; later, academy advice led to the establishment of the Weather Bureau, the Smithsonian Astrophysical Observatory, and the National Bureau of Standards; and academy recommendations played a leading role in the establishment of the U.S. Forest Service.

In 1916, at the request of Pres. Woodrow Wilson, the academy established the National Research Council to attack problems arising from the shortage of nitric acid and organic chemicals and from urgent needs in communications and preventive medicine. The council was active in the development of devices useful in antisubmarine warfare and in directing antiaircraft fire, in the development of effective insecticides, and in the testing of lenses and the production of optical glass. The council also participated in the investigation of traumatic shock and the development of procedures for the selection of officers and the classification of draftees.

Among the steps of lasting significance taken during the years immediately after World War I were the launching of the extensive program of National Research Council fellowships to enable young scientists to receive postdoctoral research training. The council inaugurated a Highway Research Board to provide a modern technological base for the development of a national highway system, and published between 1926 and 1933 the eight volumes of the *International Critical Tables of Numerical Data, Physics, Chemistry, and Technology.*

So great was the effort required by World War II that a group of academicians persuaded the federal government to establish its own agency, the Office of Scientific Research and Development, providing for appropriate links with the academy. Among the accomplishments of the resulting collaboration were the recommendations of an academy committee that an intensive drive for the military application of nuclear fission be pursued; recommendations on the large-scale production of penicillin, the development of quinine substitutes, the battlefield use of sulfa drugs and the use of human blood plasma in transfusions; on the design of adequate defenses against the possibilities of biological warfare; on the stockpiling of strategic materials; on research in metallurgy and mineral technology; on the selection and training of aircraft pilots and of specialists in radar and electronics; and on problems relating to human nutrition and aviation medicine.

The impact of World War II subordinated for a time the academy's role as a learned society. Funds from governmental sources rose from 6% of the entire budget of the academy and the council in 1939 to 62% in 1948. During the same period total annual expenditures increased from a little over $700,000 to more than $3,100,000. In the 1960s these reached $15,000,000 a year. The rapidly increasing demands upon the academy after World War II resulted in its reorganization as the National Academy of Sciences–National Research Council, in which the members of the academy are trustees as well as participants, and the council is made up of representatives of the great national scientific and engineering societies and of the government. Several thousand scientists and engineers participate in the activities of the overall organization. Among the undertakings of the Academy–Research Council were the inauguration of the Atomic Bomb Casualty Commission (to study the long-term effects of the bombings in Hiroshima and Nagasaki) and a series of extensive engineering tests of highway construction. Some of the academy's major activities have stemmed from the deepening involvement of science in many facets of public policy. In 1955 a continuing survey of the biological effects of atomic radiation was undertaken with private support. Reports emanating from this study set forth the state of knowledge in specialized fields for the benefit of scientific workers and summarized the situation in nontechnical language for the education of the public in the biological problems accompanying the advent of the atomic age. Other areas of public concern into which the academy has looked include federal support of science, world population problems, civil defense, personal loyalty requirements relating to the award of governmental research grants, railroad and urban transportation, the utilization of technical and scientific manpower, and—at the request of Pres. John F. Kennedy—research needs and opportunities in the field of natural resources.

See A. H. Dupree, *Science in the Federal Government* (1957).
(F. Sz.; H. J. Le.)

NATIONAL ARBITRATION TRIBUNAL: *see* Industrial Court.

NATIONAL ARCHIVES, U.S. The National Archives and Records Service, part of the General Services Administration, consists of the National Archives, the Office of Federal Records Centers, the Office of Records Management, the Office of the Federal Register, and the Office of Presidential Libraries. It is headed by the archivist of the United States, who is also chairman of the National Historical Publications Commission.

The National Archives preserves, describes, and services federal records retained because of their enduring value. It holds the nation's most important records dating from about 1774. They include the original laws, executive orders, and proclamations, treaties, records of the Congress and virtually all the permanently valuable records of federal executive agencies. The holdings, most of which are freely open for research, are described in finding aids published from time to time. Records of high research value are available to scholars and research institutions on microfilm. The Declaration of Independence, the Constitution of the United States, the Bill of Rights, and many other historic documents are on display in the National Archives Building.

The Office of Federal Records Centers is responsible for the appraisal of records, for the economical maintenance of noncurrent records, and for assisting agencies with the efficient management and disposition of their records. The Office of Records Management is responsible for developing and promoting improved paperwork practices throughout the government.

The Office of the Federal Register publishes the daily *Federal Register*, the *Code of Federal Regulations*, the *United States Statutes at Large*, the *United States Government Organization Manual*, and the *Public Papers of the Presidents of the United States*, all obtainable through the Government Printing Office.

The Office of Presidential Libraries administers the Franklin D. Roosevelt Library at Hyde Park, N.Y., the Harry S. Truman Library at Independence, Mo., the Dwight D. Eisenhower Library at Abilene, Kans., and the Herbert Hoover Library at West Branch, Iowa. Papers of these presidents and many of their associates are housed in the libraries and contain significant materials for the study of modern U.S. history. After President Kennedy's assassination, preparations were made for the establishment of the John F. Kennedy Library at Boston.

The National Historical Publications Commission promotes and participates in documentary publication programs of public and private agencies. Projects for publishing papers of such men as Benjamin Franklin, John Adams, John Quincy Adams, Alexander Hamilton, and James Madison have been set up under private sponsorship. The commission itself undertook preparation of a documentary history of the ratification of the federal constitution and the Bill of Rights. (W. C. G.)

NATIONAL ASSOCIATION FOR THE ADVANCEMENT OF COLORED PEOPLE, a U.S. voluntary interracial organization founded to combat racism, stamp out lynching and lynch law, eliminate racial discrimination and segregation, and assure Negroes their constitutional rights. In response to a call issued by 60 Negro and white educators, clergymen, and other leaders on Feb. 12, 1909—the centennial of the birth of Abraham Lincoln—a national conference on the Negro was held in New York City on May 30–June 1 of that year. The conference idea had been conceived by William English Walling, a journalist, and nurtured by two social workers—Mary White Ovington and Henry Moskowitz—with Oswald Garrison Villard, grandson of William Lloyd Garrison. Out of this conference the National Association for the Advancement of Colored People (NAACP) was born.

Since its founding, the NAACP has sought its goal through legal action to protect the rights of Negro citizens, nonpartisan political action to secure enactment of civil rights laws, a program of education and public information designed to win popular support, and direct action to achieve specific goals. By the second half of the 20th century the NAACP had become a nationwide association of more than 400,000 members in over 1,600 local units in 50 states and the District of Columbia. Headquarters were maintained in New York City with a bureau in Washington and regional offices in Atlanta, Dallas, Kansas City, Mo., and San Francisco. Its monthly organ, *The Crisis*, had a circulation of more than 130,000.

See further NEGRO, AMERICAN.

See Langston Hughes, *Fight for Freedom: the Story of the NAACP* (1962); Wilson Record, *Race and Radicalism: the NAACP and the Communist Party in Conflict* (1964). For current history, *see* the *Britannica Book of the Year*. (Ro. C. W.; Ro. W.)

NATIONAL ASSOCIATION OF EVANGELICALS, a fellowship of various evangelical Protestant groups within the United States, was organized in 1943 in response to a "Call to Evangelical Action" signed by 147 evangelical leaders. It comprises more than 40 denominations, many independent religious organizations, local churches, groups of churches, and individual Christians. All members must subscribe to a Statement of Faith which requires belief in the "Bible as the inspired, the only infallible, authoritative word of God" and commitment to a well-defined category of fundamental Christian doctrines.

The association renders services in the major fields of Christian activity, with commissions and affiliated agencies for evangelism and church extension, higher education, Christian day schools, Sunday schools, publications, foreign missions, laymen's work, women's work, youth work, public affairs, radio and television broadcasting, government chaplaincies, world relief, international relations, social action, stewardship, spiritual life, and theological concerns. Among its related agencies are the Evangelical Foreign Missions Association, the National Sunday School Association, the National Religious Broadcasters, Inc., and the National Association of Christian Schools.

The association claims 2,500,000 full members and a service constituency of more than 10,000,000. Its national headquarters office is at Wheaton, Ill. Other offices are in Washington, D.C., New York City, and other major U.S. cities. The organization is officially related to the World Evangelical Fellowship, with offices in London. *See* also FUNDAMENTALISM.

See James DeForest Murch, *Cooperation Without Compromise: a History of the National Association of Evangelicals* (1956); J. Elwin Wright, *Evangelical Action* (1943); and the monthly journal, *United Evangelical Action*. (J. DeF. M.)

NATIONAL ASSOCIATION OF MANUFACTURERS (U.S.): *see* TRADE ORGANIZATION.

NATIONAL CONVENTION. National conventions of the Democratic and Republican parties are held at four-year intervals to nominate the party candidates for president and vice-president of the United States. The conventions, as the representative organs of the parties, also adopt platforms, elect the national committees and may adopt rules governing the national organization of the parties and their work between conventions. In practice, the conventions also act as rallies for the presidential election campaigns. Disagreements within the parties often lead to heated argument at the conventions but also usually to reconciliation and greater cohesion as each party unites behind the chosen leadership. The public image of the parties on the eve of the presidential election is in large measure the product of the conventions.

Early History.—The conventions originated during the presidency of Andrew Jackson (1829–37), after years of growing dissatisfaction over nominating procedures. The first president, George Washington, was so clearly the outstanding national leader of his time that no formal action was necessary to identify him as a candidate before his election. But when it became necessary to choose a successor among several candidates, it became apparent that somehow the field of choice must be narrowed as a preliminary step, if the electoral arrangements of the constitution were to operate effectively. By the election of 1796, the beginnings of party organization in congress were able to solve the problem; presidential nominations were then made mainly in informal congressional party caucuses until 1816, when James Monroe was nominated and elected.

Monroe's administration was marked by a virtual disappearance of such organized political parties as had previously existed in congress. In 1820 Monroe required no nomination for a re-election that was almost by unanimous consent; but in 1824 the popular vote was divided among four candidates, none of whom had a majority, and the election was thrown into the house of representatives for settlement. John Quincy Adams was chosen president, although Andrew Jackson had been the leading candidate. By 1828 the Jackson men were so strongly organized that no formal action was needed to identify their candidate, although there had been talk of calling a national convention. Jackson won the presidency in 1828 without difficulty. A clarification of party lines followed in congress, but the congressional party caucus was too discredited for restoration as a nominating agency.

The opposition parties of the time held the first recognized national party conventions in preparation for the elections of 1832. The Antimasonic party met at Baltimore, Md., in Sept. 1831, with 116 delegates from 13 states and chose William Wirt. The National Republican party, generally identified as a predecessor of the Whig party and the present Republican party, held a convention at Baltimore in Dec. 1831, at which it nominated Henry Clay. The Jacksonians met at Baltimore in May 1832 as the "Democratic-Republican National convention," hailed Jackson as their chief and nominated Martin Van Buren for vice-president. This was the first national convention of the present Democratic party.

The National Republicans held no convention in 1836 and were replaced in 1840 by the Whigs, who held national conventions through 1852. After that year the Whig party disintegrated over the issues of slavery. It was succeeded mainly by the Republican party, which held national conventions in preparation for every presidential election from 1856. Third parties and minor parties also held national political conventions; but as generally used, the term refers to the conventions of the two major parties.

Nominating Patterns.—Franklin Pierce, defeated for renomination in 1856, was the only elected president who tried and failed to win a second nomination from the national convention of his own party. But others of the period declined the effort. James K. Polk had announced himself as a one-term president; and James Buchanan thought better of any second-term attempt.

After the turn of the century, it was generally expected that an incumbent first-term president would seek renomination and achieve it easily. The "Bull Moose" drive to prevent the renomination of William Howard Taft in 1912 was the main exception; and Taft was renominated in the end, although he lost the election. Franklin D. Roosevelt won a third-term nomination in 1940 with relatively little difficulty, and a fourth in 1944 with none at all. But under the 22nd amendment to the constitution, adopted in 1951, further third-term nominations were prohibited, except for a vice-president who becomes president and serves no more than two years in his first term.

All of the eight vice-presidents who succeeded to the higher office through death of the president through 1963 sought nominations to succeed themselves. The four who made the effort during the 19th century—John Tyler, Millard Fillmore, Andrew Johnson and Chester A. Arthur—were rejected by their parties. Four in the 20th century—Theodore Roosevelt, Calvin Coolidge, Harry S. Truman and Lyndon B. Johnson—won renomination.

Nominations by the party out of power have only rarely resulted in the renomination of a previous candidate. After Van Buren's failure to secure a third nomination in 1844, and Clay's final nomination in that same year, no "titular leader" of a defeated party was seriously considered for renomination until Grover Cleveland's third nomination and second election in 1892. William Jennings Bryan was nominated in 1896, 1900 and 1908, but lost the elections that followed in each case. Alfred E. Smith sought a second Democratic nomination unsuccessfully in 1932, and Wendell Willkie sought a second Republican nomination unsuccessfully

in 1944. In 1948, Thomas E. Dewey became the first defeated Republican to receive a second nomination, but was again defeated; in 1956, Adlai E. Stevenson was renominated by the Democrats, and was also defeated.

The conventions have nominated occasionally with little or no contest even when no president or titular leader was available. Instances of this kind have included a few rare nominations that were akin to inheritance as a means for acquiring party leadership: Van Buren's first presidential nomination, in 1836; Taft, 1908; Herbert Hoover, 1928; Richard M. Nixon, 1960. Other instances have included the designation of an already obvious party choice: Clay in 1832 and 1844, Smith in 1928.

A few other nominations have involved enough agreement among the inner groups of party leaders to make the work of the conventions relatively simple. Among the Democrats, such nominations have included those of Lewis Cass, 1848; George McClellan, 1864; Horace Greeley, 1872; Winfield S. Hancock, 1880; Cleveland's first nomination, 1884; Alton B. Parker, 1904. Republican nominations of this type have included those of John C. Frémont, 1856; Ulysses S. Grant, 1868; Charles Evans Hughes, 1916; and Alfred M. Landon, 1936. Inner-group selections of the kind just noted have rarely won elections, however.

New leadership was selected after a vigorous contest in 27 of the 67 major party conventions through 1964. Each of these contests involved at least two and often three or four leading candidates for the presidential nomination of the party concerned. In 20 cases, the prize was captured by one of the major contestants. In the other seven cases of contest, compromise or "dark horse" candidates were selected after rejection of all the leading candidates. These include the cases of Polk, 1844; Pierce, 1852; Horatio Seymour, 1868; Rutherford B. Hayes, 1876; James A. Garfield, 1880; Warren G. Harding, 1920; and John W. Davis, 1924. In addition, Benjamin Harrison (1888) and Bryan (1896) have sometimes been regarded as "dark horse" candidates, but were in no sense the result of interfactional stalemate and compromise. Willkie (1940) has also been considered a "dark horse" candidate, but was conspicuously in the running before the convention opened and was not a compromise.

After the 1920s, the factors producing the "dark horse" candidacies of the past disappeared or changed considerably. In 1936, the Democratic party abandoned its century-old rule requiring a two-thirds vote of the convention to nominate. Under a regime of majority voting in both party conventions, with increasingly open campaigning before the conventions by willing candidates and with the clarification of preconvention campaigns and candidate status that takes place through public opinion polls, preconvention primaries and modern processes of communication, national conventions can usually reach their decisions quickly—unlike the Democratic convention of 1924, which required 16 days and 103 ballots under the two-thirds rule to nominate a candidate.

Sources of Candidates.—Candidates for the nominations have usually been persons with extensive political experience; although in rare instances others have been considered and nominated, as in the case of Willkie (1940), and even elected, as in the case of Dwight D. Eisenhower (1952). U.S. senators have formed the largest single category of contestants for both the presidential and vice-presidential nominations. Nominations for the lesser office were won by senators with increasing frequency from 1928; but from the nomination of Stephen A. Douglas (1860) to 1956, Harding (1920) was the only incumbent senator to win a major party presidential nomination. In 1960, however, Sen. John F. Kennedy became the nominee of the Democratic party and in 1964 Sen. Barry M. Goldwater became the Republican nominee.

Governors have long been highly important as aspirants for the nominations. Disregarding four presidential nominees who had succeeded to the presidency from the vice-presidency, 8 of the 20 first-time presidential nominees from 1896 to 1964 were incumbent governors. Three first-time nominees, Bryan, Davis and Willkie, held no governmental position at the time of their nomination; two, Taft and Hoover, were cabinet members; two, Parker and Hughes, were high court judges; three, Harding, Kennedy and Goldwater, were senators; one, Eisenhower, was a regular army general; and one, Nixon, was vice-president.

With so many sources from which candidates for the nominations may come, the conventions occupy a critical place in the career aspirations of the political and other leaders of the United States. The career development and preconvention campaign activities that lead up to the final decisions tend to involve all elements of the U.S. social order. The presidential nominating process, consisting of the never-ending actions and activities that take place in anticipation of future convention decisions, is one of the main organizing features of U.S. life and politics.

Preconvention Campaigns.—When an open nominating situation is in prospect in one party or the other, willing candidates may announce as early as October or November of the preceding year. Early candidates incur the hazards of the "front-runner," but the filing requirements for the presidential primary elections in several important states require action by December or January for a successful race in the primaries that follow.

Preconvention campaigning was dominated by the so-called presidential primary elections after World War II, although they were held in fewer than half of the states. Since 1904, when Wisconsin provided for the selection of convention delegates at a primary election, the states have experimented with such widely different systems that no easy summary is possible; but in most of these states the delegates to the national conventions are chosen in a public election at which the adherents of the respective parties may vote. The voters may also be given an opportunity, directly or indirectly, to express a preference among two or more of the candidates for a presidential nomination. The chronology of the presidential primaries in a typical presidential year begins with New Hampshire in March; includes Wisconsin, New Jersey, Pennsylvania and Massachusetts in April; the District of Columbia, Maryland, Indiana, Ohio, Alabama, West Virginia, Nebraska, Oregon and Florida in May; and California, Illinois, New York and South Dakota in June.

Something is usually known concerning the presidential candidate preferences of the would-be delegates, even in the states where there is no provision for putting such information on the ballot. In many of the primary states, would-be delegates can indicate their candidate preference on the ballot if the candidate gives consent; and in a few states, notably New Hampshire, Oregon and Florida, they can do so without the necessity of securing candidate consent. Generally when there is an active contest for the nomination of one party or the other, opposing presidential candidates of national stature can be expected to campaign vigorously in at least three or four of the presidential primary states. These state campaigns and elections usually attract national attention and clearly affect the estimates of the candidates that are held by the voters, as well as those held by the prospective delegates, even those from states where no primaries are held.

Time, Place, Composition.—The national conventions meet at a time and place previously determined by the respective party national committees. Formerly the conventions were usually held in June, but in 1952 and 1960 both were held in July, and in 1956 in August. In 1964 the Republican convention was held in mid-July and the Democratic convention late in August. There is no policy on which party meets first.

Chicago has been chosen as the convention city most frequently in the 20th century, with Philadelphia second. Baltimore was the favourite meeting place from 1832 to 1872. For most of a century, voting strength in both conventions was apportioned among the states in accordance with their electoral college vote, usually two convention votes for each of the state's senators and representatives in congress; and this was still a major factor in the apportionment in the 1960s. In preparation for its 1916 and later conventions, however, the Republican party adopted rules curtailing the representation of congressional districts (mainly in the south) where the Republican vote was light. Both parties later adopted the practice of giving "bonus" votes to the states carried by the party in a previous election, which had the effect of inflating total convention voting strength to more than 1,300 votes in each party by 1956. In Republican conventions, state delegations usually were restricted to their authorized size, with one vote for each

delegate; but the Democratic party repeatedly authorized the election of additional delegates on a half-vote basis and frequently seated delegates who held less than half a vote, with resultant confusion of voting procedures. In 1960, the Democratic party put all delegates on a half-vote basis and increased the total number of votes to 1,521.

Proceedings.—Each convention is opened by the chairman of the national party committee, and usually elects a temporary chairman on the first day. The temporary chairman may give the keynote address and usually presides until the organization of the convention has been completed. Senators have often served as temporary chairmen, but governors have done so increasingly in the 20th century. The permanent chairman usually takes over on the second or third day of the convention and presides during the adoption of the party platform and the balloting on presidential and vice-presidential nominations. During the 19th century, state and local party leaders usually served as permanent chairmen; in the 20th century the post was usually filled by an incumbent senator or representative in congress.

Party platforms are prepared in committees designated for the purpose. Platform issues have been hotly fought, with divided votes, in many Democratic conventions, including notably those of 1924 and 1948; but no platform issue came to a divided vote on the floor of a Republican convention from 1936 to 1960. There was, however, a Republican floor fight in 1964.

Nominations are the work of the convention as a whole and have not directly involved any prior committee action since 1840. Candidates are placed in nomination with eulogistic nominating and seconding speeches; noisy demonstrations are then staged by the supporters of each nominee parading up and down the aisles; and eventually the convention votes. The roll of the states is called alphabetically, and the vote of each state delegation is reported by its chairman; if necessary the delegation is polled. The state's vote may be divided among two or more candidates, unless the delegation is bound by its state to vote as a unit. Many contests are settled on the first or second ballot, but even in the 1940s and 1950s, several ballots were sometimes necessary. In rare instances, such as Franklin D. Roosevelt's nomination at the Democratic national convention of 1936 and Lyndon B. Johnson's nomination at the 1964 Democratic convention, a candidate is nominated by acclamation without the formality of a roll call vote.

Vice-presidential nominations follow the presidential. Frequently the vice-presidential choice has been determined by the presidential nominee in consultation with other party leaders, after which other candidates for the lesser nomination have withdrawn and the convention has ratified the choice without a contest. But in 1956, Stevenson followed the example of Bryan in 1896—an example that Bryan never again followed himself—in insisting that the convention itself make the choice. Sen. Estes Kefauver won the nomination on the second ballot.

Throughout the 19th century, the candidates usually remained at their homes while the conventions were in session; and committees were sent, often weeks later, to advise the successful candidates officially of the convention action. In the 20th century, willing candidates began to be present at the convention city oftener but rarely appeared in the convention itself before 1932. In that year, however, F. D. Roosevelt came to Chicago by airplane from Albany, N.Y., and appeared in person at the end of the Democratic convention to accept its nomination. After that time, major candidates were usually present in the convention city during the proceedings, and appearance of the nominees to make acceptance speeches at the final session became customary.

Reform Proposals.—Throughout their history, the conventions have been among the most criticized of political institutions, perhaps because they provide so many opportunities for the organization, manipulation and display of political power. Throughout the 20th century, a favourite reform proposal has been to replace the conventions with a national presidential primary, to be provided either by a constitutional amendment or by federal law encouraging uniform state action. Public reaction to the conventions of 1952, the first to receive full television coverage over nationwide networks, was interpreted by some observers as giving great impetus to the movement for a national presidential primary. But that impetus failed to show itself in congress, except in the adoption of a presidential primary law for the District of Columbia. State legislatures also were slow to register any notable desire to install primaries in states where they did not already exist.

At mid-20th century the conventions undoubtedly had become the object of a greater amount of professional and scientific research activity than at any previous time in their history. While such research mainly added to the store of knowledge concerning the complexities of the presidential nominating process, it also produced many suggestions for changes in procedures. It seemed that these might eventually have a significant cumulative effect without changing the fundamental nature of the convention institution, which seemed to be firmly established as a part of the U.S. political system.

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NATIONAL COUNCIL OF CHURCHES. The National Council of the Churches of Christ in the U.S.A. was formed in December 1950 by a merger of 12 national interdenominational agencies, several of which had been organized as early as 1908. Its purpose is to provide an organization through which member churches can express their common faith and cooperate with one another on programs to which the bodies themselves consent or which they initiate. The council has no authority over its constituent bodies. Among its objectives and functions, as stated in its constitution, are to encourage fellowship and counsel concerning the spiritual life and religious activities of the churches; to promote cooperation among local churches and the development of state and local councils of churches; to encourage study of the Bible; to do for the churches such common services as are desired; and to provide a medium of consultation, research, and planning.

By 1967 there were 30 Protestant and Orthodox bodies constituent to the council, of which 24 were Protestant. Almost 40 other denominations or agencies of denominations cooperated in one or more of the council's programs. In the constituency of the council were approximately 144,000 local congregations with about 110,000 ministers. In these were over 40,000,000 members, of which more than 35,000,000 were Protestant. The council also cooperated with about 900 local and state councils of churches which were responsible to their own state and local churches.

The council carries out many of its activities through four divisions. The Division of Christian Life and Mission provides encouragement of study and action in international affairs; education among groups and individuals to apply Christian principles to economic life and racial and cultural relations; counsel and guidance to the ministries in hospitals and prisons; and coordination of activities in furtherance of religious liberty, social welfare, and stewardship. The division also maintains a consultation service on church building; administers a cooperative migrant ministry for seasonal farm workers; and encourages broad planning to meet the special needs of rural and urban churches and of home missions institutions. The Division of Overseas Ministries coordinates, counsels, and interprets the cooperative phases of the overseas work of participating foreign mission boards and denominations; supplies medical services to foreign missionaries; and conducts a literacy program in about 200 languages. The Division of Christian Education helps the churches to develop guidance materials for local work in religious education; gives leadership in the improvement of administration of Sunday school programs; and administers about 600 leadership schools annually. It encourages weekday

religious education and vacation schools and coordinates the educational work of the denominations with respect to church-related colleges.

The Division of Christian Unity, created in 1965, includes United Church Women, who participate in activities of local interdenominational councils of church women; encourage observance of the annual World Day of Prayer; and engage in varied programs in missions, family life, race relations, and civil liberties. United Church Men, also in this division, aid in the development of co-operative programs among local groups of laymen and encourage their interest in such subjects as missions and education.

Among other units of the council, the Department of Church World Service is a channel through which many denominations carry on a world-wide program of relief and rehabilitation to needy and suffering persons abroad, in most cases victims of natural disasters and political upheaval. It has administered services resulting in the resettlement of more than 115,000 refugees in the United States and has shipped overseas as much as 350,000,000 lb. of materials, mainly food, in one year. An activity of the Department of Evangelism is a cooperative ministry in the national parks that provides religious services to visitors. The Broadcasting and Film Department presents radio and television messages; develops films and film strips; and provides training for both clergymen and laymen on the use of radio and television. The Department of Research carries on various research projects; promotes research by other agencies; and maintains a centre of information on church statistics. It edits the *Yearbook of American Churches,* which presents official information from all faiths.

The General Assembly of the council (triennial) and the General Board (meeting between sessions of the assembly) on occasion issue policy statements. Among them are: the council stands opposed to racial segregation in the churches and community life; believes in and supports the right of both employers and employees to engage in collective bargaining; believes in and supports the procedures of the United Nations; advocates broad international trade and the foreign-aid program of the United States; is unalterably opposed to Communism and stands against its evils, violence, and violations of human rights.

The council's General Board consists both of clergymen (almost two-thirds) and lay persons, elected or appointed by the constituent bodies. On the committees supervising the program units lay people approximately equal clergymen in numbers. Of the council's net budget, more than half comes from church bodies; the remainder is made up of proceeds from sales of materials, gifts of individuals, foundations, and corporations, and proceeds from investments. Headquarters is in New York City.

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NATIONAL DEBT: *see* DEBT, PUBLIC.

NATIONAL GEOGRAPHIC SOCIETY, a U.S. scientific society founded in Washington, D.C., in 1888, "for the increase and diffusion of geographic knowledge." From a small local organization founded by eminent explorers and scientists it had grown to become the largest scientific and educational society in the world, with an international membership of over 4,500,000 in the late 1960s. All members receive the society's monthly journal, the *National Geographic Magazine,* and many maps issued as supplements. Annual membership dues support all of the society's activities, which have included more than 200 major scientific projects and expeditions.

From the expeditions of Walter Wellman and Robert E. Peary to Richard E. Byrd and Paul A. Siple, the society has supported and encouraged arctic and antarctic exploration and published firsthand accounts of explorers. In the early 1930s its giant stratosphere balloons, launched jointly with the U.S. army air corps, pioneered in scientific exploration of the upper air and attained the greatest elevation reached by man up to that time (13.71 mi.). National Geographic expeditions, often cosponsored with the Smithsonian and other institutions, have studied volcanic eruptions and earthquakes, excavated Machu Picchu, lost city of the Incas on a Peruvian mountain top, and discovered in Mexico the oldest dated work of man in the new world.

The society helped explore and bring into the U.S. national park system such national treasures as the Valley of Ten Thousand Smokes in Alaska, Carlsbad caverns and Pueblo Bonito in New Mexico and the giant sequoias of California. In 1958 the society presented Russell cave, Alabama—in which was uncovered a record of 9,000 years of North American prehistory—to the national park service. (*See* also ALABAMA: *History.*) In 1949–56 the society and the California Institute of Technology, working with the Palomar observatory telescopes, produced for world distribution a *Sky Atlas* of unprecedented scope. More recent activities have included archaeological examination of the vast, long-forgotten capital of Maya civilization, Dzibilchaltun, in Yucatán, in co-operation with Tulane university, and anthropological research by Dr. and Mrs. L. S. B. Leakey in east Africa that has produced fossil remains of hominids of record antiquity.

Besides its expeditions, its magazine and its maps, the society fulfills the purpose for which it was organized through its school service which issues weekly bulletins to educators, librarians and students in the United States; a news service which issues daily releases on world events for press, radio and television; its illustrated books presenting scientific information in readily understandable form; globes, atlases, educational television; and occasional scientific monographs by its expedition leaders.

Melville Bell Grosvenor, son, grandson and great-grandson of presidents of the society, became its president and editor in 1957. *See* also GROSVENOR, GILBERT HOVEY.

See *National Geographic Magazine,* 75th Anniversary Issue (Jan. 1963). (M. B. G.)

NATIONAL GUARD, the name applied in the U.S. to a volunteer organization of individuals who devote part of each week to military training. Older than the nation, it has the longest history of any military organization in the U.S. Its origin goes back to the early 17th century when the colonists, to protect their lives and property, formed militia companies (*see* MILITIA). As the nation grew, the National Guard grew, and as towns sprang up and states were added to the union, additional guard units were formed for local and national protection.

Early History.—The oldest National Guard units in the U.S. with unbroken lineages are the 101st Engineer Battalion and the 182nd Infantry Regiment, Massachusetts National Guard. These units began Oct. 7, 1636, when the Boston general court ordered all military men in the area to form into militia regiments. Two of these, the north regiment and the east regiment, which fought in the Revolutionary War, later became the 182nd Infantry and the 101st Engineers.

Throughout the colonies, similar militia organizations were formed, and in 1775 the Committee of Safety of the second Continental Congress organized them into an overall defense force. These militia provided about 165,000 of the 396,000 troops raised for Washington's continental army. During the period 1776–90 specific militia laws were first passed by the states to regulate the militia and enroll all free males between certain ages as a proper, natural, and safe defense of a free state. These were based on the Declaration of Independence and the Articles of Confederation, which declared that a well-regulated militia was necessary but should not be superior to the civil power nor assume the role of a standing army in time of peace. From these laws arose the concept of a volunteer, state-supported national guard.

After independence, the principle of the citizen-soldier was considered so important by Washington and the first Congress that it was written into the Constitution. Section 8, article I empowered Congress to provide for calling forth the militia to execute the laws of the union, suppress insurrections and repel invasions, and for organizing, arming, and disciplining the militia; the states were to appoint officers and to train the militia according to the discipline prescribed by Congress. The second amendment to the Constitution (article II of the Bill of Rights) recognized the right of the citizen-soldier, in the interests of "a well-regulated militia," to keep and bear arms. Ultimately this basic authority resulted in the establishment of the present National Guard.

Although President Washington constantly pressed Congress to prepare "a uniform and well-digested plan" for the militia, no action was taken, and militia were separately formed and trained by each state. By the act of Feb. 28, 1795, Congress gave the president authority to call out the militia in cases of invasion and other emergency, but federal use of state militia depended on the individual state's acceptance of the president's request. A step toward a uniform militia and an eventual national guard was taken when Congress in 1808 provided for annual specific federal aid to support state militia, although they still remained under state control.

The name "national guard" was first applied to a state militia on Aug. 16, 1824, when New York's 7th regiment (now the 107th Infantry Regiment, New York National Guard), acting as an honour guard for the Marquis de Lafayette during his visit to the U.S., adopted the name in tribute to his Revolutionary War service and in honour of his command of the Garde Nationale in Paris in 1789. By 1896 most states had adopted the title, although the guard remained a state organization.

20th Century.—During the 19th century, the militia remained generally unwieldy and sprawling, although it played an important part in providing troops and units in four wars: 1812, Mexican, Civil, and Spanish-American. In 1903 Congress enacted laws whereby the federal government assumed a more direct and active part in organizing, training, and equipping the militia under the same standards as those prescribed for the regular army. With the enactment of the National Defense Act of June 3, 1916, the organized militia was officially recognized as the national guard and made to conform to regular army organization. As such, it became a component of the nation's organized peace establishment and, when called into active federal service, a part of the Army of the United States.

In 1916 approximately 151,000 guardsmen were called into federal service, of which 110,000 served on the Mexican border. During World War I the National Guard supplied more than 380,000 soldiers for the American Expeditionary Force. Seventeen guard divisions were sent overseas, of which 11 saw actual combat. Of the eight U.S. divisions rated excellent or superior by the German high command, six were National Guard divisions.

The general demobilization of units and the discharge of individuals from federal service after World War I made it necessary to rebuild the national defense force, including the National Guard. Under postwar amendments to the National Defense Act of 1916, the National Guard was reorganized to consist of the same guard divisions that had served during the war. This act, in setting forth a completely new military policy for the United States, established an "Army of the United States" which consisted of the regular army, the organized reserve corps, and the National Guard when called into federal service. The National Guard remained a state force under the command of state authorities. The new act also provided for increased federal assistance: when units reached certain minimum standards of strength, equipment, and skill, they were formally recognized as eligible for federal support.

The act of June 15, 1933, created a new component of the army known as the National Guard of the United States. This component, while identical in personnel and organization to the National Guard of the several states, was a part of the Army at all times and could be ordered into active federal service by the president whenever Congress declared a national emergency, without the necessity of being called through the governors of the states.

In August 1940 the president ordered the National Guard of the United States to active service. Between Sept. 16, 1940, and Oct. 1, 1941, the National Guard brought into service more than 300,000 men in 18 combat divisions and numerous nondivisional units, including 29 air observation squadrons. These troops immediately doubled the strength of the standing army. Guardsmen supplied trained leaders for the expanding army, with an estimated 82,000 enlisted guardsmen later becoming officers. Nine divisions went to Europe and Africa, and nine crossed the Pacific.

After World War II, National Guard units were demobilized and their personnel separated from federal service. Briefly there actually was no National Guard. On Oct. 13, 1945, the secretary of war approved the organization of the postwar National Guard, and on June 30, 1946, the first reorganized National Guard unit was federally recognized. In 1947 the air units of the National Guard were organized separately from the Army units and designated the Air National Guard. Since that time the National Guard has consisted of the Army National Guard and the Air National Guard. Since 1954 both have participated in the antiaircraft defense of the United States.

During the Korean War more than 183,000 guardsmen in 8 infantry divisions, 22 wings, and many other units were ordered into active federal service. Four divisions and 17 wings were stationed in the United States, 2 divisions and 3 wings served in Europe, and 2 divisions and 2 wings fought in Korea.

The National Guard continues to have a dual status and mission. Each federally recognized unit is simultaneously a part of the National Guard of its own state and of the National Guard of the United States. The function of the National Guard of the several states is to provide organizations in each state, so trained and equipped as to enable them to function efficiently to protect life and property and to preserve peace, order and public safety under the state authorities. The duty of the National Guard of the United States is to provide units of the reserve components of the Army and Air Force, adequately organized, trained, and equipped, available for mobilization in the event of war or national emergency, and capable of combat operations in support of war plans of the department of defense.

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NATIONAL INCOME ACCOUNTING. The traditional purpose of national income studies is to furnish measures of the production of the nation. Beginning approximately with the 1930s, and quite explicitly since World War II, their purpose has come to be conceived more broadly as that of providing a systematic account of the economic activity of the nation. Inasmuch as production is a major feature of economic activity the two aims are closely interrelated.

National Output.—The terms "national output," "income," "product" and "expenditure" are often used interchangeably. National output, the term used in the following discussion, is the total of final or end products produced by the nation during a specified period. That is to say, it is the sum of products available for consumption or for additions to the stock of capital. Raw materials and semifinished products used up in production are not counted separately. For instance, if flour is baked into bread, only the bread is counted. National output is expressed in monetary values, since these provide a common unit for summing the wide variety of goods (commodities and services) produced.

The bulk of the production covered by measures of national output consists of items that are intended for sale in the market. Goods provided outside the market place are usually excluded, even though they may resemble items that are included by virtue of the market criterion. For instance, the services of housewives are usually excluded while services rendered by domestics are included. However, monetary values are generally imputed to wages paid in kind, to food and fuel produced on farms for home consumption, to the services which owner-occupants derive from their homes, and sometimes also to certain services, such as the handling of bank deposits, which financial institutions render free of charge to individuals. The treatment of nonmonetary items raises difficult problems in the measurement of the output of industrially undeveloped countries, where many types of productive activity that are channeled through the market in western countries are performed within the confines of the individual household.

The above explanation of national output has been in terms of product flows, because such an approach makes clear that the goal is to measure goods available for the satisfaction of human wants.

However, inasmuch as the production of goods gives rise to a simultaneous flow of incomes—wages, profits, etc.—national output may also be envisaged as a sum of income flows. In practice, national output measures are prepared both by summing product flows and by summing income flows.

The relationship between these two types of measures is basic to the understanding of the entire structure of national income statistics. Accordingly, a somewhat more exact explanation of it will be given by reference to the operations of a typical business enterprise. (The bulk of national output originates in such enterprises, although certain services—mainly those of household and government employees—also are counted as part of national output.)

The typical business enterprise produces goods which it either sells or adds to its inventories. Chargeable to this production are purchases of raw materials and other intermediate products from other enterprises (but not purchases of fixed plant and equipment); wages, salaries and other incomes paid out in production; indirect business taxes, such as sales, excise and property taxes; and depreciation and kindred allowances for fixed capital used up. A residual item of profit or loss equalizes the expenses chargeable to production with its value.

Expenses chargeable to production and profits	Production
Purchases of intermediate products	Sales
Wages and other incomes chargeable to production	Inventory change
Indirect taxes	
Capital consumption allowances	
Profits	

If a statement of this type is prepared for the business system as a whole, those sales of enterprises that represent purchases of intermediate products by other enterprises cancel one another. Thus purchases of intermediate products disappear from the left-hand side of the statement and sales on the right-hand side are correspondingly reduced. Matching the noncanceling final products there remains a numerically equivalent total consisting of income streams (including profits), indirect taxes and capital consumption allowances. (Inasmuch as the income aggregate reflects current production, capital gains and losses are not included.)

Variant Measures.—All measures of national output are net in the sense that intermediate products used up in production are not counted separately, but only as part of the value of the final products in which they are embodied. The definitions, however, vary significantly in other respects. Three points of differences may be noted.

1. Mainly because it is difficult to estimate how much fixed capital is used up in production during a given period, many national output measures are defined on a "gross" basis; *i.e.*, before deduction of capital consumption allowances. This definition is adopted even though in principle the using up of fixed capital is similar to that of intermediate goods. However, "net" measures allowing for the use of fixed capital are just as common, even though the allowances usually fall short of being meaningful from the standpoint of indicating the true net change in the capital stock.

2. Measures of national output are sometimes valued in terms of market prices and thus reflect indirect taxes, which are part of market price. Alternatively, national output may be defined net of these taxes (in technical terms, at factor prices or costs).

As is suggested by the previous demonstration of the equivalence of the product flow and income flow measures, net national output at factor prices is equivalent to the sum of incomes generated in production—wages and salaries, interest, rents and profits. These are measured before deduction of direct taxes—mainly taxes on individual or business earnings.

3. Measures of national output may refer to the output produced within the confines of a nation, or to the output to which residents of a nation have a claim. The two definitions differ because earnings derived from abroad provide residents of one nation with claims on output produced in others.

Differences between the gross and net and the market price and factor price measures are usually substantial. In the United States, for instance, the gross market price measure (gross national product) exceeds the net factor price measure (national income) by about one-fifth, with capital consumption allowances and indirect taxes contributing about equally to the spread. Differences between output measures due to variant treatments of international claims may also be significant.

It is necessary to distinguish between genuine output measures and various related aggregates that are not strictly measures of output. A widely used aggregate of the latter type (personal income, in the commonly accepted terminology) measures the sum of incomes received by individuals. Although the bulk of this aggregate arises in the production of national output, it cannot be regarded as a measure of the latter, since, on the one hand, it excludes some forms of income arising in production (such as undistributed profits) and, on the other, it includes incomes that do not reflect current productive activity (for instance, relief payments).

Adjustment for Price Change.—Measures of national output are usually expressed in terms of the prices current in the period to which the measures refer. Accordingly, changes over time in similarly defined output magnitudes reflect both changes in the quantity of goods produced and in the level of prices at which these goods are valued. For many purposes it is useful to have measures which separate the effect of the "real" (*i.e.*, quantity) change from that of the price change. They are obtained by expressing the goods produced in different time periods in terms of constant prices. These are usually the market prices that actually prevailed in one year, or in an average of years, during the period for which the measure is constructed. The approach to the comparison of real outputs produced in different countries is similar to that just outlined for time comparisons.

Output Breakdowns.—Measures of national output are usually accompanied by breakdowns of the totals that provide significant information on various aspects of the economy. The following are the breakdowns most frequently used.

1. The value of national output is shown in terms of the economic character of the products—essentially consumption and additions to capital stock, with further subdivisions of these two basic categories. It is also shown in the same statement in terms of the sales of these products to major purchaser groups, usually consumers, business enterprises, government and foreign nations. The exact manner in which the type-of-product and the type-of-purchaser classifications are reconciled is not uniform. The aggregate broken down in this way is usually valued at market prices.

2. The value of national output is shown in terms of the various types of incomes—wages and salaries, interest, rents and profits—originating in production. This classification is usually of the aggregate expressed net at factor prices. Sometimes, however, capital consumption allowances and indirect taxes are included, and a breakdown of the entire value of national output gross at market prices is thus provided.

3. The value of national output may be classified to show the portions of it originating in the various industries, such as agriculture, manufacturing and trade. This classification is generally given in terms of the income rather than the product flow measure. Industry breakdowns of output vary as regards the output definition (net or gross, market or factor price, etc.) that is used.

4. National output may be shown allocated to the various regions of a nation. To sidestep some of the special problems involved in such an allocation, the total is often not strictly a measure of national output, but the related aggregate of individual income receipts.

5. Some variant of this aggregate also most frequently underlies statements in which income is classified by the size of the unit income, the unit being usually the family or the single individual living separately. Such size distributions show the number of consumer units and the total income in successive income brackets.

System of Accounting.—It is apparent that the output breakdowns listed shed a great deal of light on the structure of the economy. However, the facets of the economy so illuminated remain separate, and no fully coherent picture of the whole in terms of its component parts emerges. The technique of national income accounting (social accounting, national accounting, etc.—terminology varies) has been designed to overcome this

shortcoming. It helps to envisage the precise relation to one another of the various facets of the economy on which information has been obtained, and it provides a framework for the actual preparation of coherent statistical pictures of the economy.

In essence, the economy is regarded as consisting of transactors, such as enterprises, households and governmental units, each such entity recording its transactions in a consistent set of accounts. For each transactor, three types of accounts are usually distinguished conforming to certain basic and distinct economic functions. The first account records its transactions as a producer —along the lines sketched above in the explanation of the equivalence between the product and income flow measures. The second shows its transactions as a recipient of net income (from its own production as well as from other sources) and as a consumer, and includes a residual item of saving. The third account summarizes its transactions as a saver and investor, showing the disposition of its total saving among financial and tangible investment. To show interrelationships clearly, each transaction would be identified twice in an ideal scheme. For instance, purchases made by one transactor unit in its capacity as consumer would be shown as sales of another unit in its capacity as producer.

Many problems are encountered in drawing up the specifications of this accounting scheme. Some of these arise because the basic types of accounts distinguished are not applicable to all types of transactors with equal ease. For instance, the essential features of the production account for enterprises can be envisaged by reference to the operating statement of a typical business firm. But there is no similar guide to set the pattern for the production accounts of households and governments, and experts are not unanimous in their choice among several alternatives.

As to the detail in which transactors might be classified, there is no limit in principle. In the extreme, the economy might be depicted in terms of a separate set of accounts for each transactor. In practice, information is insufficient to implement such a scheme; moreover, so detailed a picture would be of no use, because in it one would not see the forest for the trees. Accordingly, statistical pictures of the economy in terms of interrelated accounts are confined to broad consolidations of the ultimate detail. Essential information on aspects of the economy which these consolidations do not bring out is shown in supporting tables.

Many types of consolidations are possible; one deserves mention because closely related variants of it underlie the national income presentations of many countries. In this consolidation, the accounts showing the productive activities of enterprises and other economic transactors are summed to yield twin measures of the national output—one in terms of product flows, the other in terms of income flows. Accounts showing transactors as recipients of income—including transfers, such as relief payments and taxes —and as consumers of output are usually distinguished for two broad groups, households and government; a consolidated receipt and expenditure account is provided for each of these groups. (The corresponding accounts for enterprise transactors are often merged with the production accounts.) Next, the saving-investment accounts for all transactors are consolidated to show such an account for the nation as a whole. Finally, an external account is provided to show transactions with foreign countries.

This particular consolidation of the underlying accounting scheme is selected for statistical implementation for pragmatic reasons. It contains measures of total output, which is the focus of national income statistics; it shows explicitly the transactions of households and governments, and saving-investment transactions per se, which are important for understanding the functioning of the economy; and it suppresses distinctions that are of lesser significance or that cannot generally be quantified because statistical information is lacking.

Related Systems.—The term national income statistics is usually confined to the measures of national output and of its breakdowns, and to the summary descriptions of the economy that have been described. There are three bodies of statistical information, not covered by the conventional use of the term, that can be seen to be closely related to national income estimates if the national income accounting approach is adopted.

1. Interindustry relation (input-output) studies aim at a depiction of the economic process which focuses on product flows among industries. They provide a full accounting for these flows, including intermediate goods, which are excluded from conventional national income statistics because the latter are concerned with final output.

At a high level of abstraction which omits many detailed points of comparison that are of importance in the actual use of the data, the relationship of input-output to national income statistics may be grasped by reference to the detailed accounting scheme for individual units that has been shown to underlie the latter. Input-output tables can be regarded as an alternative manner of summarizing this scheme; in essence, transactors are grouped on an industry basis.

2. Moneyflow systems trace, in addition to the flows accounted for in national income statistics, financial transactions such as transfers of deposits and lending and borrowing. These are not reflected in conventional national income estimates because the latter provide only one consolidated saving-investment account for the nation as a whole in which domestic financial transactions cancel. These transactions could be introduced into national income statistics by providing separate saving-investment accounts for appropriate groups of transactors. Again, this is only a general sketch of the relationship between the two systems.

Input-output and moneyflow data have been developed less extensively than national income estimates narrowly defined, partly because they require additional primary statistical information that is difficult to obtain. The extent to which they have been integrated with the national income accounts varies from country to country.

3. Statistics of national wealth are usually distinguished from those of national income, but inasmuch as wealth is largely the result of saving and investment, which are part of the national income estimates, the close relationship between the two sets of figures is apparent.

Uses of National Income Statistics.—National income data are a tool for evaluating the performance of the economy, mainly in terms of the total amount and the composition of goods provided, and their distribution among various groups of the community. They are also an aid in understanding the functioning of the economy; *e.g.*, the nature of business fluctuations, the regularities in the distribution of income and the tendencies for long-term economic growth or retardation. They foster such understanding because they provide quantifications of many of the key magnitudes with which economic reasoning on these matters deals.

Among the practical uses of the data, those concerned with public policy have been most prominent. National income estimates have been used, for instance, in formulating policy recommendations relating to economic mobilization during war, to the stabilization of business activity and to economic reconstruction and development. Intelligent policy decisions in these and other matters involve the assessment of the probable course of future events. For instance, anti-inflationary measures are in order, not if inflation has prevailed in the past, but if it is believed that it will prevail in the future. National income categories have been used to furnish a set of concepts in terms of which the future is viewed, and the record of recent and past developments provided by the statistics has been studied to yield clues as to the probable course of future events.

The extent to which these economic forecasts have been elaborated has varied. Often policy recommendations have involved only implicit forecasts of selected aspects of the economy. Sometimes they have been based explicitly upon complete descriptions ("models") of the anticipated course of the economy as a whole. While the latter approach has not been more successful, it will be outlined because it exhibits some of the logic and limitations that characterize also the more eclectic variant.

In problems relating to wartime economic mobilization, for instance, the broad technique is to estimate the total national output that can be produced under given assumptions relating to the availability of labour and other resources and probable trends in productivity. This total is then allocated among the conflicting

military and civilian requirements. Next, the money demands for civilian output that would be generated at the projected level of national income are estimated. Finally, if these demands are found to differ from supplies at existing prices, the tax, monetary, allocation and other measures needed to bring them into equality at reasonably stable prices are determined.

The phase of this analysis that deals with the probable magnitude of private demands at the projected level of national income usually relies heavily on past regularities in economic behaviour, such as past relations between income and market demand. These relations are also used in gauging the effects on demand of tax measures, such as specified changes in tax rates. But relations that have obtained in the past are often modified in projecting the future, to take into account the expected effects of altered circumstances. Other techniques, such as surveys of spending intentions, can also be used to help in forecasting.

Similar techniques are applied to problems of peacetime stabilization. The demand for national output is forecast on the basis of foreseeable future developments. If this demand is found to deviate from a level of output that is satisfactory from the standpoint of the stabilization goal, the fiscal, monetary and other measures necessary to stimulate or restrict demand are gauged. Projection of past relationships and surveys of spending intentions are the mainstays of this analysis also.

Use of national income data in problems of economic reconstruction and development involves a similar confrontation of the projected national output with the demands upon it and adjustment of the two to each other by means of the policy actions available to the government. In many instances an analysis of the role of international trade, aid and investment is essential in working out a solution.

Even though national income statistics are used widely in formulating public policy recommendations, the precise nature and significance of their role is not clearly established. In only a few countries have the methods reviewed been used intensively even on a technical level. Moreover, the weight which policymakers have given to recommendations based on these methods has been limited by other considerations that influence practical policies, as well as by the admitted shortcomings of the methods themselves.

The conclusions these methods suggest are uncertain partly because national income data are subject to considerable error but mainly because our knowledge of the future behaviour of the economic system is imperfect. National income estimates provide only a record of past events, and there is no guarantee that the regularities disclosed will persist in the future. Nor will plans indicated in surveys of spending intentions necessarily materialize.

Nongovernmental uses of national income statistics also have become prominent. In particular, businessmen use the estimates to gauge the general economic climate in which their enterprises will operate. The over-all magnitudes embodied in these forecasts are used also to infer future market conditions for particular goods in which individual firms are interested, either as purchasers or sellers. These evaluations aid in the formulation of investment, production, price and other policies.

In addition to these and other applications, which have made national income statistics a widely used tool for practical orientation in the economic world, the data have been employed increasingly in academic studies, to test and develop hypotheses of economic theory. The problems encountered have to a large extent coincided with those confronted in the practical use of the data.

Sources and Methods of Compilation.—Existing programs of primary data collection are not designed specifically to measure national output, its components and the other entries in the national accounts. Instead, these magnitudes must be estimated by utilizing information prepared largely for other purposes. Prominent among this information are census enumerations and sample surveys, and statistics that are by-products of various governmental activities such as the administration of social security systems, tax laws and expenditure programs. Many other sources, too varied to summarize, are also used. The basic data often depart definitionally and in coverage from the items in the national income accounts. Estimation of these items involves, accordingly, the integration of all the available—and sometimes conflicting—information, and the filling of data gaps by resort to partial and indirect evidence.

National income figures are thus subject to error not only because of inaccuracies in the basic data but also because of imperfections in the estimating methods. Moreover, their margin of error cannot be precisely quantified, because the usual mathematical techniques for measuring error are not applicable to this complex case. Estimates of the margin of error which occasionally accompany national income figures fall short of definitional precision and incorporate a great deal of subjective judgment.

The reliability of national income statistics depends on the adequacy of the primary information and the effectiveness of the estimating techniques. It varies greatly from country to country, and within each country among the several entries in the accounts and according to the time period covered. Reliability is likely to be vastly higher for advanced industrial countries than for countries in which industrial processes have not developed. This situation is so mainly because industrial economies are characterized by transactions that lend themselves to registration in statistical form, and because the problems confronting such economies are likely to induce extensive data collection.

Other things being equal, relative errors in broad aggregates are likely to be smaller than those in its separately estimated components, because of offsetting error. For any given series, estimates referring to the remote past and to very recent periods are likely to be less accurate than estimates for intervening dates. This situation is so because the primary data diminish rapidly as one explores further into the past, and because estimates for recent periods are usually made before all the source material is at hand. Similarly, quarterly and monthly series are likely to be less accurate than annual estimates.

In an intensive use of the data it will be necessary to go beyond these generalizations and, mainly by an examination of the methodology underlying the estimates, form a judgment as to the order of their reliability. Thus, not only the preparation of national income statistics but also their use requires skill.

Availability of National Income Statistics.—National income estimates were prepared (in England) as early as the 17th century. But workmanlike estimates covering a span of years and built up from detailed components are largely a product of the 20th century. The economic problems associated with the depression of the 1930s and World War II made it vitally important to understand the economy and gave further impetus to the development of the statistics, largely under governmental aegis. In the postwar period, problems of economic reconstruction and development have had similar effects.

Originally indigenous to western industrial countries, national income estimates are now available for a large number of others, differing widely as to needs, resources technologies and institutional structure. The UN and other organizations have been active in promoting international comparability, both by developing standard accounting systems and by preparing compilations in which reported series are adjusted to uniform definitions.

Other noteworthy tendencies are the preparation of estimates on a less than annual basis and a speed-up in their publication schedules. This emphasis on recency reflects the active use of the data in current business analysis.

Unsettled Problems.—Following are some outstanding unsolved problems relating to the design of national income statistics.

1. As noted earlier, measures of national output are confined largely to output intended for sale, but marginal departures from this rule are made by imputing values to certain nonmarket items. These imputations are a source of irritation logically, because they do not flow from any general definition of output that can be specified. Moreover, the treatment of nonmarket production constitutes an acute practical problem in the analysis of economic conditions in countries whose market economies are undeveloped and also in international comparisons. Accordingly, much thought has been devoted to nonmarket output. Some progress has been

made through the proposal of international conventions for its treatment, and *ad hoc* solutions may be found to serve the needs of specific analyses. But it seems doubtful whether an operational definition of national output not anchored to the market criterion ever can be devised.

2. There has been a tendency to advance either market or factor price as the sole basis for valuing output, to the exclusion of the other method. On the whole, the market price valuation has gained in acceptance. It expresses goods in terms of the prices at which they are actually exchanged, and hence is the more realistic, easily understood and statistically convenient method.

The major justification of factor price series is that they are the best available measures of the services rendered by the ultimate agents of production, such as labour and capital, and that they provide a tool for the investigation of problems involving the allocation of these productive resources among alternative uses. Indirect business taxes must be excluded, it is maintained, because they do not reflect the services of productive agents as does the sum of wages, profits and other incomes originating in production.

The main objection to this argument is that it is based upon an assumption of circumstances—mainly stable and competitive business conditions—that do not obtain in practice. If these are absent, national output aggregates cannot be used to gauge resource allocation even if indirect taxes are excluded. For instance, the productive contribution of capital resources will not be reflected adequately in the national income totals in times of reduced economic activity when profits are depressed and in some instances even negative; similarly, monopolistic practices in an industry may give rise to incomes that give an exaggerated notion of the proportion of procedure resources actually engaged there.

3. Questions have been raised as to the proper distinction between final output and intermediate products. Specifically, it has been urged that not all of the output purchased by government be considered final, as is commonly done. Some of it should be excluded from the national output total, it is said, as are intermediate products. Somewhat more tentatively, it has been suggested that not all output bought by consumers be regarded as final either. No clear-cut proposals have been made, but the general idea appears to be to distinguish purchases that are direct causes of final human satisfaction from those that are only indirect conditions of it, and to exclude the latter. Opponents of the idea have argued that the proposed distinction cannot in fact be drawn; and they have not been refuted, either in logic or through the presentation of a viable classification that implements the proposed narrowing of the final product concept.

4. For some of the uses that are made of the data, it would be desirable to extend the definition of capital formation beyond its core, tangible capital formation by business, to intangible items, such as expenditures for industrial research, and to capital formation by government and consumers. Little has been done to recognize intangible capital, but capital expenditures by government have increasingly been taken into account, instead of being treated like current consumption.

The acquisition of residences is the only consumer purchase that is generally recognized as capital formation. There are sound reasons for extending this treatment to other consumer durables, inasmuch as these also outlast the normal accounting period and thus constitute additions to wealth. However, the extent to which capital accounting has been applied to them in actual national income estimates has been limited.

Measurement of capital formation on a gross basis, *i.e.*, before deduction of capital consumption allowances, raises problems because it is difficult to frame a uniform definition. For instance, it is hard to draw a systematic line which will either exclude or include repair and maintenance expenditures. In addition, the gross measure is insufficient because it does not show net additions to the capital stock. However, it appears difficult also to obtain a net capital formation measure that is meaningful for output measurement.

The conventional capital consumption allowances made by business are inadequate to serve as subtrahends from gross capital formation for this purpose. To an increasing extent they are affected and made noncomparable over time by changes in tax laws. In addition, they are usually stated in terms of the original cost of the capital goods, and hence cannot be deducted from gross capital formation, which is expressed in current prices, to obtain a meaningful indication of the net change in capital stock. The realism of the methods used to allocate capital consumption charges over the lifetime of the assets is also often in doubt. It is not easy, however, to devise alternative, more meaningful measures of capital consumption.

The task of offsetting capital equipment used up against capital equipment produced is made difficult by changes in the character of the equipment, and by inadequate knowledge of the actual life span of capital goods and the time pattern according to which they are consumed.

5. Difficulties (additional to those involved in the accounting for nonmarket production) are encountered in comparing outputs produced in situations that differ radically as to needs, resources, technologies and institutional organization. These difficulties arise because in these circumstances the composition and the types of goods produced are likely to be very different. If, for instance, output of commodity A in one country is double that in another while output of commodity B is one-half, it is not possible to make an unambiguous comparison of the outputs of A and B combined. The result depends on the relative value that is attached to each commodity. Again, if in one time period output of transportation equipment consists of horse-drawn carriages, and in another of automobiles, it is not really possible to make a quantitative comparison between the two. As long as differences in composition and kind are moderate, the methods for calculating real national output described earlier will yield useful results. But little significance attaches to the precise outcome of comparisons when these differences are substantial.

6. Apart from problems involving the definition of output, many others have arisen concerning accounting design: what are the economic groups whose activities should be separately shown? What types of accounts should be established? How should the transactions registered in the accounts be classified? What part of the information should be presented in interrelated accounts, and what part in supporting tables? While many of these issues are largely presentational, some have broader significance. For instance, the finances of unincorporated business are usually intermingled with the household finances of their owners, and one of the important problems of accounting design is to find a satisfactory place for unincorporated enterprise among business and household transactors. *See* also references under "National Income Accounting" in the Index.

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continuing series, *Studies in Income and Wealth* and *Income and Wealth*, respectively. Vol. 22 of *Studies* contains a comprehensive discussion of theoretical problems. (G. Jr.)

NATIONALISM, a state of mind in which the supreme loyalty of the individual is felt to be due to the nation-state. Though attachments to the native soil, to parental traditions and to established territorial authorities have been known throughout history, it was only at the end of the 18th century that nationalism began to become a generally recognized sentiment molding public and private life and one of the great, if not the greatest, single determining factors of history. Thus nationalism is a modern movement, but, in the short span of its existence as a dominant element of societal life and organization, it has shown such a dynamic vitality and such an all-pervading character that the mistake has frequently been made of regarding nationalism as a permanent, or at least very ancient, factor of history. In reality nationalism arose as a dominant force in the 18th century in western Europe and in North America; the American and the French revolutions may be regarded as its first powerful manifestations. From the western world, after having penetrated the new countries of Latin America, it spread in the early 19th century to central Europe; thence, toward the middle of the century, to eastern and southeastern Europe, until, at the beginning of the 20th century, it put its stamp on the ancient lands of Asia and Africa. Thus nationalism has become a dominating force everywhere—so much so that the 19th century has been called "the age of nationalism" in Europe, while the 20th century has witnessed the rise and struggle of national movements throughout Asia and Africa.

Nationalism implies the identification of the state or nation with the people, or at least the desirability of determining the extent of the state according to ethnographic principles. In the age of nationalism, but only in the age of nationalism, the principle was generally recognized that each nationality should form a state—its state—and that the state should include the whole nationality. Formerly states, or territories under one administration, were not delineated by nationality; men's loyalty was not due to the nation-state, but to other, different forms of political organization: the city-state, the feudal fief and its lord, the dynastic state, the religious group or the sect. The nation-state was nonexistent during the greater part of history and for a very long time it was not even regarded as an ideal. In the first 15 centuries of the Christian era the ideal was the universal world-state, not loyalty to any separate political entity. The Roman empire had set the great example which survived not only in the Holy Roman empire of the middle ages, but also in the *res publica christiana* (Christian republic or community) and in its later secularized form of a united world civilization and world policy as it appeared in the writings of the 17th century.

As political allegiance, before the age of nationalism, was not determined by nationality, so civilization was not thought of as nationally determined. During the middle ages civilization was looked upon as determined religiously; for all the different nationalities of Christendom as well as for those of Islam there was but one civilization—Christian or Muslim—and but one language of culture—Latin (or Greek) or Arabic (or Persian). Later, in the periods of the Renaissance and of classicism, it was the ancient Greek and Roman civilizations which became a universal norm, valid for all peoples and all times. Still later French civilization was accepted throughout Europe as a valid civilization for educated people of all nationalities. It was only at the end of the 18th century that, for the first time, civilization was considered to be determined by nationality and the principle was put forward that a man can be educated only in his own mother tongue, not in languages of other civilizations and other times, be they classical languages or the literary creations of other peoples who had reached a high degree of civilization. From the end of the 18th century on, the nationalization of education and public life went hand in hand with the nationalization of states and political loyalties. In many cases poets and scholars emphasized cultural nationalism first. They reformed the national language, elevated it to the rank of a literary language and delved deep into the national past, thus preparing the foundations for the political claims for national statehood soon to be raised by people in whom they had kindled the spirit of nationalism.

National feeling was evident in certain groups at certain periods, especially periods of stress and conflict, before the 18th century. Its rise was prepared by a number of complex events: the creation of large, centralized states by the absolute monarchs, who destroyed the feudal allegiances and thus made possible the integration of all loyalties in one centre; the secularization of life and education which fostered the development of the vernacular languages and weakened the ties of religious or sectarian loyalties; the growing economic interdependence which demanded larger territorial units, which would at the same time give the necessary scope to the dynamic spirit of the rising middle classes and their capitalistic enterprise. This large, unified territorial state with its political and economic centralization was filled in the 18th century with a new spirit—an emotional fervour similar to that which in preceding periods characterized religious movements. Under the influence of the new theories of the sovereignty of the people and the rights of man, the people replaced the king as the centre of the nation. No longer was he the nation or the state; the state had become the people's state, a national state, a fatherland. Nation and state became identified, as civilization became identified with national civilization.

This was opposed to all the conceptions which had dominated political thought for the preceding 2,000 years. During that period man had commonly stressed the general and the universal and had seen in unity the desirable goal. Nationalism stressed the particular and parochial, the differences and the national individualities. These tendencies became more pronounced as nationalism developed. In the 17th and 18th centuries the common standards of western civilization, the regard for the universally human, the faith in reason—one and the same everywhere—and in common sense, the survival of Christian and Stoic traditions were too strong to allow nationalism to develop fully and to disrupt society. Thus nationalism in its beginning was thought compatible with cosmopolitan convictions and with a general love of mankind, especially in western Europe and North America.

England.—The first full manifestation of modern nationalism occurred in 17th-century England, in the Puritan revolution. That century saw England the leading nation in the scientific spirit, in commercial enterprise, in political thought and activity. Swelled by an immense confidence in the new age, the English people felt upon their shoulders the mission of history, a sense that they were builders of destiny at a great turning point from which a new true reformation and a new liberty would start. In the English revolution an optimistic humanism and Calvinist ethics merged; the influence of the Old Testament gave form to the new nationalism by identifying the English people with ancient Israel. The new message, carried by the new people not only for England, but for all mankind, was expressed in the writings of John Milton in whose famous vision the idea of liberty was seen spreading from Britain, "celebrated for endless ages as a soil most genial to the growth of liberty" to all the corners of the earth. "Surrounded by congregated multitudes, I now imagine that I behold the nations of the earth recovering that liberty which they so long had lost; and that the people of this island are disseminating the blessings of civilization and freedom among cities, kingdoms and nations."

English nationalism was thus much nearer to its religious matrix than later nationalism which rose after secularization had made greater progress. The nationalism of the 18th century shared with it, however, the enthusiasm for liberty, the humanitarian character, the emphasis upon the individual and his rights and upon the human community beyond all national divisions. The rise of English nationalism coincided with the rise of the English trading middle classes. It found its final expression in Locke's political philosophy and it was in that form that it influenced American and French nationalism in the following century.

British North America.—The rising nationalism of the British settlers was influenced partly by the traditions of the Puritan revolution and of Locke, and partly by the new rational interpretation given to English liberty by contemporary French

philosophers. American nationalism became the typical product of the 18th century. The American settlers became a nation engaged in a fight for liberty and individual rights, basing that fight on current political thought, especially as expressed by Thomas Jefferson and Thomas Paine. This was a liberal and humanitarian nationalism, regarding America as the vanguard of mankind on its march to greater liberty, equality and happiness for all. The ideas of the 18th century found their first political realization in the Declaration of Independence and in the birth of the American nation. Their deep influence was felt in the French Revolution.

France.—Rousseau had prepared the soil for the growth of nationalism by his stress on popular sovereignty and the general co-operation of all in forming the national will, and also by his regard for the common people as the true depository of civilization. Under his influence Herder gained a new understanding of art and civilization by emphasizing folklore, folk songs and primitive popular traditions as revealing the true creative forces of a nation. He went beyond Rousseau in his appeal to the past—often to the primitive past. He glorified the instinctive and irrational, and turned attention from the universally human and general to the peculiarities of each national tradition, regarding them as valuable sources of creative inspiration. Under Herder's influence German romantic nationalism later stressed these factors of irrationalism and of national peculiarities.

The nationalism of the French Revolution, on the other hand, was the triumphant expression of a rational faith in common humanity and liberal progress. The famous slogan "liberty, equality, fraternity" and the Declaration of the Rights of Man and of the Citizen were thought valid not only for the French people, but for all peoples. Individual liberty, human equality, fraternity of all peoples: these were the common cornerstones of all liberal and democratic nationalism. In their name the French nation constituted itself, overthrew the monarchy and soon began to spread the new gospel across Europe. Under their inspiration a new ritual was developed which partly took the place of the old religious ritual: festivals and flags, music and poetry, national holidays and patriotic sermons. In the most varied forms nationalism permeated all manifestations of life. Like the rise of American nationalism, the rise of the French produced a new phenomenon in the art of warfare: the nation in arms. In America and in France, citizen armies, untrained but filled with a new fervour, proved superior to professional armies which, though highly trained, fought without the incentive of nationalism. The revolutionary French nationalism stressed free individual decision—in the formation of nations. Nations were constituted by an act of self-determination of their members. The plebiscite became the instrument whereby the will of the nation was expressed. In America as well as in revolutionary France, nationalism meant the adherence to a universal progressive idea, looking toward a common future of freedom and equality, not toward a past characterized by authoritarianism and inequality.

Germany and Other Countries.—Napoleon's armies spread this nationalism throughout Europe and even into the near east; across the Atlantic it aroused the Latin Americans. But Napoleon's yoke turned the nationalism of the Europeans against France. In Germany, where the struggle was led by writers and intellectuals, it turned into a rejection of all the principles upon which the American and the French revolutions had been based and of the liberal and humanitarian form of nationalism. German nationalism began to stress instinct against reason; the power of historical tradition against rational attempts at progress and a more just order; the historical differences between nations against their common aspirations. The French Revolution, liberalism and equality were regarded as a brief aberration, against which the eternal foundations of societal order would prevail.

This interpretation was shown to be false by the developments of the 19th century. Liberal nationalism reasserted itself; it permeated more and more peoples: the rising middle class and the new proletariat. The revolutionary wave of 1848, the year of "the spring of the peoples," seemed to realize the hopes of nationalists such as Mazzini, who had devoted his life to the unification of the Italian nation by democratic means and to the brotherhood of all free nations. Though his immediate hopes were disappointed, the 12 years from 1859 to 1871 brought the unification of Italy and Rumania, both with the help of Napoleon III, and of Germany; at the same time the 1860s saw everywhere great progress in liberalism, even in Russia and Spain. This victorious trend of liberal nationalism was, however, reversed in Germany by Bismarck. He unified Germany on a conservative and authoritarian basis and defeated German liberalism. The annexation of Alsace-Lorraine against the will of the inhabitants was contrary to the principle of nationalism based upon the free will of man. The people of Alsace-Lorraine were held to be German by objective factors, by race, independent of their will or of their allegiance to any nationality of their choice.

In the second half of the 19th century nationalism disintegrated the supranational states of the Habsburgs and the Ottoman sultans, both of which were based upon prenational loyalties. In Russia the penetration of nationalism provoked a twofold attitude: some nationalists advocated an acculturation of Russia to the general progress of western mankind. They proposed a westernized Russia, following the common destiny of progressive society. Others stressed the distinctive character of Russia, its independent and different destiny, based upon its past of autocracy and orthodoxy. These Slavophiles, similar to and influenced by German romantic thinkers, saw Russia as a future saviour of a west undermined by liberalism and the heritage of the American and French revolutions. As a result of World War I, nationalism triumphed in central and eastern Europe. The new nation-states, Austria, Hungary, Czechoslovakia, Poland, Yugoslavia, the U.S.S.R., as well as Rumania, emerging from the ruins of the Habsburg and Romanov empires were, however, subject themselves to the strains of internal nationality conflicts and territorial disputes with neighbouring states.

Lenin's triumph in Russia in 1917 meant the triumph of international communism over Russian nationalism. Fascism and National Socialism in Italy and Germany in the 1930s presented an unprecedented intensification of an authoritarian nationalism. In their turn they influenced the older totalitarian movement of communism. In World War II the communist leaders tried to use nationalism for their own purposes. After the war, the new nations created after World War I came under communism; but nationalism in these communist-controlled countries rebelled against the claim of centralized leadership throughout the communist world. With Tito setting an example in Yugoslavia, this so-called national communism became important and helped inspire the liberation movements in Poland and Hungary in the fall of 1956, and to bring about the consequent shift away from centralized communism.

Asia and Africa.—World War I stirred the masses in Asia to inaugurate their age of nationalism under the leadership of such powerful personalities as Kemal Atatürk in Turkey, Saad Zaghlul in Egypt, Ibn Saud in the Arabian peninsula, Gandhi in India, and Sun Yat-sen in China. Atatürk succeeded in replacing the medieval structure of the Islamic monarchy with a revitalized and modernized secular republic in 1923. The demands of Arab unity were frustrated in Africa and Asia by British imperialism and in Africa by French imperialism. Yet Britain showed a gift for accommodation with the new forces by helping to create an independent Egypt (1922; completely, 1936) and Iraq (1932), and displayed a similar spirit in India, where the Indian National Congress, founded in 1885 to promote a liberal nationalism inspired by the British model, had become more radical after 1918. In China Sun Yat-sen pleaded before his death (1925) for China's cooperation with communist Russia. Only Japan, influenced by Germany, used modern industrial techniques to strengthen a more authoritarian nationalism.

After World War I, the League of Nations, organized as the first major institution to attempt to internationalize an attack on war, embodied in its governing principles the progress to independence through nationalism as being in accord with the best traditions of western liberalism. The treaty of Versailles, in addition to providing for the constitution of the League, had reduced the empires of the losing Central Powers, mainly Germany and Turkey, by dispersing their African colonies as mandatories to England, France,

Belgium and South Africa, and their Pacific possessions to Japan, Great Britain, Australia and New Zealand, under classifications varying in their expectations of independence. The United Nations continued this plan after 1945 in its trusteeship system (*see* further MANDATE and TRUSTEESHIP SYSTEM).

The end of World War II saw for the first time a period in history in which the political attitude of nationalism was the greatest determining force. The swell of nationalism was especially notable throughout Asia and for the first time in Africa. The League of Nations numbered among its original members five Asian countries (China, India, Japan, Thailand and Iran) and two African countries (Liberia and the Union of South Africa, later the Republic of South Africa) and had added only three Asian countries (Afghanistan, Iraq and Turkey) and two African countries (Egypt and Ethiopia) before its dissolution in 1945. Of the mandated territories under the League's control only Iraq, Lebanon and Syria achieved independence during its lifetime. Of the original 51 members of the United Nations in 1945, eight were Asian (China, India, Iraq, Iran, Lebanon, Saudi Arabia, Syria and Turkey) and four were African (the same as in the League). Less than a quarter of a century after the founding of the United Nations, 66 member nations had been added, 55 of them being Asian and African. Whereas Asian and African nations had never totaled a third of the membership in the League, they came to represent nearly half of the United Nations. Of these new Asian and African nations, four in Asia and seven in Africa were in part or in whole created from mandated territories.

The emergence of the United States and the U.S.S.R. as dominant world powers, both inside and outside the United Nations, and the prospect of nuclear war stimulated the new nationalism. India, Pakistan, Ceylon, Burma, Malaya in Asia, and Ghana in Africa achieved independence peacefully from the British Commonwealth, and the Philippines from the United States. Others had to fight hard for their independence in bitter colonial wars, as in French Indochina (Vietnam, Laos, Cambodia) and French North Africa (Tunisia, Algeria). From the beginning communism had appealed to the new nationalist movements in Asia and Africa, first for support in their struggle against western capitalism, and later after independence was achieved in competition with western capitalism for financial and technical aid. Chinese nationalism under Chiang Kai-shek during World War II was reduced with the take-over of the Chinese communists, but after Khrushchev's announcement of the "de-Stalinization" process in 1956, Chinese communism began to drift away from supranational communism, as the European communist countries had earlier, until in the late 1960s Russian and Chinese mutual recriminations of "revisionism" barely concealed a Chinese nationalism in which Mao had risen beside Lenin in the place of honour. As Chinese communism turned farther and farther inward, its influence on newborn Asian and African nations apparently waned.

Ambitions among new Asian and African nations clashed as they had earlier in Europe. Disputes and situations in the United Nations illustrated the problems of the new nationalism: the struggle with Netherlands colonialism for the establishment of Indonesia, continuing in the case of West Irian (West New Guinea) into the late 1960s; the Suez crisis in 1956, with the intervention of UN forces between those of Egypt and Israel; continuing troubles in the middle east ranging from the establishment of Israel to inter-Arab state disputes brought on by the establishment of the United Arab Republic; the India-Pakistan dispute over Jammu and Kashmir; the Korean partition and subsequent war; the four-year intervention in the Congo; the struggle of Greece and Turkey over the newly independent Cyprus; Indonesian and Philippine objection to the inclusion of Sarawak and Sabah (North Borneo) in the newly formed Federation of Malaysia.

Many new nations, all sharing the same pride in independence, faced difficulties. As a result of inadequate preparation for self-rule, the first five years of independence in the Democratic Republic of the Congo passed with no semblance of a stable government. The problem of varying peoples and languages was exemplified in the Federation of Nigeria, where an uncounted population including an uncounted number of tribes (at least 150, with three major divisions) used an uncounted number of languages that included at least a hundred languages and dialect clusters. Religious differences kept the question of whether the predominantly Muslim state of Jammu and Kashmir should go with Muslim Pakistan or Hindu India alive for nearly 20 years after the India Independence act became effective in 1947. Desperate economic competition caused trouble, as in Israel where the needed life-giving water of Jordan kept it in constant dispute with its water-hungry Arab neighbours.

Meanwhile in Europe after World War II, the spirit of nationalism first waned with the establishment of NATO and the common market schemes, but later the leadership of De Gaulle, claiming to speak as a spokesman not only for France but for Europe, and the resurgence of West Germany indicated a revival of nationalism.

See also IMPERIALISM; COLONY; SELF-DETERMINATION; and the History sections of articles on countries named above. For socialist and communist attitudes toward nationalism, *see* SOCIALISM; COMMUNISM. *See* also COLD WAR; and references under "Nationalism" in the Index.

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NATIONALITY. As a legal concept, nationality is distinguishable from the popular use of the term to denote membership in a nation, meaning a people bound together by ethnic, religious, or linguistic ties. (*See* NATIONALISM.) It is also distinguishable from citizenship (*q.v.*), a somewhat narrower term that is sometimes used to denote the status of those nationals who have full political privileges. Before an act of the U.S. Congress made them citizens in the full sense of the word, for example, American Indians were sometimes referred to as "noncitizen nationals."

Not only individual human beings but also companies (corporations), ships, and aircraft have nationality for the purposes of law. It is in reference to natural persons, however, that the term finds most frequent use. In general, nationality implies the duty of allegiance on the part of the person and the duty of protection on the part of the state. The UN Universal Declaration of Human Rights (*see* CIVIL LIBERTIES) in 1948 stated that "everyone has the right to a nationality" and that "no one shall be arbitrarily deprived of his nationality. . . ." Whether an individual possesses the nationality of a particular state may determine whether or not that state has a right to exercise jurisdiction over him in certain circumstances. If he is a national he may enjoy political and economic rights and privileges that he would not otherwise have. How one acquires nationality, how it may be lost, the possibility of statelessness, and applications of the concept in international legal relations are matters of some practical importance.

The concept of nationality is found in both international law and national law. It is the nation-state which sets the criteria, through constitutional or statutory provisions, for determining who shall be its nationals. The right of a state to confer its nationality is, however, not unlimited, for otherwise it might impinge upon other states' rights to determine what persons shall be their nationals. By the *jus soli*, a person who is born within a state's territory and subject to its jurisdiction acquires that state's nationality by the fact of such birth. By the *jus sanguinis*, a person has a nationality as an inheritance from one or both of his parents. States vary in their use of these two principles. Some give priority to the *jus soli* but also rely to some extent on the *jus sanguinis*; others apply principally the *jus sanguinis*, but not all of these exclude the *jus soli*. When one state cedes terri-

tory to another, inhabitants of the region that is ceded commonly have an opportunity to acquire that state's nationality. Practice, however, supports the idea that the individuals concerned should be allowed a free choice, with the understanding that those who choose to retain their old nationality may have to leave the territory. Another method of acquiring nationality is through the process of naturalization (*see* NATURALIZATION LAWS).

An individual may lose his nationality through extinction of the state of which he has been a national. He may also lose it through naturalization in another state, but there is no universally binding law which requires that a state must recognize that one of its nationals, by reason of his being naturalized in a foreign state, has divested himself of his former nationality. There have been some treaties committing each signatory to recognize that its nationals who have migrated to the territory of another signatory and become naturalized there shall be regarded as having divested themselves of their original nationality.

The right of expatriation has not been universally recognized, however, and the possibility of dual or multiple nationality remains. Nor has the effort to eliminate statelessness been completely successful, although such an objective was considered by the League of Nations in 1930 and by the International Law Commission of the UN. Under U.S. legislation of the 1950s, loss of nationality may be the result of treason, desertion from the armed forces, evasion of the military draft, service in the army of a foreign state, or voting in an election in a foreign state.

In the late 1940s there was a move in the British Commonwealth to continue, through parallel legislation, a common status of British subject or commonwealth citizen, while each of the states retained its own citizenship. (*See* COMMONWEALTH OF NATIONS: *Nationality and Citizenship.*) Such common status as resulted did not rest indefinitely upon a common allegiance, as some of the states concerned adopted the republican form of government.

One problem that has been dealt with in national legislation and in a projected international agreement is that of the nationality of married women. The trend has been away from the practice that allowed a woman's nationality to be changed by the mere fact of her marriage or by a change in her husband's nationality. The UN General Assembly in 1957 approved a Convention on Nationality of Married Women. This convention embodied the rule that a woman's nationality is not to be automatically changed by virtue of a change in marital status.

In international law nationality assumes significance in various circumstances. In extradition treaties, states have often included clauses making it optional for them to surrender persons who are their own nationals. If a state desires to expel a person from its territory only the state of which the person is a national is obligated to receive him. A state's failure to afford reasonable protection to aliens may lead to claims by other states, the adjudication of which will require decision of questions concerning the nationality of claimants. Legal questions may also arise in connection with legislation affecting enemy aliens. Such persons may seek to avoid disabilities by becoming naturalized in a third state, but such efforts are not always successful.

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NATIONALIZATION is one of a number of ways in which the state can alter or terminate the control or ownership of private property. Generally, in mature systems of law, the state or local government authorities possess the right to take private property for particular public purposes, such as the construction of roads, reservoirs or hospitals. In 1254 a power of this nature was granted by charter to the city of Copenhagen. Other examples may be found in the middle ages in German and Scandinavian law. The same principle was acknowledged in the French Declaration of the Rights of Man in 1789, as it was also in the fifth amendment to the constitution of the United States. The exercise of this right, which is normally accompanied by the payment of compensation, may be described as "expropriation" or as "eminent domain" (*q.v.*). By contrast, "nationalization" is historically a more recent development and differs both in motive and degree from "expropriation."

Nationalization is customarily, though not exclusively, associated with the implementation of communist or socialist theories of government. This is certainly true both of the transfer of industrial, banking and insurance enterprises to the state in Russia in the period after the acquisition of power by the Soviet regime in 1918 and of similar developments in Bulgaria, Czechoslovakia, Hungary, Poland, Rumania and Yugoslavia after World War II. The same may be said also of the nationalization of the coal, electricity, gas and transport industries in the United Kingdom and France between 1945 and 1950. However, the conscious implementation of political and economic doctrine has on occasion become mixed with resentment at foreign control over industries upon which the state may be largely dependent. This was clearly a factor in the nationalization of the oil industries in Mexico in 1938 and in Iran in 1951, in the nationalization of the Suez Canal company in Egypt in 1956 and in the nationalization of foreign businesses in Cuba in 1960.

The process of nationalization may take various forms: the assets of the nationalized companies are transferred to the state; or the share capital is made the object of the transfer, leaving the company in existence to carry on its business under state control. In any event, the result is ultimately that title to or control over the property is placed in the state itself or in a state-established and publicly controlled organ.

Questions of international law normally arise only when the property is owned either by aliens or by companies in which aliens have a large shareholding interest. It has become established as a matter of general principle that aliens carrying on activities or owning property in foreign states are entitled to treatment in accordance with a "minimum standard of international law." In particular, the arbitrary treatment of aliens is unlawful, as is discriminatory treatment directed toward them solely because they are aliens. In addition, as a result of a number of diplomatic episodes and international arbitrations, it is acknowledged, at least in relation to isolated takings of private property, that such taking is lawful only if accompanied by the payment of fair compensation. There are two leading decisions on this point. In the case of the Norwegian ships (*Norway* v. *United States*, 1925), the Permanent Court of Arbitration held that the United States was under an obligation to pay to Norwegian nationals, whose rights under certain shipbuilding contracts had been seized by the United States during World War I, a sum described as "fair compensation" for the loss which they had suffered. In assessing the amount payable, the court took into consideration such factors as the value of the contracts as between a willing buyer and a willing seller on the date of the seizure, the sum which the Norwegian nationals had actually expended and the amount of interest due if payment in respect of the seizures had been promptly made. The second case, that of the *Chorzów factory*, between Poland and Germany, decided by the Permanent Court of International Justice in 1927 and 1928, arose out of the seizure by the Polish authorities of certain German property in breach of the terms of the treaty of Versailles and of the Geneva convention of 1922. The case is notable for the distinction drawn by the court between lawful takings of alien property, for which fair compensation should be paid, and unlawful takings, for which not mere compensation, but true damages, should be paid. In this case the taking was unlawful because it involved a breach of a treaty; the judgment also may be interpreted that a taking may be unlawful if no genuine attempt is made to assess or pay fair compensation. A further important feature of the judgment is that it identifies "fair compensation" with "the value of the undertaking at the moment of dispossession, plus interest to the day of payment," and thus establishes an objectively ascertainable standard of fair compensation.

It remains a matter of controversy whether these authorities apply with equal force when the scale of the taking of alien property is expanded from isolated expropriation to large-scale nationalization. On the one hand, emphasis is placed upon the continuing

rights of the foreign investor. It is argued that these rights remain unaffected by any difference in degree between expropriation and nationalization; that there is no reason why the foreign investor should bear the cost of implementing local political policies; and that the alien suffers equal material loss in both cases. The right to nationalize alien property is, for these reasons, said to be conditional upon the payment of "prompt, adequate and effective compensation." On the other hand, stress is laid upon the sovereign right of every state to determine its own political, social and economic future. If need or theory require that the ownership of property should be vested in the state, its freedom of action should not be fettered by the fact that it is too poor to pay the fair market price for alien property. The foreign investor, it is argued, places his capital abroad in the hope of making profits, and he would not do so if he did not consider that the returns outweighed the risks. This contention is frequently coupled with the assertion that in many cases the value of the original investment of the alien had been fully returned to him in profits repatriated during the period of operation.

No international tribunal has yet been placed in a position to express an authoritative view on the controversy. The suggestion has been made that in case of true nationalization the solution lies in the payment of "partial compensation." It is doubtful, however, whether this formula is either sufficiently precise or adequately supported by authority for it to be accepted as representing existing law; though, admittedly, in practice, many disputes have been settled by agreement for amounts which have fallen short of the real value of the property involved. When the British claims against Mexico for expropriation of oil properties were settled in 1947, the compensation probably did not amount to more than one-third of the value of the property seized. Nor was any higher standard of compensation achieved by the "lump sum" agreements relating to the nationalization measures of the eastern European states after World War II. Although this method of settlement normally leads to the certain payment of at least a proportion of the true value of the property, it has been estimated, for example, that under the agreements between the United Kingdom and Yugoslavia and Czechoslovakia the original owners received respectively no more than 45% and 25% of their claims. In the case of the Suez Canal company, the Egyptian government agreed in 1958 to pay to the company a sum of £E28,300,000 over a period of six years and to allow the company to retain all its assets situated outside Egypt.

However, despite the apparent generality of the practice of settling nationalization disputes by agreements providing for compensation which is less than the full value of the property nationalized, there does not appear to be sufficient warrant for the view that customary international law now acknowledges the validity of nationalizations not accompanied by the payment of fair compensation. There is equally no adequate justification for the view that, because a number of states have nationalized foreign companies in breach of express undertakings to permit their operation for a fixed period of years, there is no rule of international law which protects specific contractual commitments. Nevertheless, as a means of reducing difficulties arising out of the uncertain content of the rules of customary international law relating to compensation, states whose nationals tend to be investors are placing increasing reliance upon specific treaty clauses providing for the protection of investments. The United States, in particular, has since the end of World War II entered into treaties of friendship, commerce and navigation which contain mutual undertakings on this point, coupled with clauses conferring compulsory jurisdiction upon the International Court of Justice.

For socialist and communist attitudes toward nationalization *see* COLLECTIVISM; COMMUNISM; SOCIALISM. *See* also references under "Nationalization" in the Index.

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NATIONAL PARKS AND NATURE RESERVES. For hundreds if not thousands of years and in many countries man has given some sort of protection to those wild animals he has used for food and sport. Before the 19th century he seldom had any other motives; it is only relatively recently that animals have been thought worthy of preservation for their own sakes and for the appreciation of future generations of mankind. Even more recently has man begun to realize that it is not only the so-called game animals that need to be preserved, but the forests, the water and the soil itself—in fact, the whole natural scene.

Whatever the motives for preservation, the means must nearly always include setting aside areas where restraints are enforced. Such restraints may be permanent or restricted to certain months of the year; they may give protection to all creatures or to one class only (for example, birds) or even to one particular species, or they may impose restrictions upon the use of certain natural resources, such as timber. The area may be tiny or very large, privately owned or in government hands.

Because there are so many kinds of areas of preservation and because they have been coming into being in many countries at the same time, it is hardly surprising that there has been little uniformity of terminology. A national park in the United States or Canada is intended to safeguard natural features and wildlife in a way that will contribute to public enjoyment. National parks in England and Wales are thinly inhabited regions where the natural scenery is safeguarded; animal and bird life in Britain is preserved in nature reserves. In Africa, generally, the chief purpose of a national park is the preservation of wildlife. A game reserve may be a place where a stock of game for shooting is maintained by game management or it may be a larger area designed to preserve wildlife that is rapidly disappearing elsewhere. Even within a single country where the legal status implied by a name is usually clear, the actual effect of restrictions may vary from being highly effective to being worse than useless. A game reserve that is small in area may be invaluable because it protects a rare species and is properly guarded; another enormous area without guards and with only nominal restrictions may be a happy hunting ground for lawbreakers. In some countries, also, the local people have not learned the economic and tourist potential in their wild animals and slaughter them indiscriminately, either for meat or for portions of the carcass, or destroy the essential habitat by overgrazing of domestic livestock or by using the lands for crops.

The paradox of national parks is that whereas they may depend on tourists for their existence by creating public interest in wildlife preservation, the animals themselves depend for their preservation on being unmolested. The best way of resolving this paradox would seem to be to restrict the movement of the visitor, as has been done in numerous parks, by setting aside an area within or near the national park where hotels, restaurants, parking places for cars, etc., can be provided, and by locating a limited number of roads within the park. A constructive partnership must, in fact, be established between those responsible for tourism and those responsible for the preservation of the natural features the park was established to safeguard.

In a comprehensive article such as this it is not possible to distinguish between the effectiveness of areas of preservation nominally enjoying the same status, a fact that should be kept in mind in using the tables in this article. (These tables are derived from source materials from individual countries, *Derniers Refuges, Atlas Commente des Réserves Naturelles dans le Monde*, published in 1956 by the International Union for the Conservation of Nature and Natural Resources, and parts i and ii of the United Nations' *List of National Parks and Equivalent Reserves*, 1961 and 1962. Permission to use them is gratefully acknowledged.)

(C. L. BE.)

This article is divided into the following main sections:

I. United States
II. Canada
III. Africa
IV. Asia
V. Great Britain
VI. Europe
VII. Australasia
VIII. Central and South America

For bird and game protection and the protection of sea mammals and fish *see* WILDLIFE CONSERVATION.

I. UNITED STATES

The United States was long notoriously wasteful with its resources. In the brief span of three centuries verdant forests of vast regions were leveled, cover was torn from its soil, wildlife was pillaged and countless other offenses were committed against the natural fertility of the land. Fortunately, steps were taken early to prevent the exhaustion of natural resources. One early move in this direction was the transfer to the state of California, in 1864, of the Yosemite valley and the Mariposa grove of *Sequoia gigantea;* they were added to Yosemite National park in 1906. The concept of national parks under federal ownership originated in 1870, when the Doane-Washburn expedition investigated reports of the wonders of the Yellowstone. After some discussion of developing this region under the homestead laws, the matter was resolved when a member of the expedition, Cornelius Hedges, proposed that it should be the possession of all the people. Members of the expedition drafted legislation to that end, creating Yellowstone National park, and it was signed by Pres. Ulysses S. Grant in 1872. Eighteen years passed before Yosemite, Sequoia and General Grant national parks were established in 1890. During this time the idea of protecting outstanding scenic and scientific resources, wildlife and vegetation, for their own sakes, and to ensure perpetuation of the aboriginal attributes of the American scene grew into a concept of national policy.

The national park system was expanded during the following decades, not only with the addition of vast natural areas, but also with the inclusion of places of especial significance in the human history of exploration of the continent and the development of American Indian culture. At mid-20th century the system administered 176 areas comprising about 21,800,000 ac. and by the late 1960s about 220 areas embracing more than 26,500,000 ac.

Much of this land was originally part of the public domain, as was almost all of the land acquired by the new republic, beginning with western lands ceded by 7 of the original 13 states and continuing with later acquisitions such as the Louisiana Purchase. (For the disposition of this vast amount of territory *see* LAND TENURE: ECONOMIC AND AGRARIAN ASPECTS: *The United States;* and LAND SYSTEM [U.S.].) From these public lands were reserved the national forests, most of the national park system and many other reservations. However, large tracts have been donated to the national park system by some of the states and some gifts have been made by individuals.

Kinds of Protected Areas.—National parks are established by congress; another act of congress is required to change boundaries or to modify the basic protection, unless boundary adjustment provisions were specifically stated in the original act. National parks have been defined as spacious land and water areas of nationwide interest established as inviolate sanctuaries for the permanent preservation of scenery, wilderness, and natural vegetation and animal life in their natural condition.

National monuments are established by specific acts of congress or under the Antiquities act of 1906 which authorizes the president to reserve, by proclamation, federal lands for the protection of objects of historic, prehistoric and scientific interest: the latter provision enables the president to act without delay to safeguard assets in danger of despoilment. Jurisdiction over national monuments was originally in the hands of several different federal agencies, but in 1933 it was consolidated under the national park service.

Of the national monuments, about a third protect natural areas of scientific importance. Among the largest, Katmai, in Alaska, contains active volcanoes and the Valley of Ten Thousand Smokes as well as extensive forested habitat of several species of bears and other wildlife; Glacier Bay National monument (*q.v.*), also in Alaska, contains some of the most impressive active tidewater glaciers on the continent, high mountains and abundant wildlife; Death valley (*q.v.*) in California-Nevada contains outstanding sonoran desert ecology.

Other monuments, ranging from a square mile to several hundred thousand acres, are notable for their canyons, caverns, natural arches and other geological features, or for botanical exhibits such as succulent cactus, Joshua trees, coastal redwoods, etc. Some have been established especially to safeguard particular species of wildlife. Remains of aboriginal Indian cultures are preserved in about 20 national monuments; most of these are in the southwestern states but some are in other parts of the country. The remaining national monuments relate to the history of the continent after the coming of the white man. Places notable in the colonial and Revolutionary and American Civil War periods in the east, sites made famous in the settling of the west and landmarks in the careers of the nation's leaders are preserved and restored.

The national park service also administers national historical parks, military parks, battlefield parks and sites, and memorials commemorating principal engagements of the French and Indian War, the American Revolution and Civil War, and historic residences and sites not included in the system of national monuments. The value of this kind of preservation may be seen, for example, in the village of Appomattox Court House in Virginia, where Gen. Robert E. Lee surrendered to Gen. U. S. Grant on April 9, 1865, thus effectively terminating the Civil War. The village was at that time the seat of Appomattox county; later, when the county seat was moved elsewhere, it fell into decay and was in danger of total disappearance when its establishment as a national historical monument was authorized in 1935. It was thus established in 1940 and became a national historical park in 1954. It encompasses 972 ac.; the Wilmer McLean house, where the surrender took place, was restored, as were some other buildings.

Among other types of areas are national parkways, including the Blue Ridge parkway (to be 469 mi.), following the Appalachian ridges between Shenandoah and Great Smoky Mountains national parks; the Natchez Trace parkway, to follow the old Indian trail for 450 mi. between Nashville, Tenn., and Natchez, Miss.; and the George Washington Memorial parkway in Maryland and Virginia, 49 mi. when completed. Also included in the system are Civil War cemeteries; national seashores; national lakeshores; the Theodore Roosevelt National Memorial park in North Dakota; and the national capital parks in the District of Columbia, Maryland and Virginia. Public use of large reclamation reservoirs is administered (as recreation areas) by the park service. Among them are Lake Mead in Arizona and Nevada; Coulee Dam in Washington state; Glen Canyon in Arizona and Utah; Shadow Mountain in Colorado; Amistad in Texas; Arbuckle in Oklahoma; Bighorn in Wyoming and Montana; Curecanti in Colorado; Flaming Gorge in Utah and Wyoming; Sanford in Texas; and Whiskeytown-Shasta-Trinity in California.

Administration of the National Park System.—The national park service was established by an act of congress on Aug. 25, 1916, to administer the assigned areas "by such means and measures as conform to the fundamental purpose of said parks, monuments and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." This directive protects the national park system (a generic term that includes all the areas the park service administers except reservoirs) from exploitation for profit or from any development that would contravene the primary objective, that of preserving natural or historical features.

Park service policy, based on this act and augmented by more detailed formulations issued by the secretary of the interior and the service itself, is applied equally to all the categories in the system, with minor adjustments that recognize their varied charac-

TABLE I.—*A Partial List of Areas Administered by the United States National Park Service*

Name and location	Total gross acreage	Date established	Principal features
National Parks			
Acadia (Maine)	41,634	Part as Sieur de Monts National monument, 1916, and Lafayette National park, 1919; named Acadia, Jan. 19, 1929	Mount Desert Island and adjacent Atlantic coastal headlands; forests, mountains; seabirds
Big Bend (Texas)	708,221	June 12, 1944	Great bend of Rio Grande river; desert and mountain scenery; sonoran wildlife and botany
Bryce Canyon (Utah)	36,010	National monument, 1923; national park, Sept. 15, 1928	Vast eroded amphitheatres on Paunsaugunt plateau, with brilliantly coloured spires, pinnacles and walls
Canyonlands (Utah)	257,640	Sept. 12, 1964	Great wilderness area surrounding the confluence of the Green and Colorado rivers; colourful mesozoic canyons and spectacular land sculpture
Carlsbad Caverns (New Mexico)	46,786	National monument, 1923; national park, May 14, 1930	World's largest limestone caverns; calcite formations; bats; sonoran desert ecology
Crater Lake (Oregon)	160,290	May 22, 1902	Azure caldera 20 sq.mi. in area, with multicoloured walls 500 to 2,000 ft. high; conifer forests, alpine tundra, abundant wildlife
Everglades (Florida)	1,400,533	June 20, 1947	Subtropical wilderness grassland prairies, with mangroves, cypress and other plants; breeding colonies of egrets, herons, ibises, etc.; manatees; includes most of Florida bay
Glacier (Montana)	1,013,129	May 11, 1910	Glaciated Rocky mountain peaks, glaciers, lakes, forests, wildlife. Forms part of Waterton-Glacier International Peace park, established 1932
Grand Canyon (Arizona)	673,575	National monument, 1908; national park, Feb. 26, 1919	Upper half of 217-mi. gorge of Colorado river, 4 to 8 mi. wide, about 1 mi. deep; tremendous pediments, mesas and buttes carved in multicoloured rocks dating from Archean to Mesozoic eras; sonoran and montane ecology
Grand Teton (Wyoming)	310,350	Feb. 26, 1929; most of Jackson Hole National monument added 1950	Isolated glaciated Teton range with peaks to 13,766 ft.; broad open basin in foreground; conifer forests; winter feeding ground of largest American elk herd; moose, trumpeter swan, other wildlife
Great Smoky Mountains (North Carolina-Tenn.)	512,674	June 15, 1934	Appalachian ranges; primeval hardwood forests; wildlife
Guadalupe Mountains (Texas)	77,500	Oct. 15, 1966	Limestone uplift, caves; represents four climatic life zones; deer, elk, black bears, bighorn sheep, small mammals; prehistoric Indian ruins
Haleakala (Hawaii)	26,403	July 1, 1961	Haleakala volcano on Maui; endemic plants; products of volcanic activity
Hawaii Volcanoes (Hawaii)	220,345	National park including Haleakala, 1916; separate unit, July 1, 1961	Mauna Loa and Kilauea active volcanoes on island of Hawaii; tree fern forests with rare endemic plants and wildlife
Hot Springs (Arkansas)	1,032	Federal reservation, 1832; national park, March 4, 1921	Hot mineral springs and baths; characteristic Ozark woodland
Isle Royale (Michigan)	539,347	April 3, 1940	Forested island in Lake Superior; moose and other wildlife
Kings Canyon (California)	454,713	General Grant National park, 1890; enlarged as Kings Canyon National park, March 4, 1940	Canyons of Kings river and crest of Sierra Nevada range; General Grant grove of *Sequoia gigantea*
National Parks (Cont.)			
Lassen Volcanic (California)	106,934	Part as national monument, 1907; national park, Aug. 9, 1916	Lassen peak is the only recently active volcano in continental U.S. outside of Alaska; geologic, botanic and wildlife features
Mammoth Cave (Kentucky)	51,354	July 1, 1941	Limestone cave, 150 mi. of passages explored, with limestone, gypsum and cave onyx formations; underground rivers and lakes
Mesa Verde (Colorado)	52,074	June 29, 1906	Protects prehistoric Basket Maker and Pueblo Indian pit houses and finest cliff dwellings in the U.S.; Rocky mountain ecology
Mount McKinley (Alaska)	1,939,493	Feb. 26, 1917	Highest peak in North America, glaciers in Alaska range; arctic tundra; caribou, Dall sheep, wolf, bear, other wildlife
Mount Rainier (Washington)	241,983	March 2, 1899	Spectacular ancient volcano, with glaciers; dense forests, meadows, wildlife
Olympic (Washington)	896,599	Mount Olympus National monument, 1909; enlarged as national park, June 29, 1938	Wilderness of peaks, glaciers and rain forests; Roosevelt elk (subspecies of the wapiti); headlands and beaches along Pacific ocean
Petrified Forest (Arizona)	94,189	National monument, 1906; national park, Dec. 9, 1962	Extensive exhibit of petrified wood, Indian ruins and part of colourful Painted desert
Platt (Oklahoma)	912	Sulphur Springs reservation, 1902; national park, June 29, 1906	Cold mineral springs; prairie ecology
Rocky Mountain (Colorado)	262,324	Jan. 26, 1915	Front ranges of Rocky mountains, with 107 named peaks in excess of 10,000 ft.; conifer forests, alpine tundra, abundant wildlife
Sequoia (California)	386,863	Sept. 25, 1890	Groves of *Sequoia gigantea;* adjacent to Kings Canyon National park and administered jointly with it
Shenandoah (Virginia)	212,304	Dec. 26, 1935	Blue Ridge of Appalachian mountains with hardwood forests and wildflowers. Skyline drive traverses crest, continuing south as Blue Ridge parkway to connect with Great Smoky Mountains National park
Virgin Islands (Virgin Islands)	15,150	Dec. 1, 1956	Caribbean island, with green hills, beaches, tropical plants and animals; historic relics of Carib Indians and colonial sugar plantations
Wind Cave (South Dakota)	28,059	Jan. 9, 1903	Limestone caverns in Black Hills; conifer forests, open prairies; bison, antelope, prairie dog, other wildlife
Yellowstone (Wyoming-Montana-Idaho)	2,221,773	March 1, 1872	World's largest geyser area; canyons, falls, lakes, mountains; abundant wildlife of many species
Yosemite (California)	760,951	Oct. 1, 1890	Spectacular peaks, canyons, waterfalls in Sierra Nevada range; three groves of giant sequoias; dense forests; alpine tundra; wildlife
Zion (Utah)	147,035	Mukuntuweap National monument, 1909; named Zion National monument, 1918; national park, Nov. 19, 1919	Colourful tertiary canyons and mesas in high desert region
National Monuments			
A. Natural Areas			
Arches (Utah)	34,010	April 12, 1929	Eroded arches, pinnacles, in desert

TABLE I.—*A Partial List of Areas Administered by the United States National Park Service (Continued)*

Name and location	Total gross acreage	Date established	Principal features
A. Natural Areas (Cont.)			
Badlands (South Dakota)	111,530	Jan. 25, 1939	Eroded sedimentary badlands; fossils; short-grass prairie ecology
Black Canyon of the Gunnison (Colorado)	13,683	March 2, 1933	Sheer-walled canyon in San Juan mountains
Buck Island Reef (Virgin Islands)	850	Dec. 28, 1961	Coral reefs and undersea formations; marine gardens
Capitol Reef (Utah)	39,173	Aug. 2, 1937	Colourful sedimentary sandstone cliffs dissected by a narrow gorge along Fremont river
Capulin Mountain (New Mexico)	775	Aug. 9, 1916	Asymmetrical extinct volcanic cinder cone
Cedar Breaks (Utah)	6,155	Aug. 22, 1933	Vast natural amphitheatre eroded into variegated Pink cliffs 2,000 ft. thick; wild flowers
Channel Islands (California)	18,167	April 26, 1938	Santa Barbara and Anacapa Islands (1,120-ac. land area) offshore from southern California, to protect sea lion and seabird rookeries
Chiricahua (Arizona)	10,646	April 18, 1924	Tertiary rhyolitic monoliths and other geological features; arid mountains, desert and montane ecology with Mexican affinities
Colorado (Colorado)	17,362	May 24, 1911	Canyons, monoliths, in arid mesa region, bison
Craters of the Moon (Idaho)	53,545	May 2, 1924	Volcanic geology
Death Valley (California-Nevada)	1,907,760	Feb. 11, 1933	Desert wilderness; geological, botanical, faunal features; pioneer history
Devil's Postpile (California)	798	July 6, 1911	Basaltic lava columns rising as high as 60 ft.
Devils Tower (Wyoming)	1,347	Sept 24, 1906	865-ft exposed volcanic intrusion
Dinosaur (Utah-Colorado)	206,234	Oct. 4, 1915	Spectacular canyons of Green and Yampa rivers; dinosaur fossils
Glacier Bay (Alaska)	2,274,595	Feb. 26, 1925	Large tidewater glaciers, fjords; postglacial forests; abundant wildlife, especially bears
Grand Canyon (Arizona)	198,280	Dec. 22, 1932	Lower Grand canyon, including inner gorge
Great Sand Dunes (Colorado)	36,740	March 17, 1932	Shifting aeolian dunes at foot of Sangre de Cristo mountains; among the largest and highest dunes in U.S.
Jewel Cave (South Dakota)	1,275	Feb. 7, 1908	Limestone caverns with calcite encrustations
Joshua Tree (California)	557,992	Aug. 10, 1936	Stands of Joshua tree; sonoran desert ecology
Katmai (Alaska)	2,697,590	Sept. 24, 1918	Active volcanoes; Valley of Ten Thousand Smokes; subarctic conifer forests; Alaskan brown bear and other wildlife
Lava Beds (California)	46,239	Nov. 21, 1925	Volcanic geology; semi-arid mountain ecology; site of Modoc Indian war of 1873
Lehman Caves (Nevada)	640	Jan. 24, 1922	Ornamented limestone cavern in isolated Snake range
Muir Woods (California)	503	Jan. 9, 1908	Virgin stand of coastal redwood (*Sequoia sempervirens*)
Natural Bridges (Utah)	7,600	April 16, 1908	Three natural bridges, the highest 222 ft. above stream bed, with span of 261 ft.
Oregon Caves (Oregon)	480	July 12, 1909	Limestone caverns, with Jeffrey pine forest on surface
Organ Pipe Cactus (Arizona)	330,874	April 13, 1937	Sonoran desert plants and wildlife
Pinnacles (California)	14,498	Jan. 16, 1908	Volcanic and other geological features, with spire formations 500 to 1,200 ft. high
Rainbow Bridge (Utah)	160	May 30, 1910	Largest, most beautiful natural arch known, in Escalante desert, 309 ft. over stream bed
Saguaro (Arizona)	78,644	March 1, 1933	Saguaro forest and other succulent cacti
Sunset Crater (Arizona)	3,040	May 26, 1930	Volcanic cinder cone with summit crater formed just prior to A.D. 1100
Timpanogos Cave (Utah)	250	Oct. 14, 1922	Colourful limestone cave on Mt. Timpanogos
White Sands (New Mexico)	146,535	Jan. 18, 1933	Gypsum dunes 10 to 45 ft. high; wildlife
B. Archaeological Areas			
Aztec Ruins (New Mexico)	27	Jan. 24, 1923	Excavated 12th-century Indian town
Bandelier (New Mexico)	29,661	Feb. 11, 1916	Prehistoric Indian homes of later Pueblo period
Canyon de Chelly (Arizona)	83,840	April 1, 1931	More than 400 cliff dwellings dating as early as A.D. 1066, in magnificent canyon on Navajo reservation
Casa Grande Ruins (Arizona)	473	Reserved 1892; national monument, Aug. 3, 1918	Unique adobe tower probably built by Salado Indians in the 1300s in earlier Hohokam settlement
Chaco Canyon (New Mexico)	21,509	March 11, 1907	13 major Indian ruins; many smaller ruins
Effigy Mounds (Iowa)	1,468	Oct. 25, 1949	Large Indian mounds in shapes of birds and other animals
El Morro (New Mexico)	1,279	Dec. 8, 1906	Prehistoric petroglyphs, inscription in rock by explorers
Gila Cliff Dwellings (New Mexico)	533	Nov. 16, 1907	Cliff dwellings in centre of Gila Wilderness area
Grand Portage (Minnesota)	770	Historic site, 1951, national monument, Jan. 27, 1960	Principal canoe portage route of Indians, explorers and missionaries
Hovenweep (Utah-Colorado)	505	March 2, 1923	Unique towers built in 12th century
Montezuma Castle (Arizona)	842	Dec. 8, 1906	Outstanding cliff dwelling dating from about A.D. 1100
Mound City Group (Ohio)	68	March 2, 1923	24 ceremonial burial mounds of Hopewell people, dating from about A.D. 1000
Navajo (Arizona)	360	March 20, 1909	Three of largest known cliff dwellings, dating from 13th century
Ocmulgee (Georgia)	683	Dec. 23, 1936	Mounds built by farming Indians, dating from 10th century
Pipestone (Minnesota)	283	Aug. 25, 1937	Quarry from which Indians obtained materials for peace pipes
Russell cave (Alabama)	310	May 11, 1961	Cave containing record of human habitation from 6000 B.C. to A.D. 1650
Tonto (Arizona)	1,120	Dec. 19, 1907	Salado Indian cliff dwellings, in Salt river valley, dating from about A.D. 1350
Tuzigoot (Arizona)	43	July 25, 1939	Pueblo containing 110 rooms, which flourished between A.D. 1000 and A.D. 1400
Walnut Canyon (Arizona)	1,879	Nov. 30, 1915	200 small cliff dwellings, dating from A.D. 1000 to A.D. 1200
Wupatki (Arizona)	35,545	Dec. 9, 1924	Pueblos built by several tribes about A.D. 1100; desert ecology

Some other units of national park system protecting natural features

Name and location	Total gross acreage	Date established	Principal features
Theodore Roosevelt National Memorial park (North Dakota)	70,435	April 25, 1947	Badlands along Little Missouri river, with abundant wildlife
National Capital parks (District of Columbia-Virginia-Maryland)	37,406		Park system of the nation's capital, comprising 785 units
Assateague Island National Seashore (Md.-Va.)	39,630	Sept. 21, 1965	Island is a 35-mi. barrier beach parallel to Atlantic coast
Cape Hatteras National Seashore (N.C.)	28,500	June 12, 1953	Atlantic coastal beach; migratory waterfowl
Cape Cod National Seashore (Mass.)	44,600	Authorized, Aug. 7, 1961	Atlantic coastal beach; migratory waterfowl
Fire Island National Seashore (New York)	19,311	Sept. 11, 1964	Dunes, marshes, beaches; coastal wildlife
Indiana Dunes National Lakeshore (Indiana)	6,539	Nov. 5, 1966	Sand dunes and marsh on Lake Michigan shore
Point Reyes National Seashore (Calif.)	53,000	Authorized, Sept. 13, 1962	Pacific coastal beach
Padre Island National Seashore (Texas)	137,241	Authorized, Sept. 28, 1962	Flat, sparsely vegetated beachland on Gulf of Mexico
Pictured Rocks National Lakeshore (Michigan)	65,000	Oct. 15, 1966	Scenic reserve of multi-coloured rocks on shore of Lake Superior; forest

ters. Placing first emphasis on protection, with public use and enjoyment an essential corollary part of the objective, this concept of park administration has been adopted by many nations which later established national park systems of their own.

The system possesses natural resources attractive to interests that might profit from their exploitation, and from the beginning there have been repeated attempts to induce congress to weaken the rigid legal protection given one area or another. Yellowstone, Yosemite, Kings Canyon, Glacier, Grand Canyon and other areas include canyons where construction of hydroelectric or reclamation dams has been vigorously resisted; national controversies have raged over legislation that would have permitted Yellowstone lake to be dammed, Echo park in Dinosaur National monument to be flooded and other similar projects. Frequent efforts have been made to open individual parks and monuments, and even all of them, to mining; except within four areas (Mt. McKinley National park and Glacier Bay, Death Valley and Organ Pipe Cactus national monuments) in which mining is subject to regulation by the secretary of the interior, and a small section of Katmai National monument, mining was prohibited in the system.

On the principle that the native species should follow their natural behaviour patterns insofar as possible, hunting of all wildlife, including predators, is prohibited. In a few instances this policy, together with the fact that the aboriginal wildlife habitat lying beyond the park boundaries has been developed for human economic reasons, has resulted in overpopulations of certain large mammals so that the carrying capacity of the park ranges has been endangered, and the secretary of the interior has authority to reduce such species when scientific evidence demonstrates the need.

The most notable case is that of the wapiti in Yellowstone, where thousands of these elk share insufficient ranges with bison, deer, bighorn sheep and antelope. Proposals to open the park to public hunting were rejected as violating the fundamental objective, and a program of elk reduction by deputized hunters in parts of nearby Grand Teton National park proved ineffectual. Grazing of livestock is considered an activity not conforming to the purpose of the parks, but occasionally there are demands that the grasslands in the system be made available to domestic animals. Grazing privileges in effect at the time lands are brought under the park service are continued only through the lifetime of the permittee's immediate heirs, and grazing is gradually being reduced.

Overdevelopment, imperiling the assets the parks were established to safeguard, is probably the most difficult problem now confronting the administrating agency. Earlier, when most of the areas were remote and transportation slow and expensive, it was necessary to advertise them to arouse public interest in the national park program. Hotels and lodges were built in the parks, roads were provided to serve the infant tourist movement and dude ranching was developed. During the depression of the 1930s the modest appropriations provided by congress were supplemented by hundreds of millions of dollars in emergency relief funds and Civilian Conservation corps enrollees aided in keeping the parks in condition. World War II reduced the annual appropriations to as little as $5,000,000 and terminated emergency funds, but during that period relatively few tourists could travel to distant places for recreation.

The end of the war released an affluent, restless population with abundant leisure. Tens of millions of people sought their national parks, spending millions of dollars which served as a catalyst to all the myriad businesses and industries dependent on travel and recreation. Appropriations did not keep pace with this invasion of the parks, and as a park director commented, "The American people are loving their parks to death."

Supported by citizens organizations, the park service urgently requested funds from congress, with some success. But by 1953 only $33,000,000 was being provided to administer 180 areas. Antiquated accommodations were deteriorating, roads were being pounded to ruin, campgrounds were unable to withstand constant overuse: the parks were being worn out. "Mission 66," a ten-year, $459,000,000 conservation, improvement and development program, was announced in 1956 by C. L. Wirth, park service director.

New projects and the backlog of deferred construction were started immediately. The Sierra club, the Wilderness society, the National Parks association and other nongovernmental conservation organizations supported the program and offered their advice. They supported the park service in its insistence on the importance of ensuring that physical development did not impair the wilderness character of the parks and monuments, and they also approved of the decision to concentrate visitor and personnel facilities (if required to be built inside the parks) in a limited number of restricted localities connected by motor roads, leaving 95% of the land in its undisturbed natural state.

The park service's work in interpreting its areas provides factual information about scenic features, wildlife, geology, botany, history or archaeology, and also helps the visitor to widen his interests and knowledge. A staff of scientists, naturalists, historians, museum and educational experts, augmented during the travel seasons by additional ranger-naturalists and other interpretive personnel, conduct field trips, staff museums and devise original methods of enlarging the visitor's appreciation of what he sees.

Such visitor facilities as roads, trails, campgrounds and utilities are provided by the park service. Services for which a charge is made—hotels and lodges, cabins, restaurants, automobile services, buses, packhorses and other similar services—are under private management.

If a facility or the land it occupies is owned by the federal government, the concessioner operates under a contract with the park service which regulates the character and financial aspects of the concession. There remain several hundred thousand acres within the parks held in nonfederal ownership (which are gradually being acquired by purchase or exchange), and visitor facilities on these lands are not under government control.

In all of its activities, the park service is guided by the statutory advisory board on national parks, historic sites, buildings and monuments.

(*See* also articles on the various national parks. For state parks *see* articles on the various states.)

National Forests: Wilderness, Primitive and Wild Areas.—As the United States was settled, more and more land was of course cleared of forests, and not until 1877 was official recognition given to the danger inherent in the practice. In that year the secretary of the interior, Carl Schurz, aroused congressional interest in retaining permanent forests in public ownership and in improving administration of the federal real estate. This led to the beginning of a system of forest reserves authorized in 1891; 30 were created by Presidents Benjamin Harrison and Grover Cleveland. Gifford Pinchot (*q.v.*), appointed chief of the forestry division in 1898, vigorously promoted the old-world concept of forest management through sound forest practices, enforced on public lands by laws and regulations imposed by the government as custodian of their resources. Pres. Theodore Roosevelt, who strongly supported this judgment, strengthened the federal interest in forest resources by assigning responsibility in 1905 to a new forest service in the department of agriculture, with Pinchot as chief forester, and created additional national forests. The practice of reserving portions of the federal real estate for regulated use and perpetuation of their resources was gradually extended to many aspects of a national conservation program.

Initially, the national forests were intended to safeguard watersheds (and were therefore located where preservation of water resources was a vital social and economic consideration) and to ensure a permanent supply of timber, harvested by private operators under forest service regulation. Since the national forests include large areas of grassland, grazing of livestock was soon added as a proper use. Mining laws apply to these lands, hunting of wildlife in accordance with state law is permitted, reclamation and power projects are located within them and other utilization of resources is authorized by law and regulation. This concept of multiple use is the conscious goal of administration of the national forests as a whole, although opinion varies as to whether this term should be construed to mean various uses on the same area, or whether emphasis on, or limitation to, the highest or most significant use should be applied on respective parts of a given area.

Even under careful regulation most of these activities change the character of the terrain and convert primeval wilderness into artificially controlled environment. Aldo Leopold of the University of Wisconsin was the first eloquent advocate of the wilderness concept: undisturbed wilderness itself is a resource of value; present and future generations require opportunity to experience the inspiration and surcease from an increasingly mechanized culture through healthful outdoor pursuits undertaken by individual effort; and those who inherit these resources should be bequeathed some virgin forests and unmodified open spaces which they could determine how to enjoy and use in light of the cultural patterns of their day. In 1921 Leopold aroused official interest in this proposition, and in 1924 the Gila Wilderness area was established in the Gila National forest in New Mexico as the first of what was to become a series of such reservations. In 1929 Regulation L-20 was promulgated under which several chiefs of the forest service established 72 primitive areas totaling nearly 14,000,000 ac. between 1930 and 1939. The wilderness area system was given another strong impetus in 1939 when regulations were set forth providing for the establishment of wilderness areas of more than 100,000 ac. each by the secretary of agriculture and the establishment of suitable tracts of between 5,000 and 100,000 ac. by the chief forester. The existing primitive areas which had been established since 1929 continued in effect but were scheduled for restudy and reclassification within the new definitions. The wilderness concept received vigorous popular support, especially through the educational program undertaken by the Wilderness society and private citizens throughout the country.

Within the wilderness, wild and primitive areas and the Boundary Waters canoe area, no developments are permitted which are detrimental to the preservation of primitive conditions of transportation and environment. Roads may not be built in them nor

TABLE II.—*Principal Refuges Administered by the United States Bureau of Sport Fisheries and Wildlife*

Name and location	Total gross acreage	Date established	Principal features
Big Game Refuges and Game Ranges			
Arctic National Wildlife range (Alaska)	8,900,000	1960	Undisturbed arctic coastal environment and eastern Brooks range; grizzly and polar bears, Dall sheep, caribou, moose, wolf, wolverine, etc.
Cabeza Prieta Game range (Arizona)	860,000	1939	Mexican antelope, Gaillard bighorn, peccary; sonoran desert
Charles M. Russell National Wildlife range (Montana)	951,302	1936	Pronghorn, Rocky mountain bighorn, deer, elk, upland game birds; sagebrush basin
Charles Sheldon Antelope Range and refuge (Nevada-Oregon)	544,525	1936	Pronghorn antelope, mule deer, sage hen, waterfowl; sonoran desert
Clarence Rhode National Wildlife range (Alaska)	1,870,000	1960	Low-lying tundra on northwestern coast near Bering sea; waterfowl, fur-bearing mammals, etc.
Desert Game range (Nevada)	2,188,379	1936	Pronghorn, Nelson bighorn, mule deer; sonoran desert
Fort Niobrara National Wildlife refuge (Nebraska)	19,122	1912	Bison, Texas longhorn cattle, elk, beaver, upland birds
Hart Mountain National Antelope refuge (Oregon)	240,731	1936	Pronghorn, mule deer, upland birds; sagebrush plateau
Izembek National Wildlife range (Alaska)	415,016	1960	Waterfowl nesting and feeding grounds on the Alaskan peninsula; brown bear, caribou
Kenai National Moose range (Alaska)	1,730,000	1941	Kenai moose, brown bear, Dall sheep, mountain goat, furbearers, birds; rugged wilderness of mountains, swamps, lakes and rivers
Kodiak National Wildlife refuge (Alaska)	1,815,000	1941	Kodiak bear, deer, waterfowl, colonial seabirds; forested Kodiak Island
Kofa Game range (Arizona)	660,000	1939	Gaillard bighorn, sonoran desert wildlife and vegetation, including rare *Washingtonia filifera* palm
Little Pend Oreille National Wildlife refuge (Washington)	43,959	1939	Upland birds, deer, black bear
National Bison range (Montana)	18,541	1908	300 to 400 bison, elk, deer, Rocky mountain bighorn; high prairie
National Elk refuge (Wyoming)	23,754	1912	Winter range of southern Yellowstone elk herd, trumpeter swan, sandhill crane, beaver; in Jackson Hole basin adjacent to Grand Teton National park
National Key Deer refuge (Florida)	6,745	1954	Rare dwarf Key deer, spoonbill, great white heron; on Florida Keys
Nunivak National Wildlife refuge (Alaska)	1,109,384	1929	Musk ox, reindeer, shorebirds; tundra
Pribilof Islands reservation (Alaska)	50,163	1909	Established to protect endangered fur seals, which had increased to 1,500,000 animals in 1959; controlled harvesting under bureau of commercial fisheries; colonial seabirds
San Andreas National Wildlife refuge (New Mexico)	57,217	1941	Nelson bighorn, deer, birdlife; sonoran desert
Simeonof National Wildlife refuge (Alaska)	10,442	1958	In southeastern part of Shumagin Island chain; sea otters
Sullys Hill National Game preserve (North Dakota)	1,674	1914	Bison, elk, deer, goose
Wichita Mountains Wildlife refuge (Oklahoma)	59,020	1905	Bison, elk, deer, pronghorn, longhorn cattle, turkey, rare Mississippi kite, waterfowl; upland prairies and mountain range

Name and location	Total gross acreage	Date established	Principal features
Migratory Bird Refuges General			
Aleutian Islands Wildlife refuge (Alaska)	2,720,235	1913	50 major islands extending 1,200 miles from Unimak to Attu; active volcanoes, Pacific coastland arctic tundra; rare sea otters, colonial seabirds, shorebirds, waterfowl, bear, whale, seal
Bering Sea Wildlife refuge (Alaska)	41,113	1909	Elders and other sea ducks, alcidae, arctic fox; tundra
Great White Heron Wildlife refuge (Florida)	1,997	1938	Great white heron, spoonbill, Key deer, mangrove keys
Okefenokee Wildlife refuge (Georgia)	330,973	1937	Crane, ibis, egret, limpkin, alligator, furbearers; primeval bald cypress swamp
Santa Ana Wildlife refuge (Texas)	1,981	1943	Remnant of tropical forest on Rio Grande river; tree duck, chachalaca and other birdlife with Mexican affinities
Migratory Bird Refuges Waterfowl			
Aransas Wildlife refuge (Texas)	47,261	1937	Sole wintering ground of rare whooping crane; abundant wintering waterfowl, migratory land birds and shorebirds; spoonbill, egret and heron rookeries; deer, peccary; peninsula on Gulf of Mexico
Bear River Migratory Bird refuge (Utah)	64,895	1928	Vast marshes of Bear river delta on Great Salt lake; millions of nesting and migratory ducks and geese; 200 species of birds recorded; furbearers
Cape Romain Wildlife refuge (South Carolina)	34,698	1932	Atlantic coastal marshes and islands; waterfowl, shorebirds, rail, loggerhead turtle, furbearers
Delta Wildlife refuge (Louisiana)	48,799	1935	Vast marshes on coast of Gulf of Mexico; major wintering grounds of blue, snow and other geese; abundant ducks, herons, rails and other birds; muskrat
Lacassine Wildlife refuge (Louisiana)	31,125	1937	
Sabine Wildlife refuge (Louisiana)	142,717	1937	
Kentucky Woodlands (Kentucky)	65,712	1938	Upland hardwood forests; eastern turkey, grouse, waterfowl
Lower Klamath (California)	21,459	1908	Vast restored marshes on Pacific waterfowl flyway; millions of geese and ducks, white pelicans, shorebirds, herons, upland birds, waterfowl
Sacramento (California)	10,776	1937	
Tule Lake (California)	37,337	1928	
Des Lacs (North Dakota)	18,881	1935	River marshes in northern prairies, restored to provide waterfowl nesting, feeding and wintering grounds; prairie chicken, sharp-tailed grouse
Lower Souris (North Dakota)	58,693	1935	
Upper Souris (North Dakota)	32,089	1935	
Loxahatchee (Florida)	145,525	1951	Subtropical swamp created by diked reserve, waterfowl wintering ground; limpkin, rare Everglade kite
Malheur (Oregon)	180,851	1908	Restored river marshes on Pacific waterfowl flyway; abundant birdlife, antelope, muskrat, beaver
Upper Klamath (Oregon)	12,533	1928	
Mattamuskeet (North Carolina)	50,177	1934	Atlantic flyway wintering grounds for waterfowl, especially whistling swan; furbearers
Swanquarter (North Carolina)	15,501	1932	
Red Rock Lakes (Montana)	39,946	1935	Lakes and marshes on continental divide; principal U.S. breeding ground of rare trumpeter swan; Shiras moose, furbearers
White River (Arkansas)	112,313	1935	Bottomland hardwood forest; abundant waterfowl, herons, turkeys, songbirds, furbearers

timber harvested (except in one-half of the canoe area under certain specific regulations), and other commercial uses are kept to a minimum. Hunting is permitted, since the states have not ceded jurisdiction over the wildlife there.

Unlike the national park system, the wilderness area system is subject to alteration of boundaries and change of policy by executive order within the department of agriculture; congressional action is not required. Certain citizens' organizations feel that it should be, to ensure the permanence of the protection afforded by the system, and legislation to that end was introduced in congress.

Most of the wilderness and primitive areas are west of the Great Plains. Robert Marshall described them as "regions which contain no permanent inhabitants, possess no means of mechanical conveyance, and are sufficiently spacious that a person may spend at least a week or two of travel in them without crossing his own tracks. The dominant attributes of such areas are: first, that visitors to them have to depend exclusively on their own efforts for survival; and, second, that they preserve as nearly as possible the essential features of the primitive environment." Most of them are high, rugged terrain of peaks and forests, tundra and mountain glades, clear rivers and lakes. Some are vast stretches of arid and semiarid country, interspersed with varied ecological conditions. Others have special attributes, such as the Boundary Waters canoe area (formerly known as the Superior Roadless area) in Minnesota, which protects the finest lakeland canoeing country in the United States by prohibiting logging on shorelines or the use of airplanes for transport, and which is contiguous with similar regions in Canada's Quetico Provincial park, in Ontario. Hikers and campers may follow thousands of miles of trails, on foot or with packhorses, to experience the kind of life their forefathers knew. The wild areas provide similar pursuits but are of smaller size. They are equally valuable as undisturbed examples of primeval ecology important to scientific research and for the determination of proper conservation practices on other land.

Wildlife Refuges.—Before the advent of white man, the American continent teemed with wildlife. Bison in the millions roamed the eastern forests and Great Plains. Pronghorn antelope may have been even more numerous. Passenger pigeons, more than a billion in a flock, nested in the hardwood forests. Waterfowl bred by the tens of millions in lakes and sloughs and marshes. Great rookeries of egrets, ibises and other herons inhabited the southern swamps. Beavers and other furbearers filled the waters of the forests, prairies and coastal swales. North America supported as many species and greater numbers of birds and mammals than any other temperate region on the earth.

Loss of the bulk of this wildlife heritage is part of the price the United States has paid for its civilization. The forest habitat of deer, bear, moose and many other species gave way to clearings as first the eastern and midwestern hardwoods were cut, and then vast stands of western conifers were logged. The prairies and plains became farms, many of their natural lakes, potholes and marshes were drained and plowed. Cities and highways occupied extensive acreages where once myriad animals lived. The pioneer settlers lived off the game of the land until cattle usurped the ranges. Meat from wild animals supported the rising cities; hundreds of thousands of barrels of passenger pigeons and Eskimo curlews, among other species, were shipped from St. Louis and other midwestern cities to cities in the east. Bison and antelope were slaughtered nearly to extinction, and the vogue for plumes on women's hats led to decimation of the egret and heron rookeries.

During the second half of the 19th century the states began to enact game laws, but enforcement was weak until national sentiment stimulated more effective protection under state game and conservation commissions. Fortunately, action came in time to enable most species to survive, but the passenger pigeon became extinct in 1914 and some species and subspecies of other animals no longer exist. The ranges of many animals, such as the grizzly bear and timber wolf, were restricted to a small number of protected localities, especially in national and state parks, refuges and preserves. A more thoughtful type of sportsman began to exert influence and to promote funds for restoration of endangered animals. The American Bison society purchased the last intact bison herd left in the United States and shipped it to Yellowstone National park, where it thrived; in the 1960s, more than 6,000 bison existed in the United States and additional herds inhabited reserves in Canada. Pronghorn antelope were reestablished in many places and spread into adjacent regions. Elk recovered so successfully under reasonable laws and on protected ranges that new herds were established in many parts of the country.

White-tailed deer actually benefited from the conversion of dense forests into smaller woodlands bordered by open terrain and may be more numerous now than in aboriginal times.

The vigorous interest taken by the federal government in wildlife restoration has been primary in the success of this program. On July 1, 1885, the branch of economic ornithology was established in the division of entomology, U.S. department of agriculture; it became the bureau of biological survey in 1905 under the direction of C. Hart Merriam. Originally designed to undertake research into the economic importance of birds and mammals, the bureau achieved international eminence as a scientific institution. It administered the Lacey act of 1900 which prohibited shipment across state boundaries of game taken illegally, and gradually market hunting was eliminated. Under the Migratory Bird Treaty act of 1918, the bureau was given power to extend federal protection to avian species that migrated between Canada and the United States; in 1937 a similar treaty with Mexico broadened this power.

Prior to ratification of these treaties, conservation of wildlife had been a responsibility only of the states, except in the national park system where jurisdiction over wildlife has been ceded to the federal government; these conventions enabled the federal government to share this responsibility.

Reservation of federal land as national wildlife refuges was accomplished initially by executive orders of the president, the first refuge being the three-acre Pelican Island off the east coast of Florida, established by Theodore Roosevelt in 1903. Many early bird sanctuaries, however, were created by the National Audubon society, a citizens' organization, to preserve egret rookeries in the south. The severe decline of waterfowl and shore birds because of overshooting and drought, and diminishing populations of larger mammals, evident during the first decades of the 20th century, stimulated reservation of large federal units such as Malheur and Upper Klamath National wildlife refuges in Oregon, the Pribilof Islands reservation in Alaska, the National Bison range in Montana and the Wichita Mountains Wildlife refuge in Oklahoma. By 1929, there were 87 federal refuges in 24 states and the territories.

The Migratory Bird Conservation act of 1929 provided broad legislative authority for refuge acquisition and development and some funds were appropriated for the programs. A second decline in the waterfowl population became evident, and under the dynamic leadership of Director J. N. Darling new sources of funds for the refuge program were provided. The Migratory Bird Hunting Stamp act of 1934 required all waterfowl hunters 16 years of age and over to have in their possession a federal stamp, and the Pittman-Robertson act of 1937 called for a 10% (later 11%) federal excise tax on sporting arms and ammunition to be allocated to the states to pay three-quarters of the expense of wildlife restoration programs. By 1953 the federal grant amounted to $10,000,000 annually. Originally, refuges purchased with duck stamp money were inviolate but in 1949 the secretary of the interior was empowered to open one-quarter of the area of such refuges to public shooting if the status of the species' population warranted, and in 1958 this was increased to 40% of most refuges.

The 1940 Convention on Nature Protection and Wild Life Preservation in the Western Hemisphere extended the application of certain protective measures to those American republics ratifying the treaty. In 1939, the biological survey was transferred to the U.S. department of the interior and in 1940, together with the bureau of fisheries, became the fish and wildlife service; in 1958, it was reorganized as the bureau of sport fish-

eries and wildlife, a part of the United States fish and wildlife service.

The revival of once drastically decimated species, such as pronghorn antelopes, bighorn sheep, bison, white-tailed deer, mule deer and elk, has been due in significant measure to these refuges, as well as to the protection afforded by the national park system and state game reserves and improved laws.

Similarly, largely as a result of preservation and restoration of essential breeding, feeding and wintering habitat in federal and state refuges, combined with favourable continental weather cycles, waterfowl population trends of the continent reached a peak during the years 1952 to 1956. Unfavourable weather conditions over a large segment of the breeding habitat, starting in 1956, resulted in a marked population decline in some species of waterfowl, especially the diving duck species. The objective of preserving waterfowl nesting areas, migration resting places and winter feeding grounds was co-ordinated in planning and legislative programs with other conservation activities. Vast sums were spent not only to acquire existing habitat on coastal marshes, bottomlands on the principal river systems and interior sloughs, but also to restore great areas that had been drained. Many storage reservoirs and other impoundments built to secure water benefits proved invaluable as waterfowl sanctuaries. Continued research by the fish and wildlife service revealed that waterfowl follow certain routes or flyways to and from their nesting grounds, each flyway being used by the population nesting in a particular geographic region. Series of refuges have been established to serve the welfare of the respective populations during the entire course of their movements.

In spite of the success achieved in arresting waterfowl declines and in perpetuating the species of ducks, geese and swans, their future security requires increased efforts to offset continued conversion of essential habitat to other purposes.

The growth of such a large and varied system of federal refuges, and the corollary development of refuges and sanctuaries by the states and private organizations, is evidence of changed attitudes toward wildlife on the part of the American people. Since they seldom are dependent on game meat for food, hunting is regulated to preserve species for future generations, and most sportsmen's organizations support governmental controls. During the 20th century there developed a large body of public opinion interested in wildlife for its own sake and as a source of personal enjoyment and scientific study. Both of these interests have strongly endorsed refuge programs and the expenditure of tax revenues for this purpose.

II. CANADA

National parks in Canada are established by parliament and are administered by the national parks branch of the department of northern affairs and national resources. Banff, Jasper, Kootenay and Yoho National parks adjoin each other in the spectacular Rocky mountains, and Mt. Robson, Hamber and Mt. Assiniboine Provincial parks and Glacier National park, in British Columbia, extend the continuous protected complex to cover 13,000 sq.mi. These are accessible by highway and rail and have excellent visitor accommodations. Vast portions of these parks are true wilderness, enjoyed by explorers and mountaineers. Other national parks in the Canadian Rockies, in the forests and lakelands of the plains and eastward to the Atlantic coast, provide a variety of environment, recreation and wildlife. Except for recognition of

TABLE III.—*Principal Parks in Canada*

Name and location	Total gross area in sq.mi. (approx. acreage in parens)	Date established	Principal features
National Parks			
Banff (Alberta)	2,564 (1,641,000)	1885	Central Rocky mountain scenery, with peaks to 11,900 ft.; bighorn sheep, mountain goat, elk, moose, bear, etc.
Cape Breton Highlands (Nova Scotia)	367 (234,900)	1936	Rugged Atlantic and Gulf of St. Lawrence shoreline, with coves and forests
Elk Island (Alberta)	75 (48,000)	1913	Rolling prairie; fenced herds of mammals
Fundy (New Brunswick)	79 5 (50,900)	1948	Mixed conifer and hardwood forests rising above Bay of Fundy; moose, white-tailed deer, black bear and other wildlife
Georgian Bay Islands (Ontario)	5.4 (3,500)	1929	Tiny islands in Georgian bay, Lake Huron
Glacier (British Columbia)	521 (333,400)	1886	Rocky mountain wilderness; peaks, glaciers, lakes, conifer forests, abundant wildlife
Jasper (Alberta)	4,200 (2,688,000)	1907	Peaks to 12,394 ft., famous Columbia ice field covers 150 sq.mi.; conifer forests; abundant wildlife
Kootenay (British Columbia)	543 (347,500)	1920	Rocky mountain scenery and wildlife; hot springs
Mount Revelstoke (British Columbia)	100 (64,000)	1914	Rolling alpine plateau 6,000 ft. in elevation, snowfields, glaciers
Point Pelee (Ontario)	6 (3,800)	1918	Peninsula in Lake Erie, noted as sanctuary for birds
Prince Albert (Saskatchewan)	1,496 (957,400)	1927	Conifer and deciduous forest, lakeland with excellent canoeing; migratory waterfowl and other wildlife
Prince Edward Island	7 (4,500)	1937	25 mi. of forested coastline on Gulf of St. Lawrence, with beaches and bays; many kinds of small mammals
Riding Mountain (Manitoba)	1,148 (734,700)	1929	Forested plateau rising 1,000 ft. above the plains; many glacial lakes; abundant wildlife
St. Lawrence Islands (Ontario)	0.4 (260)	1914	Protects a mainland area and 12 of the Thousand Islands in the St. Lawrence river
Terra Nova (Newfoundland)	153 (97,920)	1957	Forests, barrens and rocky hills rising from sheltered sounds indenting Atlantic coast
National Parks (Cont.)			
Waterton Lakes (Alberta)	203 (129,900)	1895	Canadian portion of Waterton-Glacier International Peace park. Rocky mountain ecology, noted for lakes, wild flowers and animals
Wood Buffalo (Alberta Northwest Territories)	17,300 (11,072,000)	1922	Protects only remaining herd of wood buffalo in its natural state and related plains buffalo, the total herd numbering 12,000 to 14,000 animals
Yoho (British Columbia)	507 (324,500)	1886	Glaciers, ice fields, lakes and waterfalls among canyons and peaks, in Rocky mountains
Provincial Parks (partial list)			
Cypress Hills (Alberta)	78 (49,920)	1952	Rare specimens of preglacial plant and insect life
Garibaldi (British Columbia)	966 (618,097)	1927	Pacific coast mainland, with mountain lakes, peaks and glaciers
Hamber (British Columbia)	95 (60,585)	1941	Northern wilderness conifer forest, adjoining Jasper and Banff National parks, on Big Bend highway
Mt. Assiniboine (British Columbia)	20 (12,850)	1922	Outstanding Rocky mountain scenery, south of Banff
Mt. Robson (British Columbia)	803 (513,920)	1913	Rocky mountain peaks, lakes and glaciers
Strathcona (British Columbia)	829 (530,319)	1911	Peaks, glaciers, alpine meadows and Della falls, in centre of Vancouver Island
Tweedsmuir (British Columbia)	3,788 (2,424,400)	1938	Vast mountain wilderness area, with abundant wildlife
Algonquin (Ontario)	2,910 (1,862,144)	1893	Wilderness area and wildlife preserve in northern forests
Quetico (Ontario)	1,795 (1,148,800)	1909	Forested wilderness lakeland, adjoining Boundary Waters canoe area in U.S.
Gaspesian (Quebec)	514 (328,960)	1937	Rugged terrain on Gaspé peninsula, reserved to protect caribou and other wildlife
Laurentide (Quebec)	3,612 (2,312,100)	1895	Park containing many lakes and tumultuous rivers; abundant wildlife
La Verendrye (Quebec)	4,746 (3,038,000)	1939	Wild terrain of forests, lakes and rivers
Lac La Ronge (Saskatchewan)	1,140 (729,600)	1939	Representative northern spruce and poplar forests, with many species of wildlife

native Indian rights, hunting is prohibited, and legislative action is required to alter boundaries.

Six provinces have set aside provincial parks, many as magnificently scenic and as important to wildlife as the national parks. They are administered under regulations promulgated by the respective provincial governments, and hunting is permitted in some of them. Tweedsmuir Provincial park, in British Columbia, is one of the largest wilderness areas (3,456,100 ac.) in North America. The Quetico Provincial park, in Ontario, protects 1,148,800 ac. of forested lakeland adjoining the Boundary Waters canoe area in Minnesota. Canada has reserved dozens of game preserves and wildlife sanctuaries, some of great size. Musk oxen, caribou and other abundant wildlife are safeguarded on about 1,000,000 ac. in the Northwest Territories, Yukon and Alberta. More than 1,200 sq.mi. of crown lands comprise bird sanctuaries under the Canadian wildlife service, and the provinces and local governments have reserved many other refuges. Until well into the 20th century much of Canada was remote wilderness, but the accelerated expansion of industrial exploration and development throughout the country, especially after World War II, increased the importance of these reservations in ensuring the survival of Canada's extraordinary wildlife populations.

III. AFRICA

Popular imagination envisions Africa as a continent still teeming with millions of wild animals roaming freely over velds, forests and jungles. Actually the habitat has been so restricted by human settlement and economic development and so many species of larger mammals have been hunted so ruthlessly that in many countries wildlife persists in significant numbers only where national parks and reserves have been established.

Even in the areas where the natural environment is preserved and the animals are protected, poaching by natives for meat and ivory endangers the wildlife populations. Parks and reserves are further threatened by pressures from native tribes to permit use of grasslands in national parks for cattle, frequently a symbol of wealth and prestige rather than a source of food, which have destroyed verdant pastures over wide ranges.

During the latter part of the 19th century the preservation of Africa's wildlife began to be a matter of concern, and various steps were taken in that direction (*see* WILDLIFE CONSERVATION: *International Co-operation*). The rise of independent native governments after World War II threatened to reverse these gains because of indifference and inexperience on the part of the new governments and the attitude of many native peoples that all land must be devoted to producing economic commodities to raise the standard of living for their increasing populations. Many tribes consider wildlife only a competitive nuisance, and poaching is both widespread and increasing.

Most of the new nations have retained the parks and reserves their predecessors established and are endeavouring to provide administrative machinery to handle them. The future of these areas and their natural resources depends on how effectively sound policies are applied. Various conferences, such as the one at the Northern Region, Tanganyika, in Sept. 1961, under the sponsorship of the Commission for Technical Cooperation in Africa South of the Sahara (CCTA) and the International Union for Conservation of Nature were held to analyze these problems.

By the 1960s there were about 25 African countries with national parks or equivalent reserves, protecting more than 265,000 sq.mi. Kruger National park, in Transvaal, Republic of South Africa, covers 8,000 sq.mi. and presents one of the most extraordinary exhibits on earth of wild animals. From their cars, visitors can watch lions, elephants, giraffes, hippopotamuses, many kinds of antelopes and other creatures living their natural lives. Established in 1898 in response to Pres. Paul Kruger's warning that African wildlife would be exterminated unless protected, the park was enlarged in 1926 and is administered by a National Park Board of Trustees with official and civilian members. This board also supervises four other national parks, of which the Kalahari Gemsbok National park, in Cape Province and Botswana, created in 1931, is a unique sanctuary for oryx, springbok, red hartebeest, kudus, elands, ostriches and many other animals of the arid desert. The few remaining Bushmen (*q.v.*) also are found there. Other parks in South Africa are administered by similar but provincial boards.

Three national parks in Cape Province are notable for rare species protected in them. Addo National park preserves the last Addo elephants; Swellendam National park safeguards a remnant herd of bontebok antelopes; the Mountain Zebra National park has ensured the survival of that race of zebras. The Umfolozi reserve in Natal has a population of about 300 rare southern white (or square-lipped) rhinoceroses (1959), as well as black rhinoceroses. The Orange Free State has a number of game reserves, of which the Somerville Game reserve (26,000 ac.) is the most important. There are also many other reserves in South Africa where hunting is prohibited or strictly controlled, or where particular botanical, zoological, geological or historical features or specimens are protected.

Outstanding among the reserves of the world are the national parks of the Democratic Republic of the Congo. These were most efficiently protected under the careful policies of the Institut des Parcs Nationaux du Congo Belge, and in spite of the confusion attending establishment of an independent government the new administration continued the protection of these areas to the best of its ability. Albert National park was reserved in 1925, initially to protect the shy mountain gorilla, but by subsequent acts and royal decrees it was enlarged as a reserve dedicated to the protection of all animal life and vegetation and to scientific and ecological exploration and study. This park (part in Rwanda), and three others established later, Kagera National park (Rwanda), Garamba National park and Upemba National park, safeguard a wide variety of natural environment from the snow-clad peaks of the Ruwenzoris to the jungle rain forests of the Congo basin. They are the home of the pygmy people and the habitat of such rare animals as the okapi and bongo, as well as many other species. Scientists from all over the world come to these parks, and their reports on every ecological aspect of the region published by the Institut are invaluable contributions to knowledge of Africa and to its development. Because of the scientific importance of preserving natural conditions unchanged, only certain portions of the Albert National park and of the Kagera National park are open to tourists.

In Rhodesia an official program endeavouring to eliminate the tsetse fly, carrier of the nagana parasite in cattle, by widespread slaughter of the larger wild animals has led to scarcity of most wildlife except in national parks and forest reserves, where animals are protected. The Wankie National park with the adjacent Robin Game sanctuary covers a large area where tourists are encouraged to come between June and November to see great herds of antelope, buffalo, elephant, many species of birds and other animals. Victoria Falls National park to the north preserves one of the most famous scenic features in Africa.

Zambia established Kafue National park in 1950 in the basin of the Kafue river; it is a reserve larger than Kruger National park. Native tribes, occupying 5% of the park, retain certain rights, but passage through the reserve is restricted to determined routes. The park is open to tourists and supports a wealth of wildlife. Zambia also possesses game reserves and "controlled areas" where the number of animals allowed to be killed by nonresidents is regulated according to the population of those animals; there are also reserves for fish protection, forest reserves and others where careful policies of protection are enforced. Some of these contain famous waterfalls, caves and other scenic and archaeological features.

In northern Tanzania eastward from Lake Victoria as far as the conservation area stretches the Serengeti National park, which preserves the finest assembly of plains animals in Africa. During the dry season the animals roam the comparatively well-watered western section of the park which the tsetse fly makes uninhabitable to man and livestock. The park contains the best extensive grassland range of central Africa, undamaged by the light grazing of the native animals. In the wet season, the wildlife migrates into the eastern area of the park and even farther eastward into the conservation area, where it comes into contact with thousands

TABLE IV.—*Principal Parks and Reserves in Africa*

Name and location	Total gross area in sq.mi. (approx acreage in parens.)	Date established	Principal features
ALGERIA			
Djurdjura	64 (40,900)	1935	High terrain of Djurdjura; conifer and cedar forests; monkey, boar, jackal, wildcat; raptores and other birds; reptiles and other wildlife
ANGOLA			
National Parks			
Cameia	3,861 (2,471,000)	1957	In the Haute-Cuenene; gnu and antelope
Bikuar	3,135 (2,006,400)	1964	Eland and antelope
Iôna	6,148 (3,934,700)	1937	Hartmann's zebra, rhinoceros, cheetah, other wildlife
Mupa	2,548 (1,630,700)	1964	Black rhinoceros, elephants, zebras, antelope
Quiçâma	3,846 (2,461,400)	1957	Abundant mammals and birds, especially elands and elephants
Reserves			
Cangandala	232 (148,480)	1963	Varied flora; rivers; giant sable antelopes
Luando	3,197 (2,046,100)	1938	Abundant wildlife, especially giant sable antelopes and elands
Milando	4,680 (2,995,200)	1951	Antelope, hippopotamus, lion and leopard
Moçâmedes	3,475 (2,224,000)	1957	Black rhinoceros, Hartmann's zebra, Burchell's gazelle, oryx, leopard, other wildlife
BOTSWANA			
Chobe Game reserve	4,500 (2,880,000)	1959	Elephants, sable antelopes, elands, kudus, ostriches, zebras, impalas, giraffes, hippopotamuses, lions, leopards, rhinoceroses, variety of birds
Kalahari Gemsbok National park	4,300 (2,752,000)	1931	Shares reserve with South Africa; acacia trees and desert shrubs; lions, elands, red hartebeests
Moremi Wildlife reserve	700 (448,000)	1961	All major species of Central African wildlife
CAMEROON			
Waza Game reserve	656 (420,100)	1934	Sudanese plains, wooded on the west; giraffe, antelope, aquatic and marsh birds
Bouba-Djida Nature reserve	849 (543,620)	1947	Wooded plains; rhinoceros, giant eland and others
Faro Nature reserve	1,270 (815,450)	1947	Uninhabited plains; rhinoceros, giant eland and other animals
Campo Kribi Game reserve	1,200 (768,000)	1932	Dense equatorial forest and swamp, completely uninhabited
Dja Game reserve	1,930 (1,235,530)	1950	Equatorial forest inhabited by diverse wildlife
Bafia reserve	162 (103,784)	1949	Buffaloes, hippopotamuses, monkeys, wild boars
Douala-Edéa reserve	618 (395,367)	1932	Elephants, monkeys, guibs, chevrotains, hippopotamuses
Bénoué reserve	695 (444,790)	1947	Elephants, buffaloes, rhinoceroses, elands, antelopes, lions, waterbucks
CENTRAL AFRICAN REPUBLIC			
André Félix National park	656 (419,840)	1959	Grassland with marshy savanna during rainy season; antelopes, buffaloes, giraffes, elephants, lions, ostriches
Bamingui-Bangoran National park	3,906 (2,500,000)	1933	Broad peneplain with great granitic-gneissic outcrops; lagoons important for protection and reproduction of black rhinoceros
Nana Barya reserve	849 (543,360)	1953	Wooded and herbaceous grasslands; elephants, buffaloes, giant elands, rhinoceroses
Ouandjia-Vakaga reserve	3,770 (2,412,500)	1940	Upper basin of Chari river; antelopes, buffaloes, giraffes, elephants, lions, ostriches
Saint-Floris National park	386 (247,000)	1933	Forested sudanese grassland; elephants, lions, giraffes
Zemongo reserve	3,633 (2,325,000)	1940	Hilly wooded grasslands broken by gallery forests; special protection for elephants and rhinoceroses
CHAD			
Manda National park	417 (266,760)	1965	Elephants, hippopotamuses, buffaloes, kudus, giraffes, elands, gazelles, hyenas, lions, birds
CHAD (*Cont.*)			
Zakouma National park	1,145 (732,684)	1963	Meandering rivers; rhinoceroses, elephants, elands, lions, panthers, lynxes, birds, crocodiles, snakes
Bahr Salamat reserve	7,950 (5,088,200)	1964	Plains flooded during rainy season, elephants, hippopotamuses, giraffes, antelopes, kudus, gazelles, panthers, birds
Dougia reserve	299 (146,718)	1961	Elephants, gazelles, antelopes, lions, aardvarks, birds
Siniaka Minia reserve	1,644 (1,052,220)	1961	Kudus, elands, hyenas, birds, giraffes, lions
REPUBLIC OF CONGO			
Odzala National park	424 (271,400)	1940	Almost inaccessible area in western Congo; abundant forest wildlife, including elephant, bongo antelope, anthropoid apes; pygmies
DEMOCRATIC REPUBLIC OF THE CONGO			
Albert National park	3,160 (2,022,400)	1929; 1934	A world-famous national park on the Uganda and Rep. of Rwanda border; equatorial jungles, Ruwenzori mountains (Mountains of the Moon) and Virunga volcanoes with cloud forests, giant lobelias and heather; most of Lake Edward; great variety of wildlife, including mountain gorilla, elephant, thousands of hippopotamuses; pygmies
Garamba National park	1,900 (1,216,000)	1938	Grass and wooded savannas on ancient peneplain, on northern border; abundant wildlife, including white rhinoceros, giraffe, elephant, hippopotamus and other plains species
Upemba National park	4,529 (2,932,300)	1939	Vast plains, with deep river valleys rising to forested Kibara plateaus, in central Katanga; varied animal life, including eland, klipspringer and other antelope, many elephants and buffalo, lion and other mammals, aquatic birds
DAHOMEY			
De la Boucle de la Pendjari National park	1,064 (680,775)	1954	Savanna grasses and prairies; buffaloes, lions, antelopes, wild boars, some elephants
W du Niger National park	1,940 (1,241,704)	1952	Many elephants, lions, wild boars, hippopotamuses
ETHIOPIA			
Managasha National park	12 (7,500)	1958	On mountain range west of Addis Ababa; experimental forestry practiced; most beautiful sections maintained in primeval state; wildlife strictly protected
FRENCH SOMALILAND			
Mt Goudah reserve	38 (24,320)	1939	Mt. Goudah and surrounding primitive forests of junipers (*Juniperus procera*), firs, *Medenia* palm, dai
GHANA			
Mole River Game reserve	900 (576,000)	1962	Owned by the Gonja people, managed for complete protection of wildlife; savanna forest
GUINEA			
Monts Nimba Nature reserve	56 (35,831)	1944	On boundary of Ivory Coast and Guinea; rich tropical forests; varied wildlife, chimpanzees; important region for ecological study; more than 200 species of endemic plants
IVORY COAST			
Banco National park	12 (7,500)	1935	Dense ancient forest and forestry school
Bouna Game reserve	3,861 (2,471,100)	1958	Peneplain grasslands and dry woodlands; most large west African antelopes, carnivores, monkeys, etc.
Tai Game reserve	1,641 (1,050,200)	1926	Little-explored plains, with abundant wildlife
Elephant Plain reserve	76.5 (49,000)	1958	Protection of elephants
Monts Nimba Nature reserve	19 (12,350)	1944	Rich tropical forests; varied wildlife, chimpanzees; 200 species of endemic plants

TABLE IV.—*Principal Parks and Reserves in Africa (Continued)*

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
KENYA			
National Parks			
Aberdare	228 (145,900)	1950	Higher elevations of Aberdare range, with lakes, dense forests, bamboo and moorland, alpine meadows; abundant populations of elephant, buffalo, rhinoceros and other wildlife, including rare bongo antelope
Lake Nakuru	18 (11,520)	1961	In the floor of the Rift valley; flamingos (between 1 and 2 million); 380 different species of birds
Mount Kenya	227 (145,300)	1949	Elevations above 11,000 ft. surrounding Mt. Kenya (17,058 ft.), with glaciers, tarns and moraines; heavily forested, alpine meadows; many birds and smaller mammals but no larger animals
Nairobi	44 (28,200)	1948	Open plains and acacia savanna, deep river valleys, near Nairobi; Ngong reserve contiguous; famous place to see lion, cheetah, leopard, rhinoceros, giraffe
Tsavo	8,034 (5,141,800)	1948	Semiarid plains, with dense brush and two principal rivers, lava cones, the Mzimi springs; baobab, acacia, euphorbia; elephant, rhinoceros, hippopotamus, lion, many species of antelope; divided into Tsavo East and Tsavo West
African District Council Reserves			
Masai Amboseli Game reserve	1,259 (805,800)	1948	Open level terrain at about 4,000 ft., north of Mt. Kilimanjaro; arid, interspersed with swamps and springs, belts of acacia forest; dry salt bed of Lake Amboseli; native trust land of Masai tribe; outstanding exhibit of most east African mammals and birds; competition with cattle being reduced by providing artificial water supplies; transferred to the African District council in 1961
Masai Mara Game reserve	700 (448,000)	1948	Open rolling plains with thickets and riverine vegetation; abundant wildlife, including most east African mammals; part of Masai land unit, transferred to the African District council in 1961
Meru Game reserve	600 (384,000)	1959	Foothills of Nyambeni hills to Tana river; grassland, rain forest and riverine forest; abundant variety of wildlife, *Oryx beisa*, reticulated giraffe, Grévy's zebra
Samburu Game reserve	44 (28,200)	1960	3,000 ft. elevation; semidesert scrub, abundant bird life; great variety of antelope; elephant, buffalo, leopard, reticulated giraffe, Grévy's zebra
LIBERIA			
Mt. Wutini reserve	23 (15,000)		Rolling ground to rugged terrain; wildlife refuge
MALAGASY REPUBLIC			
Ambre Mountain National park	71 (45,500)	1958	Volcano with smaller craters and lakes; dense deciduous moss forest; lemurs
Isalo National park	314 (201,400)		Runiform massif, limestone outcrops, lemurs, rare birds
11 nature reserves	1,639 (1,482,000)	1927–1952	Protects birds and small mammals, especially lemurs; forests with orchids and lepidoptera
MALAWI			
National Park			
Nyika Plateau	325 (208,000)	1965	High mountain grassland with evergreen forest relics at 7,000 to 8,000 ft.; eland, zebra, hartebeest, reedbuck, lion and leopard
Game Reserves			
Kasungu	800 (512,000)	1956	Open grassland and grassy woodland; lion, zebra, oribi, klipspringer, elephant, black rhinoceros, buffalo, eland, leopard, hartebeest
MALAWI (*Cont.*)			
Game Reserves (Cont.)			
Lengwe	45 (28,800)	1960	Dry woodland with open grassland, large areas of dense thorn thicket; Nyala antelope, bush buck, buffalo, impala, other wildlife
Majete	70 (44,800)	1960	Leopard, lion, zebra, klipspringer, elephant, eland, other wildlife
Mwabri	60 (38,400)	1954	Dry woodland with grassy water courses; leopard, lion, hartebeest, black rhinoceros, other wildlife
Nkhota-Kota	680 (435,200)	1954	Lion, zebra, black rhinoceros, klipspringer, other wildlife
MALI			
Boucle du Baoulé National park	2,977 (1,905,182)	1954	Baoulé river basin, with sudanese savanna and forests; elephant, giant eland, sable antelope and other wildlife; total area includes 3 reserves attached to park
MAURITIUS			
Bel Ombre National reserve	3.5 (2,271)	1951	Intermediate montane climax forest, with ebony
Macabe-Mare Longue reserve	2.5 (1,253)	1951	Upland climax high forest on lateritic soils
MOROCCO			
Tazekka National park	2.3 (1,450)	1950	Jebel Tazekka (1,979 m. [6,493 ft.]) in Middle Atlas range; high rainfall produces forest cover, including Atlantic cedar; wildlife
Toubkal National park	141 (90,000)	1942	High Atlas mountains, peaks rising to 4,185 m (13,730 ft); desert, with juniper and oak forests at higher altitudes; endemic plants; mouflon, mountain gazelle, endemic lake trout
MOZAMBIQUE			
Gorongosa National park	2,135 (136,600)	1935; 1960	Elephant, buffalo, kudu, eland, zebra, rhinoceros, hippopotamus, other abundant wildlife
Niassa Game reserve	5,792 (370,700)	1960	Protection of all animals
Maputo Game reserve	290 (18,600)	1960	Protection of elephants
Marromeu Game reserve	579 (51,900)	1960	Protection of buffalo
NIGERIA			
8 game reserves	5,348 (3,422,500)		Regulated hunting; giraffe, elephant, waterbuck, kob and other wildlife, there are also several smaller animal life sanctuaries
RHODESIA			
Robert McIlwaine National park	20 (12,800)	1952	Bushmen's paintings; lake
Matopos National park	153 (98,000)	1953	Granite *kopjes* and Bushmen's cave paintings; sable and other antelope
Rhodes Inyanga National park	133 (85,100)	1950	Mountainous country; exotic and indigenous forests; wildlife
Victoria Falls National park	205 (131,200)	1952	Victoria falls, 355 ft. high, 5,580 ft long, in Zambezi valley; rain forest; elephant, sable, roan and other antelopes; lion; many other species
Wankie National park	5,128 (3,281,900)	1950	Gemsbok, 2,000 elephants, buffalo, wildebeest, sable antelope, impala, roan antelope, kudu, lion and other wildlife
Kyle Dam Game reserve	35 (22,400)	1964	One of the largest reedbuck populations in southern Africa; hippopotamuses, buffaloes, elands, white rhinoceroses
RWANDA			
Kagera National park	970 (627,500)	1934	Verdant basin of Kagera river on Democratic Rep of the Congo border; varied animal life, with zebra, antelope and marsh birds predominating
SENEGAL			
Niokolo-Koba National park	965 (617,800)	1951	Limit of the northern sudan savanna; elephant, giant eland, antelope, carnivores, hippopotamus, civets, birds

TABLE IV.—*Principal Parks and Reserves in Africa (Continued)*

Name and location	Total gross area in sq mi. (approx. acreage in parens)	Date established	Principal features
SEYCHELLES			
Aldabra Islands Nature reserve	60 (38,400)	1955	Complete protection of giant tortoise and, on South Island, of all animals
Vallee de Mai reserve (Praslin Island)	0.07 (46)	1946	Protects *Coco de mer* palm and native birds
REPUBLIC OF SOUTH AFRICA			
National Parks			
Addo Elephant (Cape Province)	26.5 (16,900)	1931	Southern tip of province; impenetrable bush, habitat for 35 rare Addo elephants and scarce Cape buffalo; 11 species of extirpated antelope reintroduced, abundance of other mammals, birds and reptiles
Golden Gate Highlands (Orange Free State)	16.9 (10,800)	1963	Highlands park inhabited by eland, black wildebeest, springbok, red hartebeest
Kalahari Gemsbok National park	3,730 sq mi (2,387,200) in Cape province, 4,300 sq mi (2,752,000) in Botswana	1931	Bright red Kalahari sandveld, 5 in of rainfall annually, acacia trees and desert shrubs and grasses, Kalahari lion and other endemic species, especially gemsbok, springbok, eland, red hartebeest
Kruger (Transvaal province)	8,000 (5,120,000)	1898; 1926	World famous wildlife sanctuary, mostly open veld, other parts dense brush and open forests; most species of South African animal life
Mountain Zebra (Cape Province)	25.5 (16,300)	1937	Karroo mountain region, established especially to protect the very rare mountain zebra; other indigenous animals reintroduced, open to public
Royal Natal (Natal province)	32 (20,500)	1916	High scenery of Drakensberg mountains; gray rhebok, mountain reedbuck, other wildlife; Bushmen's paintings
Swellendam (Cape Province)	10.7 (6,800)	1931	Open river basin, habitat for 450 bontebok antelope, gray rhebok, gray duiker, steinbok, eland, red hartebeest
Nature Reserves			
Cape of Good Hope (Cape Province)	27 (17,300)	1939	On tip of Cape of Good Hope; rare vegetation, including blue *Disa* orchid, mimetes heath, Vaal rhebok, grysbok, etc.
Game Reserves			
Natal province			
Giant's Castle	92 (59,000)	1903; 1952	Open rugged grassland, peaks of Quathlamba Drakensberg range and headwaters of Mooi and Bushman's rivers, highland antelope, many leopard
Hluhluwe	89 (57,000)	1951	Almost every species of wildlife in Zululand, including white rhinoceros, black rhinoceros, impala, kudu, etc.
Ndumu	37 (23,700)	1924; 1947	Thorn savanna, *Ficus* riverine forests and a large lake, hippopotamus, crocodile, nyala
Nkuzi	97 (62,000)	1912	Thorn veld and *Ficus* forest; nyala, impala and some black rhinoceros
St. Lucia	190 (121,600)	1897; 1939	St. Lucia lake and estuary on False bay, and coastal scrub and jungle, hippopotamus and many kinds of birds
Umfolozi	112 (72,000)	1897	Rolling thorn veld; sanctuary for white rhinoceros
Orange Free State			
Willem Pretorius	40.6 (26,000)	1956	Open plains, bush and *kloofs* and Doornberg range; plains species of wildlife
Transvaal province			
Barberspan	14 (8,940)	1954	Ornithological research station on Lake Barberspan, thousands of waterfowl, flamingo, pelican and other birds
Loskop dam	41 (26,200)	1940	Protects wildlife on four farms bordering Loskop reservoir; cycads, including *Encephalartos*
SOUTHWEST AFRICA			
Etosha Game park	26,000 (16,640,000)	1928	Desert region from ocean to plains contiguous with Moçâmedes reserve in Angola; herds of elephants, springbok, zebras and blue wildebeest
SUDAN			
Boma reserve	533 (341,120)	1960	Boma mountain, Rub river, white-eared waterbucks, zebras, gazelles, hartebeests, giraffes, roan antelopes
Dindir National park	2,470 (1,580,800)	1939	Open savanna bush well suited to hoofed animals, especially roan antelope, kudu, giraffe, hartebeest, reedbuck, buffalo
Fangak Island reserve	50 (32,000)	1935	Primarily protects lechwes; swampy island with papyrus
Nimule National park	100 (64,000)	1954	Plateau, sparse timbered trees and scattered bush, main species is white rhinoceros; also elephant, buffalo, hippopotamus, waterbuck, hartebeest
Southern National park	6,500 (4,160,000)	1939	Dense and open forests and plains, especially giant eland, white rhinoceros, elephant, buffalo, giraffe, variety of smaller mammals
Juba reserve	120 (76,800)	1939	Rich green valleys, white rhinoceroses, elephants, buffaloes, hartebeests, oribis, duikers, waterbucks
Bengangai (Bongo) reserve	600 (384,000)	1939	Giant equatorial trees, dense thickets, natural habitat of bongo, also elephant, buffalo, giant forest hog, colobus monkey
Shambe reserve	400 (256,000)	1939	Primarily protects Nile lechwes; low marshy land surrounded by high savannas; white rhinoceroses, waterbucks, lions, leopards, giraffes, roan antelopes
Numotina reserve	1,000 (640,000)	1939	A semiupland with thick forest, rich vegetation and an abundance of water; elephant, buffalo, waterbuck, bushbuck, hartebeest
Soboloka reserve	450 (288,000)	1939	Primarily protects Barbary sheep and ibexes, on western bank of the Nile
Zerraffe reserve	2,700 (1,728,000)	1939	Island bounded by the White Nile and Zerraffe rivers, lowland with swamps on edges; especially protects the Nile lechwe; sitatunga, elephant, hippopotamus, buffalo
SWAZILAND			
Mlilwane Game sanctuary	1.7 (1,100)	1964	Giraffes, hippopotamuses, white rhinoceroses, kudus, nyalas, ostriches, crocodiles, white-tailed gnus, birds
TANZANIA			
National Parks			
Lake Manyara	123 (78,700)	1957; 1960	Five distinct vegetation zones; buffalo, elephant, lion, leopard, rhinoceros, many water birds, especially flamingo. Area lies between escarpment of rift wall and Lake Manyara
Mikumi	650 (416,000)	1964	Lies in a horseshoe of hills, variety of wildlife, good for viewing lion, elephant, buffalo, hyena, impala, giraffe, wart hog, hippopotamus, zebra, and wildebeest, many other species
Ngurdoto Crater	25 (16,000)	1960; 1962	Crater surrounded by rain forest; string of fresh water Momela lakes; from crater rim can be viewed buffalo, elephant, rhinoceros, giraffe, waterbuck, wart hog, and baboons on crater floor
Ruaha	5,000 (3,200,000)	1964	Along banks of the Great Ruaha river; fine elephant country; greater kudu, zebra, lion, waterbuck, ostrich, others
Serengeti	5,600 (3,584,000)	1929; 1951, 1959	Treeless plains, savanna type stretches, riverine bush, thick forest; chiefly famous for lions, more than 35 species of plains game, abundant bird life, more than 1 million animals, of which 300,000 are wildebeest

TABLE IV.—*Principal Parks and Reserves in Africa (Continued)*

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
TANZANIA (*Cont.*)			
Game Reserves			
Biharamulo	450 (288,000)	1959	Wooded rolling plains on shore of Lake Victoria, northern limit of range of sable antelope; Lichtenstein's hartebeest, and Sharp's steinbok
Gombe Stream	61 (39,000)	1943	Shore of Lake Tanganyika; mountain country, with woodland and gallery forest, and mountain meadows; chimpanzee, red colobus monkey
Katavi Plain	650 (416,000)	1951	Woodland, thornbush, plains and lakes; many buffalo, hippopotamuses, elephants, lion
Kilimanjaro	720 (460,800)	Before 1914; 1951	Summit of Mt. Kilimanjaro between 6,000 ft. at forest line to 19,340 ft., with rain forest, moorland, tundra and ice fields; animal life includes Harvey's and Abbott's duikers, elephant, buffalo, leopard, eland, colobus and blue monkeys, and other wildlife
Mkomazi	1,350 (864,000)	1951	Very arid hilly area; semidesert vegetation and animal life, including lesser kudu, oryx, gerenuk, rhinoceros, elephant and larger carnivora
Mt. Meru	99 (63,400)	Before 1914; 1951	Upper slopes of volcanic Mt. Meru from 5,500 to 14,979 ft., with rain forest, bamboo, cedar and heath; colobus monkey, giant forest hog, rhinoceros, elephant
Rungwa River	7,822 (5,006,100)	1951	Rolling wooded plains, with rocky ridges; sable and roan antelopes, greater kudu, elephant, buffalo
Selous	11,512 (7,367,700)	Before 1914; 1951	In Rufiji river basin, with open grasslands, patches of dense hardwood forest; primarily an elephant reserve
Tarangire	525 (336,000)	1957	Acacia thornbush and floodplains; elephant, rhinoceros, wildebeest, impala, Coke's hartebeest, eland, lesser kudu; ecological research station
Ngorongoro Conservation area	4,000 (2,560,000)	1956	Grass plains, thornbush, rain forest and mountain moorland, dominated by vast extinct Ngorongoro crater, rising over 11,000 ft., main gorge and Lake Eyasi branch of Rift valley; rhinoceros, elephant, buffalo, leopard, mountain reedbuck and giant forest hog in higher terrain; plains species lower down
TUNISIA			
Djebel Bou Hedma State park	508 (32,500)	1936	Plateau area in southern Tunisia, with remnant of acacia park land; gazelle mouflon
UGANDA			
Murchison Falls National park	1,504 (962,600)	1952	Includes famed Murchison falls and the Victoria Nile; mostly open grassy plains, large number of crocodiles, hippopotamuses and characteristic plains animals; aquatic birds
Queen Elizabeth National park	764 (489,000)	1952	Includes Kazinga channel joining Lake Edward to Lake George; tropical forests, swamps, grassland and volcanic craters; chimpanzee, elephant, antelope, lion, hippopotamus
UGANDA (*Cont.*)			
Aswa Lolim Game reserve	40 (25,600)	1959	Dry savanna, seasonal habitat of Uganda kob ranging from Murchison Falls National park adjacent
Kigezi Game reserve	200 (128,000)	1952	Grassland and tropical forest; plains and forest animals
Toro Game reserve	202 (129,300)	1946	Savanna and swamps on shore of Lake Albert; variety of wildlife, including elephant, buffalo, lion, hippopotamus
Bugungu Hippopotamus and Elephant sanctuary	183 (117,100)		On southwest boundary of Murchison Falls National park; special protection for hippopotamus and elephant
Debastien Game sanctuary	760 (486,400)	1958	Open plains, with characteristic wildlife
Elephant sanctuary	1,350 (864,000)		On southern boundary of Murchison Falls National park; special protection for elephant
Gorilla sanctuary	17 (10,900)		On Congo border, special protection for gorilla
Mt. Kei and Otze Crown Forest White Rhinoceros sanctuaries	250 (160,000)		Basin of the White Nile river, special protection for the rare white rhinoceros
ZAMBIA			
Kafue National park	8,650 (5,536,000)	1950	Kalahari sand (south), forests, floodplains, grasslands and marshes (north); eland, sable, roan, kudu, lechwe and other antelope, zebra, elephant, hippopotamus, rhinoceros
Isangano Game reserve	325 (208,000)	1957	Woodland and grassy plains, with perennial streams and Bangweulu swamps; only sanctuary for the rare black lechwe; elephant, buffalo, lion, various antelope
Kasanga Game reserve	150 (96,000)	1941	Papyrus swamp, bordered by grassland and woods; many wildlife species, including rare sitatunga and shoebill stork
Lavushi Manda Game reserve	580 (371,200)	1941	Wooded plateau and rocky hills; varied wildlife
Luangwa Valley Game reserve	5,000 (3,193,600)	1942	Flat valley of Luangwa river, with lower foothills; acacia woodlands, lagoons in river plain flood in rainy season; abundant and varied animal life, including elephant, rhinoceros, Thornicroft's giraffe
Lukusuzi Game reserve	1,050 (672,000)	1942	Wooded escarpments and plateaus; breeding ground for elephants; other animals
Lunga Game reserve	650 (416,000)	1951	Low forests and small grass plains; varied wildlife
Lusenga Plain Game reserve	340 (217,600)	1942	Woodlands and plains along Kalungwishi river; varied wildlife
Mweru Marsh Game reserve	1,210 (774,400)	1942	Papyrus and Phragmites marsh, merging into dry plains and woodlands; animal life abundant, including elephant, sitatunga, some black rhinoceros; myriad wading birds on mud flats in dry season
Sumbu Game reserve	780 (499,200)	1942	On southern shore of Lake Tanganyika, with river deltas, rocky ridges, woodland and small grass plains; many animals, especially elephant and blue duiker
Lochinvar ranch (private game reserve)			A large area, especially important to perpetuation of the red lechwe

of cattle herded by nomad Masai tribesmen. These cattle, sometimes diseased, usually undernourished and of little economic value, threaten to overgraze and destroy the range. In the mid-1950s, demands from the Masai, some of whom consider wild animals a competitive nuisance, threatened to cause drastic reduction of the national park with consequent destruction of the wildlife and its habitat. In 1956 the world-famous botanist and ecologist W. H. Pearsall studied the problem and recommended drastic changes in the government's plans. For the most part these changes were put into effect. In addition to the Serengeti and other national parks, Tanzania possesses game reserves where hunting is prohibited and other reserves where certain species are protected and where hunting is regulated.

Similar problems exist in Kenya and elsewhere in east Africa. The game department, the Royal National parks of Kenya and the Kenya Wild Life society have experimented with the concept of encouraging native participation in the benefits derived from national parks and reserves with a success that indicates this approach is feasible. Poaching, for biltong (meat), ivory and rhinoceros horn, is a serious threat to protected animals. Between 1946 and 1960 six national parks and six national reserves were established in Kenya. In 1961, three of the national reserves were transferred to African district councils under careful agreements in recognition of the growing interest of the native people in wild-

life preservation. Nairobi National park is close to the principal city and is famous as a placè where visitors can see lions at close range, giraffes, Thomson's and other gazelles, and a host of other mammals and birds beside the roads. It is too small to provide sufficient range for its wildlife, and herds of zebras and antelopes sometimes roam out of the park onto nearby farms, followed by lions which may commit depredations on livestock. Were it not for the supplementary habitat provided by the Ngong reserve nearby, the wild populations would find it difficult to perpetuate themselves. Tsavo National park to the south contains 8,034 sq.mi. of thorn scrub considered useless for human development but abounding with much wildlife. In its Mzimi pools hippopotamuses have lived for generations and may be observed swimming with escorts of fish in the crystal-clear water. A proposal to utilize these pools for a reclamation project was defeated by Mervyn Cowie, director of the Royal National park system in Kenya, and other conservationists. The Mount Kenya and Aberdare National parks were temporarily closed to the public because of the Mau Mau uprisings. The Marsabit reserve is one of the most beautiful regions of Africa and protects many species, some not found in the southern part of the country. There are also other reserves that support large wildlife populations. Three small national parks are historical and archaeological sites.

Murchison Falls National park, established in 1952 in Uganda, protects one of the famous waterfalls in Africa and is the habitat of many crocodiles, hippopotamuses, elephants, lions, leopards, antelopes and other species. Queen Elizabeth National park was also established in 1952 between lakes Edward and George. The view of the Ruwenzoris and other mountains across the lakes attracts many visitors, and the park itself is noted for its volcanic craters. Among other forms of wildlife there, this park supports a considerable population of chimpanzees. Its thousands of hippopotamuses have so greatly increased under protection that they are creating an overgrazing problem near the two lakes and the Kazinga channel which connects them. The solution to this problem seems to lie in the hippopotamus-cropping program now in operation. Uganda also has special reserves for the rare northern white rhinoceros and for gorillas and the large elephant sanctuary.

Equatorial Africa has suffered loss of animal life and vegetal cover, but the French authorities there were interested in preserving the most outstanding scenic areas and wildlife populations. The governments that replaced French administration endeavoured to continue this protection, although the change in political status caused some uncertainty about the future of the reserves. A number of nature reserves were established, of which the Vassako-Bulo reserve (375,000 ac.) protects wooded plains and arid forests in the Central African Republic. Adjacent to this reserve, and bounded also by three others, is the Parc National du Baminui-Bandoran (2,500,000 ac.); it has been suggested these areas be combined into a single national park. The Parc National Saint-Floris (40,000 ac.) is the sole habitat of the heronlike shoebill (*Balaeniceps rex*) in the Central African Republic. The Odzala National park in the Republic of Congo and the Parc Nationale de l'Okanda (475,000 ac. in Gabon) have been reserved in relatively unexplored regions. Most of these reservations are patrolled only by local inhabitants.

In Cameroon the Waza Game reserve protects rich animal life of plains species and thousands of aquatic birds. A 1,000-ac. isolated mountain forest was set aside in 1948 as the Monts Bamboutos reserve, and extensive areas are devoted to zoological reserves, game reserves and protected forest reserves where wildlife is safeguarded.

The Guinea Monts Nimba reserve (48,186 ac.), on the border between the Ivory Coast and Guinea, supports varied forest animal life, notably chimpanzees, and an abundance of epiphytic plants..

A large population of mammals and birds is protected in the Niokolo-Koba National park (617,800 ac.) in Senegal. The Parc National du "W" in Niger and a complex of contiguous reserves in Upper Volta and Dahomey, totaling 3,120,500 ac., protect many west African animals. The Banco National park (7,500 ac.) in the Ivory Coast contains a dense relict forest. In Mali, the Boucle du Baoulé National park is a mountainous, scenic forested area with abundant wildlife, bordered by large game reserves.

The extraordinary and unique animal life and vegetation of the island of Madagascar have been decimated over seven-tenths of the country by exploitation, but between 1927 and 1960 six nature reserves were established under the guardianship of the Musée National d'Histoire Naturelle in Paris. Under a decree of 1952, four similar reserves were created to protect especially dugongs, all species of lemurs, egrets and the endemic vegetation. In 1956 Jean-Jacques and Arlette Petter undertook an ecological study of the lemurs on the island, under the sponsorship of the Musée, the Institut de Recherche Scientifique de Madagascar, the Conseil National pour la Recherche Scientifique en France and the International Union for Conservation of Nature; this study added greatly to scientific knowledge and led to recommendations for additional reserves.

In Angola elands have increased markedly in the Quiçâma National park (2,461,440 ac.), as have other species. The beautiful rare giant sable antelope is especially protected with other wildlife in the Luando reserve. Black rhinoceros (150–200 in 1960) and Hartmann's zebras are abundant in the Moçâmedes reserve and inhabit others. The largest elephants in the world are found in Angola, and sizable herds are safeguarded in several of the reserves.

In the Somali Republic national parks and nature reserves have been established for the protection of animal life and vegetation, and laws have been enacted to ensure the survival of certain endangered species and to regulate hunting of others. Zoological and game reserves have also been established.

The two national parks in Morocco, the Toubkal National park and the Tazekka National park, are bordered by game reserves where hunting is regulated on a rotation basis. The land is arid but supports some protected forests.

National parks in Algeria are administered under strict policies to ensure perpetuation of natural ecological conditions. Visitors may see the varied wildlife of North Africa, including apes, foxes, several species of cats, reptiles and birds. The animals of this region were depleted by the ancient Romans to provide for their circuses. Tunisia has reserved two areas of interest to tourists, the Parc forestier d'Ain-Draham and the Forêt domaniale du Bou Kornine.

IV. ASIA

Although interest in national parks came later in Asia than in Africa, several countries have well-developed park systems. In Japan, for example, in spite of the large human population and need for agricultural and other economic exploitation of land, 7% of the total land area has been set aside as parks. Inspired by visits to the national parks of the United States in 1923 and 1924, Tsuyoshi Tamura influenced the Japanese government to enact a national parks law in 1931. By 1936, although funds were limited, 11 national parks had been established. After the close of World War II came recognition that the natural beauty of Japan represented one of its richest natural resources. New parks were created and their development for tourists and the enjoyment of the Japanese people was stimulated. In addition, quasi-national parks, administered by the prefectures, were established.

The Japanese visit their parks in great numbers. The parks also protect many religious shrines and temples, the most notable being the Grand Shrine of Ise in Ise–Shima National park. Fujiyama, in Fuji–Hakone–Izu National park, is among the most nearly perfect volcanic cones in the world; it is revered by the Japanese and is a major attraction for foreign tourists.

Japan possesses more crater lakes, or caldera, than any other country, and some of the largest in the world are in the national parks, those in Aso, Akan and Towada–Hachimantai being especially magnificent. The Japanese Alps are noted for gorges and waterfalls, for virgin forests and unusual wildlife. Equal in beauty are the rocky headlands and serene islands of the ocean coasts and borders of the Inland sea, with their forests and beaches and rocky islets inhabited by myriad nesting sea birds.

Any of the national parks may be visited from centres of popu-

TABLE V.—*Principal Parks and Reserves in Asia*

Name and location	Total gross area in sq mi. (approx. acreage in parens.)	Date established	Principal features
BURMA			
Nature Reserves (by Forest division)			
Kahilu (Thaton)	62 (39,700)	1928	Sumatran rhinoceros, serow, sambar, muntjac, barking deer, hog deer, musk deer; jungle birds
Kyatthin (Shwebo)	104 (66,600)	1941	Forests of Mt. Thaw; gaur, sambar, thamin, muntjac
Maymyo (Maymyo)	49 (31,400)		Barking deer, jungle fowl, partridge, peafowl
Mulayit (Thaungyin)	54 (34,200)	1936	Barking deer, muntjac, pig, tiger, leopard, birds
Pidaung (Myitkyina)	279 (178,400)	1918	East of upper Irrawaddy river; elephant, tiger, gaur and banteng (rare wild cattle), bear, leopard, barking deer, pig, jungle birds
Shwe-u-daung (east Katha and Mongmit)	126 (80,600)	1918	Sumatran rhinoceros, elephant, banteng, serow, sambar, tiger, leopard, jungle birds
Shwezet-taw (Minbu)	213 (136,600)	1940	Gaur, thamin, sambar, muntjac
CAMBODIA			
Angkor National park	41.3 (26,429)	1925	Monuments built by the Khmers, dense forest that partially covers the monuments
Kravanh Game reserve	1,091 (693,280)	1959	Varied wildlife
Koulen Promtep reserve	5,690 (3,641,490)	1960	Oxlike koupreys
Kirirom reserve	315 (201,708)	1962	Varied wildlife
Lomphat reserve	762 (487,777)	1964	Oxlike koupreys
Phnom Prich reserve	757 (484,446)	1960	Grassy plain; dipterocarp forests
CEYLON			
Gal Oya National park	98 (63,000)	1954	Skirts Gal Oya reservoir; evergreen and savanna forests, range of mountains on outer border; elephant, leopard, deer, sloth bear, etc.; remnants of ancient jungle tribe
Yala National park	91 (58,300)	1938	Coast line broken by lagoons; rocky hills rich in ancient ruins; forest and scrub
Hakgala reserve	4.4 (2,820)	1938	Representative collection of high-altitude plants
Wilpattu National park	252 (161,300)	1938	Mainly sandy area, a few rocky outcroppings; wildlife includes elephant, sambar, leopard and many species of birds
Ritigala reserve	5.8 (3,776)	1941	Mountain massif rising to 2,000 ft.; upper slopes support mixed vegetation of wet and dry zones; ancient Buddhist ruins
Wasgomuwa reserve	112 (72,036)	1940	Steep rocky hills
Yala Strict Nature reserve	111 (71,000)	1938	High forests and rocky hills; elephant, deer, leopard and other mammals and birds
INDIA			
National Parks			
Corbett (Uttar Pradesh)	125 (80,000)	1935	Jungle animal life, including elephant, tiger, leopard, sloth bear, several species of deer, sambar, goral, pig, wild dog, crocodile, python, many species of birds
Hazaribagh (Bihar)	150 (96,000)	1955	Tiger, leopard, bear, sambar, barking deer, etc.
Kanha (Madhya Pradesh)	98 (62,500)	1956	Easy view of large herds of hoofed animals, abundant wildlife, including gaur, sambar, axis deer, muntjac, etc.
Shivpuri (Madhya Pradesh)	61 (39,000)		Tiger, leopard, bear, sambar, spotted bull, four-horned antelope, Indian gazelle and varied bird life
Taroba (Maharashtra)	45 (28,800)	1935; 1956	Tiger, leopard, sambar, spotted deer
Wildlife Sanctuaries			
Dachigam (Kashmir)	55 (35,200)		Densely forested Himalayan mountain area north and east of the valley of Kashmir, between 9,000 and 13,000 ft.; primary refuge of the rare Kashmir stag; also musk deer, leopard, black bear, brown bear, boar and other wildlife
INDIA (*Cont.*)			
Wildlife Sanctuaries (*Cont.*)			
Gir (Maharashtra)	527 (337,300)	1900	On Kathiawar peninsula, arid desert with dry mixed deciduous teak forest surrounded by a belt of thorn scrub, intersected by narrow rivers; only remaining habitat of Asiatic lion; also chital, sambar, boar, chinkara, four-horned antelope, nilgai, monkey, leopard
Kaziranga (Assam)	166 (106,200)	1908	Tall elephant grassland bounded on north by Brahmaputra river; principal refuge of great Indian rhinoceros; buffalo, gaur, elephant, tiger, sambar, hog deer, swamp deer, boar, crocodile and bird life
Keibul Lamjao (Manipur)	20 (12,800)	1954	Established to protect only known wild population in India (100 in 1960) of the brow-antlered deer
INDONESIA			
G. Indrapura Nature reserve (West Sumatra)	49 (31,325)	1929	Wildlife; habitat of rare *Anaphalis javanica* plant
Gunung Loser Nature park (North Sumatra)	1,625 (1,040,250)	1934	Habitat of elephant, Sumatran rhinoceros, deer, tiger
Lautan Pasir Tengger Nature reserve (East Java)	20 (13,025)	1919	A sea of sand in the Tengger mountains
S. M. Bali Nature park (Nusa-Tenggara)	78 (50,000)	1941	Especially for protection of the "white starling" (*Leucopsar rothschildi*), tiger, deer and an ox indigenous to Bali
Sumatra-Selatan Nature park (South Sumatra)	1,394 (892,000)	1935	Sumatran rhinoceros, elephant, deer, serow, mouse deer, tapir, macaques, gibbons; giant *Rafflesia arnoldi*
Udjung Kulon–Panailan Nature reserve	161 (102,800)	1921	On two Javan islands; especially protects the very rare Javan rhinoceros; also tiger, chevrotain, barking deer; extraordinary vegetation
ISRAEL			
Arbel National park	5 (2,980)	1952	Mt. Arbel; isolated caves are breeding places for many birds, including the wall creeper; caves contain ruins of Hebrew fortress in Roman times
Jarmaq National park	35 (22,550)	1955	Peaks of Heidar, Adatir, and Hiram; picturesque valley of Leiman, rare and characteristic species of forest and maquis flora and fauna; ancient ruins
Mt. Carmel National park	40 (25,740)	1960	Abundant fossils; typical Mediterranean forest and scrub vegetation merging into higher pine forest; eagles and falcons
Elat Gulf Coral Reef reserve	0.5 (300)	1964	Coral reefs containing corals and coral fish; tropical sea fauna
Ein Gedi reserve	3 (1,750)		Oasis with distinctive flora not to be found elsewhere; abundant and varied fauna
Hula Swamp reserve	1.3 (800)	1957	Remnant of Huleh swamp with its typical flora and fauna; aquatic plants; nesting colony
Maagan Michael Fishing Ponds sanctuary	0.9 (600)	1959	Fish ponds full of nesting birds; many gulls and terns
Mt. Gilboa reserve	3 (1,950)	1962	Geological profile of Mt. Gilboa shows rocks of the Cretaceous and Eocene eras; transitional forest; Irano-Turanian vegetation
Mt. Meyron reserve	27 (17,500)	1965	Highest mountain area in the country; rare trees and flowers; varied fauna
Nahal Amud reserve	3 (1,875)	1965	Gradual change from typical Mediterranean plant life to steppe vegetation; nesting place of birds of prey, including the Bonelli eagle
Nahal Bezet reserve	3 (1,900)		Meandering river; many ferns; nesting places of birds of prey; small carnivores
Nahal Dishon reserve	5 (3,150)		Complete geological profiles of rocks typical of Galilee; rare plants; birds of prey; colonies of hyraxes
Nahal K'ziv reserve	4 (2,500)		Mountain gorge between cliffs; fine example of maquis woodland along slopes; nesting place of birds

Table V.—*Principal Parks and Reserves in Asia (Continued)*

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
ISRAEL *(Cont.)*			
Nahal Shorek reserve	4 (2,450)	1965	Typical geological and botanical section of Judean hills
Nahal Tabor reserve	4 (2,350)	1962	Steep springs in rocks of Eocene epoch; typical riparian vegetation; many acacias; gazelles
Ramoth Issashar reserve	16 (10,000)	1959	Slopes covered by annual grasses; many gazelles
Solelim Forest reserve	1.2 (740)	1962	Park land of Vallonea oak; climax of grey Eocene limestone soils
JAPAN *National Parks*			
Akan (Hokkaido)	338 (216,200)	1934	Active volcanoes, caldera lakes and hot springs, virgin conifer forests with rhododendron, azalea and birches, brown bear, snow rabbit and other wildlife, home of primitive Ainu people
Aso (Kyushu)	282 (180,500)	1934	Mt. Aso and vast atrio or sunken crater ringed with mountains in south, the Kuju plateau with many peaks in north, separated by grassland wilderness; forests and alpine meadows; wildlife
Bandai-Asahi (Honshu)	732 (468,700)	1950	Three disconnected sections: Mt Gassan volcano and Asahi range (north), Mt Iide, a granite peak with virgin forests and Mt. Azuma and Mt. Adatara volcanoes (central); Mt. Bandai (south) erupted in 1888 to produce some of world's largest dammed volcanic lakes; bear, monkey, serow in central section
Chichibu-Tama (Honshu)	188 (121,600)	1950	Spectacular scenic vistas of sedimentary ranges, rivers and dense dwarf bamboo moss forests, with virgin pine and spruce fir forests at higher elevations, several villages
Chubu Sangaku (Honshu)	655 (419,500)	1934	Forested Japanese Alps, with peaks, gorges and perpetual snows
Diasen-Oki (Chugoku)	123 (78,900)	1936	Mt Daisen and other peaks, with virgin pine and beech forests and snow-clad summits, religious shrines, Oki section includes 180 islands with many cliffs and grottoes, oldest shrine in Japan on Shimane peninsula
Daisetsuzan (Hokkaido)	896 (573,100)	1934	Three volcano groups and Ishikari range, with cliffs, gorges, waterfalls; vast alpine meadows and virgin conifer forests; brown bear, only Japanese habitat of crying "hare" (pika)
Fuji-Hakone-Izu (Honshu)	472 (302,200)	1936	Famous Fujiyama volcanic cone (3,776 m [12,388 ft]) with virgin forests, lakes and plains, Mt. Hakone area includes several volcanic peaks and hot springs, volcanic Izu peninsula noted for hot springs
Hakusan (Honshu)	183 (117,100)	1962	Small volcanic peaks around Mt. Hakusan, gorges, waterfalls, fossil forests; bear, antelope and other wildlife inhabit virgin forests, shrines
Ise-Shima (Honshu)	201 (128,600)	1946	Forested peninsula and coast line and island archipelago; Grand Shrine of Ise is national centre of religious worship; pearl farms in bays; bird life
Jo-Shin-Etsu Kogen (Honshu)	729 (466,800)	1949	Rugged Tanigawa range in north, with plateaus and volcanoes stretching south, including Mt. Asama, highest active volcano in Japan (2,542 m. [8,340 ft.]); Mt. Myōkō-Mt. Togakushi volcano complex to northwest; hot springs, forests; monkeys, antelopes
Kirishima-Yaku (Kyushu)	213 (136,500)	1934; 1964	23 volcanoes, some active, others with caldera lakes, hot springs; evergreen and azalea forests; several religious shrines, with giant cryptomeria trees
Minami Alps (Honshu)	138 (88,500)	1964	Popular mountainous park; rocky hills, cliffs and virgin forests
JAPAN *(Cont.)* *National Parks (Cont.)*			
Nikkō (Honshu)	543 (347,700)	1934	Scenic Nikkō volcanic area, peaks, lakes, waterfalls, marshes, virgin forests, abundant mammals and birds; several temples, including Toshogu shrine
Rikuchu Kaigan (Honshu)	45 (28,600)	1955	90 km (56 mi.) of coast line, cliffs, islands and beaches, pine and deciduous forests and subtropical vegetation; abundant bird life
Saikai (Kyushu)	94 (60,105)	1955	Dendritic coast line, Kujuku islands and Goto archipelago, subtropical forests, harbours
San-in Kaigan (Honshu)	35 (22,200)	1964	Sea-coastal park: inlets, capes and islands, cliffs, dens and grottoes, famed Tottori sand dune
Seto Naikai (Honshu)	255 (162,900)	1934	About 600 islands and coast land of Inland sea, fishing villages and farmlands; religious shrines; monkeys
Shikotsu-Toya (Hokkaido)	381 (243,800)	1949	Scenic volcanoes and caldera lakes, with virgin conifer forests and alpine vegetation; brown bear, Yeso squirrel, Japanese sable, birds, etc
Shiretoko (Hokkaido)	160 (102,200)	1964	Shiretoko peninsula, volcanic mountain ranges, Mt Iwo yama still active; virgin forests; wild bears, nesting sea birds; most primeval nature in Japan
Towada-Hachimantai (Honshu)	322 (206,000)	1936; 1956	Lake Towada, a double caldera lake, headwaters of Oirase river, and Hakkōda volcanoes, with primeval deciduous forests at lower elevations, conifers and alpine vegetation on slopes; Hachimantai section includes volcanoes and plateau, with hot springs
Unzen-Amakusa (Kyushu)	99 (63,300)	1934	Northern unit consists of plateau of Mt Fugen and other peaks, azaleas, boxtrees and deciduous forests; Amakusa section is an archipelago, with villages and historical relics of Christianity in Japan
Yoshino-Kumano (Honshu)	216 (138,200)	1936	Mt. Yoshino and Yoshino shrine, noted for cherry blossoms, rugged Omine mountain chain and Mt Odaigahara plateau stretch southward, with dense forests, gorges and cascades, the Kumano seacoast is bordered by innumerable rocky islets
Quasi-national Parks			
Abashiri (Hokkaido)	144 (92,400)	1958	Coast line, with shallow lakes and dunes; arctic vegetation; sea birds, seals; relics of Ainu culture
Biwa-ko (Honshu)	350 (224,100)	1950	Lake Biwa and surrounding Mt. Ibuki region
Sado-Yahiko (Sea of Japan)	178 (113,700)	1950	Volcanic Sado Island in the Sea of Japan
Yaba-Hida Hikosan (Kyushu)	420 (268,900)	1950	Volcanic area, adjacent to Aso National park; religious relics
Yatsugatake-Chusin-Kogen	154 (98,487)	1964	Volcanic mountain range, volcanic mesa, hot springs
JORDAN			
Azraq Desert Oasis National park	1,563 (1,000,000)	1966	Wildlife, migratory birds; desert castles, home of Bedouins; Azraq desert castle was used by Lawrence of Arabia
Qumran National monument and park	3.1 (2,000)	1966	Site encloses area of Dead Sea scrolls
MALAYSIA			
King George V National park	1,760 (1,126,400)	1938	Includes mountains, a wide plateau with unusual plants, many rivers and limestone outcrops; tropical rain forest; elephant, Sumatran rhinoceros, gaur, sambar, muntjac, Malayan tapir, bear, tiger, leopard
Taman Negara National park	1,677 (1,073,280)	1939	Virgin tropical forest, rivers with game fish; limestone outcrops
Krau Game reserve	252 (161,280)	1939	Virgin tropical forest; elephants, all species of deer, Malayan honey bear, Malayan tiger

TABLE V.—*Principal Parks and Reserves in Asia* (*Continued*)

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
MALAYSIA (*Cont.*)			
Sabah			
Kinabalu National park	275 (176,000)	1964	Surrounds and includes Mt. Kinabalu; area rich in flora and fauna; mountain intimately connected with folklore of Sabah
Sarawak			
Bako National park	10 (6,400)	1956	Coastal bays and coves near Cape Po; forest and open country; wild pig, mouse deer, monkeys, gibbon, bird life
Endau-Kota Tinggi Wild Life reserve	878 (561,900)	..	Protection of native animal life
Templar	5 (3,000)	1955	Limestone deposits; forests
NEPAL			
Chitawan Wildlife sanctuary	240 (153,600)	1956	Swampland and forest; great one-horned rhinoceroses, tigers, leopards, bears, gaurs, sambars, barking deer
Sukla Phanta Wildlife sanctuary	90 (57,600)	1964	Swampland, short-grass plain and forest; swamp deer, black bucks, spotted deer, barking deer, hog deer, tigers, leopards, elephants
PHILIPPINES			
National Parks			
Aurora (Luzon)	10 (5,800)	1937	Rolling terrain with dipterocarp forests and varied wildlife
Basilan (Basilan)	25 (15,900)	1939	Peaks and rough terrain, headwaters of six large rivers; virgin forest; varied wildlife
Bataan (Luzon)	121 (77,600)	1945	Verdant virgin forests on Bataan peninsula overlooking Manila bay; commemorates battle of Bataan; abundant wildlife
Bicol (Luzon)	20 (12,900)	1934	Scenic virgin dipterocarp forests on plateaus and river valleys; deer, wild boar, hornbill
Central Cebu (Cebu)	59 (38,000)	1937	Only extensive remaining virgin forest on Cebu; wildlife
Hundred Islands (Luzon)	7 (4,600)	1940	Coral islets, underwater coral formations, caves and fine beaches; Indian pygmy goose, Philippine bulbul, fish, etc.
Mayon Volcano (Luzon)	21 (13,500)	1938	Mt. Mayon (7,943 ft.) and rugged terrain, with grasslands and forests of dwarf trees; deer, boar, monitor lizard, many birds
Mt. Apo (Mindoro)	15 (9,800)	1936	Mt. Apo (9,691 ft.) volcano, highest in the Philippines, with moss and dipterocarp forests; monkey-eating eagle
Mt. Arayat (Luzon)	14 (9,200)	1933	Forested volcanic peak (3,564 ft.), with springs, rivers and small waterfalls
Mts. Banahaw-San Cristobal (Luzon)	35 (22,400)	1941	Rough forested country surrounding Mt. Banahaw (6,000 ft.) and Mt. San Cristobal (4,092 ft.); abundant wildlife
Mt Canlaon (Negros)	95 (60,700)	1934	Mt. Canlaon (8,000 ft.) and surrounding rugged forested terrain, with craters, hot springs; monkey, deer, boar
Mt. Data (Luzon)	21 (13,600)	1936	Pine-covered peak with ravines and waterfalls; varied wildlife
PHILIPPINES (*Cont.*)			
National Parks (*Cont.*)			
Mt. Isarog (Luzon)	39 (25,000)	1938	Rough forested region, with canyons, rivers and waterfalls; boar, deer, hornbill
Naujan Lake (Mindoro)	7.6 (4,900)	1956	Naujan lake and surrounding marshes and forests; principal breeding area of marsh birds; crocodile, sail-finned lizards
Quezon	38 (24,292)	1934	Largest forest park in Philippines; unbroken and extensive forest of numerous species; abundant wildlife; memorial statue of Pres. Luis Quezon
Sohoton Natural Bridge (Vizayan)	3.2 (2,100)	1935	Large natural bridge in forested rolling terrain, with limestone cave; deer, boar, monkey
Game Refuge and Bird Sanctuary			
Liguasan Marsh (Mindanao)	170 (108,600)	1940	Lush mangrove marsh; waterfowl nesting area, with other birds; monkey, deer, pig
SINGAPORE			
Bukit Timah reserve	0.3 (184)	1883	Forest lowland covering granite hill with 581 ft. elevation; many species of plants
Kranji reserve	0.08 (51)	1883	Climax mangrove marsh
Pandan reserve	0.56 (356)	1883	Pioneering and tidal mangrove plant associations
THAILAND			
Tung Slang Luang Natural park	494 (316,160)	1963	Virgin area of river, waterfalls and mountain scenery in northwest Thailand; tiger, leopard, deer, elephant
Khao Sam Roi Yord National park	23 (14,720)	1966	Large caves and jagged limestone mountain; many endemic plant species; goatlike serows are commonly found along mountain cliffs
Khoa Yai National park	837 (535,680)	1963	Mountains, rolling plateau, streams, waterfalls; big game animals; many birds
Phu Kadueng National park	134 (85,760)	1962	Streams, waterfalls, ponds; mountain with rolling grassland interspersed with pines; natural rock garden
TURKEY			
National Parks			
Karatepe-Arslantaş	16 (10,297)	1958	High elevation red oak and red pine forests, inhabited by roe deer, wolf, jackal, wild swine, marten and other animals; partridges and eagles; Hittite epitaphs, Phoenician and Roman mosaics and reliefs
Manyas Bird Paradise	0.2 (130)	1950; 1959	Grove of willows and shore line reeds on Lake Manyas, in Balikesir, nesting habitat for cormorants, egrets, spoonbills and glossy ibises
Soguksu	4 (2,525)	1959	Protects forested watershed adjacent to thermal spring resort of Kizilcahamam
Yozgat Pine Forest	1 (660)	1958	Representative of indigenous pine and oak forests of Anatolia; reforestation projects

lation in a single day; accommodations are excellent.

India's national parks protect some of the outstanding forest, jungle and mountain scenery of the subcontinent and an abundance of wildlife of many species. They are administered by the chief conservator of forests, the North East Frontier agency, or by other departments of the government; the Indian Board for Wild Life, founded in 1952, serves in a quasi-official advisory capacity.

Four of the many wildlife sanctuaries established in the respective states are of especial importance in the survival of rare endangered species. The Gir forest, northwest of Maharashtra, is the only remaining habitat of the Asiatic lion (*Panthera leo persica*). (This or a closely related race survived in Greece until A.D. 100. The lion is referred to 130 times in the Bible; it became extinct in Palestine about the time of the Crusades, but survived into the 20th century in Arabia, Iraq and Iran.) In India, lions inhabited much of the north and central portions until the 19th century, but the last recorded outside the Kathiawar peninsula was in 1884. Some 300 lions survive in the Gir forest, where they feed on other wild species and on livestock owned by the Maldhari, who have religious scruples against killing animals. After 1900 the lion was protected by decree of the many princes and the maharajah of the peninsula, and the animals have increased since.

The Kaziranga Wild Life sanctuary, in Assam, is the principal remaining habitat of the great Indian rhinoceros (*Rhinoceros unicornis*), which 500 years ago ranged over a large part of northern India and Nepal. Hunting, desiccation of fertile land by unrestricted livestock grazing, agriculture and fires, and the fantastic value placed on rhinoceros horn and other parts of the carcass for magical medicine, to detect poison in drinking potions and as an aphrodisiac, reduced the population drastically. Nearly all of these animals remaining in India (about 400 in 1960) are in sanctuaries and reserves, 260 of them in Kaziranga, where they are

safe from poaching and have become tolerant of human activity. In spite of royal restrictions on hunting in the Rapti valley of Nepal, poaching is a serious problem.

The Keibul Lamjao sanctuary is the only habitat of the brow-antlered deer (*Cervus eldi eldi*), feared to be near extinction before World War II but now holding its own locally under protection. The Kashmir stag (*Cervus elaphus hanglu*), the Himalayan relative of the European red deer and the American wapiti, was carefully protected by the maharajah of Kashmir prior to independence, and is safeguarded in the Dachigam sanctuary.

Indonesia has set aside over 100 nature reserves, ranging from small sanctuaries for bird life to large territories designed to protect all natural features and wildlife. The most important is the Udjung Kulon–Panailan Nature reserve at the western end of Java. This is the only known habitat of the Javan rhinoceros (*R. sondaicus*), a single-horned inhabitant of dense low tropical forest, of which possibly 24 to 48 individuals were surviving in the 1960s. Although these are given careful protection, scientists fear their numbers are too low to permit adequate reproduction and that the species may become extinct in the near future.

In Ceylon, under the Fauna and Flora Protection act of 1938, national parks and nature reserves are dedicated to complete protection of native vegetation and animal life; entry to them requires payment of a fee in the case of national parks or a written permit in that of the strict nature reserves. Intermediate zones mostly adjacent to the reserves serve as buffers between them and areas of human culture.

In addition, several sanctuaries give strict protection to vegetation and wildlife. Preservation of a number of Ceylonese animals is dependent on these reserved areas, including the hog deer, leopard, sloth, bear and especially the Indian elephant, which may cease to exist as a wild species outside the reserves. (F. M. PD.)

V. GREAT BRITAIN

National Parks.—The tenth national park in England and Wales was established in 1957 in the Brecon Beacons. A total area of over 5,200 sq.mi. was then covered by national parks. They are: the Lake District National Park, the Peak District, Snowdonia, Dartmoor, the Pembrokeshire Coast, the North York Moors, the Yorkshire Dales, Exmoor, Northumberland (a part of the county) and the Brecon Beacons. National parks in England and Wales are set up under the National Parks and Access to the Countryside act which received the royal assent in Dec. 1949 and established a National Park commission whose duties include selecting areas it considers suitable to become national parks.

These are extensive areas of country possessing a marked degree of natural beauty and good opportunities for open-air recreation, which have been designated by the commission and confirmed by the minister of housing and local government, in order to preserve and enhance their characteristic beauty and to improve their facilities for enjoyment by the public. The provisions of the 1949 act relating to national parks did not extend to Scotland, but those relating to nature conservation extended to all parts of Great Britain and are the responsibility of the Nature Conservancy, as explained below.

The passing of the 1949 act was the culmination of a campaign dating from the second half of the 19th century, fought by various voluntary organizations which strived to preserve the countryside and its wildlife and to secure public rights of access to mountain and moorland. These included the Commons, Open Spaces and Footpaths Preservation society, the National Trust, the Society for the Promotion of Nature Reserves, the Ramblers Association, the Royal Society for the Protection of Birds and the Councils for the Preservation of Rural England (C.P.R.E.) and Wales.

In the early 1930s there was a growing public interest in the idea of creating national parks, and the efforts of the voluntary organizations were co-ordinated by the formation in 1935 of the C.P.R.E.'s standing committee on national parks, which made representations to the government to take effective action. Committees were appointed by the government of the day to consider the question of national parks and other relevant problems concerning the countryside, notable reports of this period being those of the Addison committee (Cmd. 3851) in 1931 and the Scott committee (Cmd. 6378) in 1942. It was by now generally realized that a further and more comprehensive investigation was needed.

In May 1945 a report on national parks (Cmd. 6628) by John Dower—an architect and a great authority on the landscape—was presented to parliament by the minister of town and country planning and published for information and as a basis for discussion. Later the same year the government appointed a committee under the chairmanship of Sir Arthur Hobhouse to consider the Dower report and to make recommendations.

The report of the Hobhouse committee (Cmd. 7121), published in 1947, recommended the setting up of a National Parks commission and the creation of 12 national parks. This report formed the basis of the legislation of 1949, but the passing of the Town and Country Planning act in 1947, which transferred planning control from district councils to county councils, had a profound effect on the degree to which the Hobhouse committee's recommendations were accepted.

The National Parks commission does not itself administer the national parks, as was recommended in the Hobhouse report; apart

TABLE VI.—*National Parks in Great Britain*

Name and location	Total gross area in sq.mi. (with approx. acreage in parens.)	Date established	Principal features
Peak District (mainly Derbyshire but including parts of Cheshire, Staffordshire, West Riding of Yorkshire and Sheffield)	542 (346,900)	1951	Gritstone moorland of the south Pennines in central England; limestone uplands, wooded dales
Lake District (Cumberland, Lancashire and Westmorland)	866 (554,200)	1951	Spectacular mountain scenery with lakes and fells in northwestern England; interesting wildlife, rock climbing, wooded valleys
Snowdonia (Caernarvonshire, Denbighshire and Merioneth)	845 (540,800)	1951	Snowdon and the Cambrian mountains in north Wales and Cader Idris. Cwm Idwal and other National Nature reserves
Dartmoor (Devon)	365 (233,600)	1951	Plateau of wild moorland in southern England; tors, river valleys and hanging oak woods; prehistoric relics
Pembrokeshire Coast (Pembrokeshire)	225 (144,000)	1952	Rocky coast line and the Prescelly mountains in south Wales. Norman castles, prehistoric sites and island bird sanctuaries
North York Moors (North Riding of Yorkshire)	553 (353,900)	1952	Open moorland plateau extending from the plain of York to the northeast coast of England; medieval castles and abbeys
Yorkshire Dales (North and West Ridings of Yorkshire)	680 (435,200)	1954	Wide, sweeping upland moors, cut by deep pastoral valleys, in the central Pennines of England; caves, castles and prehistoric and Roman sites
Exmoor (Devon and Somerset)	265 (169,600)	1954	Heather moorland, once a Norman Royal hunting forest with a fine sea coast on Bristol channel; prehistoric camps
Northumberland (Northumberland)	398 (254,700)	1956	Cheviot hills on Scottish border of England and Hadrian's wall; moorlands, fells, rivers and forests, ancient British and Roman camps
Brecon Beacons (mainly Brecknockshire, but including parts of Carmarthenshire and Monmouthshire)	515 (329,600)	1957	Northward-facing escarpment in south Wales rising nearly to 3,000 ft., with moorland on southern slopes, and many rivers; caverns, prehistoric and Roman remains; Carreg Cennen castle

from its executive powers to select areas for such designation, the commission's duties are mainly advisory. The national parks are administered by special park planning authorities set up under the 1949 act, on which sit a proportion of members appointed upon the nomination of the minister of housing and local government by reason of their special concern with the national aspect of the parks.

Within national parks the normal life of the area goes on; the land is not sterilized, neither does designation affect in any way the existing ownership of the land. The park planning authorities control development just as county councils do elsewhere throughout England and Wales, but in doing this they pay special regard to the fact that the park is one of Britain's finest landscapes which stands in need of preservation.

Other duties of the park planning authorities include the drawing up of annual programs to accomplish the purposes of the parks. And they have special powers. They may, for example, make arrangements to provide accommodations, meals and places of refreshment where the existing facilities are inadequate. They may lay out caravan (trailer) sites and parking places, and arrange for facilities for sailing, bathing, boating and fishing. For approved facilities of this kind, the government pays grants up to 75% of the total expenditure. Grants are also payable for approved measures taken to preserve and enhance the natural beauty of the parks, such as the removal of disfigurements, the restoration of derelict land and the planting of trees. (L. J. W.)

Nature Reserves.—Nature reserves in Great Britain may be traced back as far as the medieval royal forests which had nothing to do with silviculture but were managed under strict legislation designed to secure the maximum protection, cover and food for beasts and birds of the chase. In modern times a few small bird sanctuaries were created informally during the 19th or early 20th century and from 1894 there was statutory power to establish bird sanctuaries, although most of the orders made for this purpose were not actively enforced.

During World War I a comprehensive list of proposed nature reserves was drawn up for the board of agriculture but no official action was taken until the appointment by the planning ministers in 1945–46 of the two Wildlife Conservation Special committees for England and Wales and for Scotland, in connection with the National Parks committees. The reports of these committees resulted in the creation by royal charter in 1949 of the Nature conservancy as a crown body under the supervision of a committee of the privy council with the objects of advising scientifically on conservation, of operating nature reserves and of undertaking scientific research.

The program of national nature reserves includes areas in England, Scotland and Wales ranging in size up to approximately 40,000 ac. and forming the best available examples of natural or seminatural habitats including arctic-alpine vegetation, bogs, woodlands (both deciduous and coniferous), fens, grasslands, inland waters, dunes, salt marshes, expanses of shingle, sea cliffs and islands.

Among the largest nature reserves are the Cairngorms Nature Reserve in the eastern Scottish Highlands (39,689 ac.), the Inverpolly Nature Reserve in the western Highlands (26,791 ac.), the Moor House Nature Reserve in the Westmorland Pennines (10,000 ac.) and the Beinn Eighe Nature Reserve in the western Scottish Highlands (10,450 ac.).

British nature reserves inevitably differ from those in less developed countries in being mostly smaller, more frequented and farther from their primitive state. The majority are open to public access but several are closed except to permit holders. Some are primarily selected as "living museums" to conserve picked examples of natural communities of plants and animals or to serve as refuges for rarities. Others are partly or mainly used as open-air laboratories on which experiments are conducted into the effects of climate and drainage, or of different types of management treatment such as grazing, planting, fencing and control of burning. Comprehensive records are kept of the elements and changes in the animal life and vegetation and of the enrichment or impoverishment of soils.

The broad purpose of the conservancy's nature reserves is to provide suitable and secure arrangements for long-term studies of the natural resources of Great Britain and to preserve for future generations the best possible range of examples of the natural vegetation and animal life. These official nature reserves are supplemented by a somewhat larger number of unofficial reserves managed by the Society for the Promotion of Nature Reserves, the Royal Society for the Protection of Birds, the National trust, the National Trust for Scotland and various regional or county trusts, of which the Norfolk, Yorkshire and Lincolnshire Naturalists' trusts are leading examples. In addition the conservancy has notified to local planning authorities more than 1,700 sites of special scientific interest over which the Nature conservancy must be consulted before permission for development is given.

(E. M. N.)

VI. EUROPE

Plato and other philosophers of antiquity recognized the desirability of a harmonious relationship between man and his natural environment, but the ancient civilizations did not develop the concept that nature itself is worth preserving. Royal prerogatives, from early times through the middle ages and into modern times, often restricted hunting of certain species of animals to nobles, protected eagles and hawks for falconry and closed extensive areas to trespass by commoners. These were feudal measures to benefit the oligarchy, although they resulted in some measure of nature protection.

Some of these preserves were maintained for centuries and saved primeval regions and wildlife species. The aurochs, ancestor of domestic cattle, protected by royal decrees, survived in Poland until 1627. In the same country, all hunting was prohibited in the Belovezh forest in the 17th century and only by this protection was the wisent, the European bison, perpetuated to modern times.

The Renaissance brought an interest in natural philosophy and with it the stirring of an appreciation of nature and its processes. Local communities began to restrict exploitation of the resources of economic importance, to control woodcutting and grazing, and even to preserve natural areas intact, as in the case of the Bois de la Haye, in Holland, in 1576. During the mid-19th century the German naturalist Alexander von Humboldt conceived the idea of establishing natural monuments for preservation of natural ecology. It was not until the 20th century, however, and mainly after World War I, that European nations undertook extensive establishment of national parks and nature reserves in the modern sense. By 1960, almost every European country had set aside some areas to protect scenery, natural environment and wildlife.

In Austria, for example, the *Länder* have promulgated laws and ordinances which provide varying degrees of protection to a large number of nature reserves ranging in size from a few acres to many square kilometers. These include outstanding scenic mountain areas, forests, lakes, geological formations and relic habitats of rare plant associations as well as important wildlife habitat. A 200-m. zone is protected from exploitation along a number of scenic highways, and green belts have been established around certain cities.

In France, part of the Forest of Fontainebleau, near Paris, was established as a nature reserve in 1953. The Pelvoux park, established in 1923, is a scenic alpine area where, in spite of wars, many wild animals have survived, notably the chamois. The Camargue reserve, established in 1927, is a world-famous ornithological sanctuary and research area, where flamingos, herons, avocets and other marsh birds breed in numbers and unusual plant associations occur.

A considerable number of nature reserves and bird refuges have been established in Belgium by the citizens' associations Ardenne et Gaume, Reserves ornithologique de Belgique, and De Wielewaal, to protect scenic features, habitat of nesting and migrating birds, plant associations and other natural features. They are relatively small but serve important conservation purposes. Two official nature reserves were established in 1957.

Nature protection has been practised in Denmark since 1805 and in Czechoslovakia since 1838, but modern nature reserves in both

TABLE VII.—*Principal Parks and Reserves in Europe*

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
AUSTRIA			
Karwendel reserve	280 (179,200)	1943; 1947	Alpine and subalpine vegetation and animal life in limestone region of the Karwendel mountains of Tirol
Hohe-Tauern Scenic reserve		1942	The valleys from the Gerlostal to the Raurisertal, Gasteinertal, Kleinarltal and the upper reaches of the Grossarltal
Neusiedler See and Seewinkel Scenic reserve		1940	On the Danube plain at the Hungarian border; source of major rivers; notable bird life; hydrobiological research station
BELGIUM			
Lesse et Lhomme National park	4 (2,500)	1954	Protects scenic region with unusual geological formations
Hautes Fagnes Nature reserve	14 (9,125)	1957; 1958	Swamps, peat bogs and Ardennes plateau with glacial and subalpine plant associations, ecological research station
Westhoek Nature reserve	1.3 (823)	1957	Sand dunes; beach research; maritime flora
BULGARIA			
Belogradchishki Skali National park	31 (19,768)	1949	Natural rocky formation cut by two rivers, two artificial lakes; conglomerate formations resemble animals and people
Kailuka National park	3.3 (2,149)	1939	Narrow river valley surrounded by sheer limestone rocks; hilly area planted with pitch pines, sycamore trees, acacias, walnut trees
Ropotamo National park	3.2 (2,093)	1962	Forest in a periodically flooded area, ash trees, brushwood, grasses, water lilies; nesting birds and wild flowers
Vihren National park	26 (16,645)	1962	Marbled limestone, glacial valleys, forested; rare alpine grasses
Vitocha National park	25 (16,000)	1933	In the massif of Rila, near the Yugoslavian border, with forested mountains and a peat bog noted for its wild flowers
CZECHOSLOVAKIA			
Krkonoše and Jizerské Hory	460 (294,400)	1955	Glaciers, alpine meadows, peat bogs, hot springs, plants and wildlife; 150 sq.mi. classified as a strict nature reserve
Dobročský Prales reserve	0.2 (128)	1913	Primeval forest
Mohelenská Hadoová reserve	0.2 (128)	1952	Rocky serpentine hillside; dwarf plant forms
Velký a Malý Tisý reserve	2.5 (1,600)	1955	Ponds with water and marsh flora; nesting ground of water birds
Žofínský Prales reserve	0.4 (256)	1838	Protected primeval forest with typical mountain flora
Sumava Protected Landscape region	723 (462,720)	1963	Extensive forest area along southwestern border of Bohemia; 10 nature reserves within this area; evidence of glacier activity from Ice Age; extensive peat moors; relict species of flora and fauna
Tatranský Národní park	463 (296,320)	1949	High mountain scenery, on Polish border, with glaciers, forests, endemic plants; chamois, bear and other wildlife
DENMARK			
Skallingen	12 (7,700)	1939	Largest nature reserve in Denmark, on the west coast of Jutland, with dunes, marshes and a research laboratory
Tipperne og Klaegbanken	3.5 (2,200)	1895; 1936	Several islands on west coast of Jutland protect thousands of nesting shore birds, terns and other birds, also migrant species; ecological laboratory
FINLAND			
National Parks			
Linnansaari	3.1 (2,000)	1956	Group of about 20 islands in Lake Haukivesi; osprey colony; rare plants; access by boat
Pyhähäkki	3.9 (2,500)	1956	Virgin pine forest, swamps and peat lakes
Oulanka	41 (26,450)	1956	Wild terrain along the Oulou-joki river and tributaries
Pyhätunturi	11.6 (7,400)	1938	Pyhatunturi is the most southerly arctic mountain in Finland, a traditional sacred place for Lapps
FINLAND (*Cont.*)			
National Parks (Cont.)			
Pallas-Ounastunturi	193 (123,500)	1938	Lapp fjord country, with arctic mountains, peat lands and forests
Lemmenjoki	149 (95,100)	1956	Lemmenjoki river drainage; mountain gorge and lakes
FRANCE			
National Parks			
Vanoise	208 (133,440)	1963	Mountainous region near Gran Paradiso in Italy; alpine fauna and flora
Port-Cros	58 (37,070)	1963	Island of bush, forest and subforest
Reserves			
Camargue Nature reserve	36 (23,140)	1928	Zoological refuge on delta of Rhône river, noted for nesting flamingos; ecological research
Forest of Fontainebleau	6.3 (4,006)	1953	Protects natural beauty and biological features in environs of Paris
Pelvoux park	85 (54,430)	1923	Alpine region, with chamois and other wildlife
WEST GERMANY			
Naturschutzpark Hoher Vogelsberg (Hesse)	84 (53,750)	1958	Volcanic uplands, one-third covered by copper beech and spruce forest; balance agricultural
Naturschutzpark Lüneburger Heide	78 (50,000)	1909	Established to protect and restore the landscape and native heath; spur ridges extend over a wide plain of alluvial sands, with valleys and streams, oak, birch and pine forests
Naturpark Münden (Lower Saxony)	76 (48,868)	1951	Hilly area with volcanic peaks, copper beech and spruce forests, and open pastures
Naturpark Pfälzer Wald	654 (418,250)	1958	A sandstone plateau with deep valleys, the largest continuous forest in the Federated Republic. 120 villages are scattered in the area
Naturschutzpark Siebengebirge (Cologne)	33 (21,250)	1922; 1930	Many volcanic mountains and limestone formations; forests and wildflowers, including orchids. Mining, destruction of plants (except removal of timber under permit) and disturbance of wildlife prohibited
Naturpark Südeifel	42 (26,750)	1958	Plateau area in mountainous Eifel region on the Luxembourg frontier; one half mixed deciduous and conifer forest, the remainder mostly farmland; wildlife abundant
GREECE			
National Parks			
Grove of the Daphni Monastery	0.55 (350)		Outside of Athens; wine festival in the park every September
Wooded area at Mt. Olympus	47 (30,000)	1938	Includes Olympus mountain peak, mythological home of the gods; light forests of pine, beech and broad-leaved evergreens
HUNGARY			
Tihany National park	2.7 (1,700)	1952	Volcanic area, with 100 rock cone geysers and lakes; Bronze Age ramparts and 12th century monk cave dwellings
Kis Balaton reserve	5.5 (3,508)	1951	Reed marsh rookery of egrets, ibises, spoonbills and other herons; entry to the area is by permit only
Aggtelek-Jósvafő	3 (1,970)	1945; 1958	Limestone cavern, 15 km. (9 mi.) long, with large chambers and formations, extending into Czechoslovakia, where it is also protected
Szalajkavölgy reserve	2.2 (1,395)	1955	Centre of paleolithic culture in the Bükk mountains
ICELAND			
Thingvellir National park	15.4 (9,880)	1928	Postglacial lava plain with deep fissures; Öxará river; meeting place of ancient *althing* (parliament) of chieftains from A.D. 930
Eldey Nature reserve	0.006 (3.7)	1940; 1960	Rookery of gannets; last two living examples of the now extinct great auk were found here

TABLE VII.—*Principal Parks and Reserves in Europe* (*Continued*)

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
IRELAND			
Bourn Vincent Memorial park	17 (10,550)	1932	Mountains and lakes of Killarney, with farm and forest lands; last herds in Ireland of European red deer; Japanese deer introduced
North Bull Island Nature reserve	5 (3,200)	1931	Sandy island; sanctuary for migratory and wintering birds
ITALY			
Abruzzo National park	113 (72,000)	1923	High mountains in Marsica region in central Italy, with cirques, moraines and peaks rising to 2,247 m. (7,372 ft.); thick pine and deciduous forests; chamois, bear, roe deer and other wildlife
Circeo National park	29 (18,400)	1935	Promontory, southeast of Rome, containing maritime forest of Terracina, coastal dunes and associated animal life and vegetation
Gran Paradiso National park	240 (153,940)	1922	Scenic mountain ranges, rising to 4,061 m. (13,323 ft.), in northwest Italy, with extensive glaciers, alpine vegetation and animal life
Stelvio National park	368 (235,600)	1935	Magnificent alpine region on Swiss border, with several life zones and their characteristic plant associations and forests, with crags rising 3,899 m. (12,792 ft.); glaciers; stag, chamois, roe deer, bear and other wildlife
NETHERLANDS			
Hoge Veluwe National park	23 (14,700)	1935	Forests, heather with red deer and mouflon (introduced)
Kennemerduinen National park	5 (3,064)	1950	Dunes and bird life
Texel Island Nature reserve	5.5 (3,500)	1909	Terns and other sea birds
Boschplaat reserve	17 (10,870)	1924	On island of Terschelling; dunes and seacoast; sea birds and waders
State Game reservation	11.6 (7,400)	1955	Woodland; red deer, roe deer, wild boar
Kobbeduinen reserve	9.2 (5,900)	1955	On island of Schiermonnikoog; sea-dunes
De Wieden reserve	7.4 (4,750)	1934	Water and marshland; rich interesting flora; water and marsh fowl
NORWAY			
Kong Karls Land reserve (Spitsbergen)	200 (128,000)	1939	Arctic islands; polar bear reserve
Gutulia area (Hedmark)	3 (2,000)	1957	Primeval mountain forest of Norway spruce and Scots pine; bogs
Ormtjernkampen area (Oppland)	1.8 (1,125)	1956	Primeval mountain forest of mainly Norway spruce
Vaggetem area (Finnmark)	2 (1,250)	1910–11	Primeval forest of Scots pine
National Parks			
Børgefjell (Nordland and Nord-Trondelag)	382 (247,000)	1963	Alpine and subalpine area, numerous lakes and rivers; birdlife especially interesting
Rondane (Oppland and Hedmark)	222 (142,080)	1962	Alpine area, 10 peaks more than 2,000 m. (6,562 ft.); interesting geology; popular skiing area
POLAND			
National Parks			
Babia Gora	6 (4,105)	1954	Remnants of ancient Carpathian forests in the Babia Gora range, part of the West-Beskidy mountains in southern Poland and extending into Czechoslovakia
Bialowieza	20 (12,683)	1947	Best preserved part of the primeval forest of Bialowieza; heights of trees up to 57 m. (187 ft.), some hundreds of years old; largest breeding centre of rare European bison
Kampinos	84 (55,235)	1959	Forested dune area, near Warsaw; prehistoric dwellings; elk and a numerous heron colony
Karkonoski	22 (13,773)	1959	Northern slope of Karkonosze mountain range in southeast Poland on Czechoslovakia border, with glaciated peaks, lakes, waterfalls and forests
POLAND (*Cont.*)			
National Parks (*Cont.*)			
Ojcow	6 (4,139)	1956	Picturesque Pradnik and Saspowka valley; notable rock formations; large caverns; primitive forests; endemic Ojcow birch; great eagle owls, water ouzels, bats, historical castles
Pieniny	10 (6,692)	1932; 1954	Picturesque lime mountain range; numerous valleys; Dunajec river gorge; entire area a forest, many endemic and rare plants; deer, lynx, great eagle owl, rare insects
Slowinski	69 (44,479)	1966	Migratory birds; moving dunes; dwarf pine tree forest
Swietokrzyski	23 (14,935)	1950	Main Swietokrzyski mountain range; beech and fir forests; areas of scattered rocks mark primitive nature
Tatra	84 (53,890)	1954	Polish Tatra mountains, highest part of the Carpathians; numerous highland lakes and caverns; chamois and marmot
Wielkopolska	21 (13,307)	1957	Moraine forests on Warta river; post-glacier lakes and wildlife
Wolinski	18 (11,500)	1960	Shores of Wolin Island; glaciers, island cliffs with forests; dune plants; rare bird species; white-tailed eagles, great eagle owls, ospreys
RUMANIA			
Retezat National park	50 (32,125)	1935	Glaciated summits 2,572–8,205 ft. (784–2,501 m.) high; conifer forests; chamois, lynx, bear, raptorial birds
Cetăţile Ponorului reserve	1.8 (1,142)	1955	Three massive peaks and a magnificent scenic portal; caves with underground rivers; the wild Galbena valley; ancient beech forests
Forêt et Lac de Snagov reserve	6.6 (4,292)	1952	Relic of ancient mixed hardwood forest on Danubian plain; lake
Les Clairières à Narcisses reserve	1.5 (964)	1957	Vast glades of *Narcissus stellaris* in an oak forest at foot of Mt. Fafaras
Pietrosul Mare reserve	10 (6,672)		Glacial relief; glacial lakes; alpine flora; chamois
Tourbière "Tinovul Mare" reserve	2.6 (1,668)	1955	Sphagnum peat bog with many rare plants; pine and birch forests
Reserves of the Danube delta	129 (82,780)	1963	Great variety of water fowl; pelicans, egrets, herons, swans, avocets, geese, ducks
SPAIN			
National Parks			
Covadonga (Oviedo and León)	65 (41,820)	1918	Covadonga mountains; pasture land, abundant chamois; also, mountain lions, bears, numerous birds; forests of beech, oak, sycamore, ash, hazel; many rivers cross the park
Ordesa (Huesca)	8.4 (5,375)	1918	Ordesa valley in the Pyrenees; Arazas river with three waterfalls; pine forests, variety of plant life; pheasant, falcon, trout, chamois
Teide (Isla de Tenerife)	42 (27,182)	1954	Teide and Gran Circo mountains, exotic vegetation; volcanic formations; unique flowers
Caldera de Taburiente (Isla de la Palma)	13.5 (8,649)	1954	Roque de los Muchachos mountains; volcanic formations; variety of exotic plant life; thorny plants; old laurel forest; goats
Aigues Tortes and Lake San Mauricio	41 (25,946)	1955	Sierra de los Encantats mountains in the Pyrenees; numerous lakes; black pine forest; wild boar, chamois, white partridge, trout
SWEDEN			
National Parks			
Abisko	29 (18,560)	1909	High mountain scenery near the arctic circle; most of park rich mountain vegetation; reindeer, bear, lynx, golden eagle, snowy owl, other wildlife; Lapp settlements
Muddus	195 (124,800)	1942	Coniferous woodland and bogs; virgin pine forests, abundant wildlife

TABLE VII.—*Principal Parks and Reserves in Europe* (*Continued*)

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
SWEDEN (*Cont.*) *National Parks* (*Cont.*)			
Padjelanta	788 (504,100)	1962	Wide mountain plain situated around lakes Virihaure and Vastenjaure; valuable botanical region with species not found elsewhere in Sweden; many large wild animals; rich bird life; summer pasture for reindeer; summer quarters of Lapps
Sarek	735 (470,490)	1909	Largest wild area in Europe; high mountain region, extremely rough country, dense willow thickets, large glaciers; rich fauna; delta of the Rapaalven
Stora Sjöfallet	48 (31,000)	1909	Extensive mountain region around mountain lakes in the Stora Lule alv river system; many different types of topography, flora and fauna
SWITZERLAND			
Swiss National park	5,025 (3,216,000)	1914; 1959	An alpine sanctuary, primarily to serve scientific research; high Alps from 1,500 to 3,173 m. (4,921–10,410 ft.); magnificent scenery; endemic plants; chamois, red deer, roe deer, ibex (introduced 1920) and other wildlife
UNION OF SOVIET SOCIALIST REPUBLICS *Russian S.F.S.R.*			
Altai (Gorno-Altai autonomous *oblast*)	3,575 (2,287,800)		Scenic taiga of fir, cedar and larch, rising to alpine tundra; many wildlife species, including snow leopard, wild dog, ibex, musk and roe deer, bear and others
Astrakhan (Astrakhan *oblast*)	295 (189,075)	1919	Protects nesting area of coot, sheldrake, pelicans, herons and spoonbills, and molting grounds for myriad waterfowl, on Volga delta; fish are abundant; hydrological research
Barguzin (Buryat A S.S.R.)	970 (620,500)	1926	Protects mountainous terrain of northern Transbaikalia and especially the dark sable inhabiting its forests; seal rookeries on the Ushkany Islands
Bashkir (Bashkir A.S.S.R.)	313 (180,000)	1958	Mountain and steppe forests of southern Urals; varied wildlife; Kapov cave contains primitive drawings
Caucasus (Krasnodar *krai*)	984 (629,500)	1924	Beech and conifer forest with rhododendrons, rising to alpine meadows in western Caucasus; mountain goat, chamois, deer; re-established bison roaming at liberty
Darwin (Vologda and Yaroslavl *oblasti*)	432 (276,600)	1945	Broken pine forest, sphagnum marshes and heather; elk, bear, lynx, upland birds, shore birds, waterfowl; established to study ecological changes in connection with building of Rybinsk reservoir
Ilmen (Chelyabinsk *oblast*)	125 (80,000)	1920	In honour of Lenin; pine and birch forest; stretches of steppe covered with feather grass; preservation and study of geology; minerals and semi-precious stones
Kandalaksha and Lapland reserve (Murmansk *oblast*)	385 (245,200)	1932	Arctic tundra and mountainous terrain along Murmansk coast; vast numbers of alcids and other sea birds; elk, brown bear, lynx and wolverine on Veliki Island; islands in Kandalakshski gulf are covered with spruce, pine, and birch forests; seals along shore; Lapland includes mountain tundra, established to protect wild reindeer and beavers
Kedrovaia Pad (Primorski *krai*)	60 (44,200)	1916	Mixed forest of Mongolian oak, Manchurian fir, cedar, Amur cork and other far eastern trees; sika (*Cervus nippon*), roe deer, musk deer, boar, leopard, bear, marten and other wildlife
Khekhtsir	174 (111,620)	1963	Manchurian vegetation; Korean cedars, firs, Mongolian oaks, Manchurian ash trees; grapes, lemons; wild boars, roe deer, foxes, other small mammals
U.S.S.R. (*Cont.*) *Russian S.F.S.R.* (*Cont.*)			
Khingan	325 (144,000)	1963	Bears, Manchurian hares, game birds; mountainous cedar taiga; birch, aspen
Komsomol	124 (79,534)	1963	Mountains on banks of Amur river; Korean cedars, lindens, alder trees; brown bears, wolverines, elk
Mordvinian (Mordvinian A.S.S.R.)	118 (75,250)		Pine forests with some deciduous trees; varied wildlife
Oka (Ryazan *oblast*)	88 (56,500)		Mixed forests and flood-plain marshes and lakes of Pra river
Pechora–Ilych (Komi A S.S.R.)	2,790 (1,785,750)		Central taiga of spruce and pine; mountain taiga of conifers, including stone pine; sable, reindeer, capercaillie; domestication of elk
Prioksko–Terrasny (Moscow *oblast*)	19 (12,000)		Pine and broad leaved forests, steppe vegetation; breeding of bison
Sikhote-Alin (including Sudzukhe reserve) (Primorski *krai*)	2,342 (1,499,000)		Broad-leaved and conifer forests, including Amur lime, Korean pine, Yeddo spruce, Khingan fir and other species; tiger, leopard, baribal bear, Amur bear, Manchurian deer and other wildlife; Sudzukhe includes southern vegetation of Manchurian type; punctate deer, mountain antelopes
Stolby (Krasnoyarsk *krai*)	184 (117,500)		Mountain taiga belt, mixed pine and larch forests; pillarlike rock formations
Suputinka (Primorski *krai*)	62 (39,750)		Border zone between Manchurian cedar forests and mixed deciduous spruce and fir forests; varied wildlife
Teberda (Stavropol *krai*)	361 (231,000)		Conifer and beech forests, with rhododendrons, rising to alpine meadows on north slope of greater Caucasus mountains; a major tourist attraction
Tsentralno–Chernozemny (Kursk and Belgorod *oblasti*)	16 (10,500)		Three areas of virgin steppe, with oak groves
Tsentralno–Lesnoi (Kalinin *oblast*)	82 (52,750)		Mixed forests and meadow steppe; bear, marten, capercaillie
Volga–Kama (Tatar A.S.S.R.)	30 (19,000)		Varied pine forests, with lichen and moss; lime and oak forests; discontinuous section of taiga on forest steppe
Voronezh (including Khoper reserve) (Voronezh and Lipetsk *oblasti*)	182 (116,000)		Oak and pine forests, with groves of European alder along Usman river, established to increase number of beaver; many roe deer; Khoper includes oak and aspen groves and alder woods along Khoper river, protecting especially muskrat and beaver; bison
Zhigulevsk (Kuibyshev *oblast*)	53 (33,750)		Oak groves; residual pines on limestone; picturesque cliffs and crags
Armenian S.S.R.			
Dilizhan	113 (72,348)	1958	Northern slopes of lesser Caucasian range and basin of Kura river; groves and sparse woods
Garni	103 (65,900)	1958	Basin of Azat and Veda rivers, from 900 to 2,000 m.; scenery with waterfalls; Armenian mouflon, bezoar goat, boar, bear
Azerbaijan S.S.R.			
Gek-Gel	27 (17,500)		Upper forest belt and sub-alpine meadows; Lake Gek-Gel, formed by landslide in A.D. 1139; bear, marten, roe deer
Kyzylagach	363 (232,500)	1929	Gulf of Kirov in the Caspian sea and adjacent islands; coastal reed and salt marshes, wintering habitat of waterfowl, waders, flamingos, bustards and other birds
Turianchay	50 (31,324)		Protects the only habitat of elder pine in the world, a stand of thick-trunked pistache and desert vegetation
Zakataly	109 (62,490)	1930	Southern slope of greater Caucasian range, rising to 3,668 m.; zones of forest and alpine meadows; Dagestan mountain goat, chamois, deer, boar and other wildlife

TABLE VII.—*Principal Parks and Reserves in Europe* (*Continued*)

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
U.S.S.R. (*Cont.*)			
Belorussian S.S.R.			
Berezina	262 (161,500)	1925	Pine groves and spruce woods on Berezina river; to protect habitat of beaver and other wildlife for eventual distribution to other areas
Estonian S.S.R.			
Matsalu	42 (27,170)		Matsalu gulf and basin of Kassari river; nesting grounds and migratory routes of waterfowl and other birds, largest colony of graylag geese in Baltic area
Nigula	11 (6,825)	1957	Pine and sphagnum marsh
Vaika	0.1 (88)	1957	Eider duck and other sea birds
Viydumyaye	2 (1,493)	1957	Rare and endemic plants on Saaremaa Island
Georgian S.S.R.			
Adzhameti	18 5 (11,883)	1957	Residual stands of Imeritian oak, *Quercus hartwissiana*, and *Kolkhidian zelkova*
Babaneuli	3 (1,976)	1960	To preserve stands of *Kolkhidian zelkova*
Batsarsky	12 (7,630)	1957	To preserve residual yew groves and stands of beech
Borzhom	56 (35,875)	1959	Forested western part of Trialeti range; mineral springs
Kintrish	23 (15,000)	1959	Preserves native species of trees
Kolkhida	2 (1,250)	1959	Lake Palnostomi, wintering grounds of waterfowl
Lagodekhi	52 (33,250)	1912	Forested mountains and alpine meadows; mountain goat, deer and other wildlife
Mariamdzhavarsky	4 (2,750)	1959	Scotch pine groves
Ritsa	62 (39,820)	1957	Lake Ritsa and deciduous forests; mountain goat, chamois, roe deer
Saguram	19.5 (12,500)	1957	Residual tertiary vegetation
Satapliysky	1.2 (750)	1957	Limestone caves with fossils
Vashlovani	26 (16,900)	1957	Steppe, semidesert and stands of pistache and juniper; central Asian gazelle
Kazakh S.S.R.			
Alma-Ata	276 (177,000)	1960	Forested mountains of northern Tien Shan, rising to 3,000 m., with meadows and glaciers; bear, Siberian deer, central Asian gazelle, mountain sheep and other wildlife
Aksu-Dzhabaglinsky	273 (185,230)	1926	Talass Alatau range, rising to 4,000 m , Aksu river canyon; snow leopard, bear, mountain sheep, bustard and other wildlife
Barsa-Kelmes	77 (49,500)	1939	Coast of Lake Aral and Barsa-Kelmes Island; onager and central Asian gazelle introduced; gulls, waterfowl and flamingos on shore
Kirgiz S.S.R.			
Issyk-Kul	2,860 (1,830,552)	1958	Preservation and expansion of game animals, birds, fish
Sarychelek	76 (49,129)		Semenov fir, Schrenk spruce forest, with nut and fruit trees, in southern Tien Shan; water conservation
Latvian S.S.R.			
Engures	5 (3,350)		Lake Engures, habitat of nesting and migratory birds
Grini	2.7 (1,750)		Only habitat of cross-leaved heath (*Erica tetralix*) in U.S.S.R.
Moricsala	3 (2,088)	1957	Gulf and islands in Lake Usmas, with deciduous forests and rare herbaceous plants
Šlītere	31 (19,620)		Protects virgin forest
Lithuanian S.S.R.			
Žuvintas	12 (7,918)	1946	Lake Zuvinto and adjacent forest and marsh areas, nesting grounds of waterfowl, including 50 pairs of whooper swans
U.S.S.R. (*Cont.*)			
Tadzhik S.S.R.			
Childukhtaron	59 (37,500)		Residual nut and maple forests
Gazimailik	59 (37,500)		Natural environment of Kok-Tau range
Iskanderkul	117 (75,000)		Deciduous and juniper forest and high mountain steppe; picturesque mountain lake at 2,176 m ; snow leopard, ibex
Ramit	59 (37,500)	1959	Forested upper reaches of Kafirnigan river; alpine meadows
Tigrovaia Balka	162 (103,375)		Southern deserts of central Asia; flood plain forest of Vakhsh river; Tugai deer, central Asian gazelle, bird life
Turkmen S.S.R.			
Badkhyz	294 (212,173)	1941	Hilly plains, spurs of Paropamiz range and deep Yeroilanduz salt depression; 500 onager, also gazelle and cheetah
Gasan-Kuli	272 (174,150)	1932	Reed and salt marshes on Caspian sea; waterfowl wintering grounds; only habitat in central Asia of the partridge *Francolinus orientalis*
Repetek	135 (86,500)		Eastern sand desert of Kara-Kum, with desert plants; gazelle, the wild cat *Felis margarita*, the hare *Lepus tolai*, sand jerboa, reptiles, bird life
Ukrainian S.S.R.			
Azov-Sivash	47 (30,000)		*Solonets* steppe on islands and salt marshes around Sivash; protects migratory and wintering waterfowl; deer and game birds acclimatized on Biryuchy Island, and pheasants and the goat antelope *Saiga tatarica* have been introduced
Aksaniya-Nova	2 (1,250)		Residual virgin steppe
Black Sea	47 (30,000)	1927	Protects migratory and wintering waterfowl and nesting gulls and terns, as well as other bird life
Crimea	118 (75,500)		Highest peak in Crimean mountains, Roman-Kosh (1,545 m.); zones of oak, beech, mountain steppe, pasture, with Crimean and Scotch pine on southern slope; deer, mouflon (acclimatized), stone marten, Crimean barbel and other wildlife
Kamennye Mogily	1.4 (890)	1927	Granitic hills rising to 100 m. above stony steppe, with rare types of plants
Khomutovskaya Steppe	4 (2,564)	1926	Virgin feather grass and meadow steppe, with semidesert and desert animal life
Mikhaylovskaya Steppe	0.8 (505)	1928	Virgin meadow steppe
Streletskaya Steppe	2 (1,313)	1948	Virgin grass steppe; habitat of *Marmota bobac*
Uzbek S.S.R.			
Amu-Darya	234 (150,000)		Delta and marshes of Amu-Darya river, with nesting and migratory waterfowl, flamingo, bustard and other bird life; central Asian gazelle saiga, boar
Chatkal Mountain forest	137 (87,500)	1947	Stands of juniper and deciduous trees in western Tien Shan; central Asian goat, white-toed brown bear, snow leopard, Pallas's cat, other mammals and varied bird life
Zaamin Mountain forest	33 (25,935)	1960	Forested mountains and alpine meadows of northern slope of Turkestan range; bear, lynx, mountain goat, mountain sheep and other wildlife
YUGOSLAVIA			
Fruska Gora National park	89 (57,125)	1960	Hills; native vegetation; birds; archaeological sites
Biogradska Gora National park	8.2 (5,250)	1952	Virgin forest of fir, spruce, beech, maple; red and roe deer, trout, capercaillies
Durmitor National park	125 (80,000)	1952	Five canyons, 14 lakes; mixed forest; ammonite fossils; chamois, roe deer, bears

TABLE VII.—*Principal Parks and Reserves in Europe (Continued)*

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
YUGOSLAVIA (*Cont.*)			
Galičica National park	93 (59,400)	1958	Mixed high-altitude forests
Lovćen National park	8 (5,000)	1952	Mountain massif; fjords; overlooks Adriatic sea
Mavrovo National park	286 (182,720)	1949	Mountainous; bears and lynx; power reservoir
Paklenica National park	15 (9,900)	1949	Two wild scenic canyons; mixed forest; cliffs and rocks
Perister National park	47 (30,000)	1949	Two glacial lakes with abundant trout; pine forest
Plitvička jezera National park	75 (47,900)	1949	Mountain; mixed forest; bears, roe deer, capercaillies; 16 lakes with trout and crayfish; 4 limestone caves
YUGOSLAVIA (*Cont.*)			
Risnjak National park	13 (8,600)	1953	Dinaric mountain system; Balkan and alpine vegetation meets Mediterranean types; mixed forest; rich fauna
Trebević National park	4 (2,471)	1954	Forest, meadows, wildflowers; animal life includes roe deer, bears, capercaillies
Mljetska jezera reserve	12 (7,750)	1948	Island with three salt lakes; Aleppo pine and dense brush
Perućica reserve	6 (3,585)	1952	Virgin forest of beech, maple, ash, hornbeam, fir, spruce, pine; chamois, roe deer, bears, wild boars, martens, golden eagles; waterfall

countries are of much more recent establishment. In Poland, nature protection began in the 15th century, when the aurochs and other endangered species were given royal protection, but it was not until 1919 that a provisional state commission for the protection of nature was founded; this commission initiated establishment of national parks and enactment of conservation legislation. A nature protection act, which placed the national parks under the ministry of forestry, was passed in 1949. Scientific research is conducted in the parks by many institutions, under the direction of the Polish Academy of Sciences.

In the Federal Republic of Germany, legislative control over nature protection was the responsibility of the *Länder* after 1945; the federal government acts to develop uniformity of state legislation. Many agencies are concerned with problems relating to nature protection and a large volume of law has been promulgated, the most fundamental being the Reich Nature Protection law of 1935. In addition, there are numerous private organizations that co-ordinate their efforts and co-operate with the official agencies as closely as possible. Their problems are complicated by the fact that all nature reserves in Germany are leased from private landholders, except a part of the Lüneburg Heath reserve that is owned by the Nature Reserves society. A variance of opinion exists between those people interested in the establishment of nature reserves primarily for the strict protection of species and associations of vegetation and animal life and related scientific research, and those who regard outdoor recreation as an essential purpose of reserves. In practice, reserves serving both purposes have been created, and in addition to the major nature parks there are hundreds of smaller reserves of scientific significance and scenic importance.

In Finland, legislation enacted in 1923, 1938 and 1956 provides for the establishment of reserve areas on government land. National parks are set aside on virgin land for the preservation of animal life and vegetation and for visitor enjoyment. Nature reserves are established mainly for scientific purposes and entry is by permit. Of ten national parks and reserves created in 1938, six were located on the area ceded to the Soviet Union; to compensate for their loss the 1956 law was passed to establish additional parks and reserves in southern Finland. The national parks and nature reserves protect forested mountains, lakes, coastal shore lines and islands. Roads, trails, lodges and campgrounds and other accommodations are provided in the national parks.

National parks and nature reserves in the U.S.S.R. are state property and come under the national budget. Special organizations or committees set up by the council of ministers direct the work in the parks, the responsibility in some cases resting with the U.S.S.R. Academy of Sciences or the academies of sciences of the union republics.

The natural features as a whole are under protection and may be put to use only by permission of the government of the U.S.S.R. or of the union republics. If any special features in a certain area are protected, the area is declared a prohibited area; other-

TABLE VIII.—*Principal Parks and Reserves in Australasia*

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
AUSTRALIA			
New South Wales			
Blue Mountains National park	359 (230,000)	1959	Rugged scenic sandstone country in Blue mountains, with peaks, towering cliffs, deep gorges and bushland valleys; stunted trees on higher slopes, dense rain forest in valleys; with eucalypts and blue gums; varied wildlife
Brisbane Water National park	25 (16,000)	1959	Broad ridges dropping to tidal waters; rain forest in gullies; Hawkesbury sandstones have unique vegetation and abundant wildflowers; Bouddi National park (1,280 ac.) and sanctuaries adjacent
New England National park	72 (46,000)	1935	East slopes of Great Dividing range, to 5,280 ft., largely rain forest, with hardwoods on ridge tops; varied wildlife
Royal National park	56 (36,000)	1955	Forest reserve, with coastal surf beaches
Warrumbungle National park	22 (14,000)	1953	Rugged volcanic Warrumbungle range; kangaroos, wallaroos, giant wedge-tail eagles, etc.
Kosciusko State park	2,344 (1,500,000)	1944	Mt. Kosciusko, 7,316 ft., and other peaks and rolling grassy plateaus; Yarrangubilly caves; Snowy mountains hydroelectric scheme is mainly within park; winter sports area
AUSTRALIA (*Cont.*)			
New South Wales (Cont.)			
Kuring-gai Chase	59 (38,000)	1894	Exposed sandstone ridges, bushland scrub, rain forest in gullies, tidal inlets; profuse native flowers; koalas, kangaroos, dormouse "opossums" (phalangers), Albert lyrebird, etc.
Morton National park	70 (45,000)	1938	Mountain terrain with sandstone summits and deep gorges; open bloodwood-scribbly gum forest and heathland on higher slopes, hardwood forests and rain forest in gorges
Nadgee Faunal reserve	44 (28,000)	1957	Combination of seashore, lagoon, moorland, swamp, river valley, open forest and mountain habitat, with great variety of plant and animal life
Northern Territory			
Ayers Rock–Mount Olga	487 (311,700)	1958	Ayers Rock, 20 mi from Mt. Olga (3,507 ft.), is a huge monolith 2,850 ft. rising 1,143 ft. above the surrounding plain; numerous native paintings on rocks; desert oak, mulga, mallee, bloodwood and spinifex; kangaroo, wallaby, bandicoot, euro, many lizards, varied bird life

TABLE VIII.—*Principal Parks and Reserves in Australasia (Continued)*

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
AUSTRALIA (*Cont.*) *Northern Territory (Cont.)*			
Katherine Gorge	88 (56,069)	1963	Walls of red and brown quartzite tower 200 ft. on each side; variety of shrubs, trees and palms grow from ledges and crevices; fish and fresh-water crocodiles; parrots and many types of finches; wallabies in the hills
Queensland			
Bellenden-Ker National park	125 (80,140)	1921	Mt. Bartle Frère (5,275 ft.) and other jungle-clad peaks in McPherson and Great Dividing ranges; kangaroos
Carnarvon Gorge	104 (66,480)		"The Grand Canyon of Queensland"; a vast chasm, 20 mi. long, 50–400 yd. wide with vertical sandstone cliffs up to 600 ft. high; many caves containing aboriginal art; open forest; platypus
Eungella National park	192 (122,600)	1941	Dense jungle and tropical forest; waterfalls on peaks up to 4,000 ft.
Lamington National park	76 (48,510)	1915	Magnificent mountain scenery, waterfalls and forests which include the antarctic beech; Albert lyrebird, rufous scrub-bird, marsupials
Hinchinbrook Island National park	152 (97,232)		Picturesque mountain and waterfall scenery with numerous caves
South Australia			
Belair	3.2 (2,064)		Public recreation area; mainly hilly bushland; eucalyptus; kangaroo, wallaby, emu, koala
Flinders Chase	212 (135,700)	1905; 1919	Ancient peneplain and coastal cliffs and beaches on Kangaroo Island; great gray and sooty kangaroos, endemic black-faced kangaroo, wallaby, echidna, phalangers; koala and platypus introduced; penguins, pelicans and other birds; orchids
Para Wirra	4.1 (2,596)	1963	Rocky gorges; dam and artificial lake; kangaroos
Tasmania			
Cradle Mountain-Lake St Clair National park	529 (338,560)	1921	Mountain region, 2,000 ft to 5,305 ft. (Mt. Ossa), with rivers and lakes; forests of King William pine, pencil pine, eucalypt, Tasmanian rain forest, savanna and plains; marsupials and other wildlife
Mt. Field National park	63 (40,034)	1916	Glaciated valleys with forests of giant eucalypt and rain forest, rising to Mt Field West (4,721 ft.) and highland moors; Russell Falls, areas of vegetation unique to Tasmania: mountain shrimp in mountain tarns; wildlife plentiful
Victoria			
Kinglake National park	22 (14,079)	1928	Heavily forested south slopes of Plenty ranges, with deep fern gullies and waterfalls; 326 plant species recorded, including rare orchids; several species of kangaroo, wallaby, bandicoot, dasyure, wombat, koala, echidna, platypus, reptiles and a variety of birds
Mallacoota Inlet National park	17.5 (11,225)	1932	Evergreen bush on Genoa river, wildlife
Mt. Buffalo National park	43 (27,280)	1898	Granite plateau rising to 5,645 ft.; wet sclerophyll forest, subalpine woodland, sod tussock grassland in valleys; wombat, wallaby, echidna, kangaroo, lyrebird and other bird life
Wilson's Promontory National park	160 (102,379)	1905	Magnificent mountain and coastal scenery; fern gullies; wombat, koala, emu and other wildlife
Wyperfeld National park (Mallee)	218 (139,760)	1921	Semidesert Mallee region in west, sand hills lightly covered with heath and dwarf shrubs in east; black box and red gum trees on creek flats; black-faced kangaroo; Regent parrot, cockatoo, emu, mallee fowl

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
AUSTRALIA (*Cont.*) *Western Australia*			
Kalbarri National park	560 (358,000)	1963	Rocky gorges; rich in native flora
Nornalup National park	52 (33,139)	1957	Heavily timbered with karri, marri and jarrah trees; bottlebrush plants; ocean beaches
Penguin Island reserve	0.05 (31)	1957	Sanctuary for penguins
Porongorups National park	9 (5,651)	1957	Rugged hills in Porongorup range; stands of karri trees in valleys
Yanchep National park	10 (6,422)	1957	Caves; koalas, kangaroos, emus, black swans
BRITISH SOLOMON ISLANDS PROTECTORATE			
Queen Elizabeth park	24 (15,200)	1954	Contains Mt. Austen and the Mantanikai river valley, a very broken country interlaced with ridges and valleys; tropical hardwood forests; bird life
FIJI			
Ravilevu Nature reserve	15.5 (9,930)	1959	Forested mountain area with spectacular waterfalls and gorges; rare birds
Tomaniivi Nature reserve	6 (3,720)	1958	Mt. Victoria (4,341 ft.) and surrounding forests; rare birds; orchids
NEW ZEALAND *National Parks*			
Abel Tasman (South Island)	70 (44,635)	1942	Coastal and elevated region along Tasman bay, with mixed forests and beaches
Arthur's Pass (South Island)	384 (242,888)	1929	Southern Alps, with glaciers, river valleys and virgin forests; birds; 29,990 ac. wilderness area where buildings, horses and vehicles are excluded
Egmont (North Island)	129 (82,290)	1900	Mt. Egmont, with alpine vegetation, subtropical forests, sphagnum swamp and waterfalls; kiwi, rifleman bird, fantail and other birds
Fiordland (South Island)	4,724 (3,023,102)	1952	Mountain forests and fjords on coastline, with lakes, rivers and waterfalls; only habitat of the rare flightless rail or takahe (*Notornis hochstetteri*) and of the large owl parrot or kakapo (*Strigops habroptilus*); other birds; seals
Mt. Aspiring (South Island)	769 (492,300)	1964	Relatively remote mountainous area dominated by Mt. Aspiring (9,957 ft.); beech and rain forest
Mount Cook (South Island)	270 (172,979)	1953	15 peaks above 10,000 ft. in Southern Alps, Tasman glacier and other glaciers, montane scrub and alpine growth
Nelson Lakes (South Island)	221 (141,127)	1956	Two lakes located in mountainous terrain, with mainly beech forest
Tongariro (North Island)	260 (166,519)	1894	Three volcanoes, forests, treeless plains, and Mt Ruapehu with small glaciers; crater lake; hot springs and geysers
Urewera (North Island)	770 (493,011)	1954	Mountain ranges, crags, waterfalls and virgin forests; Maori-owned Lake Waikareiti; kiwi and other bird life
Westland (South Island)	329 (210,257)	1960	Western slope of Alpine chain (over 11,000 ft.) extending to sea level; glaciers, lakes, dense forests
Scenic, Natural and Historic Reserves			
Waipoua Forest reserve	36 (22,800)	1952	Kauri pine (*Agathis australis*)
Kapiti Island Bird sanctuary	6 (4,300)		Bush birds, waterfowl, sea birds, tuatara
Little Barrier Island Bird sanctuary	11 (6,960)	1894	Bush birds
Cape Kidnapper Gannet sanctuary (North Island)	0.05 (32)	1914	Only known mainland gannet colony
Waitangiroto White Heron colony (South Island)	3 (1,910)	1929	Only known nesting place of the white heron

TABLE IX.—*Principal Parks and Reserves in Central and South America*

Name and location	Total gross area in sq mi (approx. acreage in parens)	Date established	Principal features
ARGENTINA			
El Rey	140 (89,600)	1948	Subtropical forests on border of Bolivia, with tapir, jaguar, giant anteater, birds, reptiles and other wildlife
Iguaçu	210 (134,400)	1934	Subtropical forest on Brazilian border, with cataracts, including Iguaçu falls, 240 ft. high; abundant wildlife
Laguna Blanca	44 (28,200)	1949	Black-necked swans
Lanín	1,520 (972,800)	1937	Lanín volcano on Chilean border, with *Araucaria* forests and many lakes; varied wildlife
Los Alerces	1,000 (640,000)	1937	Mountainous region with immense forests; ancient glaciers, lakes; principal habitat of guemal deer; other wildlife
Los Glaciares	2,300 (1,472,000)	1937	Southern Andes on border of Chile, with glaciers, lakes and unusual plant associations, guanaco, chinchilla, guemal and pudu deer, condor and other wildlife
Nahuel Huapi	3,057 (1,956,500)	1922; 1934	Andean peaks on Chilean border, with glaciers, forests and lakes; guemal and pudu deer, condor and other wildlife
Perito Francisco P. Moreno	450 (288,000)	1936	Forested Andean peaks on southern border of Chile; habitat of guanaco, guemal deer, Patagonian fox, condor, swan and other wildlife
Angel Gallardo Nature reserve	231 (147,800)	1945	Subtropical forests and swamps of the Chaco, with pure forests of quebracho (*Schinopsis balansae*) and characteristic animal life
Tierra del Fuego	251 (160,620)	1961	Spectacular lakes and mountains
BAHAMA ISLANDS			
Exuma Cays National Land and Sea park	176 (112,640)	1959	Hundreds of tropical islets, coral reefs, sea gardens; marine and bird life, tropical vegetation, thousands of green turtles; unique geological phenomena, white sand beaches and dunes
Flamingo Colony reserve	287 (183,680)	1959	West Indian flamingos, total flock of 17,000, one of the largest of the few remaining colonies in the world
BERMUDA			
Castle Harbour Islands reserve	0.05 (30)	1961	Last breeding ground for Bermuda petrel and other sea birds; rugged offshore islets
Paget Marsh reserve	0.04 (25)	1950–66	Island valley containing virgin marsh flora and palmetto forest characteristic of prehistoric Bermuda
Spittal Pond National park	0.09 (60)	1954–61	Coastal valley; waterfowl refuge
Warwick and Southampton Beaches National park	0.15 (100)		Beaches, coves, bays, rock cliffs, sand dunes
BOLIVIA			
Cerro Miriqui y Saja National park	(*)	1945	Some of the highest forests in the world; chinchillas, vicunas
Tuni Condori National park	(*)	1942	Mountainous; panorama of snow fields; condors, deer, fox, hares and other fauna
Cerro de Tapilla reserve	(*)	1940	Chinchillas
Bella Vista National park	(*)	1964	Subtropical forests; variety of forest species and native orchids
Cerro de Comanche National park	(*)	1963	Extraordinary amounts of flowers; these flowers bloom every 125 years but there are always some in bloom
Tunari National park	(*)	1962	Native and exotic species of flora
BRAZIL			
Iguaçu National park	792 (506,566)	1939	Mountains and canyons, on Argentine border, with virgin evergreen forests and tropical vegetation; abundant wildlife
Itatiaia National park	46 (29,512)	1937	Mountain range reaching 7,546 ft. (2,300 m.); numerous lakes and rivers, unique geological formations; rich in plant life; abundant wildlife, birds and insects
BRAZIL (*Cont.*)			
Serra dos Orgãos National park	39 (24,711)	1939	Mountainous area extending from sea level to 8,202 ft. (2,500 m.); dense forest inhabited by large animal population; orchids and many other varieties of flowers and plants of peculiar beauty; many rivers
BRITISH HONDURAS			
Chiquibul reserve	714 (456,960)	1956	Tropical hardwood forest; tapirs, deer, wild pigs, jaguars, pumas, crocodiles
Columbia reserve	173 (110,720)	1954	Forest; tapirs, deer, wild pigs, jaguars, pumas, crocodiles
Manatee reserve	177 (113,280)	1959	Forest; tapirs, deer, crocodiles, pumas
Mountain Pine Ridge reserve	214 (136,960)	1959	Pine forest, savannas, palmettos; tapirs, deer, wild pigs, jaguars, pumas
Sibun reserve	169 (110,060)	1959	Tropical hardwood forest; tapirs, pumas, crocodiles
CHILE			
Cabo de Hornos	244 (155,908)	1945	Protects islands, some in primeval state, in Strait of Magellan; aquatic animals
Easter Island and Juan Fernández	66 (42,007)	1935	Protect vegetation, animal life and archaeological relics on islands in Pacific ocean
Fray Jorge	20 (12,847)	1941	Extensive forests and wildlife
Los Paraguas	70 (44,479)	1940	Spectacular scenery, including the Llaima volcano; *Araucaria* forests
Nahuelbuta	21 (13,381)	1939	Coastal cordilleras, primeval *Araucaria* and other forest species
Puyehue National park	290 (185,329)	1941	Many small lakes; thermal waters; volcanic activity
San Rafael National park	2,278 (1,457,922)	1945	Almost extinct varieties of trees and animals; glaciers
COLOMBIA			
Farallones de Cali National park	463 (296,400)	1962	Features information unavailable
Sierra de la Macarena National park	4,366 (2,794,311)	1948	Features information unavailable
Tairona National park	442 (282,939)	1964	Features information unavailable
Volcán de Puracé National park	46 (29,640)	1961	Features information unavailable
COSTA RICA			
Cabo Blanco reserve	5 (3,200)	1963	Forest fauna
Rio Macho reserve	424 (271,360)	1964	Watershed forest
EL SALVADOR			
Atecozol National park	0.1 (69)	1953	Fish ponds; forest; flowers
Cerro de las Pavas National park	0.03 (24.8)	1949	Mountains; valley of Virgin of Fatima; forest; gardens
Los Chorros National park	0.04 (27)	1958	Natural woods, waterfalls, ponds
GUATEMALA			
Atitlán National park and reserve	67 (42,880)	1955	Lake Atitlán is bordered by active volcanoes and the park supports pine, cypress and oak forests on their slopes; deer, squirrel and bird life, including a grebe endemic to the lake
Río Dulce National park	117 (74,880)	1955	Lake Izabal and Río Dulce from Atlantic ocean to ruins of San Felipe castle; magnificent jungle scenery, with tapir, jaguar, howler monkey and tropic bird life; open savannas with mahogany, blood trees and other native trees
Santa Rosalía reserve	1.9 (1,280)	1955	Pine and deciduous forests, with abundant wildlife, including deer, the raccoon mapache (*Procyon lotor*)
Tikal National park	224 (143,360)	1955	Tropical forest in El Petén, with mahogany, Spanish cedar and the sapodilla tree, or *chicosapote* (*Achras sapota*); deer, puma, jaguar, ocelot, tapir, mapache and other wildlife; Mayan ruins

*Area figures not available.

TABLE IX.—*Principal Parks and Reserves in Central and South America (Continued)*

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
GUATEMALA (*Cont.*)			
Cerro del Baul National park	4.6 (2,944)	1955	Mountains; pine and cypress forests; wildlife
Cerro Miramundo National park	3.5 (2,223)	1966	Xerophytic forest; mountain goats; panoramic views
El Pino reserve	1.3 (864)	1955	Pine and cypress forests; coyotes
Laguna el Pino National park	2.3 (1,472)	1955	Irregular topography; lagoons
Los Aposentos National park	0.8 (494)	1955	Pine forests, evergreens; recreation area; wildlife
United Nations National Forest park	1.9 (1,235)	1955	Plains of Pacific coast; lake; forests; wildlife
GUYANA			
Kaieteur	45 (28,800)	1930	Savanna and brushwood fauna on Potaro river; Kaieteur falls; tropical birds
MEXICO			
Cañon del Río Blanco (Veracruz)	210 (134,102)	1938	Forested headwaters of Río Blanco
Cumbres de Monterrey (Nuevo León)	952 (609,100)	1939	In Sierra Madre Oriental range; thick pine forests and wildlife
El Tepozteco (Morelos)	93 (59,304)	1937	Protects archaeological and natural features
Grutas de Cacahuamilpa (Guerrero)	5 (3,044)	1936	Spectacular cave formations; source of Amacuzac river
Ixtacihuatl-Popocatépetl (Puebla, Morelos, Mexico)	99 (63,452)	1935	Two volcanoes rising to over 5,000 m (17,000 ft.); with perpetual snows
La Malinche (Tlaxcala)	152 (97,421)	1938	La Malinche peak and forested slopes
Lagunas de Chacahua (Oaxaca)	55 (35,056)	1937	Lagoons bordering centre of Mixtec kingdom at time of Spanish conquest, waterfalls
Lagunas de Montebello National park	22 (14,453)	1959	Fifty-nine lakes of different colours surrounded by forests of pine and oak, semitropical and tropical plants; many varieties of orchids
Nevado de Toluca (Mexico)	259 (165,557)	1936	Nevado de Toluca (4,623 m. [15,167 ft.]) with lagoons in extinct crater; pine and oyamel forests; wildlife
Pico de Orizaba (Puebla and Veracruz)	76 (48,802)	1936	Citlaltepetl (5,700 m. [18,701 ft.]), highest peak in Mexico; forests include giant trees
Pico de Tancítaro (Michoacán)	113 (72,440)	1940	Extinct volcano
Sierra de San Pedro Mártir (Baja Calif.)	243 (155,673)	1947	San Pedro mountain range, with canyons, forests, and wildlife
Volcan de Colima (Colima Jalisco)	86 (54,856)	1936	Active volcano with subtropical forest on lower slopes, and pine and evergreen oaks above

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
PANAMA			
Forestal de la Yeguada reserve	19 (12,355)	1960	Lake, volcanic depressions; unique ecological and geological features
Forestal de Tonosi reserve	74 (47,234)	1960	Mountains; subtropical and tropical animals; flowering trees
Forestal de Chepigana reserve	1,014 (648,994)	1960	Only bold coast line in Panama; mountain range; varied and abundant flora and fauna
Nacional reserve	369 (236,129)	1963	Mountains; valuable timber species; game animals
"Altos de Campana"	10.2 (6,500)	1966	Biological elements of four life zones; Pacific and Caribbean slopes overlook rich scenery
SURINAM			
Brinckheuvel National park	23 (14,820)	1961	Deer, armadillos, wild boars, tapirs, jaguars, pumas
Coppenamemonding National park	39 (24,700)	1966	Breeding grounds for red ibis and brown pelicans
Kaysergebergte National park	618 (395,200)	1966	Tropical jungle
Tafelberg National park	154 (98,800)	1966	Sandstone formations; mountain fauna and flora
Voltzberg National park	216 (138,320)	1961	Deer, armadillos, wild boars, tapirs, jaguars, pumas
Wia Wia National park	139 (88,920)	1961	Breeding area for turtles
URUGUAY			
San Miguel National park	6 (3,740)		Scenic coastal area
Santa Teresa	13 (8,220)		Scenic coastal area
VENEZUELA			
Avila	312.5 (200,000)	1958	Forested mountain area between Caracas and the Caribbean sea
Guatopo	352 (225,000)	1958	Established to safeguard watershed endangered by agricultural burning; natural cloud forest on Cerro Azul in eastern section
Rancho Grande (Henry Pittier)	352 (225,000)	1937	Primeval tropical cloud forest in Cordillera de la Costa, with abundant wildlife, especially tropical birds; biological research station
Sierra Nevada de Mérida	625 (400,000)	1952	Pico Bolívar (16,411 ft.) and other snow-clad peaks in Venezuelan Andes near Colombia, forested on lower slopes, with glacial lakes
Alexander von Humboldt Natural monument		1949	Guácharo caves, with limestone formations and oilbirds (*Staetornis caripensis*)
Yacambú		1962	Scenic forested volcano

wise the parks are open to visitors insofar as the maintenance of the parks allows. Hunting and fishing or other destruction of wildlife and plants, as well as mining and livestock grazing, are prohibited.

Extensive scientific research is carried out by personnel attached to the park administrations, by other scientific bodies and by universities. The results are published by the national parks themselves, some of which publish their own journals, and in scientific periodicals. Every park has a natural history museum, and the most popular parks, such as the Crimea, Caucasus, Ritza and Teberda, have prepared special itineraries for tourists. Several films have been made on the national parks. The U.S.S.R. also has set aside nature reserves for the protection of particular features and resources.

VII. AUSTRALASIA

The preservation of natural areas and wildlife in Australia is, generally speaking, on a state rather than a commonwealth basis. In New South Wales, for example, each national park is administered by a separate trust of local residents or, in some cases, by representatives of government departments. Western Australia has a similar system. The forestry department administers the national parks of Queensland, supported in an advisory capacity by citizens' organizations, notably the National Parks association of Queensland. An official National Parks authority has been established in Victoria, also assisted by a National Parks association. A board of commissioners in South Australia and a Scenery Preservation board in Tasmania have jurisdiction over national parks and reserves in those states.

Within the parks and reserves are representative examples of most of the scenic characteristics of the continent—mountain ranges, gorges, waterfalls, marshes and lagoons—and its extraordinary vegetation and animal life. They are vital to the perpetuation of endemic species of wildlife, including unique marsupials, platypuses and other rare animals, and most unusual bird life. Some of these are dependent upon preservation of particular habitat or plant associations, an example being the koala, which requires oils of certain varieties of eucalyptus trees in its diet. Some Australian reserves are in remote sections, others are popular for camping, hiking, swimming and other outdoor pursuits. The more accessible parks have excellent accommodations.

In New Zealand, public reserves in general, including those set apart for the preservation of vegetation and animal life, are administered by the department of lands and survey of the National Parks authority. The national park board of each park is charged with the protection and control of wildlife, and the regulation of shooting of such wildlife as is considered game. Research and field work are conducted by the wildlife division of the department of internal affairs, the department of scientific and industrial research and various museums. In New Zealand

native wildlife consists mainly of birds, there being no indigenous land mammals other than rare bats and the native rat. Marine animals are protected by the marine department. The deficiency of wild game animals led to the introduction of various species for sporting purposes in the latter half of the 19th and the beginning of the 20th century. These included red deer, wapiti, chamois, Himalayan tahr and opossum. Pigs and goats were allowed to run wild, and introduced rabbits soon became so great a pest that stoats, weasels and ferrets were let loose to prey upon them. A spectacular result of their importation was the rapid diminution in the numbers of ground-dwelling and flightless birds and significant effects on other birds. Active extermination measures had to be taken against many of the foreign animals in order to try to restore the balance.

The Wildlife act, 1953, provided for the establishment of wildlife sanctuaries and refuges; it also protected most indigenous species wherever they might be found. Most reserves protect native plants as well as animals and some are set aside for the preservation of a certain species of plant; *e.g.*, the stands of kauri pine at Waipoua, the very rare evergreen shrub *Pittosporum obcordatum* in Hurumua reserve and the buttercup *Ranunculus paucifolium* near Mount White sheep station. There are also a large number of scenic reserves. The main purpose of the national parks is to provide untouched country for the enjoyment of the people, but their work in the preservation of the indigenous birds is also vitally important. In the parks of the North Island may be seen tuis, bellbirds, rifleman birds, owlet-frogmouths (moreporks), wekas and many others. But the largest of the parks, Fiordland, in the South Island, contains the greatest number of birds peculiar to New Zealand, especially the famous flightless rail or takahe (*Notornis hochstetteri*), long thought extinct but rediscovered in 1948. The area in which the takahe occurs is specially protected and no one may enter without a permit.

VIII. CENTRAL AND SOUTH AMERICA

Mexico first reserved land to protect historical sites late in the 19th century, but the establishment of national parks for the preservation of natural features and vegetation and animal life was undertaken on a major scale in the 1930s. Included in the system are spectacular scenic areas. The parks also protect vital watersheds, forests and wildlife in a country which has suffered devastating destruction of its natural resources from shortsighted exploitation. The most famous landmark in Mexico is the towering snow-clad summits of Ixtacihuatl-Popocatépetl, visible from the capital city and visited by thousands of people annually. Other peaks in the Sierra Madre ranges, caverns, forests and lagoons inhabited by myriad waterfowl are protected in other parks.

In Guatemala, national parks have been established to protect outstanding natural and archaeological features. Lake Atitlán, dominated by active volcanoes, resembles scenery found in Java; the precise boundaries of the national park have not been defined. The boat trip up the Río Dulce from Livingston through Lake Izabal, winding amid virgin jungles resounding with the calls of tropical birds and howler monkeys, is a famous attraction. The great plain of El Petén is a region of grasslands and tropical forests, the habitat of abundant wildlife, with buried Mayan cities.

The long-continued destruction of Venezuelan natural resources by overgrazing, fire and abusive agricultural practices stimulated an active conservation program in that country, which has included the establishment of national parks and natural monuments. Avila National park, near Caracas, is a popular recreational area as well as one of scientific importance. The tropical cloud forests in Rancho Grande and Guatopo National parks preserve humid jungle growth on the upper slopes of mountain ranges, with many unusual birds, mammals, reptiles and insects. The Sierra Nevada de Mérida National park is an Andean terrain of exceptional beauty.

The southern Andes possess some of the most spectacular mountain scenery in the world, and several outstanding examples along the Argentine–Chilean border have been set aside as national parks. There live two varieties of Andean deer, the guemal and the pudu, and also guanaco, chinchilla, condor and other unusual animals. Of Argentina's other national parks, El Rey and Iguaçu protect subtropical forests on the Bolivian and Brazilian border, while the Angel Gallardo Nature reserve in the Chaco on the boundary of Paraguay includes dense subtropical forests and swamps. These forests, rich in a variety of unusual plant life, are the habitat of most species of jungle fauna, including tapirs, carnivores and other mammals, many reptiles and myriad species of tropical birds. Often considered to be of almost limitless extent, these forests could easily be destroyed by exploitation.

Several of Chile's national parks are corollaries of the Andean parks in Argentina, protecting similar mountainous terrain and its forests and wildlife. Among Chile's other parks, the Cabo de Hornos National park is difficult of access, a region of gales and cold fogs, established to safeguard islands inhabited by seals and other aquatic mammals and birds. Easter Island is famous for its mysterious archaeological sculptures. Juan Fernández National park supports an endemic vegetation and animal life of scientific importance, which is seriously endangered by livestock grazing.

See also references under "National Parks and Nature Reserves" in the Index. (F. M. Pd.)

NATIONAL RESEARCH COUNCIL: *see* NATIONAL ACADEMY OF SCIENCES–NATIONAL RESEARCH COUNCIL.

NATIONAL SAVINGS: *see* SAVING, NATIONAL.

NATIONAL SECURITY COUNCIL, U.S., a council that advises the president of the United States on national security matters that require the co-ordination of domestic, foreign and military policies. Its members are the president, vice-president, secretary of state, secretary of defense and the director of the office of emergency planning.

The need for a national policy co-ordinating group more formal in character than the presidential cabinet was not recognized in the United States until the eve of World War II. It was not until 1938 that a standing liaison committee consisting of the undersecretary of state, the chief of naval operations and the army chief of staff was created. With the onset of World War II, however, policy co-ordination virtually ceased except as it was provided personally by the president, Franklin D. Roosevelt. Not until the last year of the war did a group, the state-war-navy co-ordinating committee (SWNCC), come into being with the express purpose of co-ordinating policy. The SWNCC was ineffective, for it could consider only matters referred to it by one of the departments. It was made up of assistant secretaries and lacked sufficient political prestige to influence policy.

Following World War II, congressional investigation focused attention on the lack of co-ordination that had been a factor in the Pearl Harbor disaster, and there was a general pressure for reorganization of defense agencies. The suggestion for a national security council (NSC) originated in studies by a staff of experts appointed by James V. Forrestal, then secretary of the navy. The NSC was established by law in 1947, and consisted of the president, the secretary of state, the secretary of defense, the secretaries of the three military services and the chairman of the national security resources board (NSRB). When Reorganization Plan 3 abolished the national security resources board, an executive order of March 13, 1953, named the director of the Office of Defense Mobilization to replace the chairman of the NSRB on the council. One of the most important features of the 1947 law was that the NSC was provided with a staff of its own. In time it was felt by those called upon to observe NSC operations that the staff base should be further strengthened and its military topheaviness reduced. These criticisms were taken into account in the National Security act amendments of 1949.

The functioning of the NSC continued to be the object of criticism even after the 1949 reorganization. After Pres. Dwight D. Eisenhower took office in 1953 the NSC was given a new importance and its staff was strengthened by the formation of a planning board. The members of this board, each with the rank of assistant secretary, functioned as representatives of members of the NSC. An Operations Coordinating board was also established.

With the accession of John F. Kennedy as president in 1961 the old structure disappeared. The NSC was, at first, scarcely used at all. It did not meet until after the abortive Cuban invasion of April 1961, but thereafter it began to meet at irregular

intervals. Both the Operations Coordinating board and the planning board were disbanded at the very beginning of the new administration. In their place a planning group began meeting regularly once a week. Representatives from the treasury, state and defense departments attended regularly. No formal agenda was developed, however, and no formal minutes were kept. Major segments of national policy were formed outside the NSC, and the extent to which its advice was followed depended on the policies of the president.

During the administration of Pres. Lyndon B. Johnson the NSC met with some regularity. More frequently, however, President Johnson met with only a few members of the NSC rather than with the council as a whole. (E. L. KH.)

NATIONAL SOCIALISM, the name of a movement known as the Nationalsozialistische Deutsche Arbeiterpartei (N.S.D.A.P.), National Socialist German Workers'—called Nazi—party, led, from 1920, by Adolf Hitler (*q.v.*) in Germany. Its name revealed its emphasis upon nationalism, socialism, Germanism and the working class. Like Benito Mussolini's Fascism, it combined an appeal to extreme and exclusive nationalism and chauvinist expansionism with a revolutionary call to the masses. It had from the beginning many traits in common with Fascism, and National Socialism may be regarded as the German form of Fascism. Both proclaimed themselves the implacable enemies of liberalism and democracy, of individual rights and all movements of international co-operation and peace; both stressed the subordination of the individual to the state, the inequality of men and races, the right of the strong to rule the weak and the necessity of the principle of blind and unswerving obedience to leaders appointed from above. Both praised the military virtues, despised and rejected pacifism, humanitarianism and charity, glorified hatred and conquest and aimed at the transformation of the whole nation into an armed camp perpetually ready for war.

Origins.—National Socialism, however, had its peculiarly German roots. Some can be traced to the Prussian tradition as it developed under the inspiration of great soldier kings, such as Frederick William I and Frederick II, and men of blood and iron, such as Bismarck. This tradition had always regarded the militant spirit and the discipline of the Prussian army as the model for all individual and civic life. To it was added the tradition of political romanticism, with its sharp hostility to rationalism, to the principles underlying the French Revolution and to the "superficiality" of the west, and with its emphasis on instinct, on the past, even on the remote past, and its proclamation of the rights of the exceptional over all universal law and rules. Thus, the exceptional becomes a law unto himself. These two traditions were later enforced by the 19th-century adoration of science and of the laws of nature, which, with their "iron logic," worked out beyond all concepts of good and evil. Further reinforcements came from a biological theory of life that led to the acceptance of that racialism first proclaimed by Joseph Arthur, count de Gobineau, in his *Essai sur l'inégalité des races humaines* (1853–55). It was then propounded by Richard Wagner (1813–83), who combined it with a heroic ideal of the Nordic superman, and by his son-in-law Houston Stewart Chamberlain, whose *Grundlagen des neunzehnten Jahrhunderts* (1899; Eng. trans., *Foundations of the Nineteenth Century*, 1911) profoundly influenced early Hitlerism. To romanticism, National Socialism owed the vague and fluid conceptions of folk as the basis of cultural and political organization, and of *Weltanschauung* or "total world outlook" as opposed in the name of *Kultur* to the more rational civilization of the west.

In addition to these currents in the German tradition, it ought to be pointed out that Hitler's formation was influenced during his youth by specific Austrian movements. National Socialism owed much to Karl Lueger (1844–1910), who organized the Catholic lower middle classes of Vienna in an anticapitalistic and anti-Semitic movement called the Christian Socialist party, but who remained loyal to Habsburg conservatism; and to Georg von Schönerer (1842–1921), who combined racial anti-Semitism with a violent anti-Catholicism and pan-Germanic expansionism and a bitter hostility to the Habsburgs. Schönerer's disciple Karl Hermann Wolf founded among the Sudeten Germans in Bohemia a German Workers' party that later was to assume the name of Deutsche National-Sozialistische Arbeiterpartei. This occurred a few years before Hitler founded his almost identically named N.S.D.A.P. in Munich.

Much in Hitler's ferocious nationalism and his contempt of the Slavs can be explained by the experience of his youth amid the bitter nationality struggles of the multiracial Habsburg empire.

When Hitler started his agitation in Munich immediately after World War I he found the intellectual soil well prepared by the writings of the German romanticists and of the German publicists of the War of Liberation, such as Ernst Moritz Arndt (1769–1860) and Friedrich Ludwig Jahn (1778–1852).

The last years before World War I were characterized by a renewed interest in romanticism and in the War of Liberation of 1813. In those years a German youth movement with its longing for a true community, a *Gemeinschaft*, the rebirth of the nation, and with its vague mystical enthusiasm for leadership and comradeship, expressed the opposition to rationalism and "bourgeois" liberalism. It had come largely under the influence of Friedrich Nietzsche (1844–1900) and the German poet Stefan George (1868–1933). Oswald Spengler (1880–1936; *q.v.*) and Arthur Moeller van den Bruck (1876–1925) can be regarded as the immediate forerunners of National Socialism in the intellectual field.

But the intellectual preparation would in no way have been sufficient for the growth of National Socialism in Germany if the defeat in World War I, with its ensuing disillusionment and pauperization, especially in the lower middle classes, had not paved the way for Hitler's propaganda. The peace treaty of Versailles gave Hitler a starting point, but the violent opposition which he evoked was not directed in reality against the peace treaty but against the fact that Germany had been defeated and that its plans had been frustrated. From the beginning Hitler's propaganda appealed to the military circles, which regarded the peace only as a temporary setback in Germany's expansionist program. Hitler added to the pan-Germanic aspirations for world hegemony the almost mystical fanaticism of a faith in the mission of the German race and the fervour of a social revolutionary gospel.

Psychological Methods and Theoretical Aims.—Though Hitler accepted many elements of the technique of the Bolshevik Revolution, he found a powerful ally in the widespread fear of Bolshevism, which he exploited, first in Germany and then on a worldwide scale, posing as the bulwark against Bolshevism. Thus, he secured the financial and moral support of many conservative elements that misunderstood the revolutionary and nihilistic character of his movement and its many points of similarity (as in its antiliberalism) with Bolshevism. On the other hand, he gained the adherence of the masses by vague promises of an anticapitalistic order. The banner of the N.S.D.A.P. was the red flag of the revolution, but altered to the German imperial colours by the addition of a white circle and a black swastika in the centre. The extraordinary flexibility of Hitler's dynamic doctrine enabled him to stress different elements at different times and to adapt his attitude momentarily to changing circumstances.

Hitler's most important individual contribution to the theory and practice of National Socialism was his deep understanding of mass psychology and mass propaganda in the contemporary world and his perfection of the methods learned from Bolshevik technique. His chapter on propaganda in *Mein Kampf* (1925–27) can be regarded as of the most fundamental importance. He stressed the fact that all propaganda must hold its intellectual level at the capacity of the least intelligent of those at whom it is directed, and that its content of truth does not count compared with the only valid criterion, that of success.

Hitler understood that, especially with as wide and far-reaching a goal as world domination, it was of the utmost importance to be able to present under one common denominator all potential adversaries who might themselves change according to the circumstances.

> The art of truly great popular leaders in all ages has consisted chiefly in not distracting the attention of the people, but concentrating always on a single adversary. The more unified the object of the people's will to fight, the greater will be the magnetic attraction of the movement

and the more tremendous its impact. It is part of a great leader's genius to make even widely separated adversaries appear as if they belonged to but one category, because among weakly and undecided characters the recognition of various enemies all too easily marks the beginning of doubt of one's own rightness. (From Hitler's *Mein Kampf*.)

It was a stroke of genius on the part of Hitler to find this common denominator in the Jews and Judaism. This enabled him to discover the "Jew" behind all his changing adversaries, sometimes behind Communism or Moscow, at other times behind Great Britain and the United States—in short, behind everybody and everything that at a given moment opposed his wishes or aroused his wrath.

Anti-Semitism served him also for two other purposes. National Socialism was fundamentally opposed to all concepts of international co-operation and universal catholicity; it destroyed the framework of a common humanity with common and absolute standards of law, truth and good, applicable to all men. National Socialism, therein following Nietzsche, regarded Christianity and prophetic Judaism, with their emphasis on the equality of all men under one common God and upon absolute standards of justice, as alien and inimical to the new hero ideal of the superrace, which was interpreted—not by Nietzsche, but by the National Socialists—as the true Germanic ideal. Judaism and the ethics of the Bible therefore stood in opposition to National Socialism.

National Socialism proclaimed the Germanic race as the new *corpus mysticum* on which the salvation of the world depended, as the embodiment of all nobility and creative genius and as the *Reich* ("empire") which must become the world-controlling *Reich*. This *Reich* necessarily had to have a *Gegenreich* ("Counter-*Reich*"), a counterrace that on a similarly worldwide basis would represent the antithesis of salvation and creative genius. So the Jewish people became the counterrace. National Socialism saw its duty not only in the destruction of this counterrace, but in the preparation of the German race for its real task of establishing the new world order. The third *Reich*—the hoped-for successor to the defunct second or Hohenzollern *Reich*—ruled by what Hitler called "the highest human species given by the grace of the Almighty to this earth," will have, by suitable education of the youth, in the future a generation mature for the ultimate and greatest decision on this globe. "The nation which will first take this road will be victorious," and become "one day the master of the globe."

The Jews were to be discriminated against not according to their religion but according to their "race." The fundamental contention of Hitler was that man is inescapably determined by his descent or "blood." Whoever was born from German parents remained a German forever in his nationality and character; whoever was born from Jewish parents remained forever a Jew by nationality and character. Thus Jews were declared, whatever their educational and environmental development, to be forever fundamentally different from Germans.

Hitler's racial theory was applied not only to Jews but also to people of German "blood" living in non-German lands. Germans who had emigrated from Germany and had become nationals of other countries, and even their descendants, were regarded as Germans, as *Stammesbruder* ("racial bretheren") and *Volksgenossen* ("national comrades"). Active propaganda was to be started among these Germans living in the "diaspora" (*Auslandsdeutsche*). If possible they were to be brought "home" into Germany, the true homeland of all Germans wherever they lived. If they could not be brought home, at least their loyalty to and activity for the German homeland was to be encouraged by all means. Study of German language and culture was to be promoted by all means among those Germans.

Rise to Power.—Working from these principles, Adolf Hitler was able to carry his party from its small beginnings in a beer cellar in Munich to a dominant position in world politics within 20 years. Among his more important collaborators were Alfred Rosenberg, the author of *Der Mythus des 20ten Jahrhunderts* ("The Myth of the 20th Century"; 1930), the most widely read book of the National Socialist movement besides Hitler's own *Mein Kampf;* Rudolf Hess, who helped Hitler write *Mein Kampf* during their internment in the fortress in Landsberg am Lech in 1924; Gregor Strasser, probably the most important of Hitler's collaborators, who separated from him in protest against the leader's opportunist policies and was killed in the blood purge of June 1934; his brother Otto Strasser, who in 1930 founded the Black front as a more radical wing opposed to Hitler; Gottfried Feder, who drew up the first program of National Socialism and was for several years its economic "expert" but thereafter receded into oblivion; Capt. Ernst Röhm, the founder and organizer of the SA or *Sturmabteilungen*, the National Socialist militia, who was purged in June 1934; Julius Streicher, who became famous through his anti-Semitic weekly *Der Stürmer;* Heinrich Himmler, the organizer and commander of the SS or *Schutzstaffel*, Hitler's personal elite guard, and of the Gestapo, the secret state police; Josef Goebbels, the master of National Socialist propaganda; Hermann Göring, the organizer of the German air force and controller of the German industrial mobilization; R. Walther Darré, the organizer of the National Socialist peasant policy; and finally Robert Ley, the leader of the German Workers' front.

It took 14 years for the N.S.D.A.P. to achieve power in Germany. It had been born at a time when it was only one of many semirevolutionary, reactionary and terrorist organizations springing up throughout Germany, composed of former officers and soldiers, students and other elements dissatisfied with the republican, democratic and peaceful order which seemed to dawn for Germany in 1919. That it survived and absorbed all others was due to Hitler's leadership and to the fact that Captain Röhm interested the *Reichswehr* in supporting Hitler. On Feb. 24, 1920, the N.S.D.A.P. drafted in Munich, the centre of its activities, a program of 25 points, which in 1926 was declared unalterable, but which in reality was very soon surpassed by developments. On Nov. 9, 1923, Hitler, supported by Field Marshal Erich Ludendorff, attempted his first *Putsch* in Munich, but it miscarried. Reaction was so firmly entrenched then in Bavaria, however, that Hitler was let off with only a formal punishment. The ensuing years of political and economic consolidation in Germany did not allow Hitler to make any considerable progress. The economic crisis at the beginning of the '30s, however, and the lack of energetic measures on the part of the government against the indefatigable propaganda to undermine democracy brought the first great success of the N.S.D.A.P. in the *Reichstag* elections of Sept. 14, 1930.

The *Reichstag* elections of Nov. 6, 1932, marked a temporary setback for Hitler; but an intrigue, started by Franz von Papen, prevailed upon the aged president of the German republic, Marshal Paul von Hindenburg, to name Hitler chancellor on Jan. 30, 1933. He was then only the head of a coalition cabinet of National Socialists and members of the conservative and nationalistic right. A fire in the *Reichstag* building on Feb. 27, 1933, gave Hitler the chance to rouse the spectre of a Bolshevik revolutionary danger and to hold the elections of March 5, 1933; though they gave the National Socialists only 44% of the votes, the antidemocratic totalitarian parties (National Socialists and Communists) had a majority following in Germany against the democratic republic, while the democratic forces were weak and without a clear program. Thus, the new *Reichstag*, meeting on March 21, 1933, in the garrison church in Potsdam, the historic receptacle of Prussian military spirit, "enabled" the government to assume dictatorial powers. From that moment on, the relentless process of *Gleichschaltung* ("co-ordination") began, and within a few months the German *Reich* had become a totalitarian state which was entirely identical with the N.S.D.A.P. in every concern of public or private life, and that meant with the will of its leader. (*See* GERMANY: *History*.)

Once firmly in power Hitler wished to secure his position against the left within his own party and against opposition from conservative circles without. Many of the adherents of National Socialism, especially in the SA, demanded radical social reforms. Hitler, on the other hand, wished to stabilize his revolution and to avoid alienating big business circles. The leader of the SA, Röhm, also wished to incorporate his semimilitary formations into the army, thus endangering Hitler's relationship not only with big business but also with the army leadership. The approaching crisis was heightened by the intraparty rivalries between Röhm on the one hand and Göring and Himmler on the other. The crisis was solved by the "blood purge" of June 30, 1934, when Röhm

and many other Nazi leaders were executed without trial. Hitler used the opportunity to have murdered a number of other prominent men whom he feared or disliked. Among these were Gen. Kurt von Schleicher, Hitler's predecessor as chancellor of the German *Reich*, and Gregor Strasser, who had been friendly to the trade-union movement.

National Socialism regarded Christianity from the beginning as an un-German faith. National Socialism was, in itself, a total creed centred upon Germanism and its unique and special mission bestowed upon it by nature and history. Though Hitler, for opportunist reasons, stressed his tolerance of the Christian church, or what he called "positive Christianity," true Christianity was incompatible with National Socialism as it is incompatible with Russian Communism, and the Nazis and the Communists knew it better and earlier than many Christians. The Vatican even signed a concordat with Hitler's government on July 8, 1933. But the concordat protected the Roman Catholic Church in Germany as little as it did the Protestant Church from constant interference and even persecution by the German authorities. Many Protestant ministers, though acknowledging the Nazi government's authority in all secular and political matters, denied it the right to interfere with the preaching of the gospel and with the internal administration of the church. They founded the *Bekennende Kirche* (confessing church), of which the best-known leader was Martin Niemöller.

The last conservative obstacle to Hitler's totalitarian police state was removed by the death of Hindenburg in his 87th year on Aug. 2, 1934. Hitler abolished the presidency and assumed the position of supreme commander. He now contented himself with the titles of *Führer* and *Reichskanzler*, leader and chancellor of the *Reich*. All troops and officials were immediately forced to take the oath of fidelity to Hitler personally. A plebiscite held on Aug. 19 confirmed these measures. Out of 43,529,710 votes 88.2% were cast in Hitler's favour.

In Power.—Outwardly, the Nazi party, following the pattern of the Communist party, was strictly centralized. Hitler's word was the supreme and undisputed command. The outward aspect of efficiency and unity was impressive. Nazi documents found after 1945 revealed, however, how much the party, like other totalitarian parties, was torn by internal dissensions and jealousies. There was constant overlapping and working at cross-purposes on all levels of the complex organizational system. The situation deteriorated when, after 1938 and especially with the progress of the war, the older, trained civil servants and army leaders were replaced by party members.

Opposition to the regime was broken either by outright terror or, more frequently, by the all-pervading fear of possible repression, even if no actual repression took place. As in the Soviet Union, all opponents of the regime were declared enemies of the state and of the people. An elaborate web of informers—often members of the family or intimate friends—working and reporting in secrecy imposed utmost caution on all expressions and activities. Justice was no longer recognized as objective but was completely subordinated to the alleged needs and interests of the "people." In addition, however, to the now debased methods of the normal judicial process, special detention camps were erected. In these camps—of which some, such as Dachau and Auschwitz (Oswiecim), achieved notoriety—the SS exercised supreme authority and introduced a system of sadistic brutality unknown in modern times and by far surpassing anything known in that respect in Fascist Italy or Communist Russia.

Resistance.—Church leaders participated actively in the resistance movement against Nazism. This movement never reached any popular dimensions and did not become active before the later years of the war into which Germany plunged Europe and the world. When the more rational leaders of the German army, together with members of the German official and educated class, recognized that Hitler was leading the Germans into defeat, they joined in a conspiracy that led to the attempt on July 20, 1944, to assassinate Hitler in his headquarters in East Prussia. The attempt miscarried, and the party took a frantic revenge on the conspirators. Many members of the German aristocracy and many high-ranking officers were executed, and the movement stressed again its antiaristocratic mass character as it had done at its beginning.

Turning Point; the War.—The history of National Socialism after 1934 can be divided into two parts of about equal length. The years between 1934 and 1939 were used to establish the full control of all phases of life in Germany by the party. The principal instrument of control was the unification of all the police, security and SS organizations under the direction of Himmler and his chief lieutenant, Reinhard Heydrich. The years between 1938 and 1945 witnessed the attempt to expand and apply the Nazi system to territories outside the German *Reich*. This attempt was confined, in 1938, to lands inhabited by a German-speaking population. In 1939 began the subjugation of non-German-speaking nationalities to the totalitarian Nazi police state. In 1945 this attempt collapsed.

The turning point in the brief but disastrous career of the Nazi regime in Germany was the year 1938. In that year the conservative influence in the two remaining bulwarks of an older, authoritarian but civilized Germany was ended—in the army and in the foreign office. In the same year, Hitler began German territorial expansion, carried through under diplomatic pressure, by "peaceful" means. In such a way he incorporated into the German *Reich* first the republic of Austria and then the Sudetenland (the German-speaking parts of the republic of Czechoslovakia).

By 1939 the military preparations, including the militarization of German life and education and the establishment of a war economy, had made such progress in Hitler's opinion that he could challenge the European order even at the risk of a second great war. On Aug. 23, Hitler, without consultation with his Italian and Japanese "allies," concluded a pact of friendship and nonaggression with the U.S.S.R. The pact contained a secret treaty between Germany and Russia partitioning Poland and dividing the whole of eastern Europe into spheres of influence. It was the first step opening the road into the heart of central Europe to Joseph Stalin and Russian Communism and the immediate prelude to World War II (*q.v.*), which began in Poland on Sept. 1.

To a certain extent World War II repeated the pattern of World War I: great initial German military successes; the forging of a large-scale coalition against Germany as the result of German pretensions and behaviour; the loss of the war because of German overreaching and conduct. (*See* also Germany: *History*.)

Ultimate Party Goals and Failure.—When Germany started World War II, it came as the logical outcome of Hitler's plans, known to the Germans since his publication of *Mein Kampf* (1926), and of his systematic preparations since 1933. From the beginning, National Socialism did not intend to establish a new order of authoritarianism and of inequality for Germany alone. Therein it again imitated Communism. Its dynamism was bound to expand and to spread. By its own nature it could not recognize any limits to its own volition, only limits set by opposed superior forces. Thus Hitler's first years were spent in preparing the Germans for the approaching struggle for world control and in forging that instrument which would enable Germany to establish its military and industrial superiority, and thus to fulfill its ambitions. With mounting success, the aims grew in quick progression. The first aim was to unite all people of German descent within their historic homeland on the basis of "self-determination." The next step foresaw the creation of a *Grosswirtschaftsraum* ("large economic unified space") or a *Lebensraum* ("living space"). (*See* GEOPOLITICS.) Thereby the Germans would acquire sufficient soil to become economically self-sufficient and militarily impregnable. There, the German master race or *Herrenvolk* would rule over a hierarchy of subordinate peoples and organize them with German ruthlessness and efficiency. The initial success of that plan in 1941 widened it into the vision of a hemispheric order that would embrace all of Europe, western Asia and Africa, and finally of a world order that would establish the principle of National Socialism all over the globe and give to mankind as a whole the "benefits" of a peace maintained by German bayonets and administered by a unified party bureaucracy.

The extreme neomercantilist economic self-sufficiency, protectionism and rejection of free trade, which received the new name

of *Wehrwirtschaft* ("defense" or "war economy"), was accompanied by an extreme cultural nationalist self-sufficiency and a resolute hostility against all western thought. The world rule to which National Socialism aspired would not only represent a military, economic and political domination, but equally an intellectual and moral leadership. The new world age or *Weltzeitalter* would be German and National Socialist at the same time.

These extravagant German hopes came to an end with Germany's defeat in 1945, after almost six years of war. Out of the ruins of National Socialist Germany there arose a divided and occupied Germany. The eastern provinces were put under Russian and Polish administration. The lands east of the Elbe, Saxony and Thuringia rivers, formed, under Russian occupation, a Communist-dominated state, called the German Democratic Republic. In western Germany, in close co-operation with the western democracies, the Federal Republic of Germany, under the chancellorship of Konrad Adenauer, came into being in 1949. Though a number of Germans remained faithful to National Socialism, its principles and dreams, even after Hitler's downfall, and though there were several attempts made to reorganize National Socialist groups in the Federal Republic of Germany, the political and mental climate there was not favourable to it, and it was hardly possible to speak of, or to expect, a revival of National Socialism in Germany.

See also references under "National Socialism" in the Index.

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(H. Ko.)

NATIVISTIC MOVEMENTS. Nativistic movements are efforts by members of a society to build for themselves a more satisfying way of life by eliminating foreign persons, customs, material objects or ideas. Such movements belong to the larger class of revitalization movements, all of which aim to better the life of a society, but not all of which are nativistic. Sometimes the term nativistic movement is used loosely to denote any type of revitalization movement. The term is largely restricted in usage to anthropologists and is therefore commonly applied to primitive peoples in contact with western civilization. Similar events occur, however, in western societies and are frequently studied by historians and sociologists, who employ a different vocabulary (sect formation, messianic movement, revolution, religious revival).

Revitalization movements occur in societies which have been subjected to stress and whose culture has suffered disorganization. The typical process of a revitalization movement (and therefore of a nativistic movement) may be divided into six states: (1) the inspiration of the prophet; (2) the preaching of the inspired new code; (3) the development of an organization of disciples and followers; (4) the modification of the new code to fit local and temporal requirements; (5) the transformation of the society's culture along the lines of the new code; (6) the redefinition of the new code as traditional and the translation of the revolutionary organization into a conservative status.

Generally speaking, nativistic movements are religious; the new (or revived) religion itself details the changes to be made in such secular affairs as political organization, family structure, economic pursuits, war and international relations. Revitalization movements may bring about drastic changes in culture in very short periods of time.

Typologies of nativistic movements have been developed. One such analysis divides them into four groups: (1) revivalistic-magical; (2) revivalistic-rational; (3) perpetuative-magical; and (4) perpetuative-rational. Another typology is based on the extensiveness of the new code's coverage of cultural categories. There exist also various culture-area classifications based on typical forms taken by nativistic movements in various regions.

Thus Melanesia, and especially New Guinea, has been since the latter part of the 19th century the home of various native cargo cults (*q.v.*), which emphasize the belief that a ship, with the ancestors as crew and passengers, is approaching with a cargo of European goods. On its arrival European personnel and native custom alike are to be cast aside and the cult members will enjoy the full benefits of European civilization without the interference of white masters. Some believers destroy much of their property in anticipation of the new wealth. Africa south of the Sahara is the home of hundreds of separatist churches with similar goals.

South American Indians have for centuries produced *terre sans mal* (literally, "land without evil") movements, based on the belief in a promised land, either on earth or on some other plane, to which the people can by religious ritual or physical migration actually translate themselves.

North American Indians have tended to produce revivalistic doctrines, emphasizing the spiritual purity to be achieved by following ancestral (or at least distinctively Indian) ways of ritual and daily life. In 1805 in Ohio the Shawnee prophet Tenskwatawa preached rejection of European mode of dress, of the use of alcohol and intermarriage with whites, and certain Indian practices such as witchcraft. The movement became an antiwhite religious crusade lasting until the War of 1812. The so-called Ghost Dance of the 1870s and 1890s is the best known example of a North American Indian nativistic movement. Although the prophet Wovoka was a Paiute, the Dance itself spread widely among tribes west of the Mississippi river. In essence the doctrine was millenarian: the world was soon coming to an end and the new dawn would see all Indians, dead and alive, reunited to live according to more or less aboriginal standards; in the meantime, the Indians were to avoid any sort of conflict, to dance and in trances induced by continued dancing to meet ancestors (ghosts) and supernatural beings. The second Ghost Dance received special notoriety from its association with the Sioux outbreak of the 1890s.

Theories about the causes of nativistic and other revitalization movements generally emphasize that individual psychophysiological stress is elicited by cultural disorganization and in turn motivates the prophet and his followers. For example, some U.S. Negroes called Black Muslims (*q.v.*) preached racial separation (paradoxically agreeing with anti-Negro whites) in apparent response to such stress.

See also GHOST DANCE; PEYOTISM; MYTH: *Millennialist Myths and Cargo Cults;* CARGO CULTS. Modern revivalism is discussed under REVIVALISM.

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(A. F. C. W.)

NATROLITE, a mineral species belonging to the zeolite group, is a hydrated sodium and aluminum silicate. Needlestone or needle zeolite are other names, alluding to the common shape (acicular habit) of the crystals, which are often very slender and are aggregated in divergent tufts. Larger crystals have the form of a square prism terminated by a low pyramid: the prism angle

being nearly a right angle, the crystals are tetragonal in appearance, though actually orthorhombic. There are perfect cleavages parallel to the face of the prism. The mineral also often occurs in compact fibrous aggregates, the fibres having a divergent or radial arrangement. Natrolite is usually white or colourless, but sometimes reddish or yellowish. The lustre is vitreous, or in finely fibrous specimens sometimes silky. The formula is $Na_2Al_2Si_3O_{10}\cdot 2H_2O$. The specific gravity is 2.2 and the hardness 5.5. The mineral is readily fusible. It is decomposed by hydrochloric acid with separation of gelatinous silica. *See* also ZEOLITE.

B. M. SHAUB

NATROLITE CRYSTALS FOUND IN CONNECTICUT

NATSUME SŌSEKI (pseudonym of NATSUME KINNOSUKE) (1867–1916) is by general consent the outstanding figure of modern Japanese literature. He was graduated from the English literature department of Tokyo university in 1893 and from 1900 to 1903 studied in England.

The influence of English literature is most conspicuous in his earliest published works, the satirical *Wagahai wa Neko de Aru* ("I Am a Cat," 1905) and *The Tower of London* (1905), but it can be traced through most of his later writings as well. To this knowledge of European literature Natsume brought an unusual understanding of Japanese *haiku* (*see* JAPANESE LITERATURE) and Chinese poetry, in both of which he excelled. His writings, indeed, represent one of the rare successful blendings of western novelistic techniques with Japanese traditions.

Natsume's reputation as a novelist was firmly established with *Botchan* (1906; Eng. trans., in part, by Watson, in D. Keene, *Modern Japanese Literature,* 1956) and *Kusamakura* (1907). In 1908 he left his post at Tokyo university, where he had been teaching English since 1903, in order to devote himself entirely to his novels, which were published serially in the *Asahi* newspaper. *Mon* ("The Gate," 1910) contains a first enunciation of Natsume's concern with egoism in human relations, a theme that was treated with increasing profundity and incisiveness in each of his successive novels and finally resolved in his principle of *sokuten kyoshi,* "to follow Heaven and depart from the self." *Kokoro* (1914; Eng. trans. by E. McClellan, 1957) and *Meian* ("Darkness and Light," unfinished at his death in 1916), perhaps Natsume's finest novels, deal largely with this same theme.

Natsume also wrote literary criticism, diaries and works, such as *My Individualism* (1915), in which he stated his philosophy. He died on Dec. 9, 1916, leaving behind many devoted disciples.

See Toyotaka Komiya, *Natsume Sōseki* (1953); Okazaki, *Japanese Literature in the Meiji Era,* trans. by Viglielmo (1955). (DD. K.)

NATTA, GIULIO (1903–), Italian chemist, co-winner, with K. Ziegler (*q.v.*), of the 1963 Nobel prize for chemistry for his fundamental work on olefin polymers, was born at Imperia, near Genoa, on Feb. 26, 1903. He obtained his doctorate in chemical engineering in 1924 at the Polytechnic institute of Milan. He held successively the chairs of general chemistry at the University of Pavia, physical chemistry at Rome university and industrial chemistry at Turin university, returning in 1938 to the Milan polytechnic as professor of industrial chemistry and director of the industrial chemistry research institute.

In industrial chemistry he was mainly interested in those organic reactions that proceed only at moderate or high pressures, with special concern for the kinetics and thermodynamics of the processes and the structure of heterogeneous catalysts. His work came to form the basis for the modern industrial syntheses of methanol, formaldehyde from methanol, butyraldehyde from propylene and carbon monoxide, succinic acid from acetylene and carbon monoxide, and synthesis gas.

He became best known for his discoveries after 1953, when he started intensive studies on macromolecular chemistry. These were initiated by knowledge, obtained through a licence arrangement between Ziegler and the Italian company Montecatini (of which Natta is a consultant), of Ziegler's discovery of the low-pressure synthesis of linear polyethylene of high molecular weight. By applying the Ziegler catalysts to the polymerization of propylene, Natta found in early 1954 that part of the polymer was highly crystalline, recognized that it must have been built up with a considerable degree of uniform three-dimensional, or steric, order and proved the structure by application of X-ray methods. The name "isotactic" (same shape) was coined to describe this particular symmetrical structure. Natta realized that the surface of the catalyst must also be highly regular to give rise to the isotactic polymer and then discovered variants of the Ziegler catalyst system that made possible the high-yield isotactical polymerization of propylene and other olefins.

The isotactic polymers, especially polypropylene, showed remarkable and unexpected properties of commercial importance, such as high melting point, high strength and the ability to form films and fibres. It was recognized that a new type of polymerization, termed co-ordination polymerization, was involved in these syntheses. In it the growth of the polymer chain occurs by insertion between the existing chain and the solid surface of the catalyst, which controls the geometry of the reaction. (In most earlier polymerization methods, the catalyst is remote from the growing end of the chain and has therefore no effect on reaction geometry.)

After 1954 Natta studied the mechanism of the reaction, its stereospecific aspect and the synthesis of many hitherto unknown catalysts and polymers, especially cis-1, 4-polybutadiene and the copolymer of ethylene and propylene, both of which were regarded as potentially important synthetic rubbers. (H. W. B. R.)

NATTIER, JEAN MARC (1685–1766), French painter, known for his portraits of the ladies of Louis XV's court in mythological attire, was born on March 17, 1685, in Paris, the son of Marc Nattier, a portrait painter, and of Marie Courtois, a miniaturist. He received his first instruction from his father and took the first prize at the Paris academy at the age of 15. He refused to study at the French Academy in Rome and in 1715 went to Amsterdam, where Peter the Great was then staying. There he painted portraits of the tsar and his wife, the empress Catherine, but declined an offer to go to Russia. Between 1715 and 1720 he painted the "Battle of Poltava" for Peter the Great, and the "Petrification of Phineus and of His Companions" (Tours museum), which led to his election to the Academy. The financial collapse of 1720 all but ruined Nattier, who was obliged to turn to portraiture. Notable examples of his straightforward approach are the "Marie Leszczinska" at the Dijon museum and "The Artist Surrounded by His Family," dated 1730.

Among his pictures are the "Magdalen," at the Louvre; "La Camargo" and "A Lady of the Court of Louis XV," at Nantes; the "Head of a Young Girl," at Orléans; and "Mme de Pompadour," at Marseilles. The Versailles museum owns a group of two ladies, and the Dresden gallery, a portrait of the Maréchal de Saxe. In the Wallace collection are "The Comtesse de Dillières," "The Bath (Mlle de Clermont)," "Portrait of a Lady in Blue," "Marie Leszczinska" and "A Prince of the House of France." Four portraits of the daughters of Louis XV, with the attributes of the four elements, are in the Museo de São Paulo, Braz.

He died in poverty in Paris on Nov. 7, 1766.

See Louis Dimier (ed.), *Les Peintres français du XVIII^e siècle,* vol. 2 (1930); P. de Nolhac, *Nattier, Peintre de Louis XIV* (1905). (M. N. B.)

NATURAL (in music): *see* ACCIDENTALS.

NATURAL GAS: *see* FUELS: *Gaseous Fuels.*

NATURALIZATION: *see* NATURALIZATION LAWS; CITIZENSHIP.

NATURALIZATION, PLANT AND ANIMAL. The term naturalization refers to the persistence of a species in the wild state in an adopted habitat where it eventually settles down as part of the local flora or fauna. The species in any region may be broadly classified as endemic or native and exotic or foreign.

The former are those species that either originated in that region during the course of evolution or that arrived there by natural migration from other centres of origin. They constitute the primeval flora and fauna of the region. The exotic group consists of all other species, the criterion being their observed introduction into that region. Because historical records are inadequate, some species may be misclassified as endemic, especially where civilization has been flourishing since ancient times. Such mistakes occur least in those regions recently colonized by the European: *e.g.*, Australia and New Zealand, where records are scientific and the endemic flora and fauna are fairly unique. The exotic species of a region include some or all of the domesticated species, whose persistence is entirely dependent upon the care of man; sporadic species that, though able to multiply, cannot maintain themselves in their new habitat but have to be steadily introduced afresh; and finally, the naturalized species. In the process of naturalization these species undergo somatic and genetic changes and often assume new population dynamics in their new environment, which in turn reacts on the ecology of the new habitat. (*See* also ACCLIMATIZATION.)

Introduction and Establishment of New Species.—In their movements about the world, men, both by accident and by design, have broken down many barriers that previously prevented the natural migration of species. The soil used in ships as ballast, vegetable material used as packing for goods, animal fodder and commercial seed supplies of crop and pasture plants all contained weed seeds which were distributed throughout the world. The ubiquitous naturalization of the black rat, brown rat, house mouse, European cockroach and housefly was directly effected by trade. For these animals the ship was not only a means of transport but also an environment to which they became naturalized, which allowed them to spread the more readily. Subsequently air travel removed the limitation of time that had hitherto obstructed the distribution of species unable to survive the long sea voyages. With the airplane the African malaria mosquito, *Anopheles gambiae*, gained entry into Brazil, where it soon became naturalized.

Many plants and animals were deliberately introduced from one country to another, some for domestication in the new country, and others directly for naturalization. Some plant species were brought in to grace the gardens of the colonists; others, such as the prickly pears in South Africa, the Malagasy Republic, India and Ceylon, and the eucalypti in California, were introduced for economic purposes. Most of the mammals, birds and fish were imported for the purpose of naturalization to provide game and to enrich the sources of meat and fur. In Australia and New Zealand, owing to the intense activity of the many acclimatization societies during the 19th century, almost every animal, bird or fish species of European and North American origin of interest to sportsmen was introduced with a view to attempting naturalization. Unfortunately, many of these introductions subsequently succeeded only too well (*see* below).

The second step toward naturalization is the establishment of a breeding stock big enough to ensure an initial reproductive rate greater than the initial death rate. The minimum size of the breeding stock depends on the breeding system and, in some cases, on the behavioural pattern of the species. For plants that reproduce vegetatively or by self-fertilization, and for those animals that can reproduce parthenogenetically, such as many species of insects, one specimen suffices. But for species that require cross-fertilization for reproduction at least two and often many more specimens are necessary to ensure establishment. The more social and potentially fertile a species, the smaller the population required for establishment. (J. R. Philip has given an excellent mathematical treatment of this.) According to G. M. Thomson, most plants that become naturalized are capable of self-reproduction and are prolific seed bearers.

In many cases therefore, establishment may be a limiting factor to naturalization. An introduction may fail partly because it consists of too few individuals. A later, ampler, introduction may well lead to naturalization. This happened with the rabbit in Australia and New Zealand, where several introductions were made before one became established. The naturalization of an introduced species may be limited indirectly by inbreeding degeneration, which reaches a peak in the second generation after introduction and may lead to failure, especially for species of low reproductive potential.

Ecology of Naturalization.—*Changes Effected by Man.*—When men colonize a new region, it becomes radically transformed. Lumbering, clearing, leveling, draining, firing, cultivating, stocking and many other tasks performed to make the land more habitable alter its physical and ecological aspects so much that many of the indigenous species succumb to or emigrate from the changed environment. In the old world these changes occurred long ago, so that many species have become adapted to the new habitats produced by the activities of man. Such species are commensals of civilization. Those that emigrated with the European to new continents were thus able to naturalize in the somewhat similar environments created by man in his new habitat. P. Dansereau in Canada and G. M. Thomson in New Zealand have observed that most naturalized plant species are of European origin, mainly weeds of cultivation or plants growing in waste places in both their original and adopted habitats. In classifying the 387 plant species that had become naturalized in the environs of Auckland, N.Z., T. F. Cheeseman found that 280 species were of European origin, only 14 North American and 19 Australian. This confirms that species best adapted to living in association with the European are most likely to become naturalized in regions colonized by him. Animal species in a close association with man in their original habitats maintain this close association in their new habitats. Thus, as western civilization spread, the housefly, the black and the brown rats, the cockroach and the English sparrow became naturalized.

Despite their worldwide distribution, domesticated crop plants have failed to naturalize. For in the process of being adapted as crops these plants have been much changed genetically through selection in an environment where competition from other species is minimized and inroads by animal pests and plant pathogens are constantly guarded against. Without man's care and protection, these species cannot survive. In contrast, many pasture plant species, *e.g.*, grasses and legumes, have been able to naturalize, no doubt because they have not been so highly selected.

Some domestic animal species that have escaped have been able to naturalize in exotic environments. G. G. Simpson discusses the spread of the horse on the American continent after its introduction by the conquistadores, Spanish explorers and colonists in the 16th century. Similarly, brumbies, the wild version of the domesticated horse in Australia, have spread to and inhabit some of the remote mountain areas. Escaped pigs and beef cattle both readily naturalize. Some of the wild pigs ranging over parts of New Zealand are probably the distant progeny of the pigs released by Capt. James Cook late in the 18th century. Although nominally domesticated, the beef animal raised on the open range in parts of the Americas and Australia really lives in the feral state, and may thus be considered as naturalized.

A few plant species whose original habitat is still primeval, uninfluenced by man's activities, have been able to naturalize in other regions, *e.g.*, a number of *Eucalyptus* species introduced from Australia into California to provide a source of hardwood. *Lantana* species, natives of Central America, have become naturalized in Hawaii, India and Australia, and the North American Monterey pine has succeeded in New Zealand. But none of these species has been able to enter into the primeval habitat in its country of adoption. Only in rare instances have plant species naturalized in the primeval habitat; P. Dansereau mentions the European flowering rush (*Butomus umbellatus*) that has colonized the silt margins of the St. Lawrence river system.

Naturalized faunal species are usually not so restricted to disturbed habitats as are the naturalized plant species. In New Zealand, the red deer, fallow deer, moose, elk, chamois and the Himalayan goat have all readily naturalized in the primeval mountain areas (G. M. Thomson). The various European trout species, carp and European perch have also been able to naturalize under primeval conditions of the streams in North America, Australia and New Zealand.

Response of Naturalized Species to the New Environment.—Physical aspects of the environment tend to be similar for the original and the new habitat for most naturalized species, since these are usually transposed into a climate similar to the original one. But the biotic aspects are often very different, especially for the species that naturalize in the primeval environment of the new region. While naturalized species have to cope with new competition, they often have the great advantage of no longer suffering the depredations of their original natural enemies. Sometimes they multiply so far as to attain plague proportions, which not only disturbs the previous ecological balance but also often disastrously upsets the economy of those who had introduced them.

Some species become physiologically more vigorous through naturalization. G. M. Thomson records the case of the European water cress, which is normally 2 to 4 ft. long in Europe but commonly reaches lengths of 12 to 14 ft. in New Zealand. Similarly, the spear thistle, which is 2 to 5 ft. tall in England forms impenetrable thickets some 7 ft. high in New Zealand. In its new habitat a naturalized species will eventually undergo evolutionary changes, at a rate depending on the genetic diversity of the introduced species and on its breeding system. Mutations and, for outbreeding species, genetic reassortment should restore normal levels of genetic variation in the naturalized species. Little evidence for evolutionary changes following naturalization has yet been obtained. Some changes in morphology and physiology, especially qualitative ones, can be shown to have a genetic basis, if the evolutionary transition occurs while the population is being observed. Otherwise comparative studies are required of representative samples of the naturalized and the endemic populations in a common environment; failing these the more subtle quantitative changes would remain unobserved.

M. A. C. Hinton cites a genetic change in a naturalized population of the black rat (*Rattus rattus*). In its native habitat of southeastern Asia, the black rat has a yellow to red-brown back and a white belly. It was introduced to western Europe during the crusades. Later records show that the now prevalent black form arose sometime during the 16th century. Similarly the black variety of the brown rat (*Rattus norvegicus*), which naturalized in western Europe during the 18th century, was first recorded in 1837 in Ireland. H. N. Barber found a genetic colour change in the naturalized European rabbit (*Oryctolagus cuniculus*) in Tasmania. Over most of the island the normal agouti variety is predominant. However in the rain-forest area in the north, which has been occupied by the rabbit only since clearing operations began in the 1920s, the rabbit population contains pockets with as high as 35% black rabbits.

Response of the Endemic Flora and Fauna.—Where naturalized species occupy disturbed habitats their intrinsic effect cannot be isolated from that caused by man's transformation of the environment. Only the cases involving naturalization in the primeval environment can be assessed. Native species may experience not only direct competition from the newcomer, but also more remote secondary effects.

According to G. M. Thomson the naturalization of perch, trout and carp in New Zealand waterways has led to the extinction of many endemic prey species such as the native crayfish (*Paranephros*) and the freshwater amphipods. The native grayling, kokopu, minnow and smelt also became extinct in some places, either because they fell prey to the naturalized European fish species or because they were starved out of existence by them. Some native species of plants with edible starch storage organs have been completely eaten out in parts of New Zealand by the wild pig and rat.

In some cases the endemic species have profited by the naturalization of exotic species. The New Zealand long-tailed cuckoo (*Urodynamis taitensis*) thrives upon many of the smaller birds of European origin and is becoming more prevalent. Some endemic plant-eating insects of New Zealand have taken to some naturalized plants species. The common grass grub (*Odontria zealandica*) feeds on naturalized and pasture species of European grasses and has increased sufficiently to become a serious agricultural pest.

Examples of Untoward Naturalization.—*Naturalization of the Rabbit.*—The most spectacular case history of animal naturalization is that of the European rabbit. Being highly adaptable, it has successfully colonized in places ranging from equatorial Uganda to the bleak Tierra del Fuego, Chile, and from the rain forests of northern Tasmania to the semidesert areas of inland Australia.

The rabbit, a native of Mediterranean Europe, spread to England during the 12th century, probably having been taken there by the Normans from France. It was highly prized for its meat and fur—reasons why it was introduced to Australia, New Zealand and Chile. Not until recent times has the rabbit been duly recognized as a destroyer of crop and pasture.

After a number of unsuccessful attempts to naturalize rabbits in Australia, an introduction of 24 wild rabbits from England, released near Geelong, Victoria, in 1859, established a population that in the short space of 70 years spread over most of the continent in such high numbers as completely to eat out large sections of the semiarid pastoral country. Removal of plant cover exposed these lands to wind erosion. In the wetter areas, overgrazing and burrowing in the hills caused serious water erosion. The loss to agricultural and pastoral production led to rabbit control measures, which, after the mid-19th century, became an integral part of rural management and were enforced by legislative action after 1876.

Naturalization of the Prickly Pear.—The widespread introduction of the prickly pear, likewise, caused much economic damage. The prickly pear belongs to the cactus genus *Opuntia*, native of the arid warm temperate-to-subtropical America. It was once important for the now obsolete cochineal dye industry, as a source of food for the cochineal insect that produced the dye, and had therefore been widely transplanted. It was introduced into the Mediterranean region soon after the discovery of the new world, where it naturalized in waste places and was valued for its fruit. It is also naturalized in South Africa, India, Ceylon, the Malagasy Republic and Australia. While the fruit forms an essential item of the natives' diet in the Malagasy Republic, its naturalization in Australia was disastrous. Millions of acres of good pastoral land in Queensland and northern New South Wales became densely infested with the prickly pear. The situation appeared hopeless until the advent of biological control methods.

Biological Control.—Grave economic threats may result from accidental or uncontrolled naturalization of plants and animals. Various governmental authorities have therefore established quarantine facilities and regulations. To cope with already naturalized species, biological controls have been developed. These rest on the assumption that where naturalized species multiply excessively this happens only because the new habitat lacks their natural enemies: if these are introduced, a naturalized species that has reached plague proportions may be cut back to the level of reproduction that obtains in its country of origin. There are attendant risks in that the predator species itself may in turn become a pest. A thorough prior study must be made of the likely predators, to ensure they will not attack species of value.

The naturalization of the fox in Australia, following its introduction in 1868 for the dual purpose of controlling the rabbit and providing sport, was a total failure as far as the former aim was concerned. Instead the fox itself became a serious pest, preying upon the native marsupials and birds. Similarly, the introduction of the butterfly *Thecla echion* into Hawaii to control *Lantana* was unwise because the butterfly also attacks the egg plant. In the long run biological methods afford by far the most economic way of controlling naturalized plant and animal species that have become pests. Two examples are outstanding: myxomatosis and the European rabbit; and cactoblastis and the prickly pear.

Myxomatosis and the Rabbit.—Myxomatosis is a rabbit disease caused by infection with the myxoma virus. The myxoma virus is endemic to the American continent, where the Brazilian wild rabbit (*Sylvilagus brasiliensis*) is the only natural host known. The virus is a specific parasite of the rabbit and is transmitted by the mosquito and the rabbit flea. Typical of well-adjusted parasites, the myxoma virus induces only a very mild form of the disease in the Brazilian wild rabbit. However, when contracted by the

European wild rabbit, myxomatosis proved to be highly lethal, the mortality being as high as 99.8%.

The first suggestion that this disease should be tried out for controlling the rabbit in Australia was made in 1918. Some myxoma virus was accordingly sent to Australia in 1926, but the disease failed to establish itself. After extensive host range studies (conducted by Sir Charles Martin at Cambridge, Eng., and sponsored by the Australian government) showed that only rabbits were susceptible to myxoma virus, further laboratory and field trials were made in Australia between 1936 and 1943. But the disease established itself only locally in some of the release areas, and failed to develop into an epizootic. Nothing further was done until 1950, when the Australian government requested the Wildlife Survey section of the Commonwealth Scientific and Industrial Research organization to try introducing the disease again.

Seven liberations of the virus were made in 1950, one of which was successful and the disease spread rapidly. By the third year of the epizootic, the rabbit population in southeastern Australia had been reduced by about 80%.

The myxoma virus has since been released in a number of other countries. The European epizootic was started by a private individual, A. Delille, who obtained some myxoma virus from a laboratory in Switzerland and in June 1952 injected two rabbits with it. These were released on his private estate near Paris, where, within a month, almost all the rabbits were wiped out. The French authorities tried to stamp out the disease, but by the end of 1953 myxomatosis had spread throughout France and into Belgium, Luxembourg, the Netherlands, Germany and Spain and had even crossed the channel. In 1954 the disease was successfully established in Tierra del Fuego by the Chilean government. In New Zealand and Tasmania, myxomatosis failed to assume epizootic proportions, in spite of repeated attempts to establish it.

It is believed that the relief from the rabbit problem afforded by myxomatosis may be only temporary. In Australia less virulent strains have come to the fore. Mortality has declined from 90% to 30% in seven years. Further attempts to reestablish control by the release of new virulent strains of myxoma virus have failed.

Cactoblastis and the Prickly Pear.—In 1920 the Commonwealth Prickly Pear board was formed in Australia to investigate the possibility of biological control of the prickly pear. Insects (both local and foreign) that attack the plant were studied. About 50 species from the United States were selected and sent to Australia for further tests under quarantine. Twelve of these were found suitable: they attacked no other plants. Moreover, during quarantine any parasites from abroad were wiped out. Some of these species naturalized and multiplied rapidly at the expense of the prickly pear. Then in 1925, a moth, *Cactoblastis cactorum*, was introduced from Argentina, multiplied in quarantine and set free in 1926. From 1927 onward eggs were collected in the field for distribution to other localities. By 1933 the last stand of the original infestation had been destroyed. Both plant and predator survive at low levels in a dynamic balance. Thus 22,000,000 ac. of land were reclaimed for agriculture.

Summary.—Man has had cause to regret some of his introductions. In addition to the unfortunate cases of the rabbit and prickly pear in Australia, man is responsible for the starling surfeit in the United States and the widespread depredations of the Indian mongoose in Hawaii and parts of the West Indies. These large-scale but unplanned experiments in ecology have alerted many to the dangers inherent in thoughtless programs of plant and animal introductions. But on the other hand man could not survive in his present state without reliance on the introduced cultigens, improved crop plants, that serve as his basic food. And life would be less pleasant without the plants and animals that have been widely introduced for sport, aesthetics or sentiment. *See* also MIGRATION, ANIMAL.

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NATURALIZATION LAWS. Naturalization is the act of investing an alien with the status of a national in a given state. It takes place whenever a new nationality is acquired by a person after his birth. It may be accomplished as the result of voluntary application, special legislative direction, marriage, parental action or annexation of territory. The conditions under which the privilege of naturalization will be granted are fixed by the laws of each nation. International law, however, imposes some limits on the power of a state to naturalize persons, especially nonresidents.

UNITED STATES

The constitution of the United States, art. 1, sec. 8, clause 4, authorized congress to "establish an uniform Rule of Naturalization. . . ." Congress fulfilled that mandate by enacting naturalization statutes, beginning in 1790, to establish the conditions under which aliens might be admitted to citizenship. The opportunity to become naturalized is not a constitutional right but a statutory right contingent upon establishment of the requisite facts. The requirements for naturalization have never been exacting, and the consistent national policy has been to encourage the naturalization of all qualified aliens. That policy aided in developing the strength of the United States, whose growth resulted largely from the contributions of millions of immigrants and their descendants. It marked a departure from existing British policy under which naturalization was only sparingly granted by special acts of parliament.

Naturalization by Court Process.—The principal method of acquiring a new nationality is through voluntary application in the manner provided by law. Most countries authorize the grant of citizenship by an administrative official. In the United States, however, naturalization from the first has been a function of the courts. Congress conferred power to grant naturalization upon all federal district courts and upon state courts of unlimited jurisdiction that have a seal and a clerk. An applicant may appeal to the higher courts from a decision rejecting his petition. The government is a party in every naturalization case and may appeal when it deems that naturalization was improperly awarded.

The principal disqualification for naturalization was directed against some racial groups. Originally the statutes permitted the naturalization only of "free white persons." In general, since 1790, naturalization legislation has extended rights to greater segments of alien people.

In 1952 the Immigration and Nationality act of that year (popularly known as the McCarran-Walter act) was passed over President Truman's veto. It was a comprehensive codification and revision of prior immigration, naturalization and nationality laws. It provided that "The right of a person to become a naturalized citizen . . . shall not be denied . . . because of race or sex or because such a person is married." But aliens identified with certain proscribed organizations, activities or beliefs at any time during the ten years immediately preceding the petition for naturalization, or after filing the petition and before taking the final oath of citizenship, were disqualified. However, these disqualifications did not apply if the alien could prove that his membership or affiliation in a proscribed organization was involuntary; or that it terminated before he reached the age of 16; or that it was by operation of law; or was for the purpose of obtaining employment, food or other essentials of living. Naturalization cannot be granted to an alien who claimed exemption from military service on the ground that he was an alien. Nor can it be granted to a person who, during time of war, was convicted of desertion from the armed forces of the United States or of leaving the country to avoid the draft.

Several basic qualifications always have been prescribed, vir-

tually without change, in the statutes relating to naturalization. It is important to bear in mind that these are general requirements which often have been modified with respect to special persons whom congress desired to favour.

First, the applicant for naturalization must be at least 18 years old and must have resided in the United States for at least five years following a lawful admission for permanent residence. He must have been physically present in the United States for periods totaling at least half of the five years preceding the filing of his petition for naturalization. Lesser periods of residence, and in some cases no fixed residence requirements, are prescribed for naturalization applications by wives and children of U.S. citizens, former citizens and persons who serve in the armed forces or the merchant marine and other special categories. Absence from the United States for a period of more than six months raises a presumption that the residence in the United States has been abandoned; a year's absence is regarded as conclusive. Exceptions are made for persons employed abroad by the U.S. government and certain U.S. organizations, provided the employees obtain prior approval from the attorney general.

Second, the applicant must establish that he is, and was during the requisite period of residence, a person of good moral character. Persons who have committed serious crimes during that period generally are barred.

Third, the applicant must establish that he is, and was during the requisite period of residence, attached to the principles of the constitution of the United States and was well disposed to the good order and happiness of the United States. The latter requirement was designed to exclude from citizenship aliens hostile to the United States and its institutions. For many years the courts also interpreted this requirement as forbidding the naturalization of conscientious objectors to military service. In 1946, however, the supreme court, reversing its earlier holdings, determined that conscientious objectors might be naturalized (*Girouard* v. *United States*, 328 U.S. 61 [1946]). The 1952 act permitted naturalization of persons who refused on religious grounds to bear arms. Even if a conscientious objector does not promise to bear arms, he may be compelled to do so after naturalization.

Finally, the applicant generally must meet several educational requirements. He must demonstrate an understanding of the English language, including an ability to read, write and speak words in ordinary usage. He must sign the petition for naturalization in his own handwriting if he is physically able to write, and must demonstrate some understanding of the constitution and form of government of the United States.

While the ultimate power to grant or deny naturalization is conferred upon the courts, the law vests in the immigration and naturalization service of the department of justice administrative supervision over the naturalization process. The service, headed by a commissioner of immigration and naturalization, is under direction of the attorney general and is organized into 16 district offices as well as numerous suboffices throughout the United States. The immigration and naturalization service is given broad legal authority to receive applications, interrogate the applicants and their witnesses and make recommendations to the naturalization courts. This administrative function is designed to aid the courts in discharging their responsibilities in granting or denying naturalization.

Naturalization Process.—The naturalization process begins with the filing of an application or petition for naturalization with the immigration and naturalization service. A declaration of intention, popularly known as "first papers," is no longer required. Prerequisites to the filing of such an application are attainment of the age of 18 and lawful entry into the United States for permanent residence. The procurement of an official certificate establishing such entry is not necessary. Proof of lawful entry can be made directly from visa records.

The next step is a personal investigation of the alien by the immigration and naturalization service unless the investigation is waived by the district director of the service. The applicant then files a petition for naturalization in the office of the clerk of the court. The petition is signed and sworn to by the petitioner and his two witnesses. The heart of the naturalization procedure then takes place; *i.e.*, a preliminary examination by an employee of the immigration and naturalization service. The petitioner is then notified to appear before a judge for final hearing. At the final hearing a representative of the immigration and naturalization service appears and must recommend either that the petition be granted or that it be denied.

If the court grants the petition, the petitioner takes an oath in open court forswearing all foreign allegiance and pledging allegiance to the United States. The judge then signs an order admitting him to citizenship. Thereafter the newly invested citizen receives an official certificate of naturalization. The fee of $10 must be paid to the clerk of court at the time of filing the petition for naturalization. No further fee is prescribed for the final hearing or for issuance of the certificate of naturalization.

A naturalized citizen acquires status equal to a native-born citizen, except that he is not eligible to become president of the United States. However, even after naturalization is finally granted, it may be revoked through a judicial proceeding. The statute authorizes such revocation only on the ground of "concealment of a material fact or . . . willful misrepresentation." A "material fact" would seem to be one which, if known at the time of naturalization, would have prevented the granting of the petition. This would include insufficient period of residence, illegal entry and any fact showing lack of good moral character, such as a past criminal record.

Other Forms of Naturalization.—Another method of acquiring citizenship is by derivation through a husband or parent. Prior to Sept. 22, 1922, marriage to a U.S. citizen or the husband's naturalization conferred U.S. citizenship upon an alien wife. The Cable act of that date abolished the joint citizenship of husband and wife and enabled a wife to choose her own nationality. Citizenship status previously acquired, however, was not affected.

A child under 16 years of age acquires U.S. citizenship through the naturalization of his parents if the child is residing in the United States or if he subsequently resides in the United States before his 16th birthday. Derivation takes place only if both parents become naturalized, unless one parent is dead or there has been a divorce or legal separation, in which event the naturalization of the parent having legal custody is sufficient.

A person who has acquired U.S. citizenship by derivation may apply to the commissioner of immigration and naturalization for a certificate recognizing that status. The fee for this application is $5. Upon presentation of proof establishing a valid claim to U.S. citizenship, the commissioner issues a certificate of citizenship to the applicant.

Congress also may grant citizenship by special legislation. In some instances, so-called private bills have been enacted conferring citizenship rights upon named individuals. Much more common has been the award of collective naturalization to large groups of noncitizens, particularly the inhabitants of U.S. territories and possessions.

The nationality status of the inhabitants of certain acquired territories was fixed by the treaty-making power of congress. Statutes have from time to time effected collective naturalization either prior to or upon the admission of territories to statehood. Such action was taken in territory acquired under treaties concluded with Great Britain (territory of Michigan, 1794, 8 Stat. 116); France (Louisiana, 1803, 8 Stat. 200); Spain (Florida, 1819, 8 Stat. 252); Mexico (Guadalupe Hidalgo, 1848, 9 Stat. 922; Gadsden, 1853, 10 Stat. 1031); Russia (Alaska, 1867, 15 Stat. 542); and Denmark (Virgin Islands, 1916, 39 Stat. 1706).

In the absence of definite treaty stipulations, citizenship has been conferred upon inhabitants of acquired territory by legislative enactments. In this category were the Hawaiians (act of April 30, 1900, 31 Stat. 141); Puerto Ricans (sec. 5 and 5[a], act of March 2, 1917, as amended, and sec. 202, Nationality Act of 1940); Virgin Islanders (act of Feb. 25, 1927); Guamanians (act of Aug. 1, 1950, 64 Stat. 385); other outlying possessions, provided one parent of the child born in such possessions is a citizen who has been physically present in the United States or in one of its outlying possessions for at least one year prior to the birth of the child (Immigration and Naturalization act of 1952). Finally,

U.S. citizenship was conferred collectively through the political incorporation of the original states into the United States; in the case of Texas, upon its annexation and direct admission into the union; upon American Indians born in the United States through special legislation on June 2, 1924; and upon a member of an "Eskimo, Aleutian, or other aboriginal tribe" by the 1952 act.

Full status as U.S. citizens, however, was not conferred on all the inhabitants of U.S. territorial possessions. Complete citizenship rights were extended to inhabitants of Alaska and Hawaii (before statehood), and to Puerto Rico, the Virgin Islands and Guam; but the natives of other possessions such as American Samoa were regarded as noncitizen nationals of the United States, entitled to U.S. protection but not to full citizenship status.

(J. Mak.; E. G. H.)

COMMONWEALTH OF NATIONS

United Kingdom.—General statutes providing for the naturalization of aliens were in force in England, Scotland, and Ireland in the 17th and early 18th centuries but were repealed or fell into disuse during the latter century. Thereafter naturalization was by private act of parliament. The practice of including the names of groups of applicants in a single private act made obsolete the ancient institution of letters of denization. The Aliens act, 1844, which reintroduced general naturalization under administrative regulations rather than by statute, rendered private naturalization acts unnecessary. Instances of such acts became increasingly rare, the last being, apparently, that passed for the benefit of Lord Acton in 1911.

In the history of the United Kingdom, naturalization or denization has always been by grant; *i.e.*, it has been a matter of executive discretion rather than, as in the United States, the right of an applicant who can satisfy customary or statutory requirements. British naturalization, further, has been traditionally a local matter. Thus naturalization in Ireland or in a colony generally conferred no status valid in Great Britain and did not entitle the naturalized person to British protection abroad. This state of affairs persisted into the 20th century, although it appears to have been generally accepted that a person naturalized in the United Kingdom under the act of 1844 or under its successor, the Naturalization act of 1870, was entitled to the status of a British subject in any colony. By the British Nationality and Status of Aliens acts, 1914–43, however, an imperial certificate of naturalization was introduced. It could be granted in the United Kingdom with the consent of the secretary of state, in India, in any colony and in such of the self-governing dominions as adopted the act; it could be granted without the concurrence of the secretary of state. Despite this creation of a common status of British subject by naturalization comparable to the common status of British subject acquired by an individual through his own birth or the birth of his father anywhere within the territories under the dominion of the crown, local naturalization persisted. Thus in the Union of South Africa purely local provision was made in 1924 and 1928 for the German population remaining in South West Africa. Local naturalization continued also in India because of the inability of some applicants to satisfy the requirement of an adequate knowledge of English imposed in connection with the grant of imperial certificates. Both in the United Kingdom itself and in New Zealand, special provision of an exclusively local character was made for the members of the Free French forces during World War II.

The act of 1914 was in any event repealed by the British Nationality act (1948) of the United Kingdom and by the corresponding legislation of others parts of the commonwealth. These measures effected not only a complete reversion to a system of local naturalization, but also a complete recasting of the earlier law as to the acquisition of British nationality by birth. Under these enactments the status of a British subject (or commonwealth citizen) entails the citizenship of at least one part of the commonwealth; *e.g.*, citizenship of the United Kingdom and colonies, Canadian citizenship, Australian citizenship, etc. A person may possess more than one such local citizenship; *e.g.*, a person born in Australia of a father born in the United Kingdom has both Australian and United Kingdom citizenship. In the law of the United Kingdom and colonies, a person who is a British subject by virtue of his possession of citizenship of another part of the commonwealth and who is also a citizen of Ireland is entitled to local citizenship as of right if he has been ordinarily resident locally for 12 months or for such shorter period as may be accepted in his particular case, or if he is in crown service under the local government. The possibility of an individual's availing himself of this right is, however, considerably lessened by the provisions of the Commonwealth Immigrants act, 1962, which may exclude him from acquiring the necessary residential qualification. Acquisition of citizenship of the United Kingdom and colonies, moreover, may, and usually does, involve automatic forfeiture of citizenship of another commonwealth country. The other countries of the commonwealth are not in any event so liberal toward applicants for citizenship; they ordinarily accord to persons who are already British subjects or Irish citizens at most a species of preferential treatment in the matter of naturalization. In nearly all of them, however, the process whereby a citizen of another such country or of the Republic of Ireland is admitted to citizenship is now officially termed registration rather than naturalization (the same terms apply to a woman who has married a local citizen and to a minor child).

Despite the changes described, the general statutory conditions for the naturalization of aliens in the United Kingdom, which apply uniformly in the colonies and in certain protectorates, have not altered materially since 1870. An applicant must be of full age and must have resided in the place of application or have been in crown service under the appropriate government, or partly the one and partly the other, for 12 months immediately preceding his application. He must adduce further periods of residence or service amounting to an aggregate of 4 years falling within the 7 years preceding this period of 12 months. The secretary of state has, however, certain discretion to vary the periods and types of residence or service normally required. The applicant must in addition be of good character, must have a sufficient knowledge of English and must intend to reside in the United Kingdom or colony, or to enter or to continue in crown service, service of an international organization of which the United Kingdom is a member, service of a person or body established in the United Kingdom, etc. A British-protected person (*i.e.*, a person belonging to a protectorate, protected state or trust territory under United Kingdom administration) is still technically an alien, although exempt from the alien restriction acts and thus entitled as of right to land or to reside in the United Kingdom subject to the provisions of the Commonwealth Immigrants act. Such a person is eligible for naturalization upon the same terms as any other alien except that he need only have been ordinarily resident for 12 months, or for such shorter period as may in a particular case be accepted, immediately preceding his application, or be actually in crown service.

The grant or refusal of any application for naturalization, or of citizenship registration by or on behalf of a minor still remains a matter of complete discretion, as it does for those of age (see above). A minor who is adopted by a male citizen of the United Kingdom and colonies, however, acquires the status of his adoptive parent automatically. A woman married to a citizen of the United Kingdom and colonies, whether she be an alien or already a British subject or Irish citizen, neither acquires the status of her husband automatically nor is eligible therefor by naturalization, but is entitled to obtain it by registration as of right without satisfying any condition as to residence.

A citizen of the United Kingdom and colonies by naturalization, while he remains such, possesses exactly the same status as a person who becomes a citizen by any other means (*i.e.*, by birth, descent, incorporation of territory, registration or adoption). But he may be deprived of it if: (1) his certificate was obtained by fraud, etc.; (2) he has shown himself by act or speech disloyal or disaffected toward the sovereign; (3) he has been guilty of trading with an enemy during war; (4) he has within 5 years of his naturalization been sentenced to imprisonment for upward of 12 months; (5) he has been ordinarily resident abroad for a continu-

ous period of 7 years including neither crown service nor service of an international organization of which the United Kingdom is a member and has failed to register annually at a British consulate. Where the ground of deprivation is other than the last, the deprivation either may or must be preceded by a quasi-judicial inquiry. A citizen by registration may be deprived of his status only if he has obtained registration by fraud, etc., or if, having acquired citizenship of another country of the commonwealth by naturalization, he has been deprived thereof upon grounds similar to those laid down for deprivation of naturalization in the United Kingdom and colonies.

Other Countries of the Commonwealth.—Although in a sense the British Nationality act of 1948 is the agreed model for legislation elsewhere, the requirements for naturalization and registration laid down by other commonwealth countries sometimes depart considerably from those of the parent act. The apparent conditions are moreover most misleading unless read in the light of the immigration laws, the effect of which may well be to exclude some categories of applicants altogether. It has also to be borne in mind that the voluntary acquisition (otherwise than by marriage) of citizenship of any country outside the commonwealth (and often of any country whatsoever) is a ground for the discretionary, if not the automatic, deprivation of citizenship of every country of the commonwealth overseas, irrespective of the means of acquisition of such citizenship. Further, intolerance of multiple status goes so far in some commonwealth countries that local citizenship may be withdrawn from a person who merely retains a previous citizenship rather than acquires a new one.

Canada.—The process of acquisition of citizenship otherwise than by birth, applicable to British subjects, Irish citizens and aliens alike, is by discretionary grant of a certificate. An applicant must be of full age or be the resident spouse of a Canadian citizen. An applicant other than the wife of a Canadian citizen, or a minor child, must have acquired Canadian domicile; *i.e.*, must have resided for five years after lawful admission for permanent residence. A certificate of citizenship may be revoked (1) for evasion of trial for an offense against the state; (2) for obtaining the certificate by fraud, etc.; (3) for disloyalty or disaffection; (4) where the holder has been ordinarily resident abroad for six years (or in any foreign country of which he was formerly a national for two years) without maintaining substantial connection with Canada.

Australia.—An alien applicant for Australian citizenship by naturalization must file a preliminary application or "first papers," as was formerly required under the law of the United States, and must show that he has an adequate knowledge of the responsibilities of citizenship. The remaining requirements imposed on him are substantially the same as those laid down in the law of the United Kingdom and colonies. Although a British subject or an Irish citizen acquires Australian citizenship by registration rather than by naturalization, the process is still discretionary and the conditions therefor are exactly the same as those for the naturalization of aliens, except that the requirement of "first papers" is waived and that the residence requirement may be reduced to a period of one year. The spouse of an Australian citizen or a minor child may be granted a certificate of registration at discretion without any residential or other qualification.

New Zealand.—In New Zealand the law governing the acquisition of citizenship by registration and naturalization and the loss of citizenship so acquired is virtually identical with that of the United Kingdom and colonies except that an alien woman other than a British-protected person married to a New Zealand citizen can acquire citizenship by registration only at discretion, and that "first papers" and an adequate knowledge of the responsibilities of citizenship are required of an applicant for naturalization.

Ceylon.—Naturalization as such is unknown in the law of Ceylon. Citizenship by registration is available as of right to certain categories of persons of Ceylonese descent and at discretion to spouses of citizens who shall have been resident one year. These cases apart, not more than 25 certificates of registration may be granted in any one year, and these only to persons rendering eminent public services or naturalized in Ceylon before its achievement of independence. Special provision has been made, however, for the admission to citizenship of resident Indians and Pakistanis.

India and Pakistan.—Aliens may be naturalized after five years' residence but generally only if they be citizens of countries which permit the naturalization of Indians or Pakistanis. What degree of preferential treatment in obtaining citizenship by registration is accorded to British subjects other than persons of local descent, or wives or minor children of citizens, was obscure in the 1960s.

Ghana.—An alien other than a British-protected person may be naturalized at discretion in Ghana if he has been resident six years. A British subject or British-protected person may similarly become a citizen by registration upon residence for five years or for such shorter period as may be accepted.

Malaysia.—Discretionary naturalization is the ordinary means of acquiring citizenship of Malaysia by aliens, British subjects and Irish citizens. Citizenship by registration is available, normally as of right, to wives and resident children of citizens. An aggregate of ten years' residence is ordinarily required as a condition of naturalization. But persons who have served in the armed forces for specified periods are entitled to naturalization as of right without any condition as to residence.

Before Malaysia became an independent federation in 1963, citizenship by registration was available in Singapore virtually as of right to persons born in the Federation of Malaya, citizens of the United Kingdom and colonies and, at least potentially, to citizens of any other country of the commonwealth or of the Republic of Ireland. The residence qualification in this connection was two years. Minor children and women married to citizens were admissible to citizenship by registration at discretion. Naturalization was available at discretion to aliens resident for an aggregate of eight years.

Others.—The naturalization laws of countries such as Uganda, Cyprus and Malta did not differ materially from the general pattern, but there was considerable variation in detail among them; by the mid-1960s they had not achieved their permanent form.

(C. Py.)

OTHER COUNTRIES

Since it is for each state to determine under its own law who are its nationals, a great variety of solutions can be found in the laws concerning nationality and naturalization enacted by the various countries of the world. Such legislation is recognized by other states, insofar as it is consistent with international conventions, international custom and the principles of law generally recognized with regard to nationality (*cf., Hague Convention on Double Nationality*, art. 1; April 12, 1930).

Normal and exceptional grounds are often provided side by side. In normal cases a certain period of residence, which varies from 2 to 15 years, intention to reside permanently, a minimum age, capacity to act according to the law of the state of the former nationality or of the state applied to or of both, good character, physical and mental health, a sufficient command of the language of the prospective adopting country and the ability to earn a livelihood or to support himself are the usual requirements, coupled with evidence that, upon naturalization, the applicant will lose his former nationality or has taken steps to renounce it.

Preferential treatment, consisting in the reduction or waiver of the residential qualification, is frequently accorded to husbands or to wives of nationals and to their children, if they do not acquire the nationality of the head of the family automatically or by way of option, and to ethnically related groups. Previous possession of the nationality of the naturalizing country is in some instances an advantageous and in others a precluding factor. Underdeveloped countries facilitate the naturalization of skilled persons, including teachers, and of those who contribute to the establishment of industry or invest in land. Some countries, which do not regard birth within the jurisdiction as a ground for the acquisition of citizenship at birth, permit persons born within the jurisdiction to assume local nationality unconditionally or be subject to less stringent conditions.

Government service at home or abroad, or service with the armed forces, is in some countries a ground for automatic or pre-

ferred naturalization. Distinguished services rendered to the state may be regarded as a reason for waiving all the usual requirements, but in these circumstances the power to naturalize appears to be mostly reserved for the legislature, except in countries where the head of state exercises very wide powers. While the power to grant naturalization rests with the legislature in a small number of countries, it is usually vested in the executive. However, in countries influenced by the practice in force in the United States, it is a function entrusted to the judiciary. In some countries two procedures exist, depending upon the grounds for and the effects of the naturalization in question. Revocation of naturalization is almost uniformly provided for, if the grant was obtained by fraud or if the grantee resides abroad for a prolonged period without special authorization.

According to international law naturalization must be, and is, with few exceptions, the result of a voluntary act, which may be express or implied, on the part of the person seeking a new nationality. In face of the great diversity of provisions which permit the grant of local nationality to an alien, it must not be overlooked that, following the decision of the International Court of Justice in the Nottebohm case, a state may not be able to assert its right of protection on behalf of a naturalized subject unless a genuine link existed between the naturalizing state and the new citizen at the time when naturalization was granted.

See also MIGRATION; NATIONALITY. (K. LI.)

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NATURAL LAW, or LAW OF NATURE, a term used, not always in the same sense, to denote a system of right or justice held to be common to all mankind and so independent of positive law. The use of the term in the natural sciences (physics, etc.) to mean the statement of predictable relationships among and between phenomena is wholly distinct.

The article JURISPRUDENCE deals with natural law in juristic philosophy; and the article ETHICS, HISTORY OF, deals with ideas of nature and of right in connection with ideas of good and of the moral conscience. Here it may be useful to remark some points of difference between thinkers on the subject as they arise from different approaches to "nature."

Aristotle held that what was "just by nature" was not always the same as what was "just by law"; that there was a natural justice valid everywhere with the same force and "not existing by people's thinking this or that"; and that appeal could be made to it from the positive law. He drew his instances of the natural law, however, chiefly from his observation of the Greeks in their city states, with their subordination of women to men, of slaves to citizens and of barbarians to Hellenes. The Stoics (*q.v.*), on the other hand, conceived an entirely egalitarian law of nature in conformity with the "right reason," or *logos,* inherent in the human mind; and Cicero wrote of a "true law, right reason, diffused in all men, constant and everlasting." The Roman jurists paid lip service to this notion, and St. Paul seems to reflect it when he writes of a law "written in the hearts" of the Gentiles (Rom. ii, 14–15).

St. Augustine of Hippo took up the Pauline mention and developed the idea of a man's having lived freely under the natural law before his fall and his subsequent bondage under sin and the positive law. Gratian in the 11th century simply equated the natural law with the divine law, that is, with the revealed law of the Old and the New Testament, in particular the Christian version of the Golden Rule (*q.v.*).

St. Thomas Aquinas (*q.v.*) propounded an influential systematization. The eternal law of the divine reason, he maintained, though it is unknowable to us in its perfection as it is in God's mind, is yet known to us in part not only by revelation but also by the operations of our reason; and the law of nature, which is "nothing else than the participation of the eternal law in the rational creature," comprises those precepts that mankind is thus able to formulate, namely, the preservation of one's own good, the fulfillment of "those inclinations which nature has taught to all animals" and the pursuit of the knowledge of God. Human law must be the particular application of the natural law.

Other scholastic philosophers, for instance John Duns Scotus, William Ockham and, especially, Francisco Suárez, emphasized the divine will instead of the divine reason as the source of law. This "voluntarism" influenced the Catholic jurisprudence of the Counter-Reformation, but the Thomistic doctrine was later revived and reinforced to become the main philosophical ground for the papal exposition of natural right in the social teaching of Leo XIII (*q.v.*) and his successors.

The epoch-making appeal of Hugo Grotius (*q.v.*) to the natural law belongs to the history of jurisprudence; but whereas his fellow-Calvinist Johannes Althusius (1557–1638) had proceeded from theological doctrines of predestination to elaborate his theory of a law binding on all peoples, Grotius insisted on the validity of the natural law "even if we were to suppose . . . that God does not exist or is not concerned with human affairs." A few years later Thomas Hobbes (*q.v.*) was arguing, not from the "state of innocence" in which man had lived in the biblical Eden, but from a savage "state of nature" in which men, free and equal in rights, were each one at solitary war with every other. After discerning the right of nature (*jus naturale*) to be "the liberty each man hath to use his own power for the preservation of his own nature, that is to say, of life," Hobbes defines a law of nature (*lex naturalis*) as "a precept of general rule found out by reason, by which a man is forbidden to do that which is destructive of his life . . ." and then enumerates the elementary rules on which peace and society can be established. Grotius and Hobbes thus stand together at the head of that "school of natural law" which, in accordance with the tendencies of the Enlightenment, tried to construct a whole edifice of law by rational deduction from a fictitious "state of nature" followed by a social contract (*q.v.*). In England, John Locke (*q.v.*) departed from Hobbesian pessimism to the extent of describing the state of nature as a state of society, with free and equal men already observing the natural law. In France, where Montesquieu had argued that natural laws were presocial and were superior to those of religion and of the state, J. J. Rousseau (*q.v.*) postulated a savage virtuous in isolation and actuated by two principles "prior to reason," self-preservation and compassion (innate repugnance against the sufferings of others).

The Declaration of Independence of the United States refers only briefly to "the Laws of Nature" before citing equality and other "unalienable" rights as "self-evident." The French Declaration of the Rights of Man and of the Citizen asserts liberty, property, security and resistance to oppression as "imprescriptible natural rights." The philosophy of Immanuel Kant (*q.v.*) renounced the attempt to know nature as it really is, yet allowed the practical or moral reason to deduce a valid system of right with its own purely formal framework; and Kantian formalism contributed to the 20th-century revival of naturalistic jurisprudence.

On the level of international politics in the 20th century the

assertion of human rights (*q.v.*) was the product rather of an empirical search for common values than of any explicit doctrine about a natural law.

NATURAL LAW, in science, means the formulation of some uniform character, mode of behaviour or uniform correlation of things or events; and it is frequently used in describing uniform relationships among various phenomena. Any such uniformity may be called a natural law; *e.g.*, all the laws formulated in physics and chemistry. On the other hand the term law of nature is sometimes restricted to irreducible or primary laws (like the law of gravitation) as distinguished from derivative laws (like Johannes Kepler's laws of planetary motion). *See* SCIENTIFIC METHOD.

NATURAL PRODUCTS, TOTAL SYNTHESIS OF. Natural products include all chemical substances produced by living plants and animals. Examples of classes of natural products include fats, proteins, carbohydrates, vitamins, alkaloids, antibiotics, steroids, terpenes, essential oils and many others. Total synthesis, rigidly defined, means the synthesis of a chemical substance from the elements of which it is composed. Since many relatively simple substances have already been made from the elements, in practice a total synthesis means synthesis from these substances rather than from the elements themselves.

The original objective of the science of organic chemistry was to elucidate the structures of, and to totally synthesize, all known natural products. Before such an ambitious objective could be realized, however, it was necessary to develop a logical and systematic science of organic chemistry. (*See* CHEMISTRY: *Organic Chemistry*). This development occupied the attention of numerous chemists over a period of about 200 years. Although many notable successes in total synthesis were achieved relatively early in the history of organic chemistry, only in the mid-20th century was sufficient knowledge accumulated to permit organic chemists to turn vigorously and successfully toward their original objective.

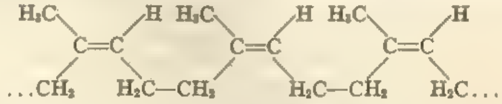
Perhaps the first total synthesis of an organic substance was the synthesis by F. Wöhler in 1828 of urea, a nitrogenous waste product formed in the kidneys of animals. Wöhler found that urea was formed simply by heating an aqueous solution of ammonium cyanate:

$$NH_4 \cdot O \cdot CN \rightarrow H_2N \cdot CO \cdot NH_2$$

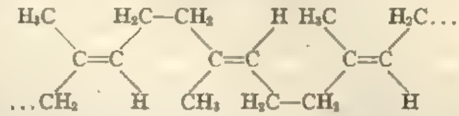
Since ammonium cyanate was a well-known inorganic substance and could be made from the elements carbon, nitrogen, oxygen and hydrogen, this reaction constituted a total synthesis. This first synthesis of a typical organic substance from purely inorganic starting material contributed toward abandonment of the idea of a "vital force" associated with the formation of organic matter, and organic chemistry was free to develop as a logical, orderly science utilizing concepts that had been formulated much earlier in the study of inorganic chemistry.

Total synthesis of organic substances is taken by the organic chemist as final and conclusive proof for the correctness of a structure arrived at by degradative or other methods. Sometimes this conclusive structure proof is the motivation for total synthesis. Frequently, however, total synthesis has important economic significance. As an example, the cultivation of the plant from which the blue dye indigo may be prepared was once an important agricultural industry. In 1883 A. von Baeyer elucidated the structure of indigo as the result of experiments extending over 18 years and devised two syntheses for the substance. In 1890 K. Heumann devised a commercially practical synthesis of indigo, permitting the sale of the synthetic product at a price lower than that of the natural dye. The synthetic product soon controlled the market. A quite different case is that of the total synthesis of the natural drug quinine by R. Woodward and W. Doering in 1945. Although a brilliant chemical achievement, the synthesis has not been applied commercially. Other synthetic drugs such as Atabrine (Atebrin) adequately control malaria, and are much easier to produce.

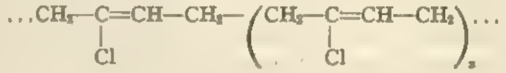
It is to be emphasized that a total synthesis leads to a material that is chemically identical in all respects to the natural product; the synthetic product is not a substitute or artificial. The field of the rubbers affords a good example of this distinction. Natural rubber is a polymer (*see* POLYMERIZATION) of isoprene (2-methyl-1,3-butadiene) in which all of the isoprene units are arranged in the cis manner; *i.e.*, similar groups are arranged on the same side of the molecule. The arrangement is as follows:



The alternative all trans arrangement of the isoprene units represents the structure of gutta-percha:

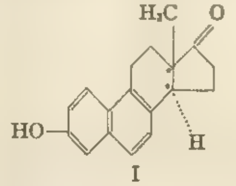


During the World War II period, when supplies of natural rubber were cut off from the western Allies, many synthetic rubbers were developed and used. All of these were substitute rubbers having some of the desirable properties of natural rubber but only grossly approximating its chemical structure. One of the first synthetic rubbers widely used in the United States was neoprene, a polymer of 2-chloro-1,3-butadiene:

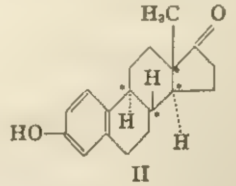


Neoprene has a random cis-trans arrangement of the 2-chloro-1, 3-butadiene units. It was not until later that a synthesis of natural rubber was achieved. In 1954 Goodrich-Gulf Chemicals, Inc., announced the synthesis of a rubber identical with natural rubber (referred to as "synthetic natural rubber"). In 1955 the Firestone Tire and Rubber company announced a similar product, and in 1956 the Phillips Petroleum company announced the synthesis of both cis and trans polyisoprene in pure form. These syntheses were achieved by polymerizing isoprene by means of certain stereospecific catalysts, perhaps a trialkylaluminum complexed with titanium tetrachloride.

The attainment of stereospecificity was one of the principal problems to be conquered in the total synthesis of natural products. In the case of the rubbers, the problem was production of a cis rather than a trans arrangement of the isoprene units. An even more subtle type of isomerism is involved in the structures of many natural products, so-called optical or dextro-levo (d, l) isomerism (*see* STEREOCHEMISTRY). This isomerism is dependent upon the fact that a molecule containing an asymmetric carbon atom (one which is attached to four entirely different groups) can exist in two arrangements in three-dimensional space. The two possible arrangements are mirror images of each other; *i.e.*, bearing the relationship of a right to a left hand. A given natural product represents only one of the various possible geometrical arrangements. Thus, the natural estrogenic hormone equilenin (I) contains two different asymmetric carbon atoms (denoted by the asterisks) and is capable of existence as four (*i.e.*, 2^2) isomers; these are *d*- and *l*-equilenin and *d*- and *l*-isoequilenin. The first total synthesis of a steroid was the W. Bachmann, W. H. Cole and A. Wilds synthesis of equilenin in 1939. All four of the possible stereoisomers were obtained.



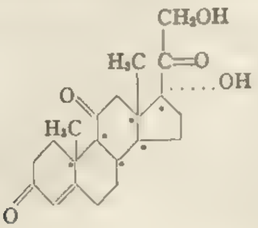
I



II

The estrogenic hormone estrone (II) represents a more difficult synthesis problem. Since there are four different asymmetric carbon atoms present, this structure can exist as 16 (*i.e.*, 2^4) possible stereoisomers. Largely because of the efforts of G. Anner and K.

Miescher in 1948 and by W. Johnson later, all of the stereoisomers of estrone were synthesized. Only one of these, of course, is the natural product. Considerable interest centred around the steroid cortisone (III), which is able to relieve the



III

symptoms of rheumatoid arthritis and is beneficial in the treatment of various allergies. A partial synthesis of this steroid from other naturally occurring steroids is carried out commercially. Total syntheses were devised by Woodward in 1951 and later by L. Sarett and by L. Barkley.

The examples cited above point up some of the problems encountered in total synthesis and indicate the extremely rapid progress being made. The following listing of a few notable total syntheses further indicates something of the scope of the field: camphor (G. Komppa, 1903); cocaine (R. Willstätter, 1923); riboflavin or vitamin B_2 (R. Kuhn, P. Karrer, 1935); thiamine or vitamin B_1 (R. Williams, 1936); vitamin A (O. Isler, 1947); carotene (Karrer, H. Inhoffen, 1950–51); morphine (M. Gates, 1952); sucrose or cane sugar (R. Lemieux, 1953); oxytocin, a peptide hormone (V. du Vigneaud, 1953); strychnine (Woodward, 1954); reserpine, a *Rauwolfia* alkaloid (Woodward, 1956); penicillin V (J. Sheehan, 1957); chlorophyll (Woodward, 1960); insulin (Y. C. Du, 1966).

Bibliography.—L. F. and Mary Fieser, *Organic Chemistry*, 3rd ed. (1956); Henry Gilman *et al.* (eds.), *Organic Chemistry*, 4 vol. (1953); Chemical Society, *Annual Reports*, vol. 1–54 (1903–58). (E. E. Rs.)

NATURAL RESOURCES. The materials of the environment useful to man are resources. Any of the many substances of the earth, the oceans and the air may become invested with an economic interest and thereby become resources. For anything to be sufficiently useful to be a resource it must satisfy three fundamental conditions: (1) it must satisfy a need of man without alteration, as water does, or it must be easily adaptable to his needs; (2) man must have developed his skills sufficiently so that he can utilize the resources available to him; and (3) the resource must be readily available with a reasonable expenditure of energy or other resources. A material may be economically useless one day and become a valuable resource the next.

Resources are either human or physical; and physical resources are either natural or manufactured. This article is concerned with natural resources which are commonly classified as vegetable, animal or mineral but these three categories may be extended to include energy from the sun, the soils of the earth and water. Resources may be further classified as nonrenewable (*e.g.*, minerals) or renewable (vegetation and water). The nonrenewable resources may be regarded as fund resources which are diminished by use. This is particularly the situation in the case of the fuel minerals. Many of the metals are not destroyed and varying fractions, depending upon the metal, can be recovered and reused. The renewable resources may be termed flow resources for the reason that with careful use they may last indefinitely. For example, a forest, managed on a sustained-yield basis, can produce timber and other forest products year after year without depleting the resource.

The adequacy of the earth's resources to sustain a growing population at different levels of culture is subject to debate, depending in part on the outlook of the inquirer. The more optimistic observer looks to technology to satisfy man's increasing demands. Great dams can be built to impound water; crop yields may be increased by plant breeding, fertilization, irrigation and mechanization. By geophysical methods mineral resources may be located and by improved methods of recovery, beneficiation and processing greater quantities of minerals may become available. The more pessimistic investigator observes the destructiveness of wars and the unproductive use of a rich heritage. He notes the impoverishment of the soil, the evidences of accelerated erosion, the destructiveness of great floods and the rapid use of fund resources.

It is obvious that wastefulness and the capacity to conserve resources, especially nonrenewable resources, exist simultaneously and a people would be without hope if they did not believe in the ability of man to satisfy his needs for an indefinite future.

Aside from economic motives, there may be humane or historic reasons for conservation of natural resources (*see* National Parks and Nature Reserves; Wildlife Conservation).

This article is divided into the following sections representing the main categories of natural resources:

I. Soils
II. Vegetation
III. Animal Life
IV. Water
V. Minerals
VI. Strategic Resources
VII. Climate

The natural resources of the continents and nations are discussed more specifically in the articles on those areas.

I. SOILS

The soil is one of the most fundamental resources of the world. The countries that have large areas of arable land are most fortunate. The food-producing capacity of the land, if protected against destructive erosion and depletion of the plant nutrients, can be maintained indefinitely. To the extent that the fertility is maintained without impairment, soil may be regarded as a flow resource.

The soils of the world were formed under a variety of conditions. The parent material from which the soil is derived is acted upon by a number of physical and chemical processes. The properties of the soil reflect something of the climate, the slope of the land, drainage conditions and the stage of development the soil has attained, but the parent material imparts distinctive characteristics to the soil which other factors cannot destroy or alter substantially.

A sandy soil derived from a sand-yielding formation remains a sandy soil although climatic conditions may impart to it distinctive structural characteristics. Abundant precipitation may result in excessive leaching but limited rainfall may permit the retention of plant nutrients in sufficient quantities to guarantee high productivity over a long period of time. Plants and animals and especially the microorganisms in the soil, assist in the formation of the soil and contribute humus (*q.v.*), which serves a number of useful purposes such as the retention of moisture and the maintenance of cultivability.

Soils may be classified into zonal soils, intrazonal soils and azonal soils. These major groups of soils may be further classified into families, series and types. The well-developed or mature zonal soils are strongly identified with the climatic and vegetational conditions under which they have developed. The intrazonal soils show less distinctively the influence of climate and vegetation and show more certainly their relation to other factors such as slope or drainage. The azonal soils, such as recent alluvium and slightly altered parent material, have not advanced sufficiently in development to take on the physical and structural characteristics of the mature soils.

Within the tropics where rainfall is abundant and the temperatures are uniformly high, the tropical forest is the typical vegetational cover. Under these conditions the mature zonal soils are generally low in plant nutrients because of excessive leaching, high in the oxides of iron and aluminum, and under cultivation deteriorate rapidly. These soils are commonly brick red in colour and contain beneath the surface a claylike substance known as laterite (*q.v.*). The mature soils in tropical America, central Africa, Indonesia and southeastern Asia, developed under humid

tropical conditions, are known as latasols and require careful management to maintain their fertility once the original forest has been removed and the land brought under cultivation.

On the savannas and the steppes of the tropics the soils are not so seriously leached as in the humid tropics but laterization is an important feature of the soil-forming processes. The leaching process is interrupted during the dry season and the maturing of the grasses helps to maintain the fertility of the soil. The mineral nutrients that the grasses have brought up from the lower horizons are made available in the surface layer when the grasses die and decay or are burned. The soils of these extensive grasslands, to the extent that they have been brought under cultivation or will be transformed from natural savannas into cultivated fields, constitute a resource of major dimensions. When the world needs the food and industrial raw materials these fertile soils can produce, cultivation can be greatly expanded.

Extensive areas in the humid subtropics such as southeastern United States, southern China, southern Brazil and southeastern Australia have soils that have developed under a forest cover. The soils in these areas are commonly red or yellow and display some of the characteristics of soils of the tropics. They show also the results of podsolization, a process identified with soil formation in the northern latitudes. These are not everywhere rich in plant nutrients because of excessive leaching, but with proper land management and fertilization these soil areas can produce great quantities of corn, cotton, tobacco, peanuts and vegetables. If they are neglected, their erodibility may result in rapid deterioration. To preserve and maintain the land in a high state of productivity will require vigilance and an understanding of the needs of the land.

Over a broad area across central Canada from the Rocky mountains to the Atlantic and across Eurasia from Scandinavia to the Pacific, the soils developed under the northern softwood forest or taiga are classed as podsols. These light gray or ashen-coloured soils are the result of the decomposition of organic matter which charges the downward-moving waters with acids which help to remove in solution the iron compounds which otherwise would give the soil a reddish colour. Beneath the thin layer of leaf litter the topsoil or A horizon of the podsols is distinctly light coloured and generally infertile. The downward percolating waters transfer the humus, clay and other fine materials downward into the subsoil. The topsoil becomes a white bleached layer directly beneath the forest litter. The subsoil is compact and coffee brown in colour. In the glaciated parts of northeastern North America and northwestern Europe are extensive areas of true podsols, which because of their sandy character, natural acidity and poor drainage have limited usefulness. Land just cleared is deceptively dark in colour because of the thin layer of leaf litter, but after being cultivated for a few years the organic matter decays and an infertile layer of ashen-gray inorganic matter is all that remains. These acidic podsols are not well suited for agriculture though potatoes, rye, oats, certain meadow grasses and vegetables do well. Large areas probably should remain in forest and be used for the production of timber and other wood products.

In northeastern United States, in much of west central Europe and in northern China the soils, developed under the deciduous forest, are mainly podsolic in character. These soils are grayish-brown in colour and have inherent structural characteristics that give them an enduring quality. The humus content is greater than in the podsol soils but they require care to maintain their high productivity.

The eternally rich lands of the world are those that have developed under a cover of grass in the intermediate latitudes. The soils in these great grasslands originated and evolved in areas of moderate to scant rainfall. In the tall-grass prairie there has been sufficient precipitation over a long period of time to remove the calcium salts and other easily dissolved minerals. The soils developed under these conditions are deep and fertile though they may require the application of lime. Nowhere in the world are the black prairie soils so well developed as in the corn belt of the United States.

In the grassland areas that receive a smaller amount of precipitation, the calcium salts and other minerals are retained and the soil may be described as slightly alkaline. These soils are known as chernozems (black earth). They are widely distributed in the dry plains of the United States and Canada, the Soviet Union, Manchuria, India, the Argentine pampas, Uruguay and eastern Australia. Where the surface of the land is relatively flat or gently undulating the danger of water erosion is slight. Under cultivation the chernozems and other soils rich in organic material suffer from wind erosion if not protected by wind stripping, mulch tillage (stubble mulching) or by the use of cover crops.

On the dry margins of the chernozems lie extensive areas that are best described as steppes. In these areas the soils have developed under subhumid conditions. These dark-coloured soils are not as rich in organic matter as the chernozems and the prairie soils. In favourable years these dry lands may be brought under cultivation and used for the production of the drought-tolerant grains such as wheat and barley. The steppes are well suited to grazing and most areas should be left in grass and used to support a pastoral industry. The soil resources of the steppes can be used most effectively if only limited areas are brought under cultivation.

In the deserts of the world small areas of fertile soils can be irrigated and brought under cultivation. The soils developed under low-rainfall conditions are potentially productive where sufficient water is available. These irrigable lands usually have soils that are rich in mineral nutrients but are generally low in organic matter and nitrogen.

The full use of the soil resources of the world to meet the needs of an increasing population for more food, fibres and other industrial raw materials will require the clearing of virgin lands, the drainage of marshlands, the irrigation of larger areas of desert and semiarid lands, the use of fertilizers and the development of more productive plants and animals. Extensive areas must be protected from destructive erosion and depletion if their productivity is to be maintained and enhanced for an indefinite future.

See SOIL; AGRICULTURE; FERTILIZERS AND MANURES; IRRIGATION; LAND RECLAMATION.

II. VEGETATION

A very high proportion of the earth, in spite of great irregularities in terrain, high altitude, expansive ice-covered areas in Antarctica, Greenland and the high mountain areas, and the extensive wastelands of the deserts, is mantled by vegetation either natural or cultivated. The natural or original vegetation of the earth may be classed as grasslands, grass and shrubs of the steppes and deserts, and forest. The plant communities may differ greatly over the world, particularly in respect to floristic composition, but the assemblage of plants makes it possible to identify the major vegetation zones of the earth. The forest of equatorial Africa is very different from the spruce forest of Canada but both are forests. Similarly, the component grasses of the campos of Brazil may be quite unlike the plants that make up the assemblage of grasses in the Nebraska prairie but both are grasslands. Also the scant grasses and shrubs of the desert margin of the Sudan produce a steppe area not unlike the great steppes that border upon the desert of Soviet Central Asia.

The science concerned with plant communities and the environmental, biological and physical factors that affect composition and succession is known as plant ecology (*see* ECOLOGY: *Plant Ecology*).

Grasslands.—Approximately 13,000,000 sq.mi. or 24% of the land area of the earth can be classed as grassland. The great grasslands consist of (1) tall-grass savanna, 31%; (2) high-grass savanna, 22%; (3) desert-grass savanna, 18%; (4) tall-grass prairie, 13%; (5) short-grass steppe, 10%; and (6) mountain grassland, 6% of the total.

The savanna grasslands cover extensive areas between the equatorial forests and the trade-wind deserts and lie largely within the tropics. The rainfall ranges from 30 to 80 in. annually with the maximum strongly concentrated in the summer or high-sun

period. It is this marked seasonality of the precipitation that has favoured the development of the tall luxuriant grasses that make up the savanna. Where the savanna borders upon the equatorial forest the expanse of grass may be interrupted by clumps or islands of trees or by a gallery forest along the watercourses or in low areas where water is available in all seasons. Toward the desert margin of the savanna the grasses are shorter and less abundant and drought-resistant shrubs become a part of the assemblage of species in the plant communities.

The tropical savannas are well represented in South America in the llanos of the Orinoco basin, the campos of Brazil and the Gran Chaco of northern Argentina and Paraguay. In Africa the Sudan is largely an expansive grassland extending from the Atlantic to the highland of Ethiopia along the parallel of latitude 10° N. This grassland extends southeastward onto the highland of east Africa. Also south of the equatorial forest an area of savanna lies across northern Angola and the southern portion of the Republic of the Congo. In northern and northeastern Australia, savanna covers an important fraction of the continent.

These extensive grasslands of the tropics, in spite of hot humid summers and the dry season in the winter or low-sun period, are widely used for cattle grazing. Locally the grassland has been brought under the plow and cultivated crops such as cotton, peanuts, sorghum grains and vegetables are grown. Potentially large areas in the tropical savannas can be cultivated and when the world requires larger quantities of the crops that can be produced there, greater use will be made of these fertile and productive lands.

The tall-grass prairies originally included the immense prairies of midland North America, the pampas of South America, the rich prairies of eastern Europe such as the Hungarian basin, the Rumanian plain and the extensive grasslands of the Soviet Union north of the Black sea and extending eastward between the northern forest and the desert interior of Asia. Limited areas of prairie once made up the vegetational cover of the veld in South Africa, the upland of Madagascar, the plains of southeastern Australia and the eastern half of South Island in New Zealand.

The tall-grass prairie of the mid-latitudes was the natural habitat of a great variety of grazing animals such as the buffalo in North America. Because of the high fertility of the soil developed under the prairie vegetation and an annual precipitation of 15 to 40 in., a high proportion of the mid-latitude prairie has been brought under cultivation. In many areas in the corn belt of North America the original grasses, including bluejoint (blue stem), needle grass and wheat grass, have all but disappeared. Only along fence rows and in a few relict areas have the original plant communities been preserved. These immense grasslands are now the great granaries of the world where much of the world's corn, wheat, rye, flax, oats, barley, soybeans and sorghum grains are grown. Also, the cultivated grasses and feed grains that have replaced the native grasses support a livestock industry of major proportions.

Grasses and Shrubs of the Steppes and Deserts.—Short scant grasses and intermingled shrubs border the desert areas both in the tropics and in the intermediate latitudes. With the mountain grasslands these areas cover approximately 32% of the land area of the world. The component grasses of these steppelands include grama, buffalo grass and needle grass. In drier parts of the steppe open spacing of the clumps of grass and herbaceous plants is a characteristic feature. These great realms of scant grass supported a pastoral civilization in the old world, and briefly a range industry in the new. In the more fertile parts of the steppe and where the annual precipitation exceeds 12 in., dry farming may be practised. The crops grown must be drought resistant such as wheat, barley, millet and the sorghum grains.

Other areas commonly included among the grasslands are the diminutive patches of grass and herbaceous plants that give greenness to desert areas after each rain or brief rainy season. In the high latitudes the tundra, and in high altitudes, the alpine meadows present some of the aspects of grassland. To a limited extent they are used for grazing and support an animal population of reindeer, musk oxen and a variety of fur-bearing animals. (*See* Grassland; Grasses.)

Forests.—The natural forest areas of the world cover approximately 22,000,000 sq.mi. or 42% of the earth's surface. The forests may be classified into a number of major types related chiefly to the nature of the assemblage of trees and the geographic location of the forest.

Tropical Rain Forest.—This is luxuriant, evergreen forest consisting of trees of unequal size and height and of varying ages forming a dense canopy of thick, leathery leaves, and composed of a variety of trees such as legumes, laurels, myrtles, figs, satinwood, mahogany and rubber trees, a true climax forest with an intermingling of many species. This type of forest thrives in areas within the tropics where temperatures are uniformly high and where the annual precipitation amounts to 60 to 200 in. In the equatorial areas of South America, Africa and Indonesia and the windward coasts within the tropics the temperature and moisture conditions support the true tropical rain forest.

Light rain forest consists of a variety of conifers and deciduous trees in the lower middle latitudes and extending into the tropics. It occupies extensive areas in southeastern United States, eastern Brazil, southeastern Asia, parts of east Africa and northern Australia. Temperatures are not as high in these areas as in the equatorial lowlands. The rainfall is also somewhat lower, averaging from 40 to 80 in. annually. As a consequence these humid subtropical areas originally were mantled by a light but valuable forest.

Deciduous forest consists of broadleaf trees which drop their leaves chiefly in the autumn and come into leaf again each spring. Typical trees include the oak, birch, beech, maple, ash and hickory. The dominant trees differ from place to place depending in part on drainage. The beech-maple association may be dominant in the wetter areas whereas the oak-hickory association may be characteristic of the higher, well-drained regions. The original deciduous forest was best developed in eastern United States, western and central Europe and eastern China. The total area of approximately 6,500,000 sq.mi. covered 12% of the land area of the earth.

Coniferous Forest.—Characteristic of middle and higher latitudes, this type of forest is made up of uniform stands of similar or related evergreen trees such as pine, fir and spruce. In the northern hemisphere it is commonly known as the northern softwood forest. In Eurasia from Scandinavia to the Sea of Okhotsk it is called the taiga. To the north, this evergreen forest decreases in height and merges into the tundra. This is a rich commercial forest which supplies large quantities of timber and pulpwood to the world's markets.

Dry Forest.—In the dry areas of the world, particularly where there is a long dry season, the open woodland may be described as the dry forest or the monsoon forest. Extensive areas in southern Asia, Australia, South America and Africa have a hot wet summer that alternates with a dry winter season. Most of the trees in this dry forest lose their leaves during the dry season but come into leaf at the beginning of the rainy season.

Thorn Forest.—Locally within the dry subtropical and tropical areas the limited rainfall of 10 to 20 in. annually may support a thorn forest. A tangle of thorn-bearing trees may make the area difficult to penetrate or cross. These areas have little or no value agriculturally, but limited areas in Africa, South America, Mexico, Australia and Asia produce gums, fruits, rubber and tanbark.

Sclerophyll brushland is a meagre forest of diminutive trees and brush. Since it is characteristic of the Mediterranean borderlands it is sometimes called the Mediterranean forest. The rainfall of these areas varies from 20 to 30 in. annually and in spite of dry summers these lands are well suited to the cultivation of citrus fruits, olives, vegetables and cereals such as wheat and barley. This type of brushland covers important areas of Mediterranean climate in north and south Africa, southern Europe, western Asia, southern California, central Chile and southwestern Australia.

Land Use and Forest Products.—As in the case of the prairies and other rich grasslands, extensive areas that were once forested have been converted into cropland. In China and in many parts

of Europe and the United States the forest has been sacrificed in order that the cultivated lands might be greatly expanded to meet the demand for increasing quantities of food and industrial raw materials. The soils of the forestlands generally were not as fertile as the chernozems and other black and brown soils developed under a cover of grass. However, the soils are easily cultivated and amenable to fertilization so that their productivity can be maintained indefinitely with proper management.

Over the many centuries when the farms of Europe and North America were literally being hewn out of the forest, the need for lumber was met by using the trees from the nearby woods. But as clearing continued and the woodlands were greatly reduced, the need for timber for homes, factories and other structures had to be met by tapping the forest resources of more distant areas. In Europe the great forests of Scandinavia, the Baltic countries and the mountain areas supplied lumber and other timber products for centuries. In eastern Asia the more heavily wooded lands of Hokkaido and the Amur valley and forests in the Soviet Union supply lumber, wood pulp, mine timbers, posts and other wood products to southern Japan and China where local supplies of timber have been largely exhausted. In the United States, after the forests of the northeastern part of the country and the middle west had been greatly reduced, commercial lumbering in the Great Lakes basin provided a rich harvest of white pine and other woods. Lumbering on a large scale spread to the south, to the Rocky mountains, the Pacific northwest and, later, to the northern forest of Canada. *See* FORESTS AND FORESTRY; LUMBERING; ARBORICULTURE; WOOD; RAIN FOREST.

III. ANIMAL LIFE

Before man took possession of the earth and modified the natural environment to meet his needs, the numerous animals were widely distributed in accordance with the suitability of the various habitats and the competitive situation among the animals themselves. The animals of the world, both wild and domesticated, constitute a major biological resource subject to both the laws of nature and the facts of economics and culture. Man in his ignorance or thoughtlessness has brought destruction and virtual extermination to herds of wild animals such as the buffalo and the caribou and to great flocks of waterfowl and other birds. At the same time he has brought his scientific knowledge and management skills to bear upon the animals he wished to retain. At mid-20th century the number of cattle in the world reached an estimated 972,000,000 head; sheep numbered 917,000,000; and swine, representing one of the major food animals of the world, totaled 386,000,000. These and other animals available to the more than 2,600,000,000 people in the world constitute a viable resource of immense worth. Yet among the animals of the earth there are predators, insects and microscopic forms of life which may challenge man's mastery over the animal kingdom. The predators may serve to hold in check the rate of growth of certain animals which might become destructive. Among the insects there are some such as the bees that are of great value, but others may be the carriers of disease germs causing unnumbered deaths each year. Man's control over the animals of the world is partial rather than complete and in effect he may be in competition with other animals, particularly the insects, to see which shall win supremacy.

In nature, without any interference from man, wild animals established a living relationship with the environment, both physical and biological. Over a long period of time the animal populations evolved from more primitive ancestors and became dispersed over the earth in relation to the favourable and limiting conditions of the environment. A habitat that is particularly favourable in respect to the essential requirements of a single or a number of species may become fully populated in a relatively short period of time. Conversely, an environment that is repeatedly subject to extremes of temperature or moisture may be sparsely occupied, and the native and migrant animals may be subject to restrictions on continued increase in numbers. Under natural conditions something in the nature of a biological balance is achieved, but this nice relationship can easily be disturbed by a change in the physical habitat or by a devastating disease that may weaken or decimate an animal group. The science of animal ecology is concerned with the relation of animals to the conditions of the environment, both physical and biological. (*See* ECOLOGY.)

Habitat Factors.—All animals are dependent upon an adequate supply of oxygen and water to meet their essential physiological needs. The temperature conditions of the habitat must have limits that can be tolerated by the animal community. Through the process of natural selection only the fittest survive. By this means a species retains its competitive advantage. The food supply must be adequate and available at the usual and necessary feeding times to maintain the animal populations. Whereas many animals such as the carnivores feed upon other animals, fundamentally they are all dependent upon adequate supplies of plant substances for continued existence. From the smallest and lowliest forms of life to the largest predators there are animals that derive their food from other animals, many of which are plant eaters. In the sea, the larger fish and other forms of life are dependent upon the availability of smaller animals, particularly fish, to maintain life but the smallest animals of the sea are dependent upon plankton (*q.v.*) and other very tiny forms of life.

Domesticated Animals.—When man began to domesticate animals and use them as a means of livelihood for himself, his family, his tribe or his group, economics became a factor in the life of the people. Before this time only natural factors had significance in the evolution, dispersal and relative abundance of the many animals that populated the earth.

Man in his early evolutionary history became a meat eater and satisfied his need for this type of food by hunting and fishing, two occupations that have continued to the present time. The domestication, breeding and the biologic and economic development of a number of animals have contributed immense quantities of animal products to the food resources of the world and introduced a stabilizing factor in the animal food industries.

The principal animals that have been domesticated include poultry, swine, cattle, water buffaloes, horses, sheep, goats, camels, the Tibetan yak, reindeer and llamas. It was largely because of man's need for a work animal and a burden bearer that several animals were domesticated, although some of these same animals also contributed products such as wool, milk, meat and hides.

Animal Power.—Domestication of animals was for companionship, for hunting, for food and for transportation. The principal work animals for centuries have been horses, cattle, water buffaloes, camels, llamas and elephants. In the densely populated areas of the orient where manpower is relatively abundant and food resources are limited, the larger work animals such as horses and oxen have been eliminated or are maintained in limited numbers only. Water buffaloes, because they are particularly well suited for work on the wet rice lands, have been retained. In parts of the tropics, because of the climatic conditions and the economic status of the people, oxen have continued to be an important source of power.

Into the early 19th century, oxen were also widely used as work animals in much of Europe and America, but they were shortly displaced by the horse. Prized for its speed, endurance, longevity and intelligence, the horse became the principal work animal throughout west and central Europe, much of Russia, in the United States and in the intermediate latitudes where European culture spread. When the European or American farmer prospered he gave up the slow plodding oxen for the horse, which was able to hold its own until the development of the tractor and the subsequent mechanization of agriculture.

Animals as a Source of Food.—The use of animal products for food is largely the result of cultural inheritance. Taboos of cultural origin may limit the consumption of certain foods which, from the nutritional point of view, are edible. For example, certain visceral organs may not be acceptable in the diet of some people but may be regarded as a delicacy by others. In India, where cattle are most numerous, the use of meat for food is restricted. On the other hand, Eskimos and other peoples far removed from foods of plant origin are heavy consumers of meat.

Although there are millions of people who do not eat meat be-

cause of religious prejudice or personal preference, meat in varying amounts is consumed widely throughout most parts of the world, depending on its relative abundance and its cost in relation to other available foods. While it is most economical for man to derive his foods directly from plant sources, there are many plants that he cannot eat. Animals act as intermediate processors of such plant foods as the coarse feed grains.

The rich agricultural lands of the world that were once in forest or in grass are now the leading producers of meat animals. Cattle by the millions are raised on the farms and ranches of the United States, Canada, Mexico, Argentina, Uruguay and Chile and on the extensive grasslands of the tropics. In Europe from the Atlantic to the dry steppes of the Soviet Union cattle are raised for dairy products, for meat and as sources of power.

Swine and poultry are more economical in the utilization and conversion of feed into edible products than cattle. Both are scavengers and make use of food materials that would otherwise go to waste. Both reproduce rapidly and mature quickly. When there is a need to increase the quantity of foods of animal origin, it can be done more quickly with swine and poultry than with cattle. In China, Europe and the United States swine and poultry are raised in great numbers though the feeds used differ from country to country. In China these animals are scavengers but in the U.S. quantities of grain are used for feed. In Europe the by-products of the dairy industry, locally grown and imported grains and wastes from the table support the two industries.

The intensive development of animal industries is a means of maintaining soil fertility if the methods of cultivation are nondestructive. By giving the animals the feeds grown on the land and by returning all manures and other organic wastes to the land, the soil, by means of the livestock industry, may be regarded as a renewable resource, and with proper management is virtually inexhaustible.

Fisheries.—The animal resources of the sea have been used for human food for centuries. The most important fisheries are located in the northern hemisphere between 40° and 60° N. where the cool waters of the North Atlantic and the North Pacific cover extensive areas of the continental shelf and where plankton and other foods are relatively abundant. They include the North sea and the shallow waters off the coast of Europe, the Grand Banks south of Newfoundland and other nearby coastal waters, the shallow coastal waters along western North America and favourable waters around Japan and the seas adjacent to the mainland of northeastern Asia. Through the years certain species such as cod, salmon and halibut have been taken in such quantities that the fishery resources have been reduced and require regulation to maintain their continued productivity.

In somewhat warmer latitudes the shellfish industry contributed important quantities of lobsters, oysters, clams and crabs to the food resources of the world, but depletion has been a threat to the industry. In Japan, western France, northwestern Washington and Chesapeake bay the oyster industry has been brought under control and a continued supply is assured. In the warm waters of the tropics fish are not as abundant as in the cooler waters of the intermediate and higher latitudes, but fish caught in local waters are important in the diet of the people. The tuna fishery in the Pacific and the shrimp industry in the Gulf of Mexico provide valuable foods prized by millions. *See* ANIMALS, DISTRIBUTION OF; ZOOGEOGRAPHY; FISHERIES; FISH CULTURE; ANIMALS, DOMESTICATION OF.

IV. WATER

Approximately 71% of the surface of the earth is covered by the oceans. These extensive salt-water areas function in various ways in the affairs of men. The broad seas serve or did serve to separate the continents and the nations that have divided the land areas of the world among themselves. The size and the distribution of the seas affect in various ways the climatic conditions of the earth and influence, as a consequence, the character of the soils, natural vegetation, agriculture and commerce. Also, the sea is a reservoir of mineral resources, but only a few, such as salt and magnesium, have been recovered.

The fresh waters that lie upon the land in the form of streams, lakes, ponds, swamps, springs and reservoirs and the ground water that occurs beneath the surface constitute the water resources of the land, though the saline waters of inland seas and subsurface structures have commercial value also.

If all the fresh water on the land and the quantity contained in the rock formations could be calculated accurately, it probably would not exceed much more than 1% of the total water on the earth. Fresh-water resources become available through the operation of the hydrologic cycle. The energy of the sun evaporates enormous quantities of water from the sea and the resulting vapour becomes a part of the atmosphere. The winds distribute this vaporous moisture widely over the earth. Upon condensation and precipitation, 30% of it is returned directly to the sea. Out of the water vapour that is transported over the land areas, precipitation provides varying amounts of fresh water for use by man. Of the water that falls on the land an important fraction penetrates the soil, percolates downward to levels below the root zone and becomes, temporarily at least, a part of the reservoir of ground water.

Under favourable topographic and geologic conditions, some of the ground water returns to the surface in springs, many of which, because of their perennial character, contribute to the regularity in the flow of streams. Waters that penetrate deeply may be returned to the surface by the numerous wells that have been put down in thickly settled areas to provide the people with potable water. By evaporation and by transpiration some water is returned to the atmosphere, but much of it becomes runoff and returns to the sea, thus completing the hydrologic cycle.

Water is a multiple-purpose resource that may be made to serve a number of functions on its way to the sea. Water on the land supports vegetation and if it is more abundant than is necessary for agriculture it may form a habitat for aquatic plants and animals. Only to a limited extent is water an industrial ingredient, but it does serve as a source of power and as a coolant. Water of the larger streams and lakes may be used to supply the culinary and personal needs of people in urban communities and the wastes from cities are discharged into these same streams and water bodies. Abundant supplies of water are required in a sanitary system to treat the sewage, dilute the effluent and flush away the wastes. In quantity, the fresh waters of the earth bear a significant relationship to the amount of precipitation that falls upon the land and its seasonal distribution. When the first land areas were uplifted above sea level, fresh water began to enter the pore spaces and other cavities in the various geologic formations. Originally most formations, especially those originating through deposition of sediments in the oceans and saline seas, contained salt water. But as fresh water penetrated these aquifers and moved along under hydrostatic pressure, most of the salt water was gradually replaced by fresh water. In the deeply buried formations salt water is still trapped and there is very little prospect that these saline waters or brines will ever be replaced by fresh water. Some rock formations contain soluble minerals that are taken into solution by the deeply penetrating fresh waters that originally fell as rain. These brines, whether they represent deeply entrapped sea water or solutions containing saline materials from the country rock, constitute an important natural resource.

Where thick layers of sedimentary and other porous rocks are so disposed structurally that surface waters are readily absorbed and penetrate deeply, the total quantity of underground water may be enormous. This reservoir of ground water is in a sense a capital fund that can be drawn upon to meet local and regional needs for water. The earth materials into which the surface waters penetrate filter and purify the water and make it readily usable for most culinary and industrial purposes. However, the water may contain sufficient mineral matter such as lime carbonate and other salts to make it hard and unsatisfactory for particular purposes unless treated.

The fresh water on the land in the form of streams, lakes, ponds and marshes represents only a fraction of the total rainfall. Like springs, lakes, ponds and marshes help to steady the flow of streams. These natural regulators have been supplemented by the construction of dams both large and small to hold back the

water in times of heavy precipitation so that adequate supplies may be available for power, irrigation, industrial and culinary purposes in times of low rainfall.

The total power derived from falling water is relatively small when compared with the power available from coal, petroleum, natural gas and atomic sources, yet certain countries such as Italy, France, Switzerland, Norway, Sweden, Canada and Japan are heavily dependent upon water power. In the mid-1950s the capacity of the water-power plants in the United States was in excess of 130,000,000 h.p., a little more than one-quarter of the world total.

Inland waters have long been highways of commerce. In the United States other means of transportation, except on the Great Lakes, have competed strongly with the waterways. In Europe, waterways, both natural and man-made, are relatively more important. But throughout history the great rivers of the world, such as the Rhine, the Volga, the Yenisei, the Yangtze, the Nile, the Amazon and the Mississippi, have been arteries of trade.

As the demand for water increases, the available supplies will need to be more carefully utilized. With proper treatment, water may be used over and over again as it moves downstream toward the sea. By cloud seeding in areas where conditions are favourable, the amount of precipitation may be increased slightly. By desalting saline waters the quantity of fresh water may be increased, but except in areas of scant supply where desalting may be practical, the immediate needs for more water will probably be met by the treatment and reuse of known supplies. *See* WATER; GROUND WATER; HYDROLOGY; OCEAN AND OCEANOGRAPHY; WATER SUPPLY AND PURIFICATION; and individual articles on hydrographic features.

V. MINERALS

In order to simplify this discussion of minerals, the great variety of inorganic substances contained in the earth's crust and the seas is treated in a limited number of categories: mineral fuels, iron and the ferroalloys, the nonferrous metals, the precious metals and the nonmetallic minerals.

Mineral Fuels.—*Coal.*—The coal resources of the world are essential to continued industrial development. Petroleum and natural gas, and to a limited extent water power and nuclear fuels, supplement coal, but the strong industrial nations must have access to this essential industrial fuel.

All coal, whether classed as anthracite, bituminous or lignite, is derived from vegetable matter accumulated and preserved under favourable geologic conditions. To be regarded as workable resources for the foreseeable future, the coal must occur at depths not exceeding 6,000 ft. beneath the surface and under structural conditions that will permit economic mining at the greater depths. The thickness of the seams or layers is an important factor in the economic production of coal, particularly in deep mines.

The leading producers of coal are the United States, Germany, the Soviet Union, the United Kingdom and Poland, all of which produce from 100,000,000 to more than 400,000,000 tons annually. Smaller quantities, generally under 100,000,000 tons annually, are produced by China, India, Japan, Czechoslovakia, France, Belgium and Australia.

The reserves of coal yet to be developed are similarly distributed over the world. In North America, chiefly in the United States, more than 2,000,000,000,000 tons of coal remain to be mined. In the Soviet Union and China the reserves total more than 2,400,000,000,000 tons, enough to meet the needs of these two great powers for many decades or even centuries. In Europe significant reserves are located in Germany, the United Kingdom and Poland. In the southern hemisphere large reserves are available in Australia and South Africa.

Petroleum.—Like coal, petroleum is believed to be of organic origin. Because it is a liquid it can be transported in pipelines, tank cars, barges and tankers. The refining of petroleum consists of distilling or fractioning off the various liquid constituents and of cracking, a process in which the heavier oils are used to produce the lighter products such as gasoline, kerosene and fuel oil which are in great demand. From petroleum are derived a number of basic raw materials used in the manufacture of plastics, detergents, synthetic rubber, explosives and dyes.

Petroleum occurs in porous sandstones and other formations with large and abundant interstices. Early man used limited quantities of petroleum as an illuminant, as a lubricant and for pharmaceutical purposes. The first well drilled specifically for oil was put down at Titusville, Pa., in 1859. For 100 years the United States has held the leadership in production except for a brief period from 1898 to 1901 when leadership passed to Russia. The principal petroleum producers are the United States, Venezuela, Saudia Arabia and Kuwait, the Soviet Union and Iraq. Others of importance include Canada, Mexico, Rumania, Indonesia and Iran. From 1918 to 1926 Mexico was second to the United States, only to be surpassed by the Soviet Union. The relative decline of Mexico was offset by the rise of Venezuela, which achieved second place in 1944, a position it continued to hold.

The ease with which crude petroleum can be transported makes it possible to concentrate refining capacity in or near the market areas. Approximately half of the world's refining capacity is located in the United States. Other major refinery centres are in the Soviet Union, the Netherlands Antilles (Curaçao and Aruba), Canada, the United Kingdom, France, Italy, Japan and Iran (Abadan).

The reserves of petroleum are unequally distributed over the earth. The United States, long a leading producer, has less than 20% of the world's known reserves. The middle east countries, having achieved recently a high place among producing areas, have approximately 66% of the reserves. The proven reserves in the Soviet Union amount to only 5%, though future exploration may increase them greatly. In South America, particularly along the eastern margin of the Andes, reserves of petroleum may maintain production for many decades.

Natural Gas.—In most petroleum areas natural gas is available for use as a fuel and as a raw material. Outside of the Soviet Union, for which production data are not available, natural gas is produced chiefly in the United States, Canada, Mexico, Venezuela and Italy. In the United States natural gas from Texas, Louisiana, New Mexico, Kansas and Oklahoma is distributed by pipeline to the industrial and domestic consumers in the northeast including New England, the south, the middle west and the Pacific coast. Production of natural gas in the United States in 1957 amounted to 10,200,000,000,000 cu.ft.

The recoverable reserves of natural gas in the United States were estimated to be 446,500,000,000,000 cu.ft. in the late 1950s. New discoveries in the southwest and California have increased U.S. proven reserves substantially.

Atomic Energy.—Uranium (*q.v.*) is the chief source of atomic energy though thorium and other radioactive minerals may be used as fissionable fuel. The known quantity of uranium in the earth's crust is equivalent to 0.008%. It is twice as abundant as zinc and many times more abundant than the precious metals. However, it is widely distributed and only in a few places is it sufficiently concentrated to warrant development and production. It has been estimated that the total heat energy available from the reserves of atomic minerals may be as much as 25 times that available from the known reserves of coal.

Atomic energy thus far has been used chiefly for weapons, but a number of reactors are being used as sources of power in electrical generators and on submarines. It will continue to be used for these and other purposes, but in the United States and other countries where other sources of power are available at low cost the use of atomic energy may be restricted for some time to come.

Uranium is recovered from deposits of pitchblende which occur in the Republic of the Congo, Canada and Czechoslovakia. In the United States, uranium ores are contained in the thick sedimentary formations of the Colorado plateau of western Colorado, New Mexico and Utah. Other sources of uranium are in the Republic of South Africa, Australia, France and Portugal. (*See* FUELS; COAL AND COAL MINING; PETROLEUM; GAS INDUSTRY; ATOMIC ENERGY.)

Iron and the Ferroalloys.—*Iron.*—In the earth's crust iron is one of the most abundant metals, exceeded only by aluminum.

Whereas iron as an element is widely distributed, the major iron minerals such as hematite (Fe_2O_3), magnetite (Fe_3O_4), limonite ($Fe_2O_3H_2O$), siderite ($FeCO_3$) and others are concentrated in rich ore deposits in a limited number of places. The richest ores, consisting chiefly of magnetite, contain 60% to 70% iron. Hematite ores seldom contain metallic iron in excess of 60%, and the poorer or leaner ores may contain as little as 20%–25%. When the iron content is under 25% the ores may be described as uneconomic or submarginal. In the United States ores under 35% iron are seldom used unless first treated to enrich them.

With the exhaustion of the rich ores in the iron ranges of the upper Lakes area in Minnesota and Michigan, the iron-bearing taconites and jasperites have become potential sources of iron. These iron-bearing formations are crushed and by magnetic and other means of enrichment the iron minerals are concentrated and pelletized by a sintering process so that the resulting ore can compete with the naturally rich ores. Domestic sources of iron ore have been unable to meet the demand and as a consequence foreign ores to the extent of 15,000,000 tons annually are imported from Canada, Sweden, Venezuela and Chile and from a number of countries that supply only limited quantities of ore.

With the completion of transportation facilities from the Gulf of St. Lawrence to the rich iron resources along the Labrador-Quebec boundary, the Knob lake ores have become available to Canadian and U.S. blast furnaces. Other Canadian ores are mined in the Steep Rock and Michipicoten areas in the Lake Superior upland. The Wabana ores of Newfoundland have long been available to furnaces in eastern Canada.

In the Latin-American countries important iron deposits in the Cerro Bolívar area of Venezuela have become available for domestic use and for shipment to the U.S. Iron ores are also produced in Chile and Brazil. The rich resources of Venezuela and the state of Minas Gerais in Brazil constitute a major reserve that may be drawn upon to support the iron industry of the future.

In Europe the chief centres of iron-ore production are in the United Kingdom, France, Germany, Sweden and the Soviet Union. In western Europe the Minette ores of Lorraine have long held first place as a source of iron. Other contributors include Spain, Italy and Austria. The Soviet Union is the leading producer of iron ore in Europe with the Krivoi Rog of the Ukraine and the Magnitnaya and other centres in the Urals accounting for most of the production. Large reserves of iron ore are known to exist in the Soviet Union so that its iron and steel industry will be adequately supplied with ore in the future.

Ferroalloys.—Limited amounts of a number of ferroalloy metals are required to produce the specialty steels needed by modern industry. These metals include manganese, chromium, nickel, tungsten, vanadium, molybdenum and cobalt.

Manganese is used as an oxidizer and as an alloy and is required in the manufacture of all steel. In the late 1950s manganese ores were mined in the Soviet Union, India, Brazil, South Africa, Ghana and Morocco. Chromium, used with nickel to make stainless steel and as a plating metal, is available in quantity in the Philippines, Turkey, the Republic of South Africa, Southern Rhodesia and the Soviet Union. The Sudbury area of Canada produces nearly 60% of the world's nickel. Smaller quantities are produced in Cuba, the Soviet Union and New Caledonia. Tungsten, important in the manufacture of tungsten carbide and as an alloy, is widely distributed but for many years China has been a principal supplier of this metal. Other producers include the Soviet Union, the United States, Bolivia, Portugal and the Republic of Korea. Molybdenum, like nickel, is highly concentrated in a single mining centre, Colorado. More than 95% of the world's molybdenum is produced in the United States. Vanadium, which imparts strength and resilience to steel, is produced chiefly in the United States, Peru, southwest Africa and Finland.

These ferroalloys, considered together, are widely distributed among many nations, but the major steelmaking countries are largely dependent upon imports to meet their needs. For example, the United States produces only molybdenum and vanadium in sufficient quantities to meet its requirements. All the other ferroalloy metals must be imported. (*See* IRON; ALLOYS; ORE DEPOSITS; and articles on the various minerals and ferroalloy metals.)

Nonferrous Metals.—These, including copper, aluminum, lead and zinc, tin, mercury, magnesium and several others, have become essential to modern industry. In the early history of man the metals that occurred in the native state such as gold, silver and copper were used for decorative and practical purposes. Either by accident or intention, copper and tin were combined to produce bronze, a metal of immense cultural and economic importance. In time other nonferrous metals acquired industrial importance. These include lead and zinc alone or in combination with other metals, aluminum, magnesium, tin and several more.

Copper.—Because of its superior quality as an electrical conductor and its usefulness as sheet metal and as a component metal in a number of alloys, copper ranks high among the nonferrous metals. Copper as a metal was known and used before the Christian era but its use in quantity came with the development of the electrical industry. Only limited quantities of copper are produced in Europe, where the mining and smelting of copper were developed early. With the development of practical methods of processing low-grade ores, many formerly uneconomic deposits have become major factors in the mining industry. The leading producers are the United States, Chile, Northern Rhodesia (Zambia), the Soviet Union, Canada and Republic of the Congo.

Aluminum.—The difficulty of separating aluminum from bauxite and a number of other aluminum-containing minerals deferred its industrial use for many centuries. The lightness of aluminum, its conductivity and its resistance to corrosion led to its use as sheet metal, for electrical equipment, in transportation equipment and for a variety of products. Bauxite, the chief source of aluminum, is produced chiefly in Jamaica, Surinam, British Guiana, France, the United States and the Soviet Union. In the production of aluminum metal the United States, Canada, the Soviet Union, west Germany and Norway, all producers of cheap electrical power, are the leading contributors. The major producers and users of aluminum are dependent upon imported raw materials with the exception of France and the Soviet Union, which are generally self-sufficient.

Lead and Zinc.—Modern industry continually requires supplies of lead and zinc. In the mid-1950s approximately 2,400,000 tons of lead were produced annually. The leading countries included the United States, Australia, the Soviet Union, Mexico, Canada and South Africa. In spite of the threat of rapid depletion of reserves, production of lead increased through the extension of known reserves and the recovery of a higher proportion of the metal in the ores.

Despite competition from aluminum and other metals, corrosion-resistant zinc is extensively used for galvanizing. Along with copper, zinc is used in the manufacture of brass. Nearly 40% of the world's zinc is produced in North America with the United States in first place. Large quantities are contributed by Canada and Mexico. The continent of Europe produces 32% of the world's supply with important contributions from the Soviet Union, Poland, Italy, Spain and west Germany. In Asia, Japan is the leading producer but larger quantities are mined in Australia. In South America, Peru is the major source. In tonnage zinc exceeds lead but both serve particular purposes in industry.

Tin.—The mining of tin ore is highly concentrated in a few centres but the metal is marketed in all parts of the world. Major production areas are in Malaysia, Indonesia, Bolivia and Republic of the Congo. During World War II Japan controlled the tin resources in the far east. The United States and many other countries had to reuse tin already on hand by detinning tin cans and recovering the metal from collapsible tubes and other sources. The U.S. built a tin smelter at Texas City, Tex., and processed imported ores, chiefly from Bolivia, to help meet its needs.

Other Nonferrous Metals.—The list of nonferrous metals could be extended to include magnesium, antimony, mercury and several others, but the metals discussed above are of major importance and are representative of this group of metals. (*See* ORE DE-

POSITS and articles on the various nonferrous metals.)

The Precious Metals.—Because of the nonperishable character of gold and its use as a monetary standard, the total quantity of metal in the world accumulates over the years. Small quantities are consumed, dispersed or lost each year but generally the total supply of gold in the world tends to increase. New gold comes chiefly from the Republic of South Africa, the Soviet Union, Canada and the United States.

While silver does not enjoy the preferred status of gold as a monetary metal, it is widely used in domestic and international transactions. In addition to its monetary use, it is also used extensively in the arts: for tableware, jewelry, photographic film and other purposes. Some silver occurs in nature as a pure metal but more often it is only one of several metals occurring together as sulfides. Mining, smelting and refining of these ores results in the recovery of copper, nickel, lead and zinc as well as silver. North America is the leading silver continent. Mexico, the United States and Canada usually rank as first, second and third, respectively, in the mining of silver ores. Other producers include the Soviet Union, Peru, Australia and Bolivia.

Platinum, osmium, iridium, rhodium, ruthenium and palladium collectively make up the platinum group of metals. These metals are of major importance in the electrical industry, in the chemical industry, chiefly as catalysts, in the arts, especially jewelry manufacture, and in dentistry and medicine. They are most widely used in the industrial countries. Production is highly centralized in the Republic of South Africa, Canada, the Soviet Union, Colombia and the United States. (*See* articles on the various precious metals.)

Nonmetallic Minerals.—The common earth materials such as rocks of various kinds, unconsolidated sediments such as sand and gravel, and clay and silt are so abundant in most parts of the world that any needed material not available locally can be obtained from nearby areas. Generally these earth materials are low-value, short-haul resources. Only a few, such as china clay, decorative stone and others that may have some special quality, can be transported over great distances economically.

Among the nonmetallic substances present in the earth's crust, a few have special qualities which make them vitally necessary in industry. Among these are such minerals as asbestos, sulfur, quartz crystals, mica, salt, the fertilizer minerals and several others.

Sulfur.—Modern industry is heavily dependent on sulfur for its proper functioning. Sulfur is obtained chiefly from deposits of elemental or native sulfur and from sulfur-containing minerals such as the sulfides. Along the Gulf coast of Louisiana, Texas and Mexico are numerous salt domes that contain native sulfur. This coastal strip is the world's leading producer. Other major producers of native sulfur are Italy, chiefly in Sicily, and Japan, where the deposits are associated with volcanic rocks. More widely over the world the processing of sulfide ores yields important quantities of sulfur. This is done in Spain, a long-time producer, Canada, Japan, the United States, the Soviet Union, Norway and the island of Cyprus.

Quartz.—Silica, consisting of oxygen and silicon and commonly occurring as quartz or in silicate minerals, is one of the most abundant earth materials. As quartz sand it is used for a variety of purposes from glassmaking to sandblasting. In spite of its relative abundance in nature, quartz crystals of great purity and large size are relatively rare and production to meet the needs of the electronics industry is largely centred in Brazil. (*See* QUARTZ; SILICA.)

Mica.—A thin platelike mineral, mica is widely known in nature where it occurs in small flakes in igneous and schistose rocks. Sheet mica in large crystals occurs in pegmatite dikes and can be quarried, split and cut to the required dimensions. Large quantities of flake mica are available wherever coarse-grained igneous rocks occur and the needs of the rubber, roofing, paint and abrasive industries can be met from these sources. The high-quality sheet mica used by the electrical industry is produced in more restricted areas including India, Madagascar, eastern Siberia, Brazil and the United States. (*See* MICA; PEGMATITE.)

Asbestos.—Before the development of spun glass and rock wool as noncombustible and heat-resistant materials, asbestos was in high demand for these purposes. Asbestos, because of its fibrous nature, can be spun and woven into heat-resistant fabrics for fire curtains, gaskets, brake linings, fire fighters' suits and many other items. Asbestos in combination with portland cement, magnesia and other substances is used in the manufacture of roofing materials and wallboard. High-quality asbestos is produced chiefly in the Thetford area of eastern Canada, but important tonnages are contributed by the Soviet Union, the southern part of Africa and Japan. (*See* ASBESTOS.)

Fertilizer Minerals.—The continued productivity of the land is dependent upon the availability of four major elements, calcium, nitrogen, phosphorus and potassium, and a number of minor or trace elements including magnesium, manganese, boron, iron, copper, sulfur, zinc and others. Calcium, chiefly in the form of lime carbonate, is relatively abundant and areas without limestone can easily secure this material.

Nitrogen in the form of nitrates is widely distributed in soil but because of its solubility it is continually being lost. The nitrogen content of the soil can be maintained by the application of manures and other organic wastes to the land. Mineral nitrates, available in the Atacama desert of northern Chile, were formerly used extensively in the manufacture of commercial fertilizers. After World War I nitrogen obtained by fixation from the atmosphere became increasingly important and makes up more than three-quarters of the nitrogen content of the commercial fertilizers.

Phosphorus usually is available from phosphate rock which contains the mineral calcium phosphate. In order to make the phosphorus readily available, the phosphatic material is treated with sulfuric or nitric acid. Small quantities of calcium phosphate occur widely in limestones and, as a result of weathering, phosphatic minerals may be residual in the soils locally. Phosphate rock in sufficient abundance to support the fertilizer industry is available in the United States, Morocco and Tunisia in north Africa, the Soviet Union and Nauru in the west central Pacific. Phosphatic material is also available from phosphorus-containing minerals and ores. For example, basic slag from the steel industry may contain enough phosphorus to justify its preparation and use as a fertilizer.

Before World War I Germany had a virtual monopoly on potash but with the loss of Alsace a portion of the production and reserves passed to the jurisdiction of France. Stassfurt, Ger., remains a major source of potash but production from deposits in New Mexico has given the United States second place. Other producers include the Soviet Union, Spain and Israel. (*See* FERTILIZERS AND MANURES; MINERAL PHOSPHATES.)

VI. STRATEGIC RESOURCES

All materials, inorganic or organic in origin, necessary to national defense or the prosecution of war may be said to be strategic. No nation should risk involvement in a major war unless its supplies of strategic materials are adequate for an extended conflict or unless it has the capacity to produce or secure these resources by trade. Certain resources may be available in quantity but they may be regarded as strategic if they are essential to defense or military effort. For example, steel and cotton are strategic materials but in the case of the United States adequate production can be maintained. The resource situation may vary from completely adequate supplies of a number of materials to negligible supplies of others. Because of technological developments, the number of materials that may be classed as strategic has grown, and the problem of securing and maintaining adequate supplies has become increasingly complicated.

Stockpiling.—In the case of scarce materials the resource situation may be so critical that stockpiles of a long list of metals, ores and organic materials should be built up to meet the needs of a nation while it absorbs the first shocks of a major war. Such emergency supplies should be large enough to meet wartime needs over a period of two to five years or even more, depending on the ease or difficulty of securing replacements.

Stockpiles of organic materials such as rubber, fibres, timber, hides and skins, condiments and wood pulp are subject to deterioration or destruction while in storage. For example, the stockpiling of raw rubber requires that a regular and continual renewal program be maintained to keep up the quality of a nation's hoard of this essential commodity.

The program of stockpiling of strategic materials should be reexamined from time to time to make sure that the proper quantities are maintained. People can be lulled into a false sense of security by the knowledge that the strategic materials have been stockpiled. As the needs of defense change the character and dimensions of the stockpile will need to be restudied.

Substitution.—If metals and other materials are not available in sufficient quantities to meet defense needs, the national security may be endangered. Substitute materials should be included in the stockpile or be in production so that the national economy will not suffer if it becomes necessary to substitute one material for another. If all of the ferroalloys are not accessible in the proper quantities the steel industry may make more abundant use of the alloy metals that are available. This in effect is the substitution of an abundant metal for one in short supply. During World War II, when the supply of tin was greatly reduced, glass containers and lacquered cans replaced the widely used tin can. It is evident that plastics can be used extensively to replace metals and wood. Continued research and technological developments will provide a variety of substitute materials when the need arises.

Subsidies.—In some instances a mining operation or manufacturing facility engaged in the production of a strategic material may be in financial difficulties. A modest subsidy may be all that is required to give such an industry economic stability and the prosperity it requires to continue in operation.

Trade and Tariffs.—National security for all nations, even such powerful countries as the U.S. and the U.S.S.R., depends upon international trade. Materials in short supply are imported and inventories and stock piles built up. To encourage this, nondiscriminatory tariffs and other politico-economic devices may be used to facilitate the movement of essential materials. *See* ECONOMIC WARFARE; MOBILIZATION, ECONOMIC.

VII. CLIMATE

On the basis of temperature and rainfall, the earth can be divided into a variety of climatic regions. Five major thermal zones may be identified: the tropical zone, the north and south intermediate zones and the north and south polar zones. On the basis of precipitation, the earth can be divided into rainfall regions: humid, subhumid, semiarid and arid. By combining temperature and moisture conditions the earth can be divided into approximately 15 major types of climate though individual climates may be repeated over the surface of the earth as many as five or six times.

Humid Tropical Climates.—Between the equator and approximately latitude 18° to 20° north and south lies an area with a humid tropical climate. Near the equator the climate is rainy at all seasons because the area is always under the influence of the doldrums. The annual amount of precipitation varies between 60 and 100 in. except in mountains where the maximum may exceed 300 in. In these equatorial areas the precipitation in the driest month may be as little as three inches in the low-sun period. When the sun is directly overhead the amount of precipitation may exceed ten inches per month. These wet equatorial climates are well developed in the Amazon basin and nearby coastal areas, in the Republic of the Congo and the borderlands of the Gulf of Guinea and in Indonesia, the Philippines and the coastal margin of southeast Asia.

Generally poleward from the equatorial climates there are extensive areas that have a savanna type of climate, a name that indicates the character of the natural vegetation. These areas have a hot climate the year around with a precipitation of 30 to 60 in. The rainfall is heavily concentrated in the summer season or the high-sun period. When the sun is low in the sky and the trade winds prevail, these savanna areas are very dry. The savanna type of climate is characteristic of large areas in South America such as the llanos and the campos and of many areas in Central America and the Caribbean. The Sudan and the plateaus of east and south central Africa contain extensive savanna areas. Large areas in India, southeast Asia and northern Australia also have this type of climate.

Dry Climates.—Large areas in the trade-wind belt and in latitudes 15° to 30° north and south are characterized by desert or semiarid conditions. These dry areas extend generally poleward into the interior areas of the continents of South America, North America and Asia. Those that lie between the true deserts and the humid areas near the coasts are semiarid and characterized by the scant vegetation of the steppe.

Humid Climates of Intermediate Latitudes.—On both the west and east sides of the continents in latitudes 30° to 65° north and south the precipitation varies from 20 to 80 in. annually. In these latitudes the annual range of temperature is much greater than in the tropics. Along the west coasts temperatures are more moderate than on the east coasts, where continental extremes are common. Summers are hot and winters cold. On the west coasts the maximum precipitation comes in the winter season but on the east sides of the continents precipitation is more evenly distributed throughout the year. Interior locations generally have a warm-season maximum.

Polar Climates.—In the arctic and antarctic areas, where the sun is continuously above the horizon for as much as six months and is below the horizon for a similar period of time, the climate is characterized by a low mean annual temperature and even in summer the temperatures are low. The winters are long and bitterly cold. Limited areas that are free of ice and snow during the short summer have a tundra type of climate. Extensive areas are always covered by ice and snow and have an icecap or glacial climate. *See* CLIMATE AND CLIMATOLOGY; SEASONS; METEOROLOGY.

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NATURAL RESOURCES, LAWS CONCERNING (U.S.). This article deals with the roles of the federal and state governments of the United States in the conservation of such natural resources as soil, forests, water, range land and minerals (including oil and gas). The dual authority of the two governments to legislate on conservation has created numerous legal complications. On the one hand, the federal government admittedly possesses broad power to provide for the conservation of

resources on land that it owns and that it acquired through cession or conquest (the public domain) or on land that it has purchased from private owners (acquired land). The extent of its constitutional power to provide for conservation of resources on land that has passed into private ownership is much less clearly defined. A state government also may have relatively broad powers of conservation with respect to land that it owns, but its conservation legislation relating to privately owned resources may sometimes conflict with provisions of the federal constitution.

State Legislation.—Under its police powers a state may eliminate threats to its resources without violating the due process clause of the federal constitution. Thus, in order to control plant and animal diseases, a state may institute inspection or preventive measures or may provide for the destruction of disease-bearing objects. Legislation to prevent physical waste is generally upheld where the resources are publicly owned (*e.g.*, wildlife). With respect to privately owned resources, however, considerable uncertainty exists about the extent to which conservation measures may be applied. The validity of regulations relating to waste of oil and gas has generally been defended on the assumption that these measures really protect other private owners who have correlative rights in the minerals rather than on any general privilege of the state to provide for the conservation of all natural resources within its boundaries. Timber and soil conservation statutes exist in a number of states, and although there has not been much litigation under these measures they are probably valid as long as the interference with property rights is no greater than is reasonably necessary. There seems to be virtually no state legislation conserving the so-called hard minerals.

In contrast to legislation aimed at physical waste, a number of the oil states have proration statutes which are designed primarily to avoid overproduction of oil and gas. These have been upheld on the ground that they also prevent physical waste, but their primary purpose would seem to be to deter economic waste through the control of prices.

An interesting aspect of state conservation legislation is the type of statute which purports to limit the use to its own citizens of resources owned by the state in trust for the public. Statutes which deny nonresidents the privilege of hunting are probably no longer valid, but a higher price for nonresident licenses can be justified on the basis of the increased cost in administering the program. U.S. supreme court decisions conflict on the right of a state to forbid exportation of its natural resources. Legislation of this type is likely to run afoul of the commerce clause in the federal constitution.

The greatly increased national consumption of water has resulted in conservation measures even in states not traditionally classified as "arid." In the western states the right to use water, which is regarded as a publicly owned resource, is in general based on priority of appropriation rather than upon ownership of land which is situated near, or which contains, water. These "appropriation" states make beneficial use the basis, measure and extent of the right to use water, and the basic postulate of their laws is that water may not be wasted even by one who has secured a right to appropriate it. These states have elaborate administrative organizations to supervise the allocation of this vital resource in the public interest. In some of these states, the right to use water may be obtained only after filing an application with the appropriate state official, stating the purposes for which the water is to be used, the type of diversion, the amount of water required and the time when it will be used. Such requirements are, of course, intended to prevent waste and the acquisition of water rights for purely speculative purposes. The major problem in western water law is the extent to which the federal government, in administering the federal public domain, may interfere with the traditional role of the state in allocating water. The famous Pelton dam case (*Federal Power Commission* v. *Oregon*, 349 U.S. 435 [1955]) precipitated the controversy in holding that the federal government was not required to obtain permission from the state to build a dam on a nonnavigable stream on federal land which had been reserved for power purposes.

Federal Legislation.—Congress has increasingly invaded the field of conservation under the commerce, treaty, and spending powers as well as under the "property clause" of the constitution. The latter provides that congress "shall have Power to dispose of and make all needful Rules and Regulations respecting the . . . Property belonging to the United States" (art. iv, sec. 3). There are numerous federal conservation programs involving federally owned land; conservation legislation under the other constitutional powers is less common. The Connolly "Hot Oil" act, referred to below, was based upon the commerce clause. The Migratory Bird treaty of 1916 was a conservation measure. Federal reclamation acts illustrate conservation under the spending power.

Grazing.—During the 20th century it became apparent that the federal range lands in the west were in serious danger of depletion due to overgrazing and other wasteful practices. Uncontrolled grazing on the public domain ended with the enactment in 1934 of the Taylor Grazing act. Although intended primarily as a conservation measure, one of the purposes of the act was to stabilize the livestock industry. The secretary of the interior was authorized to make temporary withdrawals of unappropriated land chiefly valuable for grazing and raising forage crops. He was also empowered to establish grazing districts and to issue grazing permits and licences revocable at will. The secretary has issued detailed regulations (popularly referred to as "the law of the range") relating to such matters as the kind and number of animals that may graze on federal range land, the time when grazing is permitted, etc. The program is administered by the bureau of land management of the interior department. Grazing in the national forests is similarly regulated. These areas are under the jurisdiction of the department of agriculture.

Forests.—U.S. timberlands, like the grasslands, were subjected to astonishing abuse in the 19th century. Great quantities of valuable timberland were disposed of under the public land laws as agricultural land. In order to achieve maximum production, the large lumber companies employed wasteful practices. The land was usually logged and then abandoned, timber was cut before there was need for it, and lower-grade portions of trees were not used. In 1891 the Forest Reserve act authorized the president to reserve federally owned forests from sale. Subsequent legislation provided for the administration of the national forests. The forest service of the department of agriculture was given responsibility for carrying out the program, and numerous special acts established the various national forests. The timber policy of the forest service includes the prevention of wood waste and the maintenance of a healthy relation between the volume cut and the amount of new growth. Timber available for cutting is designated by officials of the service, and contracts for the purchase of this timber are generally let on the basis of competitive bidding, provided the highest bidder has the reputation for exemplary lumbering practices. Conservation techniques include the maintenance of forest and range experimentation stations which have pioneered in the development of fire control equipment, insecticides and sprays. New strains of grasses, as well as reseeding programs, have also been introduced. The record of the forest service in administering the national forests and their grazing lands has been most commendable. (*See* also FORESTS AND FORESTRY: *Forestry.*)

Minerals.—Free mining on the federal public domain has been authorized since 1866, and mining locations for hard minerals are governed chiefly by the Mining law of 1872. The policy of the so-called location laws has been one of unrestricted exploitation of hard minerals. Certain fissionable source materials may be sold only to the federal government, and certain common varieties of minerals have been removed from the location laws. The federal government retains the right, prior to the issuance of a mining patent, to use surface vegetative materials. Petroleum, on the other hand, has always been the subject of conservation legislation. Beginning in 1909, it was thought that the nation's supply of petroleum was in danger of serious depletion, and vast withdrawals were made reserving valuable federal oil and gas land from disposal under the mining laws. Eventually, with the passage of the Mineral Leasing act of 1920, federal oil and gas land was made exclusively leasable. Leases are issued either to the first applicant or on the basis of competitive bidding, depending upon whether

the land is within a known geological structure of a producing oil and gas field. The act requires lessees to use reasonable precautions to prevent waste. Unitization (co-operative pool development) of oil and gas fields as a conservation measure has been fostered by the federal government in the public land states. The Interstate Compact to Conserve Oil and Gas, adopted by the principal oil-producing states, was approved by congress in 1935, and one of the main functions of the Interstate Commerce commission has been to promote the best conservation practices in oil and gas production. The conservation statutes of the states were also implemented by the Connally "Hot Oil" act of 1935, in which the federal government used its interstate commerce power to prevent interstate shipment of "contraband oil" produced in violation of state prorationing legislation. Apart from these instances of federal legislation, oil and gas conservation legislation is found primarily in the state regulatory measures forbidding wasteful practices and providing for prorationing, well-spacing and compulsory pooling.

Soil Conservation.—The federal soil conservation program consists of watershed treatment, soil and moisture conservation, retirement of submarginal farmlands, and the manufacture of fertilizers. Watershed treatment involves revegetation and other soil-conservation measures undertaken to retard runoff and soil depletion in the interests of flood control, water conservation and the improvement of the quality of water sources. Under the Flood Control act of 1936 the department of agriculture was authorized to investigate watersheds. Eleven watershed treatment plans were approved in the Flood Control act of 1944. The extent of federal participation in these plans varied. The Watershed Protection and Flood Prevention act of 1954 replaced earlier legislation, and under it the secretary of agriculture may make surveys and undertake the construction of works of watershed protection and improvement upon the request of a state or other local unit. The act contains detailed provisions relating to the use of federal funds in construction works. A 1938 Flood Control act also authorizes the secretary to participate in emergency watershed treatment work.

Soil and moisture conservation stems from 1935 legislation passed after the great drought and dust blowing in 1933–34 in the southwestern United States. The secretary of agriculture is authorized to carry out measures against the waste of soil and moisture resources on farm, grazing and forest lands. The interior department shares in this work in connection with land under its jurisdiction. The retirement of submarginal land as part of the federal soil conservation program is carried out principally under Title III of the Bankhead-Jones Farm Tenant act of 1937. The secretary of agriculture may acquire, by purchase or otherwise, lands unsuitable for cultivation, improve and develop them and then sell, lease or otherwise dispose of them.

The manufacture and distribution of fertilizers is a part of the soil conservation program and is under the supervision of the Tennessee Valley authority.

Water Resources.—The water resources program of the federal government includes the soil conservation measures indicated above. In addition, the government has engaged in the improvement of navigation under the numerous river and harbour acts. By the time of the passage of the 1950 act the federal government had improved about 28,000 miles of inland and intracoastal waterways and had constructed 490 locks and dams and 270 harbours, at a total cost of about $1,500,000,000.

Prior to 1936, the federal government had embarked upon a number of special flood control projects. The first general flood control act, passed in that year, extended federal flood control work to all inland waters of the country. By mid-century congress had authorized almost 1,000 projects for the various river basins in the continental United States. The largest enterprises are for the Ohio River basin, the Lower Mississippi River basin and the Missouri River basin.

Reclamation has always been a significant part of the federal water resources program. After earlier unsuccessful efforts to stimulate reclamation by the states, congress embarked upon a program of direct federal action in the Federal Reclamation act of 1902. Like earlier statutes, irrigation works were to be financed by the proceeds from the sales of public lands. A new feature was that the federal government, not the states, was to conduct the land sales and construct the irrigation works. Receipts from the sale of public lands in 13 western states were put in a special fund to be used for the construction and maintenance of such works in these states. Under the act the federal government also engages in the sale of irrigation water, which is subject to two conditions: (1) at least one-half of the total area to be irrigated must be actually reclaimed; and no water shall be sold to any one landowner for a privately owned tract exceeding 160 acres.

See also NATIONAL PARKS AND NATURE RESERVES; SOIL: *Soil Erosion and Conservation;* WILDLIFE CONSERVATION.

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(R. W. Sw.)

NATURAL RIGHTS. The doctrine that all men equally are naturally free "to order their actions and dispose of their persons and possessions as they think fit, within the bounds of the law of nature," found its clearest expression in John Locke's *Second Treatise of Government* (1690), from which this passage is quoted. It is characteristic of Locke, as of modern political thought generally, that he conceived of natural law not so much as a law ultimately derived from God and imposing obligations upon men but as a principle self-evident to human reason that all men are "equal and independent" and that "no one ought to harm another in his life, health, liberty or possessions." Since men are by nature "free, equal, and independent" it follows that "no one can be put out of this estate and subjected to the political power of another without his own consent." According to Locke "the great and chief end" for which men agree to form governments, to live in community, "is the preservation of their property."

The doctrine of natural rights stems from the individualism that emerged at the time of the Renaissance and Reformation and the transformation of the medieval Christian theory of natural law (which prescribed conduct appropriate to human beings as creatures of God) into a theory of natural rights (which emphasized the self-evident character of individual freedom and equality). This transformation was accomplished principally by Hugo Grotius (1583–1645), Thomas Hobbes (1588–1679), Samuel Pufendorf (1632–94) and John Locke (1632–1704) (*qq.v.*). The doctrine which in its Lockian form emphasized the natural right to acquire unequal amounts of property, especially in the form of money, appealed to the rising middle classes and helped to supply a justification for capitalism. Although the doctrine was frequently employed in the 19th century by conservative thinkers who sought to justify the economic *status quo*, originally it had radical implications which were fully exploited in the American and French Revolutions.

Locke was defending the Whig revolution of 1688 but his argument was employed in the American Revolution and found succinct summarization in the Declaration of Independence (1776), which states that, "We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness.—That to secure these rights, Governments are instituted among Men, deriving their just powers from the consent of the governed,—That whenever any Form of

Government becomes destructive of these ends, it is the Right of the People to alter or to abolish it, . . ." The French National Assembly adopted a similar Declaration of the Rights of Man and of the Citizen in 1789.

The doctrine did not go unchallenged and the English utilitarian Jeremy Bentham characterized natural rights as "rhetorical nonsense,—nonsense upon stilts" (*Anarchical Fallacies*, 1795). One can speak meaningfully, he contended, of legal rights but not of "natural" rights. Despite such objections, which became more numerous in the 19th century, 20th-century thinkers have persisted in proclaiming "the equal and inalienable rights of all members of the human family," a phrase which occurs in the Universal Declaration of Human Rights adopted by the general assembly of the United Nations at its meeting on Dec. 10, 1948, in Paris.

The revolutionary significance of the doctrine of natural rights which emerged in the 17th century was the fact that it sought to ground government upon individual will and consent. Society itself was thought to be the product of a contract; justice was no longer conceived as embodying principles transcending individual will and consent but rather as a reflection of the terms of the contract. In the Christian tradition as reflected in the thought of St. Thomas Aquinas, as well as in the older Aristotelian tradition, the purpose of the state was dictated not by the subjective desires of individuals but by the nature of man and the end for which he is destined. The state was conceived as existing to promote justice among men, to help men to become better human beings, to help unleash their creative capacities for good and to restrain their propensity to do evil. Justice was not a subjective concept but was rooted in objective reality. Within this tradition individuals are conceived as having rights as human beings but the rights derive from duties rather than the duties from the rights.

The proclamation of "equal and inalienable rights of all members of the human family" would appear to stem from the conviction that there are principles of justice which transcend the positive laws of any society, principles which are the same for all men in all places at all times. They provide the inspiration for social justice and the norms for evaluating existing legislation. They are the *raison d'être* of constitutional government.

Difficulties arise when an effort is made, as it must be made in practice, to distinguish between the possession of such rights and their exercise. Not only may the rights claimed by one individual conflict with the rights claimed by another, but questions arise as to the priority to be established among rights. Is "the pursuit of happiness," which the proclamation of human rights is designed to foster and protect, to be conceived in hedonistic terms or in terms of a life of reason or a life of spiritual growth in awareness of God?

There is more widespread agreement concerning the enumeration of human rights than there is agreement concerning their ultimate justification and practical exercise. Ultimately these disagreements reflect basic disagreement concerning what constitutes the good life for man. Much depends upon whether this good is conceived in material or spiritual terms, whether man is conceived to be primarily a producing and consuming animal or a spiritual creature whose ultimate destiny lies beyond life in this world. In speaking of natural rights much hinges upon how "nature" is interpreted, whether we mean by "nature" how men do in fact act when unrestrained by reason or how men ought to act in order to perfect their natural (human) potentialities.

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NATURE RESERVES: *see* National Parks and Nature Reserves; Wildlife Conservation.

NATUROPATHY, a system of medical thought and therapeutics based upon the use of natural agencies, forces, processes and products. Surgery is not a part of this system. In many places its practitioners are known as drugless healers. Naturopathy is widespread and its literature, which is very extensive, appears not only in English, German and French but in many other tongues as well. The origins of this medical cult are obscure but its roots may be found in the writings of the ancient herbalists and the practices of primitive folk medicine. (M. C. L.)

NAUKRATIS, an ancient Greek settlement in Egypt to the west of the Nile delta. The site was discovered by W. M. Flinders Petrie in 1884 at Kom Gaif just southeast of modern An Nubayrah, about 10 mi. W. of the present Rosetta branch of the Nile; in ancient times it lay on the Canopic branch, now silted up.

Naukratis was not a colony of the usual Greek type but an *emporion*, trading station, at one time possessing exclusive trading rights in Egypt. According to Strabo, the first settlers (*c.* 610 B.C.) were Milesians, favoured by the Saite pharaoh Psamtik I. Ahmose II (569–526) granted land there to Greeks from nine other cities of Asia Minor, who shared a shrine, the Hellenion, and appointed *prostatai* to superintend trading. Greeks from other cities settled there, however; according to Herodotus, the Aeginetans had a separate temple of Zeus, the Samians of Hera and the Milesians of Apollo. The foundation of Alexandria (332) probably caused Naukratis to decline, though there was new building there under Ptolemy II Philadelphus (king 285–246), and the city was still in existence under Hadrian (emperor A.D. 117–138), who adopted its constitution for his new city Antinoopolis.

The site was excavated by Petrie (1884–85) and Ernest Gardner (1885–86), and again by David George Hogarth (1899, 1903). Traces were found of Greek settlement from the late 7th century B.C. onward and of an Egyptian town to the south of the Greek one. Dedications were found to Hera and Apollo, also to Aphrodite and the Dioscuri; an enclosure to the northeast of the town containing dedications to "the gods of the Greeks" was reasonably identified by Hogarth with the Hellenion. Important finds of Greek pottery threw light on the early history of the alphabet and the commercial activity of various Greek states, especially in the 6th century B.C.

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NAUMACHIA, the Greek word for a naval battle (from *naus*, "ship," and *mache*, "battle"), used by the Romans as a term for a mimic sea fight. These entertainments took place in the amphitheatre, which was flooded with water, or in specially constructed basins (also called *naumachiae*). The first on record was given by Julius Caesar (46 B.C.) on a lake which he constructed in the Campus Martius. In 2 B.C. Augustus, at the dedication of the temple of Mars Ultor, exhibited a *naumachia* representing the battle of Salamis, in a basin constructed near the Tiber and used by subsequent emperors. *Naumachiae* were comparatively rare as they involved much expense and preparation. In that given by Claudius (A.D. 52) on the Fucino lake, 19,000 men dressed as Rhodians and Sicilians maneuvered and fought. The crews consisted of gladiators, condemned criminals and in later times volunteers. A large number of the participants were killed; the saying "Hail, Caesar, we who are about to die salute thee!" was occasioned by Claudius' *naumachia*.

Horace mentions a small-scale *naumachia*, representing the battle of Actium, on a pond in a country estate; this was mere play.

NAUMBURG, a town of Germany in the *Bezirk* (district) of Halle which after the partition of the nation following World War II became part of the German Democratic Republic. It lies on the Saale near the junction with the Unstrut about 44 km. (27 mi.) S.W. of Leipzig by road. Pop. (1961 est.) 37,391. Of many historical buildings, the best known is the cathedral of SS. Peter and Paul with four towers and two choirs; built at the end of the 12th century, it is a mixture of the late Romanesque and the early Gothic styles and contains medieval sculptures, including lifelike statues of the founders of the cathedral. The town is on the Leipzig–Frankfurt am Main railway and on main roads. Principal manufactures are textiles and toys. Near the town in the Unstrut valley are extensive vineyard areas. In the 10th century the margraves of Meissen had a stronghold there. The town was established in 1028, became a bishopric in 1029, received town rights in 1142 and was in 1432 for a short time a member of the Hanseatic

league. After the death of the last bishop in 1564 it passed to the electorate of Saxony until 1815, and then to Prussia until 1945.

NAUNDORFF, KARL WILHELM (d. 1845), was the most successful of the so-called *faux dauphins*, or claimants to the identity of the French king Louis XVII (*q.v.*). First recorded in Germany, he lived in Berlin (1810–12), went to Spandau (1812), married Johanna Frederike Einert there (1818) and, having moved to Brandenburg (1822), was arrested on a charge of coining (1824). The charge could not be proved, but in 1825 he was sentenced to three years' imprisonment on suspicion, since the court rejected his claim to be a French prince. Released in 1828, he went to Krossen and began building himself up as Louis XVII.

On the presumption of Louis XVII's death, Louis XVIII (1814) and Charles X (1824) had become kings of France. When the July revolution (1830) made Louis Philippe king of the French, the new regime might have tolerated a challenge to the preceding one's legitimacy so long as its own security was not endangered. With a tale of escape from the Temple and of adventures in obscurity, Naundorff arrived in Paris in 1833 and was accepted as Louis XVII by the latter's former governess. She took him to Prague to see the duchesse d'Angoulême (Marie Thérèse de France, Louis XVII's sister), who declined to receive him. At the trial of a rival pretender in Oct. 1834, a lawyer publicly intervened for Naundorff as Charles Louis, duc de Normandie—though Louis XVII had been named Louis Charles. In June 1836, having filed a suit against Madame d'Angoulême for recovery of her brother's property, Naundorff was deported from France. His papers were seized and held by the police.

Naundorff finally settled in the Netherlands, where he invented a projectile weapon and sold it to the ministry of war. He died at Delft on Aug. 10, 1845. His numerous descendants pursued his claims, bringing lawsuits in France, with Jules Favre (*q.v.*) as their advocate, in 1851 and in 1874, issuing a manifesto (1883) and petitioning the senate in 1910. Their cause won some passionate adherents, and the periodical *La Légitimité* (1883–1940) was devoted to it. A major counterblast was G. de Manteyer's *Les Faux Louis XVII* (1926), with its mass of documents purporting to equate Naundorff with a certain Carl Benjamin Werg. Even so, Naundorffism was still, decades later, a recurrent manifestation of what its opponents call *fauxdauphinomanie*.

BIBLIOGRAPHY.—For an introduction, *see* L. Creissels, *Louis XVII et les faux dauphins* (1936); L. Hastier, *La Double Mort de Louis XVII* (1951). For a vindication of Naundorff, *see* A. Decaux, *Louis XVII retrouvé: Naundorff roi de France* (1947).

NAUPLIA (modern Gk. NAVPLION), chief town of Argolis *nomos* (department) in the Peloponnese, Greece, at the head of the Gulf of Argos (Argolikos Kolpos), of which it is the port. Pop. (1961) 8,918. It stands on a peninsula between two rocky citadels: Itch Kale, the lower, was the ancient acropolis; Palamidhi, the higher, is named after Palamedes, son of the hero Nauplius (from which the town gets its name), who sailed with the Argonauts. The tiny island of Bourtsi (Bourdzi) in the bay has a Venetian fortress. Nauplia markets the fruit, tobacco and cotton produced in the plain of Argos and is a centre for tourists visiting Mycenae, Tiryns, Argos and Epidaurus (*qq.v.*). The museum has a fine collection of Mycenaean pottery. Nauplia shared the fortunes of Argos in classical times, but revived under the Byzantine empire. Captured in 1210 by Geoffroy de Villehardouin, it became, with Argos, a fief of the French duchy of Athens. In 1388 it was bought by the Venetians, who called it Napoli di Romania. Given to the Turks in 1540, it was recaptured by Venice in 1686, and the Palamidhi rock was fortified. In 1715 it fell again to the Turks, but the Greeks captured it during the War of Greek Independence in Dec. 1822. From 1829 to 1834 it was the seat of their government. The Greek garrison of Nauplia began the revolt against King Otho in 1862.

See G. Finlay, *History of Greece* (1876); E. S. Forster, *Short History of Modern Greece, 1821–1956* (1958). (D. M. N.)

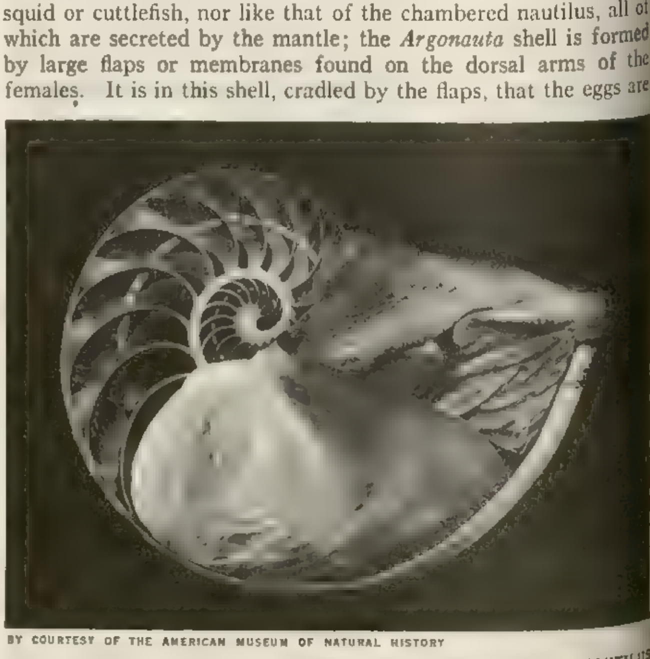
NAUSICAÄ, in Greek legend, daughter of Alcinoüs, king of the Phaeacians in the island of Scheria. When Odysseus (*q.v.*) swam ashore to Scheria, he was found by Nausicaä, who supplied him with clothes and took him to her father's palace, where he was hospitably entertained.

NAUTCH, a dance form of India, literally, any art presentation of song and dance combined. After about 1925 the title was generally applied to the stage presentation of dances of Marwari women who wear and manipulate the wide *gargari* skirt. Spinning turns, the beating of belled feet, coquetry and fluid arm movements are characteristic. (R. M. Hs.)

NAUTILUS, a popular name applied to two distinct genera of cephalopod mollusks: the pearly or chambered nautilus, *Nautilus*, of the southwest Pacific, to which the name properly applies, and the paper nautilus, *Argonauta*, a cosmopolitan genus of open-ocean octopod.

Pearly Nautilus.—Six species of *Nautilus* are recognized, their area of greatest concentration lying between the Fiji and Philippine islands, although dead shells are found on many beaches of the Indo-Pacific region. The animal produces a smooth, coiled shell about 10 in. in diameter, consisting of about 36 chambers, in the last of which it lives. All of the chambers are connected by a tube, or siphuncle, through which gases are secreted into or absorbed from the chambers, in consequence of which the shell acts as a float or hydrostatic organ that aids in ascending and descending through the water. *Nautilus* lives at various depths down to about 2,000 ft., swimming about the bottom in search of shrimp or other creatures upon which it lives. It has up to 94 small, suckerless contractile tentacles that are used for capturing prey. Nautiluses are caught in traps at night when they ascend to shallower waters. In life the shell, sold commercially in many parts of the world, is white with reddish-brown flame markings but when treated and polished is mother-of-pearl. This is the "many-chambered nautilus" of writers. In Polynesia and the Philippines the shells may be cut into fish lures by the natives or worked into cups and vases; in America and Europe they are often fashioned into lamps or other decorative items. The structure and classification of *Nautilus*, the last surviving genus of the ancient order Nautiloidea, are discussed in the article CEPHALOPODA. The nautiloids were extremely numerous in ancient seas, and are important in paleontology for dating the strata in which they occur.

Paper Nautilus.—*Argonauta* is found in all tropical and subtropical seas, living near the surface, although specimens have been captured below 3,000 ft. It feeds upon planktonic Crustacea and other small drifting life. It belongs to the eight-armed order Octopoda but differs from other octopods in possessing a thin unchambered coiled shell not at all like the internal shell of the squid or cuttlefish, nor like that of the chambered nautilus, all of which are secreted by the mantle; the *Argonauta* shell is formed by large flaps or membranes found on the dorsal arms of the females. It is in this shell, cradled by the flaps, that the eggs are



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

SECTION SHOWING INTERNAL FEATURES OF THE PEARLY NAUTILUS (NAUTILUS POMPILIUS)

laid and the young hatch out. Large shells, which attain a diameter of 12 to 16 in., are very fragile and highly prized by collectors. They are often found on the Florida coast. In contrast to the other octopods, the male of *Argonauta* is only about $\frac{1}{10}$ the size of the female, possesses no shell and was once thought to be parasitic in the shell of the female. The argonaut for many years was pictured as sailing about the surface of the seas with the arm flaps extended as sails, until the true function of the flaps was discovered. In all other essentials the female resembles *Octopus*.

See also SHELLS AND SHELL COLLECTING. (G. L. V.)

NAUVOO, a small historic town in Hancock county in western Illinois, U.S., situated on the Mississippi river about 10 mi. S.W. by S. of Fort Madison, Ia., and 40 mi. N. of Quincy, Ill. The population is about 1,000. Chief industries are wine and *bleu* cheese making. A grape festival held each fall includes the "wedding of wine and cheese," a ceremony brought from Roquefort, France. In Nauvoo is St. Mary's academy, a Roman Catholic boarding school for girls.

Nauvoo's history and significance is especially related to the Mormon era in Illinois history (*see* LATTER-DAY SAINTS, CHURCH OF JESUS CHRIST OF: *Nauvoo*). When the Mormons arrived in 1839 there were already a few buildings in what was called Commerce City; it was renamed Nauvoo by Joseph Smith and grew to be a Mormon community of about 20,000 population.

Following the exodus of the Mormons to Utah in 1846 the town was settled temporarily by a new group, the Icarians, a body of socialists chiefly of French origin; their founder and leader was Étienne Cabet (*q.v.*) of Dijon, France. After purchasing land, Cabet proceeded to establish a communal settlement not unlike other so-called communistic, frontier experiments of the time. At their peak the Icarians at Nauvoo numbered between 1,200 and 1,800. The community was open to anyone who would pay the introductory sum of 300 francs and would donate all his possessions to the community. Men 21 and over and women 18 and over were extended suffrage. A community school was established with separate instruction for boys and girls and a large community dining hall was constructed in the remains of the Mormon temple where all members of the community took their meals. Their economic theories proved unworkable in a frontier situation, however, and the Icarian community was doomed to early failure. A crisis developed when Cabet demanded and was refused dictatorial powers over the settlement. Voted from office, he left Nauvoo with 180 loyal followers and went to St. Louis, Mo., where he died soon after on Nov. 8, 1856. The community never recovered from the split; it soon disbanded and the members were absorbed into the general population.

Evidences of the Mormon and Icarian settlements are still standing, particularly in the area set aside in 1948 as the Nauvoo state park. A number of buildings are maintained as shrines by the Reorganized Church of Latter Day Saints. (G. R. GA.)

NAVAHO, the largest Indian tribe in the United States, numbering close to 90,000 (1960s) according to estimates of the bureau of Indian affairs. Contrary to the notion of the vanishing Indian, their numbers have increased remarkably; in 1868 there were not more than 12,000. The Navaho reservation and government-allotted lands in the states of New Mexico, Arizona and Utah comprise an area roughly the size of New England without Maine. The region, however, is mainly arid and will not support enough agriculture and livestock to provide a livelihood for the tribe. Thousands earn their living as transient workers away from the Navaho country, and appreciable numbers have settled more or less permanently on irrigated lands along the lower Colorado river and in places such as Los Angeles, Calif., and Kansas City, Mo.

The Navaho speak a language closely related to the Apache tongues and more distantly related to other Athapaskan languages spoken in California, Oregon and northwestern Canada (*see* ATHAPASKAN). The ancestors of the Apache and Navaho undoubtedly came from the north and probably did not reach the southwest until A.D. 1000 or later. The Navaho borrowed extensively from the Pueblo Indians: agriculture, weaving, sand paintings and ceremonial traits. Later they acquired livestock from the Spanish through the Pueblos. In the 19th century they learned metalworking from the Mexicans and came to specialize in the silversmithing for which—along with Navaho rugs—they are famous. Painted pottery was never strongly developed and the arts of pottery and basketry have nearly disappeared. The traditional type of house—the hogan—is made of logs plastered with earth and sticks, and always faces to the east. In some localities, hogans are made of stones. Nearby is a sweat house, where male members of the family bathe in ceremonial fashion.

Social Organization.—The Navaho trace descent through the mother, and residence of a newly married couple is most often near that of the bride's mother. The brothers of the mother take certain responsibilities for the upbringing, marriage and property of their sister's children. Traditionally, inheritance was mainly in the mother's line, but this custom is breaking down in the face of the law of the United States and the practices of the English-speaking neighbours of the Navaho. Today children often inherit from both parents.

There are about 60 clans. A Navaho belongs to the clan of his mother but also considers himself related to the clansmen of his father. No Navaho may take a spouse who belongs to the clan of either parent. Indeed the circle of forbidden matings is larger, for some clans are considered as being linked, and marriage into those clans closely associated with the parental group also is forbidden. In modern times clans function largely in the regulation of marriages, although one owes a clan relative hospitality and certain other courtesies. In the past, clan as well as biological relatives could claim part of the property left by a deceased person. Some clans have a particular association with certain ceremonials.

Traditional Navaho society was organized primarily along the lines of kinship. Toward one's relatives on the mother's side and on the father's side and toward one's connections by marriage one had specified obligations according to the kinship category in question. These relatives of course had reciprocal duties. Even the permitted and expected forms of joking between two classes of relatives were prescribed in some detail. The code of behaviour toward those not related either by biology or by clan was an extension of these: "Behave toward everyone as you behave with your relatives."

Religion.—The religious system is intricate. Some of the many myths relate the emergence of the first people from various worlds beneath the surface of the earth; others tell stories which justify the numerous rites that are performed. Some of these are simple rituals carried out by individuals or families for luck in travel, trade and gambling and for protection of crops and herds. The more complex rites demand a specialist who is paid according to his skill and the length of the ceremonial. One type of specialist is the diagnostician, who carries out one of various forms of divination to determine what is required. Most rites are primarily for the purpose of curing bodily and psychiatric illness. Ordinarily, ill-health is held to have a supernatural cause, such as the violation of a tabu (*q.v.*) or the malevolent activity of ghosts or witches. The patient is purified by emetics and sweating, fed herbal medicines, sung and prayed over, placed upon a sand painting. In other ceremonies there are simply prayers or songs, and dry paintings may be made of pollen and flower petals—rather than of minerals upon a background of sand. In some cases there are public dances and exhibitions at which hundreds or thousands of Navaho gather.

Tourists often attend these, especially the squaw dance which is frequently held during the summer months. This "girl's dance and sway-singing" (as the Navaho call it) is a feature of an ancient war ceremonial held to cure men who had been made sick by the ghosts of slain enemies. In modern times it serves as a marriage mart where young people meet each other and parents and other relatives can discuss the economic arrangements for projected alliances. More solemn are the night chants and mountain chants, held in the autumn months "after the thunder sleeps." The former concludes with all-night singing and dancing by masked impersonators of the divinities, and the latter with the famous fire dance in which the almost naked participants jump through flames and chase each other with burning brands.

Arts.—There are hundreds of Navaho silversmiths, principally men. For most of them silversmithing is a part-time occupation, but some are full-time professionals, either self-employed or working for stores both on and off the reservation. They make bracelets, necklaces, rings and other kinds of jewelry. Turquoise and, to a lesser extent, coral and various stones are used as settings. Silver pieces are both hammered and cast. Increasingly in modern times tableware, cigarette boxes and other articles are made for sale to others. First American and later Mexican coins were the source of the silver; now it is supplied by traders. The Navaho—mostly the women—have practised the art of weaving wool since at least 1706. The earliest surviving specimens date from the first years of the 19th century. The so-called classical period, which attracts most collectors, dates from the late 1840s to about 1875. The blankets, poncho blankets and women's dresses from this period exhibit both technical excellence and great beauty of design. While hand-spun yarns continued to be used as weft elements in coarser utility articles, ravelings of a red cloth, imported from England and called in Spanish bayeta, were prominent in loom goods intended as body coverings. Bayeta provided a shade of red brighter than could be obtained from the native dyes then available. Three-ply yarns (Saxony and zephyr) of European manufacture were also introduced by some traders.

After the mid-1870s the importation of bayeta and other foreign yarns declined. Four-ply yarns (Germantown type) made in the United States were often substituted. At about the same time the increase in the availability of manufactured clothing and other textiles brought about a gradual shift in the type of articles woven. Since 1890 the Navaho have woven only saddle blankets and women's sashes for their own use, concentrating the bulk of their production on floor coverings purchased by others. These rugs are of varying quality and aesthetic appeal. Commercial dyes of garish colour have frequently been employed, and outlandish designs (railroad trains, flags, masonic emblems and the like) have sometimes been woven. On the other hand, many rugs of the 20th century have been produced in the natural colours of white, black, brown and gray or in the soft tones derived from vegetable dyes. A small number of rugs reproducing sand paintings have been woven, often by the few Navaho men who weave. In the past almost all Navaho women knew how to spin, card and weave, and most of them produced rugs, at least occasionally.

The Navaho Today.—In spite of the activities of missionaries and of U.S. government officials, Navaho religion and social behaviour remained—except in areas immediately adjacent to the railroad and the highway—little altered until about the time of World War II, when several thousand tribesmen entered the armed services and thousands more worked in defense industries. The period after 1946 was one of vast change. Many Navaho moved into more modern cabins and began to dress much like their non-Indian rural neighbours. The level of literacy and of competence in English greatly rose. By the 1960s, the vast majority of children of school age were receiving instruction, as opposed to a minority in earlier years; about 27,000 Navaho from the ages of 6 to 18 were in school; well over 90% of this age group. The tribal council, using funds accruing from gas, oil and mineral royalties, was providing loans and scholarships for hundreds of young people to attend college or pursue other forms of advanced training. Approximately 300 Navaho were attending institutions of learning beyond the high school level. The council was vigorous in building roads and motels to attract tourist income, and in inviting small industries to locate on or near the reservation.

The income of the tribe from oil and gas leases and royalties was about $1,500,000 per year. In the same period tribal income from other minerals came to about $500,000 per year, with other substantial increments from timber and other tribal properties. In addition, the tribe has received sizable lease bonuses—about $5,700,000 per year since 1950. The tribal budget has exceeded the yearly sum of $14,000,000, of which about half was allocated to capital investments. The remainder was assigned to such categories as community services, legal and judiciary, management of minerals and range lands and operations of the tribal council.

There remained many serious problems for the tribe. Per capita income was low. About 1,600 Navaho were the recipients of public financial assistance per year. Of those relocated off the reservation nearly 40% had returned; yet the reservation could not support steadily increasing numbers. Young people who received training beyond high school found it difficult to obtain positions with salaries appropriate to their skills.

Death rates were still very high; of major causes of death only those for heart disease and malignant growths were appreciably lower than for the United States as a whole. Tuberculosis and certain diseases of the intestinal tract were nine times as great and accidents and various diseases of early infancy twice as great as the U.S. average.

See INDIAN, NORTH AMERICAN: *Southwest Periphery; see also* references under "Navaho" in the Index.

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NAVAL ACADEMY, UNITED STATES: *see* MILITARY, NAVAL AND AIR ACADEMIES.

NAVAL AFFAIRS (ARTICLES ON). The survey article SEA POWER analyzes the nature of the influence that navies and naval bases have exerted on the course of history. The roles of the various components of a navy in contesting control of the sea lanes and in serving as mobile bases for guns, rockets and aircraft are summarized in FLEET, NAVAL. Individual types of warships are described, and their historical backgrounds and contemporary roles discussed, in a series of articles that includes AIRCRAFT CARRIER; BATTLESHIP; CORVETTE; CRUISER; DESTROYER; FIRESHIP; FRIGATE; MONITOR, NAVAL; and SUBMARINE. Navies of antiquity and the strategic plans around which they were built are discussed in NAVIES, EARLY HISTORY OF.

Articles on naval installations include DOCKYARDS AND NAVAL BASES; and BUNKERING, SHIP. The training of naval officers is treated in MILITARY, NAVAL AND AIR ACADEMIES. OFFICERS, MILITARY, pertains in part to the naval service.

Various shipboard activities in war and peace are covered in such articles as GUNNERY, NAVAL; NAVIGATION; RULES OF THE ROAD AT SEA; SEAMANSHIP; and SIGNAL COMMUNICATION, MILITARY. Articles on equipment include ARMOUR, NAVAL; BUOY; ECHO SOUNDER; LOG, MARITIME; MINE, NAVAL; PARAVANE; RADAR; RADIO; TORPEDO; etc.

Specialized phases of naval warfare, in addition to those mentioned above are described in BLOCKADE; COAST DEFENSE; and CONVOY. Articles devoted to special branches of naval service include COAST GUARD; MARINES.

Many articles deal in whole or in part with the relationship between sea power and international relations. These articles include ANGARY, RIGHT OF; CONTRABAND; EMBARGO; MARE CLAUSUM AND MARE LIBERUM; NORTH ATLANTIC TREATY ORGANIZATION; PARIS, DECLARATION OF; PRIZE COURTS AND PRIZE LAW; STRAITS AND INTEROCEANIC CANALS; STRAITS QUESTION; VISIT AND SEARCH; WATERS, TERRITORIAL; etc. Additional listings are given under INTERNATIONAL RELATIONS (ARTICLES ON).

Articles on wars and major campaigns that contain sections on naval warfare include AMERICAN CIVIL WAR; AMERICAN REVOLUTION; DARDANELLES CAMPAIGN; DUTCH WARS; FRENCH REVOLUTIONARY WARS; NAPOLEONIC WARS; SEVEN YEARS' WAR; etc. Additional articles are devoted to great naval battles; *e.g.*, ARMADA; COPENHAGEN: *Battle of Copenhagen;* CORONEL, BATTLE OF; FALKLAND ISLANDS, BATTLE OF THE; FIRST OF JUNE; JUTLAND, BATTLE OF; "MONITOR" AND "MERRIMACK," BATTLE OF; NAVARINO, BATTLE OF; NILE, BATTLE OF THE; QUIBERON BAY, BATTLE OF; SAINTS, BATTLE OF THE; SAINT VINCENT, BATTLE OF; TOULON: *History;* TRAFALGAR, BATTLE OF; YORKTOWN.

Further information on the historic encounters of individual navies and on their contemporary status will be found in history and defense sections in articles on nations; *e.g.*, FRANCE; GERMANY; GREAT BRITAIN AND NORTHERN IRELAND, UNITED KINGDOM OF; UNITED STATES (OF AMERICA).

Questions of administration and personnel are dealt with under ADMIRAL; ADMIRALTY; INSIGNIA, MILITARY; MEDICAL SERVICES, MILITARY; MIDSHIPMAN; etc.

Articles on related topics include those listed under MILITARY AFFAIRS (ARTICLES ON); also, such articles as BOAT; SEAPLANE; SHIP; and SHIPBUILDING.

Biographical articles summarize the careers of the great naval strategists and tacticians such as DAVID BEATTY, GEORGE DEWEY, SIR JOHN HAWKINS, JOHN PAUL JONES, ALFRED THAYER MAHAN, and HORATIO NELSON.

Wherever comprehensive information on a topic is desired, the Index should be consulted for an inventory of material connected with it.

NAVAL ARCHITECTURE is the art and science of designing boats and ships to perform the missions and to meet the requirements laid down by the prospective owners and operators. It involves knowledge of mechanics, hydrostatics, hydrodynamics, steady and unsteady body motion, strength of materials and design of structures. A good naval architect and ship designer must have experience in a number of fields of engineering. He must also understand the characteristics and properties of construction materials and be familiar with the latest and best methods of fabricating parts and joining them. Like other branches of engineering, naval architecture involves estimates and predictions of the final performance of the ship and all its parts. Such calculations must be made while the ship is still in the paper stage in the form of plans and specifications.

This article is divided into the following sections:

- I. The Mission of a Ship
- II. Weight and Buoyancy
  1. Hydrostatic Forces
  2. Calculation of Ship Weight and Buoyancy Volume
  3. Achieving Level Attitude or Trim
- III. Metacentric Stability
  1. Concept of the Metacentre
  2. Indexes of Metacentric Stability
  3. Vertical Position of Metacentre
  4. Vertical Position of Centre of Gravity
  5. Inclining Experiment
  6. Stability of Submarines
- IV. Arrangement
  1. General Arrangement Features by Ship Type
  2. Cargo Handling
  3. Watertight Closures
  4. Ballast Tanks
- V. Resistance and Propulsion
  1. Computing Friction Resistance
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  3. Separation Resistance
  4. Resistance of Submarines
  5. Resistance in Shallow and Restricted Waters
  6. Ship Form for Minimum Resistance
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  8. Interactions Between Propeller and Ship
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  1. Dynamic Stability of Route
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  5. Heel When Turning
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- VIII. Strength of Ships
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  1. Freeboard
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- X. Ship Design Procedure
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  2. Compromises Necessary
  3. Preliminary Design Stage
  4. Contract Design Stage

I. THE MISSION OF A SHIP

The detail requirements for any given ship are made up on the basis of its mission. Just how much cargo and how many passengers is it to carry? What are the limitations on draft in the harbours it must enter? What is to be its maximum or sustained speed, and under just what conditions? What must be its cruising radius, in terms of days as well as of distance? For a tug, the towing pull or free-running speed must be stated. For an icebreaker, capacity to push its way through ice of a specified thickness must be shown. For a warship, the armament must be given, and the boundaries to be protected by armour must be specified.

The wide variety of missions for watercraft produces a great number of distinct and specialized types. Considering naval architecture and design, these are subdivided roughly into two main classes, warships and merchant ships. But the distinction is not always a sharp one. A naval transport may closely resemble a merchant passenger ship, and may be designed in the same way. A fast motor cruiser may be designed like a PT boat without torpedoes, guns and depth charges. In fact, the navy of any nation includes many merchant types, among them store and supply ships, oilers, ammunition- and missile-supply ships, repair ships, tenders for small craft, hospital ships and personnel transports.

II. WEIGHT AND BUOYANCY

1. Hydrostatic Forces.—A ship floating at rest in calm water is acted upon by two gravity forces, weight and buoyancy. Weight is the downward force on the ship. The total weight force (W) acts on the ship as if it were concentrated at the balancing point or the centre of gravity (G). Buoyancy is the upward force of all the hydrostatic pressures on the hull. The horizontal com-

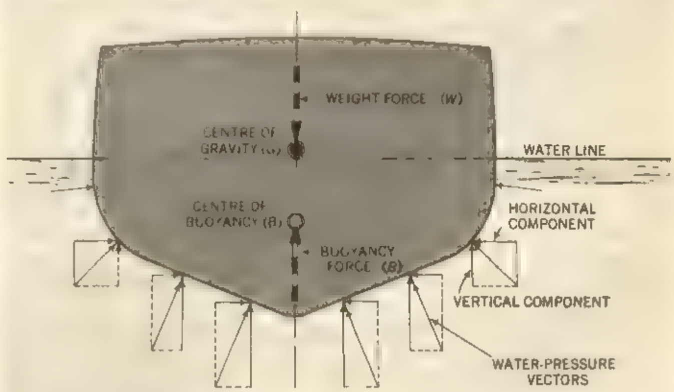


FIG. 1.—FORCES ACTING ON A SHIP HULL AT REST IN CALM WATER

ponents of the water pressures on unit areas of the ship's sides and bottom, increasing with depth, act in opposite directions and cancel each other (fig. 1). The vertical components of the water pressures on unit areas combine to form an upward force (B) equal to the weight of the water displaced by the underwater hull volume. This weight varies slightly with the specific gravity of the water. The centre of buoyancy (B) lies at the geometric centre of the immersed volume. The ship sinks in the water until the force B exactly equals the force W.

2. Calculation of Ship Weight and Buoyancy Volume.—In an early stage of the design, the ship weight is estimated as the sum of the weights of the cargo, hull, fittings, equipment, propelling and auxiliary machinery, piping systems, electrical and electronic gear, fuel, water, consumable stores, passengers and crew, plus a margin of a few per cent for weights that are underestimated. At a later stage the weights are calculated more precisely,

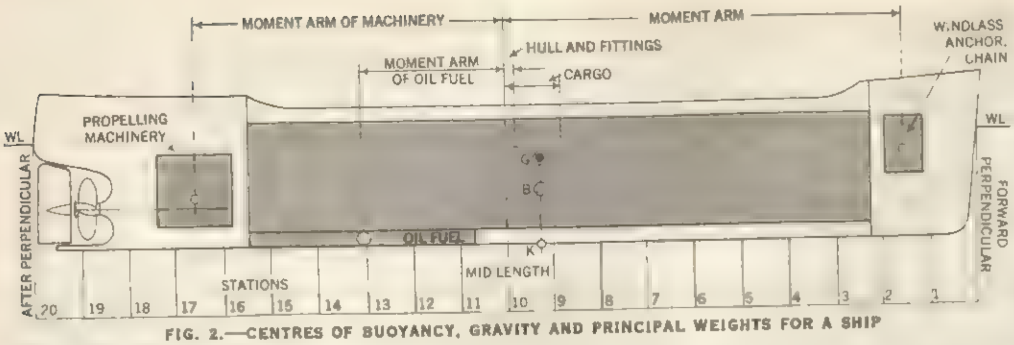


FIG. 2.—CENTRES OF BUOYANCY, GRAVITY AND PRINCIPAL WEIGHTS FOR A SHIP

submarine, W and B must equal each other exactly. It is also important to ensure that, when submerged, the centres G and B are in the same transverse plane so that the craft floats level when stopped under water (fig. 3).

The weights and weight moments for a submarine are estimated and calculated exactly as for a surface ship, but two separate volumes must be calculated one for the surface condition, with main-ballast tanks empty and one for the submerged condition, involving principally the volume of the pressureproof hull. To the volume of the latter there must be added the water-excluding volumes of all parts external to it. Among these are the outer hull structure, shafting, propellers, rudders and diving planes, anchors and chains, masts and periscopes, and the great multitude of external items. For every seven tons of solid steel in this category, about one ton of buoyancy force is gained.

or are taken from actual weights of similar items. In many cases, the weight estimates are revised constantly as the design proceeds to avoid an ultimate overweight that might detract seriously from the ship's performance.

The underwater volume of the ship under design must be adequate not only to displace a weight of water that will support the entire ship, but it must be so disposed in length, breadth and height and so shaped in every part that all the other operating and naval architectural requirements are fulfilled. When the ship is built and fully laden it must float level and upright at the designed water line (fig. 2).

As the naval architect fashions the underwater and above-water portions of the hull and maintains a running check of the estimated weights and calculated buoyancy volumes, he also keeps track of the products of these weights and volumes times the horizontal fore-and-aft distances or "moment arms" of each from the transverse vertical reference plane at mid-length. These products are known as the longitudinal weight and buoyancy moments.

To carry out these operations systematically, the underwater hull is divided into segments by imaginary transverse planes called stations. There may be 10 such segments for a boat, 40 or more for a large ship. The volume of each segment is computed together with the position of the centre of volume for each. The forward and after moments of volume are then computed in the same way as for the fore-and-aft moments of weight. A summation of the individual segment volumes gives the total underwater hull volume. The fore-and-aft positions of the centres of gravity of the individual weight groups are then estimated. Separate sums are kept of the moments of these groups forward of and abaft the mid-length. Dividing the total underwater hull volume by the volume per unit weight of the fresh, brackish or salt water in which the ship is to run gives the weight of water displaced. This must equal the total weight if the ship is to float at the designed water line. The net weight moment, forward of or abaft mid-length, is divided by the total weight to give the distance at which the centre of gravity (G) lies forward of or abaft the mid-length. The same operation for the volume moments gives the fore-and-aft position of the centre of buoyancy (B).

3. Achieving Level Attitude or Trim.—For the ship to float at the level attitude or zero trim desired, G and B must lie in the same vertical transverse plane (fig. 2). If their calculated positions are different, and the size, proportions and shape of the underwater hull are satisfactory, it is customary to shift the weights within the hull until the desired trim is attained.

In practice, the record of estimated weights and fore-and-aft moments is accompanied by a record of vertical moments above the keel (K) or the base plane. From this it is possible to estimate the position of G above K. At the same time, a record is made of vertical moments of buoyancy. When summed up and divided by the volume, these give the position of B above the keel. Both the distances $\overline{KG}$ and $\overline{KB}$ are required for estimating the metacentric stability, discussed below.

If, when the ship is built, the actual weights and volumes, or their centres, do not agree exactly with the estimated values (some equipment may have been added during the construction period), the ship floats at a water line slightly different from that contemplated by the operator and designer. For a surface ship this difference is usually of no great importance. However, for a

III. METACENTRIC STABILITY

1. Concept of the Metacentre.—One would think, at first sight, that the average surface ship of fig. 1, with its weight concentrated above its point of support (considered as the centre of buoyancy), would fall over like a top that has stopped spinning. But if properly designed it does not do so, because as the ship is inclined transversely, say by a strong wind, the centre of buoyancy of the immersed portion of the hull shifts sideways, in the same direction as the inclination. This is because the volume of the wedge of emersion (fig. 4) shifts to the low side, in the position indicated for the wedge of immersion. At the new inclined water line (W_1L_1) the centre of buoyancy moves from B to B_1. The total buoyancy force continues to act upward along the true vertical, now in the direction of B_1M. Provided no weights shift as the ship inclines, the centre of gravity remains at G, in the keel-to-deck centreline. The buoyancy force acting upward along B_1M and the weight force acting downward through G produce a righting moment $W(\overline{GZ})$ which acts to return the ship to its upright position.

For small angles of inclination ϕ, say less than 10°, the verticals through the shifted centres of buoyancy intersect the ship centreline at or close to a point M, called the metacentre. The stability provided by the action described is therefore called metacentric stability. For the situation diagramed in fig. 4, the one most often encountered in practice, it is transverse metacentric stability. For a similar situation in which the ship is inclined or

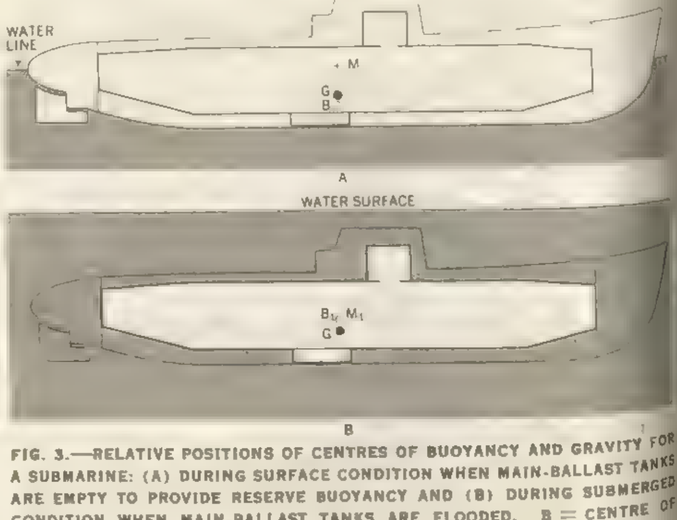


FIG. 3.—RELATIVE POSITIONS OF CENTRES OF BUOYANCY AND GRAVITY FOR A SUBMARINE: (A) DURING SURFACE CONDITION WHEN MAIN-BALLAST TANKS ARE EMPTY TO PROVIDE RESERVE BUOYANCY AND (B) DURING SUBMERGED CONDITION WHEN MAIN-BALLAST TANKS ARE FLOODED. B = CENTRE OF BUOYANCY OF THE OUTER HULL; B_1 = CENTRE OF BUOYANCY OF PRESSUREPROOF HULL; M = METACENTRE

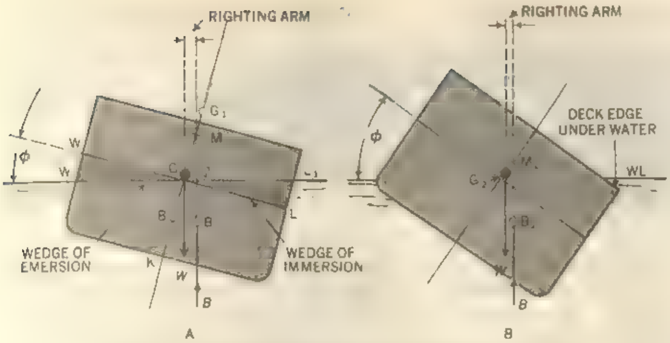


FIG. 4.—FORCES ACTING ON A SHIP WHEN HEELED

trimmed in its fore-and-aft centre plane, it is longitudinal metacentric stability.

If the centre of gravity of the ship is too high, as at G_1 in fig. 4, the righting moment for any inclination is negative; that is, it acts to incline the ship still further. The ship then has transverse metacentric instability. Whether it will capsize or not depends upon whether the position G_1 is overtaken by the vertical through B_1 as the inclination increases. If so, the ship remains in that inclined position, with a righting moment that is practically zero.

2. Indexes of Metacentric Stability.—The distance $\overline{GM}$ for positive stability, known as the metacentric height, is taken as one index of the degree of metacentric stability. The other is the range of stability, or the angle of inclination at which the metacentric height diminishes to zero. For example, when a ship is heeled transversely until the depressed deck edge goes under water (fig. 4[B]), the centre of buoyancy B_2 cannot move to the inclined side far enough to keep the metacentre M_2 well above the centre of gravity G_2 on the ship centre plane. At a critical inclination the metacentre lies at the centre of gravity and the righting moment disappears. For inclinations beyond this the metacentric height becomes negative, the righting moment becomes a capsizing moment and the ship rolls over.

A greater range of metacentric stability is built into a ship by raising the uppermost watertight deck to a higher position above the calm-water plane of flotation. The ship can then heel to a greater angle before water comes over the lower deck edge. For a craft like a sailing yacht, with a deep, heavy stabilizing keel, the deck edge can actually go under water and the range of positive stability can extend to large angles, provided water is kept out of the hull as the water level climbs higher and higher over the inclined deck.

The desirable value of transverse $\overline{GM}$ varies with the type, size and service of the ship, but within limits it is still subject to the experience and judgment of the naval architect. It averages from 0.04 to 0.06 of the beam but may be as high as 0.10 of the beam for combatant vessels subject to heavy damage. For fishing vessels it may have two values, one for the outgoing and one for the return or loaded part of the voyage. The range of positive transverse $\overline{GM}$ for a normal ship to run in the open sea is usually in excess of 40° and may run as high as 70° or more, provided the hull remains intact and the weights do not shift.

3. Vertical Position of Metacentre.—The height of the metacentre above the keel, or other selected point, depends upon the shape and size of the underwater body and of the at-rest water line. The total height $\overline{KM}$ (fig. 4) is the sum of the height $\overline{KB}$ of the centre of buoyancy above the keel and the height $\overline{BM}$ of the metacentre above the centre of buoyancy. The latter is known as the metacentric radius. The distance $\overline{KB}$ can be estimated by an approximate formula; it can be calculated by procedures applying to irregular volumes; or it can be determined by a mechanical integrator. The distance $\overline{BM}$ is the quotient of I divided by V, where I is the square moment of area of the water line plane from W to L (the sum of each unit of area multiplied by the square of its distance from the centreline) and V is the immersed volume. For a given ship length and underwater volume, both I and $\overline{BM}$ are proportional to the cube of the beam, so that the latter is an important factor in transverse metacentric stability.

4. Vertical Position of Centre of Gravity.—The vertical position of the centre of gravity is as important as that of the metacentre in determining metacentric stability and the behaviour of the ship at sea. For a cargo ship, or even for a warship, this position may change by many feet, depending upon the nature, amount and vertical position of the loads, fuel and stores. Ballast may be used to increase the total moving mass in a seaway or to place G in a more advantageous position. Ice accumulating on the upper works of fishing boats, trawlers and other small craft may be so thick, so heavy and so high above the normal centre of gravity, as well as so difficult to remove at sea, that G rises above M and the craft capsizes.

5. Inclining Experiment.—Fortunately, the naval architect is able to make a full-scale check of the predicted or calculated metacentric stability before the completed ship goes to sea. By shifting liquids or solid masses whose weights and offset positions are known accurately, the centre of gravity of the whole ship is shifted and the ship is heeled. This shift, corresponding to the distance $\overline{GZ}$ in fig. 4, is sideways for a determination of transverse $\overline{GM}$ and lengthwise for a measurement of longitudinal $\overline{GM}$. The angle of inclination ϕ of the ship for each such shift is measured accurately with special devices. Then from the relation $\overline{GZ} = \overline{GM} \sin \phi$, the actual metacentric height $\overline{GM}$ is determined for that loading condition. The height of the centre of gravity above the keel is then calculated from the relation $\overline{KG} = \overline{KB} + \overline{BM} - \overline{GM}$.

6. Stability of Submarines.—When a submarine is in surface condition its metacentric stability situation is the same as that of any surface ship. When diving or submerging its water-plane area diminishes progressively to a negligible amount. The square moment of area I_T of this plane likewise diminishes and with it the value of $\overline{BM}$. Moreover, as the main-ballast tanks are flooded and the pressure hull is taken under, buoyancy is transferred from a low to a high position, so B rises in relation to the hull. Since G remains in its original position, M drops to the vicinity of G. Indeed, for some moments during diving and surfacing it may be below G, with a negative $\overline{GM}$. The flooding, venting and blowing of the main-ballast tanks, with separate port and starboard controls, enable the submarine crew to counteract any list that may develop during this brief transition period.

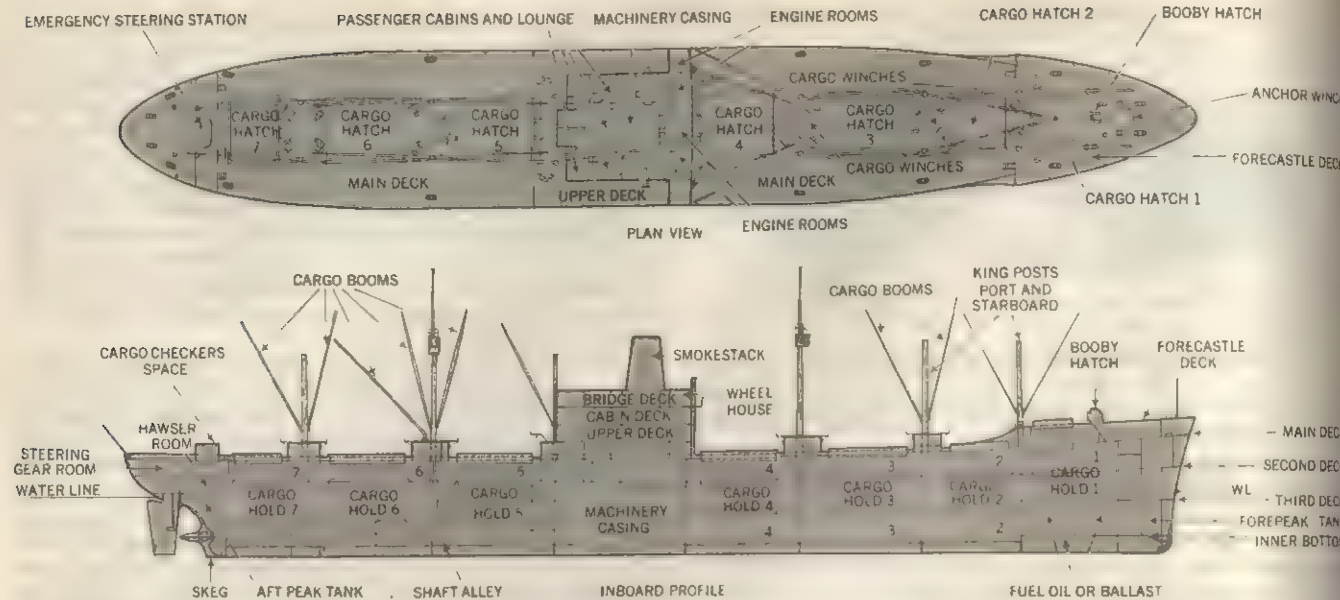
When the submarine is under the surface the water-plane area is zero, as is $\overline{BM}$. This means that B_1 and M coincide (fig. 3). In this condition B_1 is higher than G, so that the action of the buoyancy force and the weight force produces a stable situation and the craft is said to have pendulum stability. $\overline{B_1G}$ (or $\overline{GM}_1$) then replaces $\overline{GM}$ as the criterion of both transverse and longitudinal stability.

IV. ARRANGEMENT

Despite the many ships of each type that have been designed over the years and the general similarity of various spaces and their locations within the types, ship operators still find advantages in particular arrangements. This situation reveals the variety of combinations possible when the designer endeavours to make large-scale compromises with both major and minor features. Propelling machinery at the stern with crew accommodations and navigating spaces in one group aft over the machinery represents efforts to devote the most useful spaces to the cargo and to concentrate services and living spaces in a region clear of cargo-stowing and cargo-handling areas. Naval architectural requirements impose limitations concerning weight distribution, metacentric stability, hull strength and stiffness, and subdivision and damage control which can rarely be disregarded.

1. General Arrangement Features by Ship Type.—A brief tabulation of principal ship types serves to highlight the arrangement features characteristic of each.

Passenger liners for ocean crossings, carrying only passengers, baggage and incidental cargo, devote large volumes in the most comfortable part of the ship to passenger accommodations, with large additional volumes for public spaces in deckhouses and superstructures. The propelling machinery, uptakes and hatches are placed clear of the accommodations.



BY COURTESY OF U.S. NAVY

FIG. 5.—PLAN OF WEATHER DECKS AND INBOARD PROFILE OF A "MARINER" CLASS CARGO SHIP

Passenger ships for service on rivers and in protected waters utilize deck and superstructure volume as passenger spaces for practically the entire length. Excursion ships for day service extend the accommodations to overhangs beyond the main hull.

Combined passenger and cargo ships devote the most comfortable positions to the passengers without encroaching unduly on storage and handling facilities for cargo.

General dry-cargo ships provide the best available spaces and facilities for the cargo hatches, side-loading ports and holds (fig. 5). The propelling machinery is preferably aft, to keep the best cargo spaces clear; means are provided to trim the ship with liquids in ballast tanks.

Container ships, roll-on-roll-off ships, seatrains and car ferries embody special arrangements of structure, machinery and crew spaces to keep them clear of the spaces for large containers and for wheeled vehicles.

Bulk-cargo carriers, for solids or liquids or both, are the ultimate in large, single-purpose ships, with everything possible sacrificed to cargo capacity.

Aircraft carriers (*q.v.*) have flight decks of the greatest practicable area, even to the extent of using overhangs beyond the main hull. High hangars under the flight deck (fig. 6) provide storage and repair space for aircraft. Internal and deck-edge elevators move these craft to and from the flight deck.

Submarines (*q.v.*) are of the double-hull type, with a ship-shaped outer hull of relatively light construction, if their mission calls for high speed and good sea-keeping qualities on the surface. If submerged performance is the primary function they have single hulls of suitable shape. The volume between the heavy inner and light outer hulls of a double-hull craft is devoted to carrying fuel and ballast liquids which need not be protected from hydrostatic pressure.

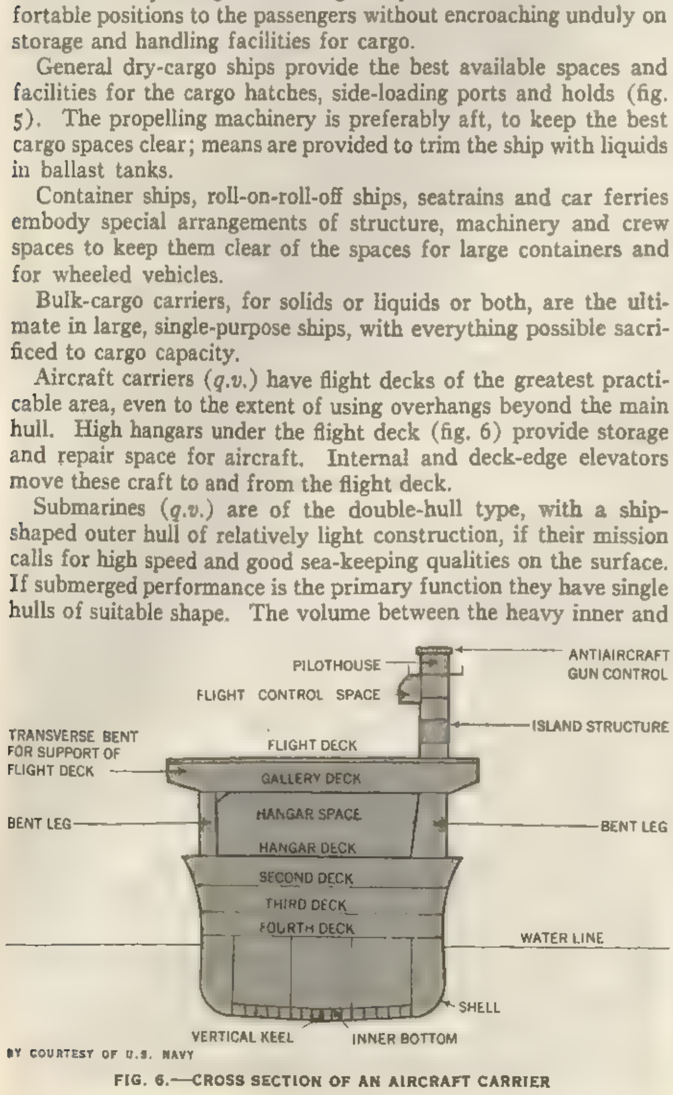


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FIG. 6.—CROSS SECTION OF AN AIRCRAFT CARRIER

Underwater cargo vessels or submersible bulk carriers also require some of their bulk volume devoted to main-ballast tanks, by the blowing of which the craft may be lifted with its deck above water and with its bottom high enough to clear the beds of estuaries and harbours. (*See* also SHIP.)

2. Cargo Handling.—The ship arrangement must lend itself to getting the cargo and other objects in and out as well as to carrying them from one port to another. Indeed, speed in loading and unloading cargo is just as important as speed through the water. Access to the holds and to the internal deck spaces is provided by hatches through the decks and by doors in the ship's side leading to the deck storage areas.

Ships carrying dry general cargo usually are equipped with their own handling gear. This enables them to transfer cargo in any port and to load to and from lighters in places where they must anchor offshore. Some bulk-cargo ships carry a huge swinging boom with a belt conveyer running on it, by which material may be dumped in high piles at a distance from the ship's side. Freight cars are loaded and unloaded from seatrains by special dock cranes that pick up an entire loaded car. Liquid cargo is pumped aboard through flexible pipes from storage tanks on shore; the unloading is invariably done by the ship's own high-capacity pumps.

3. Watertight Closures.—Whatever the mission of a craft, or the arrangement of major and minor features adopted, water must definitely be excluded from the hull under severe operating conditions. This calls for strong, tight closures for openings, including doors, port covers and protectors for glass windows. It also requires the watertight and wave-resistant sealing of large openings such as cargo hatches. On many ships these openings are closed by heavy metal covers handled by mechanical power and capable of secure sealing and locking. The structure surrounding these openings must be so rigid that its deformation under wave or sea loads or other service conditions does not jeopardize the watertightness of the cover.

4. Ballast Tanks.—When a ship is running rather light with its hull relatively high out of water, it is at a disadvantage in winds and waves. It needs added inertia to help it drive through waves, added weight to put the hull farther down in the water and more mass high in the ship to reduce the righting moment and to ease the rolling. These needs are met by building in tanks that can be filled with fresh water or reserve fuel. The tanks are easily emptied when the weight is no longer desired. Awkward and inaccessible places in the hull, where neither cargo, machinery nor useful load can be placed to advantage, can often be used for these tanks

All submarines, whether they have two separate hulls or not, carry main-ballast tanks. These are empty when the craft is on the surface; they help to lift the bridge, the deck and the hatches above the water and to provide reserve-buoyancy volume when rolling and pitching in waves. By opening flood valves at the bottom and air-vent valves at the top, these tanks may be completely flooded with sea water to make the craft submerge. To raise the submarine, the vent valves are closed and the water is blown out by compressed air. Another set of tanks, called the variable-ballast tanks, have water taken into or pumped out of them from time to time to keep the weight of the submarine always equal to the weight of the water displaced by the buoyant volume. When a submarine runs from salt water into brackish water having less weight per unit volume, some water must be pumped out of the variable-ballast tanks because the supporting forces are less in the lighter water.

V. RESISTANCE AND PROPULSION

The resistance to forward motion of a ship is of three principal kinds: friction; wave making; and separation or eddy making. Friction or viscous resistance is caused by the necessity for accelerating liquid particles in a forward direction as the bow continually runs into a region of liquid at rest. The layer of accelerated particles, augmented by vortex motion and turbulence, becomes progressively thicker as it moves aft, forming what is known as the boundary layer. The vortexes and disturbances in this layer are visible in the belt of "confused" water around a moving ship at the water line. The energy in this layer represents the work done by the ship in overcoming viscous resistance. It is eventually dissipated as heat and is not recovered.

Wave-making resistance is caused by transferring kinetic energy in the ship to energy in the surface or gravity wave system which accompanies it. While the configuration of this system near the ship remains fixed for a given speed, waves are continually left astern and the energy in them is lost.

Separation is caused by the lack of sufficient pressure in the water (see *Separation Resistance*, below) in a given region to force this water laterally inward and to make it flow closely along all parts of the ship, especially in the tapering or blunt after portion. In the region known as the separation zone, water is dragged in from astern to fill the gap that would be left because the flow does not close in from the sides. Resistance is generated by the forward acceleration of water that would otherwise flow aft and be left behind. The confused and eddying mass of water being dragged along in the separation zone abaft the square transom stern of a motorboat is clearly visible at low and moderate speeds. The added drag due to separation abaft the square stern of a skiff, immersed deeply by passengers sitting in the stern, is very real to the rower in that skiff.

1. Computing Friction Resistance.—For want of a better or more precise method, the friction resistance of a ship is computed from a knowledge of its wetted area and a friction value per unit area derived from the towing of flat planks or friction planes of various lengths at various speeds. By using very thin sections, sharply pointed at the ends, wave making and eddy making are eliminated. From the known towing forces and wetted area of the plank or plane there are derived a set of friction values per unit surface area of the plane, in terms of the towing speed. For calculating the friction resistance of a ship at any given speed, it is usually assumed that the friction value for each unit of wetted-surface area is equal to that for a friction plane having the same length as the ship and towed at ship speed. The wetted area of the ship is calculated by averaging the girth at a series of stations equally spaced along the length and multiplying by the wetted length. The flat-plate friction data cannot be applied indiscriminately to the curved surfaces of ships. Effects of given curvatures are not well known but it is assumed that the friction resistance increases as the curvature becomes sharper.

Rough areas on wetted ship surfaces are caused by uneven plating and planking; laps, butts, rivet points and weld beads; anticorrosive and antifouling coatings of plastic paint and other materials; and fouling due to marine organisms. All of them increase friction resistance and the thickness of the boundary layer. For resistance calculations their effects are lumped in a general roughness allowance, which is added to the value of the friction for a given area of smooth surface.

2. Wave-making Resistance.—Information available to the naval architect on the surface waves generated by a moving ship is derived originally from the observations of John Scott Russell in the 1840s, the experimental work of W. Froude and R. E. Froude in the 1870s and 1880s and the analytic studies of Lord Kelvin in the latter decade. These showed that: (1) A gravity wave system is formed by a moving pressure disturbance. For example, drawing one's finger across a water surface makes waves. (2) Pressure disturbances exist where there are changes in curvature around a ship, such as those at the extreme bow and stern and at the "shoulders." (3) The progressive or traveling wave system caused by each pressure disturbance consists of two parts: (*a*) a diverging group of waves, with crests and troughs lying at a small angle to the direction of motion of the disturbance, and (*b*) a transverse group of waves, with crest lines slightly convex forward, where they cross the path of the moving disturbance. The diverging waves at the bow are easily seen on any moving boat or ship, as are the transverse waves abaft the stern on any craft which is traveling rapidly. The transverse waves of the bow system, modified by the forward shoulder system, are also indicated by the crests and troughs in the wave profile alongside the ship.

In addition to the progressive waves, whose shape remains the same for a given speed but which spread outward and aft, there is a water-level disturbance that moves along with the ship and whose elevations at the bow and stern and depression amidships are not radiated as gravity waves. There may thus be six or eight or more sets of water-level changes generated by the movement of one ship. The changes of elevation due to each are superposed so that two crests coinciding produce a sort of double crest, while a crest and a trough coinciding act to cancel each other.

From a resistance standpoint the most important progressive wave systems are generated at the bow and stern. The length of a gravity wave depends upon its velocity, and the velocity of a wave whose crest travels along with the bow must correspond to the ship speed. It follows, therefore, that the second, third and succeeding crests of the transverse bow series move aft along the ship as the speed increases. This means that at certain ship speeds a transverse crest of the bow system is superposed on the stern system in such manner as to build up a traveling mound of water at the stern. The internal hydrostatic pressure in this mound acts to push the ship forward and hence to diminish its wave-making resistance.

At other ship speeds the superposition of the bow and stern wave systems drops the water level at the stern, with no compensation for the hydrostatic pressure which the bow of the ship must push against at this speed. As a result the total resistance of a ship fluctuates above and below what is known as its "natural" resistance as the speed is increased and as the various progressive wave systems combine to produce beneficial or harmful effects (fig. 7).

The velocity of gravity waves varies as the square root of the product of the acceleration of gravity and the wave length. The forward speeds of the transverse waves generated by a ship correspond to the ship speed V. The interference effects described depend upon a relation between the wave lengths L_W and the ship length L; hence the wave systems are geometrically similar if the ratio of V to the product $\sqrt{gL}$ remains constant, where g is the acceleration of gravity. This ratio is the Froude number $= \dfrac{V}{\sqrt{gL}}$.

D. W. Taylor simplified this relation in the 1900s to the ratio of the ship speed V in knots to the square root of the ship length L in feet. Thus the speed-length quotient = Taylor quotient $T_q = \dfrac{V}{\sqrt{L}}$.

When the estimated wave-making resistance is plotted on a basis of Froude number or Taylor quotient, humps and hollows show up in the curves, as shown in fig. 7, corresponding to the wave-crest

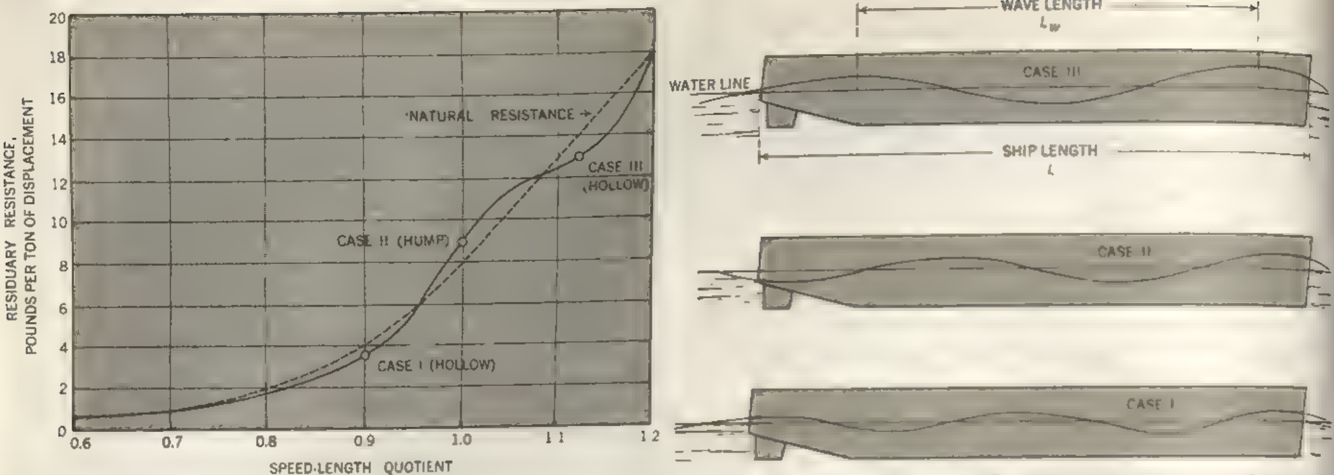


FIG. 7.—WAVE FORMATIONS CAUSING HUMPS AND HOLLOWS IN A GRAPH OF SHIP RESISTANCE. FOR CASE I, $\frac{L_w}{L} = 0.451$; FOR CASE II, $\frac{L_w}{L} = 0.557$; AND FOR CASE III, $\frac{L_w}{L} = 0.698$

and wave-trough positions in the three ship-and-wave profiles of that figure. The naval architect selects a ship length whose wave-making resistance will be less than its "natural" resistance when the ship is traveling at its most efficient speed.

The extreme case in this category occurs with the destroyerlike craft which, at a speed-length quotient of about 2.0 or a Froude number of about 0.6, rides largely on the back of its own first bow-wave crest with its stern in the first trough following. It is, in fact, constantly running uphill; part of its resistance, called the slope drag, is due to this action. A planing boat such as a speed-boat is in a corresponding position, with bow high in the air and stern squatting deeply, when about to pass through what is known as its hump speed. As this speed is reached and exceeded, if the engine has ample power and the boat is not too heavy, the boat approaches and reaches full planing speed. Here it is literally riding on top of the first crest of its own bow-wave system. With its flat stern sliding gracefully over the water there is, in effect, no stern-wave system.

A great deal of theoretical work, having as its aim the calculation of wave-making resistance from the known form of a ship hull, produces resistance curves which resemble those obtained by towing tests in model basins. The work is still limited by certain mathematical simplifications and it appears that more physical laws, not yet fully known, will have to be taken into account before the method becomes practical for engineering predictions.

3. Separation Resistance.—The drag due to separation of the boundary layer from a ship surface, and to eddying and backwash in the separation zone, is a form of pressure resistance. This means that, like wave-making resistance and some types of roughness resistance, it is due to forces exerted at right angles to the hull surface. Like these resistances, it varies usually as the square of the ship speed.

Hydrodynamic knowledge of separation phenomena and the physical laws which govern them has not progressed to the point where the onset of separation can be predicted in advance with certainty and where the magnitude of separation resistance can be calculated. It is known, however, that the pressure in such a zone is less than atmospheric, so that the water literally sucks backward on the ship. If air can be led to the zone to displace the eddying water, the suction is removed. When a motorboat with a square or transom stern extending below the water is speeded up until the stern "clears," the backwash and eddying disappear (fig. 8). With the square stern exposed to the atmosphere, the separation resistance also disappears.

4. Resistance of Submarines.—When a submarine submerges to a depth below the surface equal to four or more times its maximum diameter or its hull depth, the surface disturbance resulting from its forward motion becomes negligible and its wave-making resistance practically disappears. This is a great advantage, especially at high speed, despite the increase in wetted surface and friction resistance caused by taking the whole craft under the water. However, much of the gear above the water line in surface condition, such as flat decks, rails, anchors, capstans, chocks and similar fittings, are put there for operation on the surface. It is difficult to streamline them for low resistance under water. Moreover, minor irregularities which are accepted on the underwater hulls of surface ships become, when taken all together, major sources of added and unnecessary resistance on a submerged submarine moving at high speed.

5. Resistance in Shallow and Restricted Waters.—The forces on a ship traversing shallow waters are governed by the presence of solitary waves caused by ship motion and other disturbances. If the ship speed is slightly less than the solitary wave speed, the ship runs uphill on the back of this wave so that its hydrodynamic resistance is increased by the slope drag. If it can be speeded up so as to run slightly faster than the wave, it slides downhill on the face of the wave and its resistance is reduced below that of its deepwater resistance.

The speed of progressive waves of a given length is less in shallow than in deep water. If a tug, for example, is running at a speed in shallow water at which it has a crest at the bow and another at the stern, its speed must be decreased if the two crests are to be kept at the advantageous positions indicated. At the same time, the crests may be higher and the trough may be lower because waves become steeper as they enter shallow water. A fast

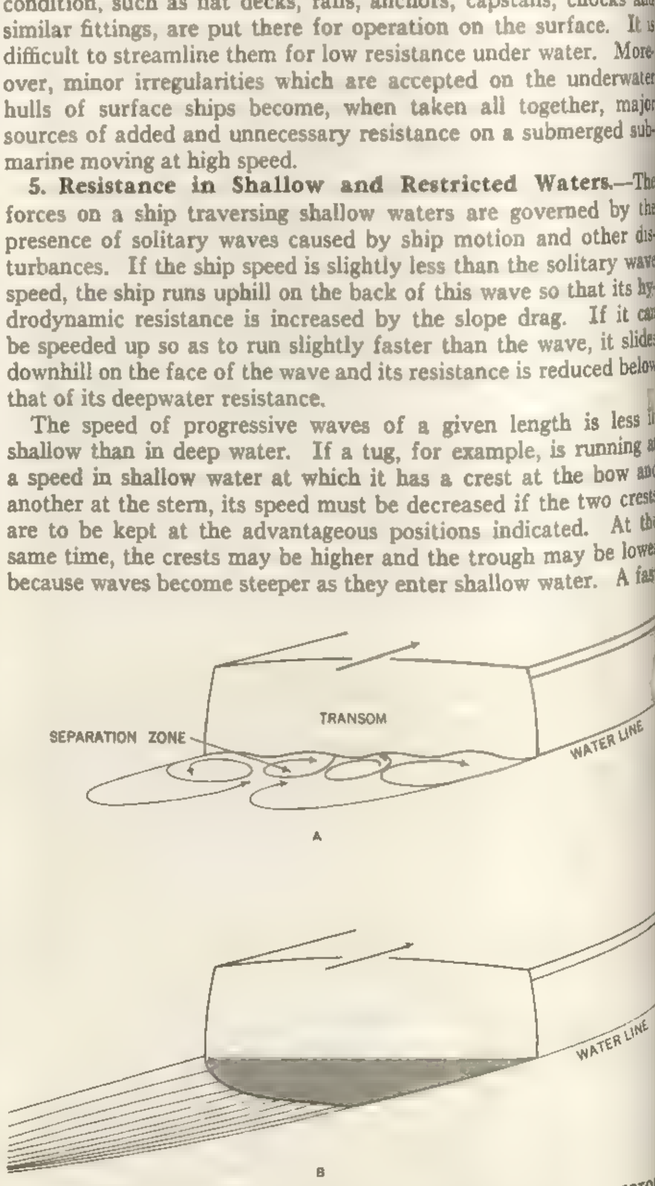


FIG. 8.—SEPARATION ZONE AND AIR FILLED DEPRESSION ABAFT A MOTORBOAT (A) DURING SLOW SPEED AND (B) DURING HIGH SPEED, WHEN THE LOWER TRANSOM AREA IS EXPOSED TO ATMOSPHERIC PRESSURE

craft also squats more deeply at the stern when running in shallow water. In fact, this increase in squat may be sufficient to cause the craft to scrape bottom even though it has plenty of water under it when at rest.

When the clearance between the bottom of the ship and the bed of the water body is initially small, the water that flows under the ship is speeded up, with an increase in friction resistance on the ship. When the sides or walls of the channel are close to the ship, the lateral constriction speeds up this flow still further. Methods of approximating the increased resistance and the depth of water necessary to give the equivalent of deepwater resistance are available, based on the method of O. Schlicting (*Hydrodynamics in Ship Design*, vol. ii, ch. 61, 1957).

Self-propelled craft designed for efficient operation in shallow and restricted waters must have (1) provision for adequate flow of water to the propellers; (2) adequate shielding to prevent drawing air from the surface; and (3) rudders of extra-large area, usually one rudder abaft each propeller, to overcome the horizontal forces resulting from the closeness of adjacent banks or of other craft being met in a channel.

6. Ship Form for Minimum Resistance.—The art and the science of naval architecture have not yet progressed to the point where the form of a ship to meet given requirements, including minimum resistance at a given speed, can be fashioned by a direct method, starting with a clean sheet of paper. Nevertheless, certain general rules based upon hydrodynamics are available: (1) The use of easy and fair surfaces along the general paths followed by the water flow. Small changes of curvature in the flow lines are particularly important. (2) At and near the surface the flow lines must follow the surface or the wave profile. Since most of the wave-making resistance is generated by pressure disturbances near the surface, easy curvature is important there. Proof of good design in this respect is low wave crests and shallow troughs around the ship when running. (3) Most of the flow in almost any type of ship goes under the bottom rather than around the sides, hence the ship form must not interfere with it. (4) Submerged bulbs intended to produce surface-wave systems that will partly neutralize the crests and troughs produced by pressure disturbances elsewhere require careful design and positioning. (5) Probably the most important feature in shaping the hull of a self-propelled craft is to provide a good flow of water to the propulsion devices. So far as known, this calls for the highest practicable degree of uniformity of relative velocity over the whole thrust-producing area, the greatest possible degree of flow opposite to the direction of advance of the blades of the propulsion device and the greatest mass density of the water in which the device is to work. Concerning the last item, it is known that the water entering the propeller disks of destroyers and other high-speed craft contains many air and gas bubbles. In the aggregate, the reduction of mass density due to them can be appreciable.

7. Action of Propulsion Devices.—Thrust by a ship propulsion device acting on the water (or on the air) is produced by imparting sternward acceleration to a mass of that water or air. The forward thrust is proportional to the product of the mass of fluid acted upon and the accelerating rate. For the most efficient propulsion, the mass should be large and the acceleration small. In a screw propeller, this calls for a large diameter and a small increase in relative backward velocity when water is passing through the propeller.

The thrust per blade of a propulsion device is measured by the reduction in pressure on the back or advancing side of the blade and the increase in pressure on the face or after side. As a rule, the former is much larger than the latter so that the blade draws or pulls rather than pushes itself through the fluid in which it works.

Modern propulsion methods for boats and ships include oars, sails, paddle tracks, paddle wheels, hydraulic and pump jets, airscrews, rotating-blade propellers and screw propellers. Screws are usually run in the open but for producing high thrusts at low ship speeds, as when towing, they may be surrounded by a fixed shrouding such as the Kort nozzle. Rotating-blade propellers offer the great advantage that the magnitude and direction of thrust can be varied at will, making them vastly more versatile than any known combination of screw propeller and rudder and giving the craft exceptional maneuverability. A tug fitted with one or more such propellers can exert a pull equally well in any direction with respect to its axis.

The number of propulsion devices depends upon the available power in each engine, the need for reliability or maneuverability, the limiting draft and many other factors. By the late 1950s shaft powers of 25,000 h.p. had been applied to single screws and in excess of 50,000 h.p. on each of four screws.

8. Interactions Between Propeller and Ship.—The operation of a screw propeller involves a number of interactions that are by no means fully understood. Part of the water through which the propeller moves is the boundary layer moving aft past the hull, with a relative velocity less than that at a distance. Another part of it lies within the wave crest (or trough) that runs along above the propeller. Because of these and other effects, the water moves at different velocities and in different directions in different parts of the propeller disk. In general, the ship drags the water along with it to a certain extent, so that its speed past the propeller is less than the ship speed. The difference is the wake velocity, and the ratio of this velocity to the ship speed is the wake fraction.

There are reduced pressures in the region forward of the propeller, resulting from corresponding pressures on the forward sides of the blades. These act to retard the ship, diminishing by a certain amount the usefulness of the full propeller thrust.

9. Efficiency of Propulsion.—The efficiency with which any mechanical propulsion device drives a ship is a product of three separate ratios. The first is the ratio of input to output when the device is running in open water by itself, as when a model is tested in a model basin. The second, known as the hull efficiency, is the ratio of the quantity representing the proportion of useful thrust to total thrust to the quantity expressing the ratio of the speed of advance to the ship speed. The third, known as the relative rotative efficiency, is the ratio of the turning moment on the propulsion-device shaft to produce a given thrust when the device is running in open water to the moment on the shaft when the device is operating in conjunction with the ship.

For ships having screw propellers, the efficiency of propulsion decreases as more propellers are added. It varies from 0.76 to 0.80 or more for a well-placed and well-designed single screw, from 0.65 to 0.72 for twin screws and from 0.60 to 0.64 for quadruple screws such as are carried by large liners and warships.

In practice, the open-water efficiency for a given size of propulsion device is found to vary in almost predictable fashion with the ratio of the thrust produced to the square of the speed of advance. This ratio is known as the thrust loading. Starting with this factor, it is possible to estimate the shaft power required to drive a ship having a known resistance at any given speed.

10. Cavitation.—Any moving submerged body, like a screw-propeller blade, has to push the water aside as it moves. If it moves so fast that the surrounding pressure is not sufficient to cause the water which has been pushed aside to close in around the body and follow its contours, or if the pressure is so low that the same thing occurs when the blade moves slowly, the water either "opens up" or it leaves the blade. In the first case, bubbles are formed in it, each filled with water vapour. When they move along into a region of increasing pressure, they collapse suddenly. The resulting severe pressure fluctuations may cause pieces of the metallic blade surface to break off in an action known as erosion. In the second case, a relatively large vapour-filled cavity is formed next to the blade (fig. 9). This may collapse on the blade or at a distance behind it.

For screw propellers of normal form, any cavity next to the blade interferes with proper flow around it and usually has a harmful effect on thrust and propulsion. Cavitation can be minimized by proper attention to the design of the propeller. The shape selected for the section is one known to be relatively free from cavitation and one on which the reduced pressure is as uniform as possible along the chord (length) of the section, from leading to trailing edge.

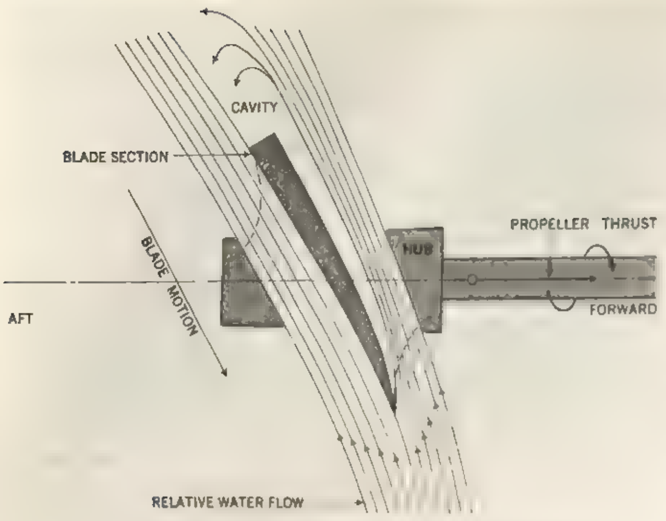


FIG. 9.—SECTION OF A SUPERCAVITATING PROPELLER BLADE

At each radius the blade is made wide enough to carry the local thrust load at the velocity of and at the average water pressure for that radius. The use of large blade areas to delay cavitation must be balanced against the loss of efficiency caused by greater friction drag on the wider blades.

On supercavitating propellers of special design, the blades travel so fast that the water pressure is never sufficient to permit the flow to follow the blade. The vapour cavity is then allowed to expand until it covers the whole back of the blade. The pressure on the back approaches absolute zero while the friction on that side disappears, since the water no longer touches it. Propeller blades of this type, with sharp leading edges and blunt or square trailing edges (fig. 9), have been used successfully on racing motorboats since the 1920s. New techniques developed in the late 1950s permitted them to be designed by logical methods.

11. General Design and Positioning of Propellers.—The propulsion device should be treated as an essential part of the ship, not as a sort of appendage to the hull, and should be designed with it. The flow to and from the propulsion device, whatever its form, is a most important feature from the standpoint of efficient propulsion as well as avoidance of objectionable vibration. Fortunately, it is possible to "see" this flow on medium and large models in circulating-water channels, to study it at length and to correct unsatisfactory features of it while the ship is still in the design stage. Model techniques are also available to give the designer a reasonably good preliminary warning of excessively large periodic forces which may be generated on the ship if corrective measures are not taken.

Because of the great thrust sometimes exerted by the single blades of powerful propulsion devices and the rapid changes of pressure and velocity which take place near them, adequate clearance spaces must be allowed between these blades and the adjacent parts of the ship.

Propulsion devices mounted in transverse ducts or tunnels, extending through the thin ends of the ship from one side to the other, apply transverse forces or swinging moments when the ship is moving or stationary. These devices greatly improve the ship's handling qualities around docks and piers.

On shallow-draft vessels, screw propellers are fitted inside fore-and-aft arch-shaped recesses called tunnels. A large proportion of the propeller area is often above the at-rest water line, but if air is excluded from entering, the tunnel fills with water when the propeller starts rotating, permitting the latter to develop thrust over its entire area.

In many cases it is possible to select the principal features and proportions of a screw propeller by the use of one or more of the many sets of series charts based upon test results of systematic series of propeller models. The disadvantage of this method is that the designer is restricted to the number of blades, blade profiles and blade-section shapes of the models that have been tested. However, there are usually two or three sets of models which approximate what the designer has in mind so that with the data from these he may feel that his combination of tentative characteristics is rather well bracketed. If the designer feels that he may encounter cavitation or if he is able to spend more time on the project, a propeller may be designed rationally by methods described in the technical literature.

12. Model Experiments.—The towing of ship models to determine their resistance and similar characteristics was initiated in 1872 by W. Froude to take the place of limited knowledge of physical laws governing ship behaviour, complexity of the interactions encountered and lack of understanding of the effects of changes in shape and proportions. To make the procedure workable at all, Froude had to separate the friction resistance from the total observed resistance. After subtracting the friction resistance, estimated on the basis of tests which he made by towing flat planks, Froude called what was left the residuary resistance. For corresponding ship and model speeds, where the Froude numbers were the same, he extrapolated the residuary resistance on the basis that this resistance per ton of displacement was the same for both ship and model. The expanded friction and residuary resistances were then added to give the total ship resistance.

In later years, techniques were developed for the testing of propellers, for self-propelling ship models, for determining lines of flow and wave profiles and for measuring the effects of minute changes upon the total resistance. Nevertheless, many of the old problems remain, despite all the time, thought and effort devoted to their solution. Indeed, it appears that advances in knowledge in the field of hydrodynamics raise new problems faster than the old ones are solved. In spite of this, the model-test procedure has been of great assistance to naval architects and, in general, of great engineering value. All the maritime nations of the world have ship-model testing establishments and very few large and important ships are built without first testing one or more models of them.

VI. MANEUVERABILITY

All self-propelled craft, of whatever size, shape, form or type, are required to steer a reasonably straight course in both smooth and rough water, to turn so as to change course or heading or to take emergency evasive action, to start, stop and back and to perform any other desired maneuvers. Submarines are required to maneuver similarly in a vertical plane, including the operations of diving, depth keeping, hovering in one spot and surfacing.

1. Dynamic Stability of Route.—The ease and reliability of steering of a ship depend, among other things, upon whether or not it has dynamic stability of route. A self-propelled ship that is stable in this sense will, if left to itself with no rudder angle applied, continue generally on its original course. If disturbed by some external force, it may swing slightly or moderately to a new course, whereupon it will continue along that course or route until again disturbed. Most slender ships like destroyers are dynamically stable in route. Others of fat or chubby shape, if left to themselves and then disturbed, will swing farther and farther from the original route. A sign of route instability is the persistence of the ship in swinging one way after moderate corrective or opposite rudder is applied to stop the swing. A ship of this type may become positively unmanageable in shallow water, where the sluggishness of any ship is intensified.

2. Steering and Turning.—Steering involves corrections to bring a ship back to a given course or heading after it has deviated as a result of some disturbance. Steering by hand control is easier and more efficient if instruments in front of the steersman show almost instantly when these deviations begin. Gyrocompasses are far more satisfactory than magnetic compasses for this purpose. Further, a ship that is dynamically stable in route, but not too much so, and one that is not oversteered, requires only a small rudder angle and relatively infrequent use of the rudder. Automatic steering by gyro pilot is available for all sizes and types of ships.

Turning is involved when changing course, when maneuvering in formation with other ships and when following a curved channel.

However, the most important turning maneuver for any ship is to sheer off suddenly and to get clear of its original course when danger is unexpectedly sighted ahead along that course. To clear the extension of its original path in the shortest distance and the least time, assuming that the ship is going too fast to be stopped completely, requires rapid laying of the rudder to the emergency angle, rapid response of the ship in starting to turn and rapid motion of the ship to the right or left of the course to clear the danger ahead.

The rudder action serves not only to swing the ship in the desired direction but also to keep its bow pointed inside the path of its centre of gravity so that the inward-acting hydrodynamic force on the hull equals the outward-acting centrifugal force resulting from motion in a curved path. The amount by which the ship heads inside the instantaneous direction of motion is the drift angle.

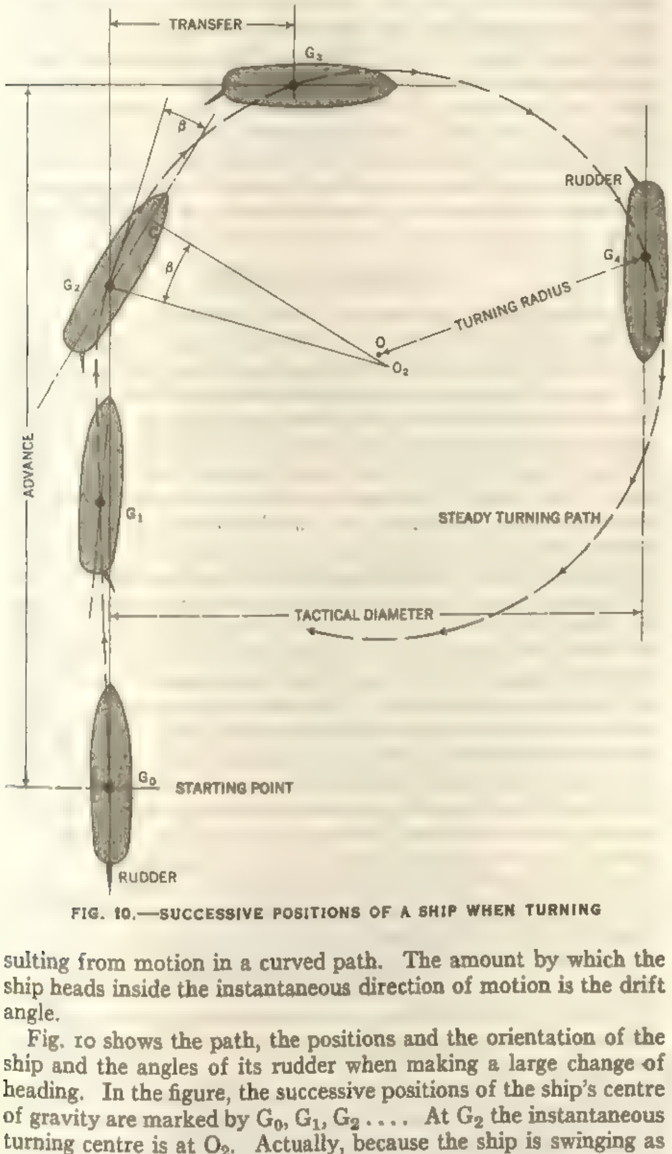


FIG. 10.—SUCCESSIVE POSITIONS OF A SHIP WHEN TURNING

Fig. 10 shows the path, the positions and the orientation of the ship and the angles of its rudder when making a large change of heading. In the figure, the successive positions of the ship's centre of gravity are marked by G_0, G_1, G_2 . . . . At G_2 the instantaneous turning centre is at O_2. Actually, because the ship is swinging as though attached to a rotating arm, the water seems to be approaching it along curved streamlines, nearly head on at the bow and at a considerable angle inward toward the stern. This angle of relative flow, involving cross flow at the stern from the outside toward the inside of the turn, acts to reduce the effective angle of attack of the rudder. At the point C the nominal flow about the ship is parallel to its centreline. To an observer on board, the ship appears to be turning about this point, hence it is called the pivoting point.

In the course of turning, especially with a large drift angle (β), the increased hull resistance causes the ship to slow down, sometimes involving a reduction of 40% or more of the speed with which it approached the turn. After the average ship has turned at least 90°, conditions become steady and its centre of gravity moves at uniform speed in a circular path with its centre at O.

In the steady-state portion of the turn the inward force caused by the drift angle exactly balances, in both magnitude and moment about the centre of gravity, the outward rudder force and the centrifugal force at the centre of gravity caused by the turning action. If the wind and sea were entirely quiet, the ship would continue to turn in a steady circle as long as the rudder was held at a constant angle and the speed remained constant.

Ability to steer a straight course or to turn readily is achieved in any given ship design by the use of a large rudder area. When the rudder is at zero angle, it serves as a vertical stabilizing fin. When angled, the large area provides the large swinging moment necessary for good turning.

3. Stopping and Backing.—Stopping in an emergency, as contrasted with normal coasting and gradual retardation, is achieved by slowing the propulsion device to less than driving speed and then by reversing its direction of thrust. If reversed too rapidly it is liable to overload the engine, to draw air down from the surface to the propeller in large quantities and to churn the air-water mixture into excessive turbulence without developing the maximum astern thrust. Capacity to start and stop quickly is built into a craft by providing an engine that will reverse rapidly and readily and by using a propulsion device with a large thrust-producing area. Both these features are stressed in the design of tugs.

4. Rudders and Planes.—Rudders and other control surfaces are usually placed at the stern of a ship for several reasons. When placed abaft screw propellers, they benefit from the increased velocity in the propeller outflow jet or race. When a vertical rudder is placed at the bow, it causes the ship to turn with a smaller drift angle and hence a larger turning radius. If the rudder is attached to the bow, it is ineffective hydrodynamically in producing a swinging moment. In fact, a normal ship, when moving backward, steers only indifferently or not at all. The rudder also receives better mechanical protection at the stern than it would at the bow.

For craft that are required to back out of long slips, or even to back into harbour entrances, like the English channel ferries at Dover, a rudder is fitted at the bow. This becomes the trailing end when backing, and the ship steers satisfactorily with a rudder at that end.

A centreline rudder mounted between two widely spaced wing propellers benefits only little or perhaps not at all from the augmented water velocity in the propeller outflow jets. Adequate swinging effect is then achieved by mounting two rudders abreast, one abaft each propeller.

The diving planes for controlling the rise and dive angle of a submarine are placed at the stern, directly abaft the propellers, to benefit from the higher water velocity in that region (fig. 11). Bow planes, if fitted, are used principally to control the depth at which the craft runs. They are effective as control surfaces because only vertical forces, not swinging or diving moments, are

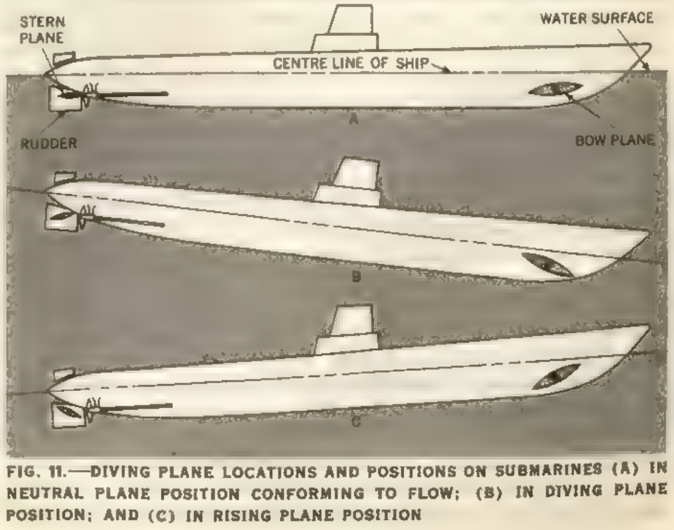


FIG. 11.—DIVING PLANE LOCATIONS AND POSITIONS ON SUBMARINES (A) IN NEUTRAL PLANE POSITION CONFORMING TO FLOW; (B) IN DIVING PLANE POSITION; AND (C) IN RISING PLANE POSITION

desired and because they project from the hull and create up or down forces independent of the hull forces.

Control surfaces called flanking rudders are placed forward of the screw propellers on shallow-draft push boats to produce side forces when the propellers are rotating astern. They enable these craft, when pushing groups of barges 1,000 or more feet in over-all length, to maneuver around river bends and through channel turns.

5. Heel When Turning.—In a turn, the inward hydrodynamic force produced by the drift angle is applied at a point well below the water line. The outward centrifugal force is applied at the centre of gravity, usually located at or above the water line. This couple acts to heel the ship outward to an angle at which it is balanced by the righting moment resulting from the transverse metacentric stability. The contribution of the rudder to this pattern is a force acting to reduce the angle of heel. Thus, in a steady turn, if the rudder angle is suddenly removed, the outboard heel is momentarily increased. Ships with small metacentric stability and comparatively large rudders have capsized through this cause.

Submarines with large, highly streamlined fairwaters around the periscopes and masts heel inward on submerged turns, especially if running at more than low or moderate speeds. This is because a large part of the inward hydrodynamic force is generated by the drift angle on the fairwater. This force acts inward at a level well above the centre of gravity, where the outward centrifugal force is applied. The outward lateral force on a rudder mounted below the main hull acts at the same time to increase the inward heel.

6. Effect of Propulsion-Device Action on Maneuverability.—The individual thrusts of independent wing propellers, with axes offset from the centre of gravity, exert a swinging moment about that centre. Ships with the rudder damaged or lost have been steered by suitable operation of the wing propellers. On some ships, pushing ahead on one screw and pulling astern on the other acts to turn the ship around almost on its own centre. Tugs with port and starboard paddle wheels driven independently, or with rotating-blade propellers, can maneuver even more readily in this fashion.

Blades of stern propellers that encounter crossflow under the ship when swinging or yawing produce lateral forces that counteract the swinging motion and increase the diameter of the turn. If air is drawn into the upper blades of the propeller on a single-screw ship, excess lateral forces on the lower blades swing the stern in the direction that the upper blades are moving, say from port to starboard. To a certain extent these forces can be counteracted by the rudder but for the most part the operator of a single-screw ship must foresee their existence and make adequate allowance for them.

7. Maneuverability of Submarines in the Vertical Plane.—Many of the factors involved in the steering and turning of ships in the horizontal plane apply also to the depth keeping, rising and diving of submarines in the vertical plane. The problem is much more severe here, however, because of the extreme relative thinness of the layer of water between the surface and the permissible working depth. The situation is somewhat similar to that which would confront the pilot of a transport airplane if he knew that at an altitude above 500 ft. his craft would disintegrate.

The undersea craft, required to run at almost constant depth for extended periods, requires reasonable dynamic stability of route in the vertical plane. It also requires controllability at extremely low submerged speeds so that it may hover at one spot or creep along slowly, without making any noise. Should the submarine crew lose vertical control with the craft headed for dangerous depths, a high-pressure air-blowing system serves to expel some of the water in the main-ballast tanks. The additional buoyancy thus gained checks and stops its descent.

8. Maneuvering Predictions and Model Experiments.—The ultimate aim of the naval architect is to formulate and collect rules and formulas by which a ship may be designed directly or by which its behaviour and performance may be predicted directly. The first are available in small part; some data for the second have been derived by tests under model towing carriages and rotating arms. These serve to determine the forces and moments resulting from elementary motions such as ahead motion with yawing deviations and motion at various drift angles when the centre of gravity is moving in a circular path, simulating a steady turn. The forces and moments are then fed into the equations of motion as outlined, for example, by K. S. M. Davidson and L. I. Schiff (*Transactions of the Society of Naval Architects and Marine Engineers*, 1946) and the integrated performance is predicted therefrom. This approach has been used primarily for the determination of dynamic stability of route, which involves only fairly small angles of attack and angular velocities. When these motions become large, as they do for large course departures, this approach can be used only with large empirical corrections.

Free-running self-propelled ship models, sometimes radio controlled, can simulate turns and other maneuvers, permitting derivation of the path of the centre of gravity, changes in forward speed, rudder angles, angles of heel and related data. Self-propelled models, supplied with power and steered by distant control from a towing carriage following, provide experimental checks on steering, dynamic stability of route, effectiveness of rudders and certain maneuvers which can be performed within the limited width of a model testing basin.

VII. SHIPS IN WAVES

Considered as the environment for boats and ships of all kinds and sizes, the term sea is used to denote all waters large enough for the operation of these craft, from creeks and ponds to lakes and oceans. The wind and the ships moving across the sea create a pattern of undulations ranging from minute ripples to waves of gigantic size. The currents moving through it must also be taken into account in all ship operations and in some ship-design problems. The variations in density, resulting from the amount of salts in solution, determine the variable-ballast tank capacity of submarines and the ability of a submarine to "sit" on a layer of dense water while largely supported by a less dense layer above.

Considering the over-all surface configuration, termed the seaway, the classical concept of a train of regular waves is highly unrealistic but it has some practical uses. The normal seaway is highly irregular, with waves of different heights and lengths traveling in many directions. For analytic purposes, it may be considered as made up of a multitude of very low waves, having the actual lengths and periods of all the sea waves and traveling in the same directions, superposed in quantity to produce the actual seaway. When this is done, a promising approach is to accept a multicomponent, random nature and to use statistical methods to define the seaway (*see* WAVES OF THE SEA).

The sea is also home to teeming masses of marine life, many of which are detrimental to ships. Marine borers attack wood exposed on underwater portions of the hull. Barnacles cling to the underwater hull, roughening its surface and increasing the ship's resistance to travel through the water. Sea water is highly corrosive to most materials, and severe electrochemical effects cause rapid disintegration of submerged metals that are unprotected.

1. Ship Motions in Waves.—Treated as a rigid body, a ship partakes of six oscillatory motions in a seaway. Three are translatory motions of the whole ship in one direction: (1) surge is the oscillation of the ship fore and aft; (2) sway is the motion from side to side; and (3) heave is the up-and-down motion. The other three oscillations are rotary: (4) roll is the angular rotation from side to side about a fore-and-aft axis; (5) pitch is the bow-up, bow-down motion about an athwartships axis; and (6) yaw is the swing of the ship about a vertical axis. Yawing is not necessarily oscillatory for every service condition. All six of these motions can and do take place simultaneously in a confused sea, so the situation is most complex.

The forces and moments caused by waves are balanced by three types of forces and moments opposing them: (1) those required to move the ship and cargo and the adjacent water to which kinetic energy is imparted by the ship motion; (2) those absorbed in damping the oscillatory ship motion or reducing its extent by the

generation of surface gravity waves, eddies, vortexes and turbulence; the energy required for setting up these disturbances is carried away and lost; (3) those of hydrostatic or hydrodynamic nature that act to restore the ship to a position of equilibrium as, for example, when the ship rolls to an angle greater than that called for by the exciting moment.

2. Effect of Shape and Proportions.—The most important single factor in cutting down the increased resistance of ships running in waves appears to be a small fatness ratio; in other words, a small underwater volume compared with the ship length. This slenderness is difficult to work into ships intended to carry cargo, but relatively easy for passenger ships. For reduction in the magnitude of ship motions in waves it is important that the damping forces and moments be as large as practicable. Moderate flare in the above-water sections at bow and stern, large beam compared with draft and fineness of the underwater sections all help to achieve this result. A deep-sea sailing yacht embodies these characteristics to a high degree.

To keep the ship reasonably dry while undergoing the rolling, pitching and heaving motions that remain, large freeboard is essential, especially at the bow. In fact, to prevent slamming under the bow when it lifts out of water and then drops heavily upon the surface, the forefoot under water must also be deep.

A good degree of damping is most necessary to avoid deep rolling. If this cannot be achieved by a transverse form suited to the service, such as that of a sailing yacht with a deep fin keel, it is accomplished by adding long fins on each side in the form of roll-resisting or bilge keels. When placed along the lines of flow, these keels add little to the ship resistance in calm water.

Active roll-resisting fins serve to quench the greater part of the roll on a fast ship with a reasonable expenditure of weight, space and cost. These fins, much shorter than bilge keels but extending several times as far outboard when in use, are rotated mechanically about transverse axes to produce angles of attack and girthwise forces which continually oppose the rolling motion. Since the moments of the roll-resisting forces diminish as the square of the ship speed, the active fins are ineffective at low speeds.

Active roll-resisting tanks of U shape have been built and tested in ships. In these, water or other liquids can be transferred rapidly from one side of the ship to the other to counteract the rolling motion, using controllable (and reversible) axial-flow propellers placed in ducts connecting the port and starboard tanks.

Considering the vertical accelerations involved, pitching and heaving, or a combination of the two, are the most objectionable for passenger comfort and safeguarding of cargo. Some form of passive pitch-resisting fin may be evolved which will accomplish its primary purpose without introducing detrimental features.

3. Hydrostatic and Hydrodynamic Loads in Service.—The naval architect must know the loads imposed upon a ship in all the conditions of its expected service in waves so that he may design the hull structure to withstand them. Aside from the static distribution of load along the length when the ship is floating at rest in calm water, there are many other buoyancy distributions in waves for exactly the same loading condition of the ship. Further, the wave action and the ship motion in waves generate dynamic forces which, under certain conditions, may be extremely important. When the bow and stern are on wave crests, with a wave trough between, the ship hull sags or bends downward in the middle. As the middle body reaches a wave crest, with the ends over wave troughs, the ship bends the other way or "hogs" and the ends droop because of the greater buoyancy amidships. Waves also produce torsional moments and the hull twists in the seaway, as when the ship is traveling obliquely through waves. Both bending and twisting actions involve shear in the structural members, as when a region that was square in shape under no load takes the shape of a rhombus when deformed. When the ship rolls, racking strains are induced in the hull because the above-water portion wants to continue to roll as the underwater portion starts to roll back the other way. Ship motions also induce inertia forces similar to those felt in elevators when starting or stopping.

It often happens that a part of the hull and an adjacent wave surface, each parallel to and approaching the other, meet with a heavy shocklike impact known as slamming. This can occur if the bow of a ship emerges from the water on a violent up-pitch and drops down upon a rising wave surface. It can also occur if a large wave strikes an overhanging part of the ship, such as the flaring hull under the forward end of the flight deck on an aircraft carrier. The tremendous blow against one end of the hull causes the whole structure to vibrate in an action known as whipping. The strains thus caused may be as great as those encountered in sagging and hogging over large waves.

Other natural loads are those caused by wind and ice. Typhoon and hurricane winds may blow with velocities of 100 knots or more. In subfreezing weather the sea spray freezes on the exposed portions of the ship, thereby adding a substantial weight. Icebreakers must be able to withstand the shock of ramming thick, solid layers of sea ice and to survive the squeezing action of pack ice.

Many of these loads may be reduced by judicious operation of

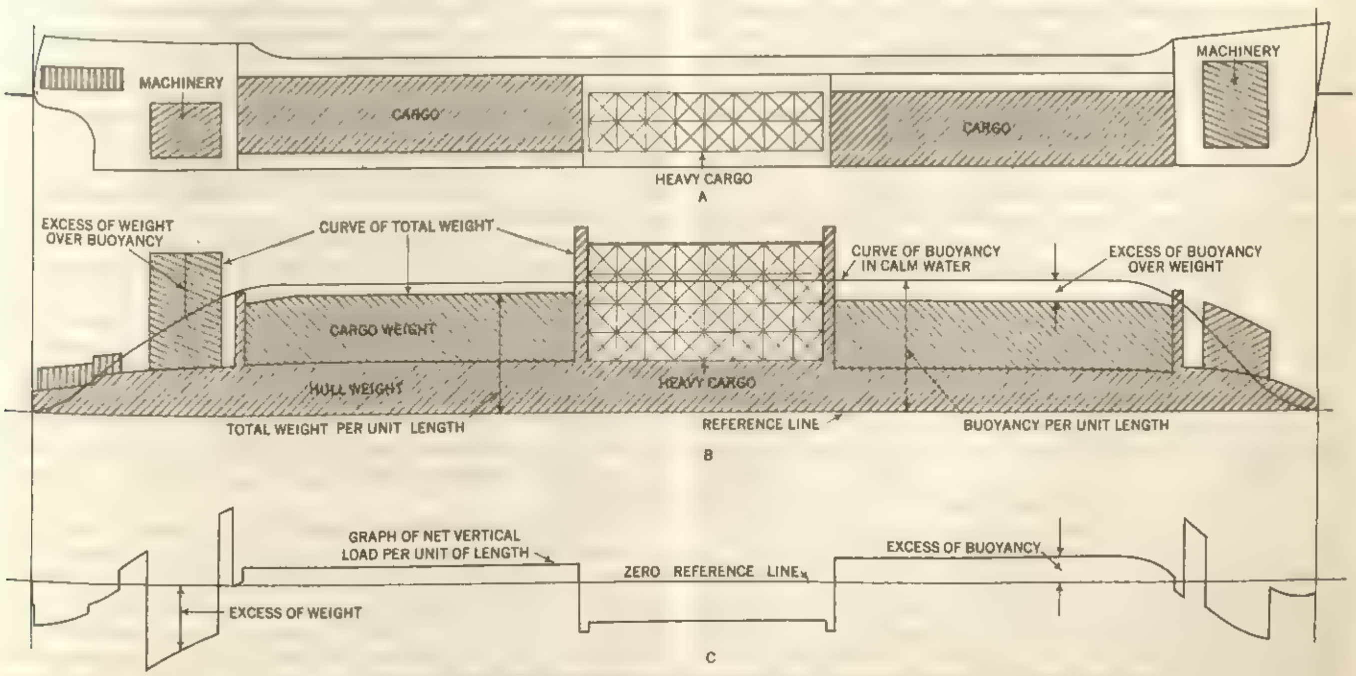


FIG. 12.—DIAGRAM SHOWING VARIATION OF WEIGHT AND BUOYANCY ALONG THE LENGTH OF SHIPS (*See text*)

the ship; for example, by slowing down or heaving to in a storm. Ship structures are designed to withstand most of them, but the exercise of good seamanship significantly lessens their intensity.

4. Variation of Buoyancy and Weight Along the Length.—At a given draft and trim in calm water, the upward buoyancy forces vary from bow to stern in a fixed fashion because each unit length of the ship is supported by a force equal to the weight of water displaced by a transverse section of unit length at that point. When summed up, all the buoyancy forces on the unit lengths equal the total ship weight. The fixed or "hardware" weights of the ship structure, the machinery, the fittings, the equipment and the fuel and stores, have a somewhat different bow-to-stern distribution when reckoned by the same unit lengths (fig. 12). If the ship is loaded with cargo, so that the fore-and-aft distribution of total weight is shown by the total hatched area in fig. 12(B), some unit lengths weigh less and some more than the water displaced by the immersed volume in those lengths. Fig. 12(C) indicates the irregular nature of the net weight or buoyancy forces at all points along the ship length.

Cargo loaded at the ends aggravates this condition and creates an elastic hogging deformation, with the midship portion bent upward and the ends drooping. Cargo loaded in the middle, with the ends empty, creates a sagging of the structure, with the midship portion bent downward. As a first requirement, the ship structure must be strong enough to take care of all the nonuniform weight distribution in calm water during normal loading and unloading. The bending caused by uneven loading, in a tanker carrying liquids and floating in still water, can be sufficient to crack the structure or to break it in two.

When the ship is in waves, the upward buoyancy forces are greatest in way of a crest and least in way of a trough while the ship and cargo weights and the distribution of these weights along the length remain the same. Since two successive waves are rarely alike, it is customary to design the hull structure to withstand the bending moments, in both hogging and sagging, produced by some assumed "standard" series of waves. One such wave has a vertical height in feet, from trough to crest, of 1.1 times the square root of the wave length in feet. This takes care of the observed fact that short waves, the most severe for small boats and ships, have height-to-length or steepness ratios greater than those of long waves. All the "standard" waves have lengths equal to the ship length.

5. Determination of Forces and Moments.—The maximum forces that a ship is likely to encounter in service, excluding temporarily those due to above-water or underwater explosions, are the weight and buoyancy forces that act vertically, caused by gravity. The moments of greatest interest to the designer are the maximum bending moment in the vertical fore-and-aft plane, for both the hogging and the sagging conditions on the assumed "standard" wave. Slamming forces may act in almost any direction, and they are usually applied at or near the ends of the ship. To predict them it is necessary to make certain assumptions and to use certain approximate formulas not described here.

Prediction of the forces and moments due to above-water or underwater explosions—a possible emergency load for all ship types—requires specialized knowledge and a great deal of experience, much of it of a secret or confidential status. Aside from direct or close hits, the explosive forces produce vertical and lateral bending and whipping, much as do the waves of the sea.

The procedure for determining the vertical bending moment is to consider the ship poised and balanced statically on the assumed wave. This means that the buoyancy graph in fig. 12(B) is replaced by one based on a curved "standard" wave profile instead of a straight one, with a crest either at mid-length or with two crests at the ends. The wave profile must be adjusted on the ship profile until the total buoyancy forces equal the total weight of the ship, and the centre of gravity is vertically in line with the centre of buoyancy. With the ship balanced on the wave a load curve similar to that in fig. 12(C) is drawn, showing the differences between weight and buoyancy at all stations along its length. At any transverse section, the vertical shear is determined by summing up the area under the load curve from one end of the ship to the section in question. By a process known as integration of the moments about a given station, the vertical bending moment curve is obtained.

6. Superposition of Calm-Water and Dynamic Wave Loads.—The final forces and moments which a ship structure is designed to withstand must take account of those imposed by the static loading, such as those due to cargo, fuel and stores loaded at a pier in port (fig. 12), plus those imposed by wave action and ship motion after the ship puts to sea. In fact, under some service conditions the calm-water bending moment may exceed in magnitude the wave-and-motion movement in a seaway.

VIII. STRENGTH OF SHIPS

A ship hull, of whatever materials it may be made, must be strong enough to withstand all the loads that may be imposed upon it by normal service and by any seaway that may be expected during its life. It must, in fact, have a reserve of strength to take care of excessive loads carelessly or negligently applied or of loads caused by unusually high, large or steep waves. The latter are encountered only on rare occasions, but they do occur.

The structural configuration, involving the disposition of material as well as the elasticity of that material, must be such that the structure does not bend or flex unduly under the specified loads. It is customary to make a ship hull much stiffer than, say, the wings of a large airplane, just as the fuselage of that plane is stiffer than its wings.

The material must be so disposed and proportioned that the hull has the minimum weight—and can be built for the minimum cost—to perform all its functions acceptably. A knowledge of how the various parts are strained, of how the applied loads are distributed among the various members and of how all of them work together is essential in order to place and proportion them in the most effective manner.

1. Strength and Stiffness.—A ship structure is sufficiently strong if it can support all the fixed loads of its machinery, fittings and equipment and all the cargo loads, and if it can withstand without permanent change of shape, cracking and fracture all the hydrostatic and hydrodynamic loads which can be imposed upon it in calm water or in any kind of seaway in which it is supposed to operate. It is sufficiently stiff if, under any of these service loads, it does not flex or deform unduly so as to interfere with the alignment of operation of machinery or with any other function, major or minor. A bronze screw propeller of a high-powered ship, having blades that are too thin, may deform so much when generating full thrust that its shape and propulsive characteristics are changed. If the blades are permanently bent under emergency maneuvering conditions, the propeller is not strong enough.

Vibratory motion can build up to unacceptable peaks if local portions of the structure are in resonance with the periodic applied forces. In consequence, rudder plating and shell plating at the stern must be stiffened to control panting or pulsating deflections from propeller forces. The shell at the bow is also subject to panting from wave-impact loadings; this requires extra stiffeners, called panting stringers.

It is customary in ship structures and ship components to limit the calculated strains under the heaviest contemplated service loading to a certain fraction of the limiting strain for the material being used at which permanent change of shape or damage will occur. The margin thus provided takes care of unusual and emergency conditions which rarely can be foreseen at the time of design. For a submarine pressure hull the collapsing depth is calculated—or determined by model tests—as part of the original design. It is considerably greater than the working depth, at which the calculated strains are limited to values which can be endured indefinitely.

2. Structural Configurations.—The arrangement and disposition of the structural material in a hull and the proportions of the structure, all known as the configuration, are most important features. A too-shallow ship hull, like a too-shallow bridge truss, requires an inordinate amount of steel for strength and stiffness. A hull that is too deep also requires too much steel because of its size, unless the various members are made too thin. Structural

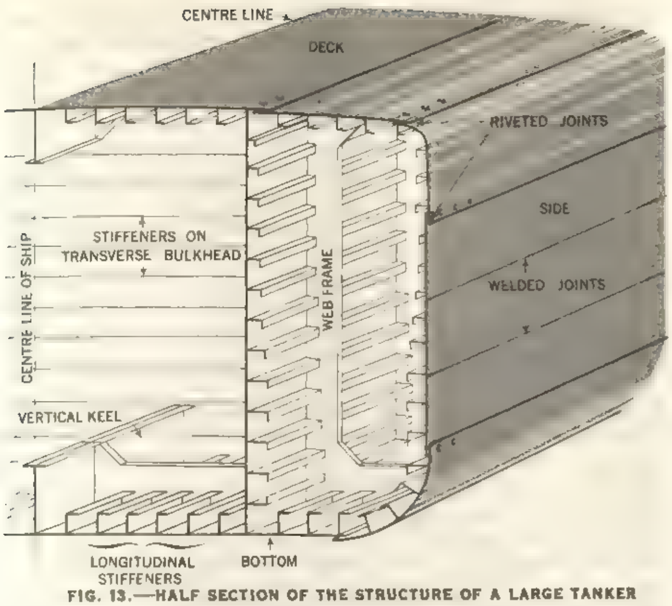


FIG. 13.—HALF SECTION OF THE STRUCTURE OF A LARGE TANKER

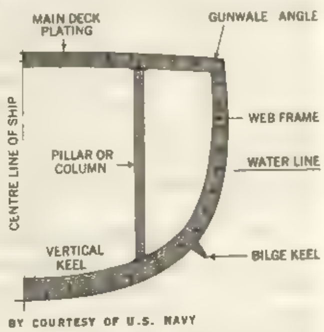
material in the form of a closed box, like a ship hull with a deck, resists vertical and lateral bending and twisting all at the same time.

It is important, for cost and weight as well as for strength and stiffness, that the structural material be placed in the ship where it will do the most good. If there is too much material in the bottom structure and not enough in the decks, the neutral axis of the section (above and below which the moment of area through the structural members is the same) will be too close to the bottom.

For a given bending deformation the upper members will be unduly strained and the lower members only partly strained. It may be advantageous to make the hull girder deeper amidships, by about one deck height, where the vertical bending moment is greatest, and shallower at the ends, where it is least.

Every boat or ship hull, both above and below the water, embodies a watertight boundary or shell which provides the buoyant volume to float it. Taken with a deck to which it is firmly attached, the whole forms a hollow box, a most economical and efficient principal structural member of the hull. Since some part of this box is in compression for bending loads, and much of it is in shear for twisting loads, the relatively thin shell—bottom, sides and deck—must be prevented from buckling, crumpling and wrinkling when it is strained. This is done by stiffening it at intervals with frames and stringers of some convenient type. They hold the flat surfaces in shape and take some of the working loads as well (fig. 13).

When the stiffening system of the deck and shell plating lies predominantly parallel to the principal ship axis the ship is said to be longitudinally framed. When the majority of stiffeners lie at right angles to that axis, it is transversely framed. Whatever the system of deck and shell stiffeners, they must be supplemented by deep web or belt frames in the first case, placed transversely (fig. 13 and 14), or by longitudinal stringers in the second case, run fore and aft. These hold the primary stiffened system in shape and help to distribute concentrated loads resulting from nonuniform placing of cargo, wave action on the outside, and external blows from striking piers and quay walls and rubbing against fenders and the sides of other ships. Longitudinal framing saves hull weight because the metal in the fore-and-aft stiffeners supplements the metal in the shell and the uppermost decks in resisting the bending moments imposed in vertical and horizontal planes.



BY COURTESY OF U.S. NAVY

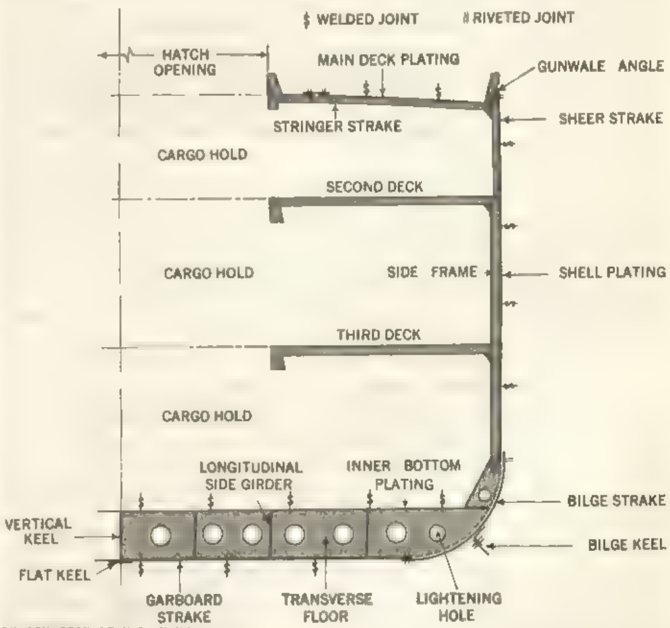
FIG. 14.—HALF SECTION OF A LONGITUDINALLY FRAMED DESTROYER

Fig. 15 shows the hull structure for a typical transversely framed cargo ship (1953 "Mariner" class, U.S.). The construction is predominantly welded. The riveted joints at bilge strake, gunwale and main deck, just outboard of the cargo hatch, function as crack arresters in case of progressive failure of the wide, flat, welded areas. The inner bottom plating forms part of the bottom flange of the ship girder; in addition, it is made watertight so that it serves as a tank top and as an additional watertight boundary if the outside plating at the bottom is pierced.

The transverse and longitudinal bulkheads required for subdivision, the internal platforms and decks required for service, access and storage and the boundaries of internal tanks for liquids are utilized for structural strength wherever practicable, to avoid unnecessary weight.

3. Scantlings and Strength Calculations.—When a structural configuration has been sketched, conforming satisfactorily to the ship arrangement, the designer selects the scantlings, defined as the size, shape, area and unit weight of the individual structural members. This is done first for the midship section, where the vertical bending moment is usually the greatest. The preliminary scantlings are chosen from experience, from a ship generally similar, from classification society rules or by a scientific analytic process.

The parts of a ship structure that make up the hull girder resisting the longitudinal bending moments must at the same time carry the more localized loadings, such as concentrated machinery loads and large external water forces. Often the latter govern the design of the part. The transverse bulkheads and the transverse web frames are designed on the basis of local loads. Watertight bulkheads are required to resist maximum water pressure when the compartment on one side is flooded.



BY COURTESY OF U.S. NAVY

FIG. 15.—HALF-MIDSHIP SECTION OF A TRANSVERSELY FRAMED CARGO SHIP

Gun and launcher foundations present special problems. They are designed by assuming various directions of impulse or recoil to find the critical direction for each important member of the foundation.

4. Structural Design of Submarine Pressure Hulls.—The depths to which combat submarines are required to submerge and the necessity for conserving weight in the inner or always-buoyant hulls of cargo submarines call for correct proportioning of the structural elements and accurate selection of thicknesses for the various parts. The uniform pressure around the entire inner hull at working depth enables the designer to calculate the exact hydrodynamic loads, but the fact that the entire structure is loaded

in compression and that the inner shell may be expected to fail by buckling more than makes up for the simplicity of loading.

The lightest pressure-resisting inner-hull form is a cylinder of circular section, stiffened by ring-shaped frames with a longitudinal spacing of from one-fifth to one-tenth or less of the diameter, depending upon the specified working depth and external pressure (fig. 16). Whether riveted or welded, the plates forming the circular sections are butted together at their fore-and-aft joints, so as to transmit the compression loads directly from one plate to the other. Theoretical formulas, supplemented and confirmed by the tests of many hundreds of scale models of steel, enable the designer to determine the plating thickness, the frame spacing, the form and size of the frames and the best method of attaching the frames to the cylindrical shell.

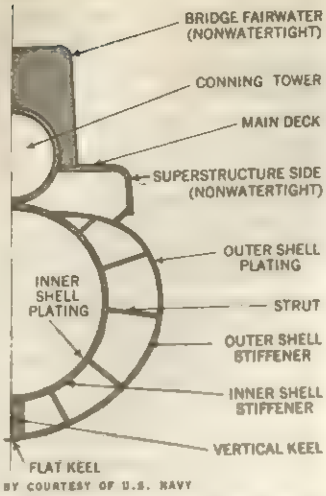


FIG. 16.—HALF-MIDSHIP SECTION OF A SUBMARINE

At each end of the submarine hull, where it diminishes in beam and depth to facilitate propulsion, the inner hull takes the form of the frustum of a cone, with circular or elliptical transverse sections of reduced diameter.

5. Detrimental Effects of Discontinuities.—The various parts of a ship hull made of elastic material are found to stretch, shorten, twist and flex as the external loads cause the whole hull to change shape. If the adjacent parts cannot deform locally by about the same amount, the heavier and stiffer members pull or push on the lighter ones.

The result may be excessive local strains, out of all proportion to the strains which would be caused normally by the principal external load. After reaching the fatigue limit the local metal may crack, buckle or break. Good structural design calls for the tapering or narrowing of members to correspond to the strength and rigidity required, and for great care in making transitions from heavy members to lighter ones along a given line of application of a load.

6. Materials of Construction.—Wood was for many centuries the most important and, in fact, the only shipbuilding material. It is still used for boats and small craft of many types, as it is easily handled and worked by local craftsmen with simple tools. However, it is a relatively weak material and is subject to rapid deterioration. Slippage along fore-and-aft flush seams is difficult to prevent. Large wooden ships had to have diagonal metal straps bolted to the planking to counteract slipping at the seams and to keep the hulls in shape. Others made use of hogging girders or tie rods running over high vertical posts to prevent the ends of the hulls from drooping. Many modern metal ships have wooden weather decks to help insulate the spaces below and to provide a good walking surface.

The development of strong waterproof glues and techniques for building up large curved members from thin laminations has greatly improved the strength and stiffness of wooden ship structures. Checking, splitting, knots and other imperfections are largely eliminated, and many short pieces can be used. Molded plywood yacht hulls made of five thin layers glued together, with the grain running in different directions, are stiff enough to hold their shape without an internal framework.

The steels most widely used for hull structures are of the medium, high-tensile and special-treatment types. By far the greatest proportion of parts are of medium steel, where the working strains are small or moderate compared with the yield strain. Both high-tensile and special-treatment steels have higher yield points; the latter has ballistic and shock-resisting properties as well. They are used for parts subjected to high strains in order to save hull weight.

Investigations in the latter 1940s revealed that many of the fracture casualties of that period were due to the use of steel lacking in notch toughness. This term refers to the steel's ability to absorb energy by stretching in the vicinity of sharp corners, notches and cracks, particularly at low temperatures or at high stretching rates. This quality is particularly important where all the plating seams around the girth are welded. Many ship structures have several riveted seams to permit adjustment of the strains due to butt welding and to localize progressive cracking. Specifications for shipbuilding steels of the 1950s required certain minimum limits on notch toughness and on adaptability to welding.

Aluminum alloys are used for the hulls of small and experimental craft and for large shipboard elevator platforms and similar structures. They are also used for the superstructures and upper works of many cargo and passenger vessels; they form the upper parts of steel hull girders which bend elastically in service. For the last-named purpose, the increased deformation or stretch of these alloys is an advantage. For a given weight, panel plates of aluminum alloy are thicker and stiffer than those of steel. They thus provide a better appearance and for many installations they do not require painting.

Use of aluminum for large ship structures, such as the hull proper, in which appreciable savings in weight are to be achieved, requires reliable welding and riveting in large thicknesses. What is more, it necessitates the acceptance of increased bending deformations along the length and lowered natural frequencies of vibration as compared with similar structures of steel.

Hulls of heavily reinforced concrete have been used for ships and barges in times of emergency, when steel reinforcing rods and labour trained in building construction were available and shipbuilding steel and labour having shipbuilding skills were not.

Plastics reinforced with glass fibre eliminate many of the joints in a hull and greatly decrease the deterioration encountered in wooden or metal hulls. They may be coloured with pigment and they lend themselves admirably to "sticking in" stiffening members and other parts and to repairs in a similar manner when damaged. Many nonstructural parts of boats and ships of all sizes and types are easily fabricated by molding in reinforced plastic.

7. Jointing, Connections and Attachments.—It is possible, with Fiberglas and similar materials, to make a small-boat hull entirely in one piece. However, as the boat becomes large enough to require a Fiberglas deck, this is made separately and attached to the hull. For larger craft, the individual planks and plates have to be joined by gluing, screwing, bolting, riveting or welding (*see* also RIVET; WELDING). Flush seams (fore-and-aft joints) and butts (girthwise joints) for smooth external hull surfaces are possible by gluing and welding. Screwing, bolting, riveting or welding require lapping the members over each other or the use of internal (and external) connecting straps, strips or other parts. Nailing for small-boat structures of wood is no longer favoured because of the difficulty in making repairs. If the limitations and advantages of each of the jointing methods are kept firmly in mind, it will be found that practically every one of them serves well in some particular application on board ship.

Welding has the great advantage over riveting in that it eliminates excess metal and saves weight practically everywhere in a ship structure, sometimes as much as 10%. As a rule, the loads are transmitted from one member to another more directly, and the resulting structure is more rigid. Under heavy deformation, such as collision damage, the welded joints will hold together better than riveted connections. Under mild deformation they are less liable to leak. Welded shell plating is much smoother than riveted plating, with appreciable savings in friction and total resistance. On the other hand, poor welding is often undetected from the outside. One small flaw in an unfortunate position can initiate a major crack.

8. Structural Tests of Ships and Models.—Those who made the early strength calculations of iron ships in the 1850s and 1860s benefited from the studies and tests of I. K. Brunel and W. Fairbairn on the tubular or box-shaped bridges previously built in Great Britain. Fracture and loss of the fast, light British destroyer "Cobra" in the early 1900s led to tests of another de-

stroyer, H.M.S. "Wolf." The need for information on the behaviour of similar structures when actually loaded to the buckling or fracture point led, in 1930, to full-scale tests of the U.S. destroyers "Preston" and "Bruce" and, later, of the British destroyer "Albuera." These tests confirmed the use of the simple beam theory for large, thin, box-shaped structures, and indicated the relative effectiveness of stiffened and unstiffened material and the rigidity of riveted joints.

Fractures of welded ship hulls during the early 1940s led to a new series of extensive structural-testing programs by Great Britain and the United States on full-size ships, including tests with various load distributions in calm water.

Beginning with the German M.S. "San Francisco" in 1934, a number of ships have been instrumented to determine in heavy seaways the wave profile along the ship's side, the water pressures and accelerations resulting from ship motion, the deflection of the ship girder and the simultaneous strains in many parts of the ship structure.

After the 1920s the techniques of making and testing structural models vastly improved. The availability, after the 1940s, of the wire-resistance strain gauge, with its small size and tiny wires cemented to the metal, made possible the testing and structural analysis of models (and ships) under high-speed dynamic loads such as impacts and shocks from underwater explosions.

IX. LAWS AND REGULATIONS FOR SAFETY

Certain safety requirements have been imposed upon the normal naval architectural requirements by law, by official regulations and by international convention. These cover a wide field, involving health, hygiene, fire protection, lifesaving and communications (radio and radar) as well as seasonal loading, watertight integrity, freeboard, subdivision and other provisions to ensure that ships will remain upright and afloat. Provision for freeboard, subdivision and other major items in the present category must be made in the original layout and arrangement sketches as part of the preliminary design.

1. Freeboard.—Aside from providing reserve buoyancy when rolling and pitching and keeping the upper decks free from green water and spray, freeboard is required to keep those decks above water when the hull is partly flooded. Adequate freeboard for running in waves must be larger in proportion to its length for a small ship than for a large one, because short waves are steeper than long ones. Freeboard must increase as the ship speed increases because of the greater pitching at higher speeds.

2. Subdivision and Floodable Length.—Subdivision by watertight bulkheads is necessary to prevent extensive flooding after only local damage. A well-designed ship should, with some damage and moderate flooding, still be able to move, steer and stay afloat. In recognition of this premise the major maritime nations of the world have approved international treaties and drafted rules specifying the minimum amount of freeboard and the extent of transverse watertight subdivision.

This subdivision is expressed as a function of the floodable length of a ship. A convenient method of relating floodable length to the ship is by a floodable-length curve. The curve is plotted on the profile of the ship so that the vertical ordinate at each point equals the portion of the ship length, centred at that point, which can be flooded without immersing a margin line. The margin line is parallel to the uppermost deck to which the transverse watertight bulkheads extend and is several inches below it, so that in calm water the ship can sink to this line without water leaking or flooding into other compartments.

When plotting the floodable-length curve, allowance is made for trim but not for heel since the ship is assumed to be open to the sea from side to side. The curve is used by the naval architect to help him decide where to place the transverse watertight bulkheads so they may be most effective in restricting the extent of flooding after damage.

The amount of water that can enter any compartment depends upon the ratio of the open-space volume to the total volume, known as its permeability. An empty hold can take nearly its entire volume of water, with a permeability of say 98%. If filled with coal, its permeability may be 20% or less.

3. Situation After Damage.—Any heel after damage makes a ship vulnerable. Excessive heel may be disastrous, as it was for the "Andrea Doria" in 1956. In a well-designed ship, subdivision is planned to ensure that the ship remains upright, or nearly so, no matter where it is opened to the sea, or that heel can be corrected by counterflooding on the opposite side. Unless the flooding occurs amidships, the ship trims by the bow or stern. This may render it vulnerable in a heavy sea. Compartments at the ends are usually shorter than those nearer amidships.

Because of the intact water plane lost and the free surface in the flooded areas, the partly flooded ship almost invariably loses some transverse metacentric stability. Such a ship can survive if somehow it can be kept upright. Several ships bombed in the 1940s were saved by lashing them to adjacent piers and other craft to hold them upright until they could be pumped out.

X. SHIP DESIGN PROCEDURE

The work outlined in the foregoing, together with other tasks depending upon the type and mission of the ship, is carried out in several definite stages, indicated by the following headings.

1. Preparation of Requirements.—When the operator decides a new ship is needed he prepares an outline of the desired requirements, often with the technical advice of a professional ship designer. The latter endeavours to embody in the specifications many features requiring decisions to be made by the owner. Settling them early avoids interruptions and delays at later stages. If these decisions are not readily made, a number of preliminary designs may be worked up to indicate the range of possibilities within the limits tentatively established by the operator. The latter is then in a better position to make his decision, or to require that further sketch designs be prepared.

2. Compromises Necessary.—A layout of the proposed ship is no sooner begun than the naval architect encounters limitations on every side. If the ship is made large enough to house all the necessary components conveniently, it becomes too large, too costly to build and consumes too much fuel. If held to a moderate size, cramping, squeezing and overlapping begin as the components are worked into the arrangement plan. The mission of the ship must constantly be kept in mind as space and facilities are pared here and there. To carry out this give-and-take process intelligently and logically, the naval architect must have a fundamental and general knowledge of all aspects of the design and an intimate knowledge of all features mentioned in this article.

Imperfect knowledge of physical laws relating to ships and their behaviour forces the naval architect to rely heavily on experimental data, empirical rules and past experience. This situation is aggravated when, as frequently occurs, he is forced to apply trial-and-error methods to certain features of the design.

3. Preliminary Design Stage.—The purpose of the preliminary stage is to present to the prospective owner one or more designs which represent a feasible and economical fulfillment of the requirements. Usually only the major features of the ship are worked out at this stage. However, an extensive knowledge of the details of ship design is called for to determine the effect of the minor features without actually designing them.

As the first step in this stage, the naval architect chooses the ship type and its size. Usually a number of existing vessels meet roughly the requirements he is trying to fulfill. With these as guides he selects combinations of hull type, machinery and structural material to form one or more parent or basic types. At other times he is faced with most unusual requirements and with design problems that appear to be entirely new to the profession. Here he must start from the beginning, with his experience, knowledge and judgment as his principal guides.

Following the roughing out of the design in small-scale sketches, the major features of the ship are laid out in three types of drawings. The general arrangement drawings show the arrangement of spaces and equipment in profile elevations and deck plans (fig. 5). The line drawings depict the external shape of the underwater and above-water hulls. This is delineated by intersections of the hull with three series of planes at right angles to each other. The

structural arrangement drawings embody midship sections such as fig. 13, 14, 15 and 16, together with typical sections at other stations and drawings showing other general features of the structural configuration and the principal scantlings. The latter are based upon a preliminary calculation of longitudinal strength (see *Strength of Ships*, above).

In preparing these drawings the naval architect must determine whether each design proposal satisfies the performance and naval architectural requirements. Based on this and a weight study, the stability can be checked.

When the preliminary design studies have been carried as far on paper as existing knowledge permits, especially with respect to the power needed to achieve the given speed, one or more models are built. These models are towed and then self-propelled with a stock propeller (many of which are available at most model basins) to determine more accurately the ship's resistance and required propulsive power. Additional data can be obtained during these and other tests, concerning the nature of the flow into the propeller position, to enable the naval architect to design a final propeller, provided the hull shape and loading conditions are not changed in the meantime.

4. Contract Design Stage.—When a preliminary design appears to give promise of a ship that will meet all the requirements to everyone's satisfaction, the naval architect proceeds with the preparation of contract plans. These are intended to be sufficiently complete and comprehensive to enable the shipbuilders to make estimates of cost and time of construction. When combined with the detail specifications, prepared concurrently by the naval architect, there is enough information at hand to enable the successful bidder to draw the working plans, fabricate the parts and build the ship in accordance with the wishes of the prospective owner and the naval architect.

The preliminary lines, general arrangement and structural plans are drawn to a large scale and in more detail. Accompanying these are diagrammatic and arrangement plans of the main propelling and auxiliary machinery or of other major features in this category, such as the pumping machinery on a dredge or on a fireboat, prepared by marine and mechanical engineers. Calculations for strength and metacentric stability and the weight estimate are also expanded and done with more precision. Diagrammatic plans of cargo-handling arrangements, hull piping, ventilation and air-conditioning systems are prepared. Similar plans are drawn for the electrical systems and for location of the electronic equipment. The detail specifications cover particular features and characteristics of all components of the ship which cannot conveniently be shown on the plans.

The preparation of working drawings to be used by the artisans and mechanics in the shipyard is a phase of shipbuilding and is not discussed here. *See* SHIPBUILDING.

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NAVAL AVIATION: *see* AIR POWER.

NAVAL STORES, a term that originally designated the pitch, tar, resin, flax, cordage, masts and timber used in building and maintaining wooden sailing ships but is now applied only to the products of the pine tree. These products fall into two groups: gum naval stores derived from the oleoresin (gum or pitch) of the living pine, commonly called crude turpentine, and wood naval stores obtained by processing dead pine wood.

The United States is the foremost producer of naval stores, with France ranking second. Large amounts also come from Greece, Spain, Portugal and Mexico. Pines planted in the maritime provinces of France by order of Napoleon I as a measure to control the sand dunes are the profitable source of French naval stores, its constancy assured by careful forestry. In the U.S. the industry is centred in the south, where longleaf and slash pines abound.

The raw material of the gum naval stores industry, oleoresin, is a semifluid substance composed of resins dissolved in turpentine oil, its chief component being pinene. It is extracted from the pine by cutting through the sapwood into the heartwood of the tree (where resins accumulate) and collecting the exudate that issues from the wound. Formerly, gum was obtained by cutting a recess or box into the pine at its base and collecting the gum in a cup placed at the point of a V-shaped gash in the rear wall of the recess. Each tapping of the tree required the cutting of a new gash, leaving a succession of scars on the tree's heartwood. Boxing was destructive of tree life, many trees surviving this treatment by only a year or two. It has given way to a wiser shallow cutting with which narrow metal gutters are employed to channel the gum into collecting cups. It has been found that an application of sulfuric acid to a fresh cut induces a fuller and more prolonged gum flow, with the result that the turpentine yield is materially increased.

Turpentine is extracted from oleoresin by distillation; the residual compounds harden into the substance known as rosin. The individual farm still was once essential to the processing of gum. The farm operation consisted of subjecting the gum to heat in a brick-supported copper pot heated by a wood fire. Turpentine and water vapour were condensed in the water-cooled copper pipes of the still, and the liquid material was discharged into a container where it quickly separated into two layers with the turpentine on top. Remaining in the still was the molten rosin, combined with dirt, sand, bark, pine needles and such other foreign matter as had escaped the occasional skimmings of the pot. Although the rosin was strained through wire mesh and cotton batting, it proved upon hardening to be impure and was dark in colour.

The farm still has largely yielded to the large central cleaning and distilling plant where the gum is freed of foreign bodies by thorough washing and filtering. From cleansed and purified gum, after the extraction of turpentine by steam distillation, a pure, translucent, pale amber rosin is produced.

Wood naval stores are derived from salvaged pine wood, such as tree stumps and "downwood" or lightwood—pine from which the bark and sapwood have fallen away in decay. Although methods of treating the wood vary, generally it is shredded and subjected to heat under pressure in a digester. The volatile components—carried off, condensed and refined by fractional distillation—yield wood turpentine and pine oil, the latter product unobtainable from the oleoresin of the living tree. The residual resin retained in the shredded wood is extracted by treatment with a mineral oil solvent. The resulting resinous solution, purified and relieved of solvent by vaporization, gives wood rosin.

Sulfate wood turpentine, a by-product of the sulfate method of making pulpwood paper, is obtained by condensing the vapour from the digester in which the wood is treated. The turpentine, seriously contaminated by sulfur compounds, is purified by chemical treatment and fractional distillation. Although no rosin is recoverable in this pulping operation, the cooking liquor used in the process may be salvaged and treated chemically to yield the useful mixture of resinous and fatty acids known as tall oil.

See also RESINS: *Natural Resins;* ROSIN; TURPENTINE.

(E. L. Y.)

NAVAN (AN UAIMH), an urban district and the county town of County Meath, Republic of Ireland, is situated at the junction of the rivers Boyne and Blackwater almost in the centre of the county and 30 mi. N.W. of Dublin by road. Pop. (1961) 3,998. The Great Mote, an imposing earthwork (52 ft. high), is on its western outskirts. The town was walled and fortified by Hugh de Lacy and grew to considerable importance during the English settlement. Later it became a defense outpost of the English pale. Its official name, An Uaimh, means "the grotto" or "the cave." A shopping and market centre, it also has manufactures of furniture, carpets and woolen goods. About 1½ mi. N.E. is Donaghmore with slight remains of a 13th-century church that succeeded a Celtic church said to be associated with St. Cassanus, a disciple of St. Patrick. A round tower (100 ft. high), which was probably

built in the 10th century at the time of the Norse invasions, survives; an unusual crucifixion scene is carved above its doorway. About 8 mi. N.W. of Navan is Teltown hill, site of an ancient royal residence (one of four built by King Tuathal), where the Aonach Tailteann (Olympic games of Ireland) were held from about 1420 B.C. until the death of Roderic (Rory O'Connor) in A.D. 1198.

(W. M. Po.)

NAVARINO, BATTLE OF (Oct. 20, 1827), one of the decisive events of the War of Greek Independence. It was the unexpected outcome of the treaty of London of July 6, 1827, providing for British, Russian and French intervention in the Turkish-Greek conflict. Assuming that the Greeks would accept and the Turks refuse an armistice, the powers instructed their naval commanders to intercept Turkish supplies. They envisaged a mere demonstration. But before the allied squadrons were united, an Egyptian fleet slipped into Navarino bay (the ancient Bay of Pylos in the southwest of the Peloponnese) on Sept. 9, there joining a Turkish squadron. Sir Edward Codrington, the British admiral, arrived off Navarino on Sept. 12. On Sept. 25 he and the French commander, Rear Adm. Comte Henri Gauthier de Rigny, held a conference with Ibrahim Pasha, the commander of the Turkish-Egyptian forces. Believing that Ibrahim had promised to cease hostilities until couriers could bring definite instructions from Constantinople, they left Navarino, intending to return on Oct. 14. Ibrahim had understood that the Greeks would cease fighting; but on hearing that Gen. Sir Richard Church, commander in chief of the Greek forces, was threatening Patras, he sent two squadrons northward toward that gulf. Shots fired by Codrington caused these to return to Navarino on Oct. 7. Codrington, asserting that bad weather prevented their keeping watch outside, persuaded his colleagues (the Russian squadron under Adm. L. P. Heiden arrived on Oct. 17) to enter the bay. Ibrahim's couriers had not returned, but he had just received a letter of Aug. 20 imploring him to fight. His ships (89 sail, 2,240 guns) were in an arc, three deep, across the bay. The allied entry on Oct. 20 (with 27 ships, 1,324 guns) was hazardous, for Ibrahim probably intended after nightfall to attack with fireships. Certain Egyptians moved a fireship prematurely and fired on a boat ordering them to desist. The action, lasting four hours, soon became general. Finally 60 Muslim vessels were sunk, and 8,000 Muslims were killed. No allied ships were lost, but 176 officers and men were killed. *See* also GREEK INDEPENDENCE, WAR OF.

See G. Douin, *Navarin: 6 juillet–20 octobre 1827* (1927).

(D. DN.)

NAVARRE (NAVARRA), a province of northern Spain. Area 4,023 sq.mi.; pop. (1960) 402,042; population density 99 per sq.mi. Originally formed by the Basques into a kingdom in the 9th century, it was not annexed to the Spanish crown until 1512 (*see* NAVARRE, KINGDOM OF). Under the Nationalist government it enjoyed a limited economic autonomy. In the remote districts Lower and Upper Navarrese (Basque subdialects) and Navarro (Aragonese dialect) are still spoken. Navarre is bounded by the French Pyrenees to the north, Guipúzcoa province to the northwest, Álava and Logroño to the west, Zaragoza (Saragossa) to the south and southeast and by the Aragonese province of Huesca to the east.

Navarre has a great variety of scenery as it stretches from the western Pyrenees to the Ebro steppes. A tripartite division is clear: the Pyrenean sector; the central basins and hills; the southern plateaus and steppes. North of a line drawn through the Araquil valley and the foothills that overlook the basins of Pamplona, Aoíz and Roncal, the Pyrenean sector consists of a tangled relief of forested mountains and well-watered valleys. The ranges consist largely of sandstones with rounded and more subdued relief (seldom exceeding 4,000 ft.) than the central Pyrenees. The chief Pyrenean road pass is the Col de Roncesvalles (Puerto de Ibañeta; 3,468 ft.), with two others to the northwest, the Puertos de Maya (Otsondo) and de Vera. The region is largely drained by the Bidasoa, an Atlantic stream. The lower basin, called Cinco Villas, has a relatively dense population in scattered hamlets. Iron workings have encouraged small metallurgical industries at Vera and Elizondo, linked by a narrow-gauge railway to Irún; but the dense stands of timber and pastoralism are the main sources of wealth.

The central depression, now utilized by the railway from Vitoria to Pamplona and then by a narrow-gauge line to Sangüesa on the Aragón river, has played a vital role in Navarrese history. It has united the diverse Pyrenean valleys and focused commerce on the provincial capital, Pamplona (*q.v.*). In this climatically transitional zone, cereal cultivation mingles with forest lands and stock rearing, and settlements become more nucleated into villages.

The southern half of Navarre consists essentially of foothills and steppes through which the valleys of the Ega, Arga and Aragón run centripetally to the Ebro. The position of Tudela (pop. [1960] 16,456) near the confluence of these valleys explains its role as a regional market town. The landscape is more arid and monotonous with cultivation of cereals, and large nucleated settlements, *e.g.*, Estella (8,236) and Tafalla (7,320). Las Bárdenas on the southeastern borders is true steppe. (J. M. Ho.)

NAVARRE, KINGDOM OF, a former independent kingdom of Spain (known until the last half of the 12th century as the KINGDOM OF PAMPLONA, after its capital and chief city) which, at the time it ceased to exist as such (1512), occupied the area of the present province of Navarre (Navarra) (about 4,000 sq.mi.) together with the Tierra de Allién Puertos, on the northern approaches to the pass of Roncesvalles. This was a small region between Labourd and Béarn whose capital was at St. Jean-Pied-de-Port. In the middle ages much of Navarre was Basque-speaking. The other language used was the Navarro-Aragonese dialect, which, together with French (after 1234), was the language of the administration. The whole kingdom was mountainous except for the Tudela salient in the southeast, where the dry plains called Las Bárdenas provided an important grazing region. Though Navarre at an early date ceased to have a frontier with the Moors, a considerable Moorish population lived there, notably in Tudela. The Navarrese Moors were allowed to serve in the army, and also provided an important source of skilled artisans. Large Jewish *aljamas* (congregations) existed in the chief towns and were protected by the Navarrese kings when persecution became serious elsewhere. Another important element were the *francos*—mostly French and Gascon immigrants—who inhabited separate quarters in Pamplona and other towns. Their relations with the native Navarrese population were often strained.

Despite its small size in the later middle ages, Navarre's part in international politics was important, not only because of its rulers' involvement in French affairs but also because it controlled the main pass into Spain in the western Pyrenees and was a buffer state between Gascony, Castile and Aragon. The chief pilgrim roads from the north to Santiago de Compostela thus traversed it. From its earliest days to 1234, after which a succession of French dynasties ruled Navarre, the kingdom's history fell within a wholly Spanish context and was closely associated with that of Aragon. Afterward strong French political and institutional influences can be detected.

Pamplona was Moorish territory after 711, but the Basque magnates of the region early achieved some degree of autonomy and (*c.* 798) one of them, Iñigo Arista, established himself as an independent ruler there and, for a time, accepted Frankish suzerainty. By the time of García Iñiguez (*c.* 860–880) this dynasty was strong enough to assume regal titles and to establish diplomatic and family relations with Asturias. Under Sancho Garcés (905–925) the rulers of Pamplona extended their dominions south of the Ebro, capturing Nájera and much of La Rioja. By a combination of diplomatic dexterity and military strength the kingdom survived, relatively unscathed, the heyday of the caliphate in the 10th century. During the reign of Sancho III the Great (1005–35), the Navarrese were able to establish a brief hegemony over all Christian Spain. Sancho's empire was, however, short-lived and in 1076 Sancho Ramírez of Aragon (1063–94) occupied Pamplona.

Until 1134 Navarre was then ruled by the Aragonese crown. It recovered its independence when the Navarrese proclaimed García V, "the Restorer" (1134–50), as king (*see* GARCÍA). An entirely new orientation was given to Navarrese history in 1234 when Sancho VII (1194–1234) was succeeded by his nephew, Theobald I

(1234–53), count of Champagne, and a succession of French rulers with important possessions in France ruled the kingdom. They included, at times, the kings of France themselves. Historically the most famous of these French rulers was Charles II (*q.v.*) "the Bad" (1349–87), count of Évreux, under whom Navarre became internationally of great importance because of the king's involvement in French politics and the spread of the Hundred Years' War to the kingdoms of the Iberian peninsula. Charles himself had ambitions to recover for his kingdom the territories in Spain which had belonged to Sancho the Great. He has been severely criticized for the brazen way in which he constantly altered Navarrese foreign policy to meet rapidly changing foreign pressures. Charles managed, however, to retain the loyalty of his subjects and to preserve the independence of Navarre, though he lost all his French possessions except Allién Puertos and (1379) had to accept Castilian garrisons in his southern castles.

The reign of Charles III (*q.v.;* 1387–1425) was relatively tranquil, but John II of Aragon (*see* JOHN, kings of Aragon) became ruler of Navarre by marriage (1425–79) and the kingdom was then the scene, for years, of civil war between his supporters, those of his son and heir, Charles, prince of Viana, and other factions favouring union with France or with Castile. In 1484 the throne passed to John II of Albret, but independence had now become impossible on account of Navarre's position between two major and mutually hostile states, France and Spain. In 1512 Ferdinand the Catholic occupied the Spanish portion of Navarre. In 1515 the country was formally annexed to the Castilian crown but retained its status, institutions and law as an independent kingdom until the 19th century; it, as a province, still preserves its own civil administration and law.

In the later middle ages Navarre was divided administratively into five *merindades*—La Ribera (Tudela), Sangüesa, Pamplona (La Montaña), Estella and Allién Puertos; in the last the functions of royal *merino* were carried out by the *castelán* of St. Jean-Pied-de-Port. Under the *merinos* were the *sozmerinos* and, in the towns, the *bailes.* The chief military officer of the kingdom was the *alférez.* The treasury (*cámara de comptos*) was partly modeled on the French system under a *recibidor general* or *tesorero*, with *recibidores* in each *merindad.* The somewhat ambiguous international status of Navarre was reflected in its coinage; apart from local currency, French, Gascon and Aragonese money circulated freely. The law of the land was based on the *Fuero General de Navarra* (a body of customary law built up before 1155) but much modified in different localities by local *fueros.* Efforts by some of Navarre's French rulers to undermine customary law were strongly and effectively resisted, though feudal grants sometimes appear. In the 14th century one-sixth of the whole population claimed *hidalguía* (noble descent) and the tax exemption which went with it. The *Corte General* of Navarre controlled, in theory, not only extraordinary subsidies (*pedidos*) but also ordinary taxation. Since, however, it was the king's prerogative to decide who should be summoned, and when, the Navarrese parliament had little real power and its legislative importance was slight. Ecclesiastical jurisdiction in Navarre was complicated, the bishops of Dax and Bayonne (in Gascony), Tarazona (Aragon) and Calahorra (Castile) having, or claiming, authority over outlying regions. Shortage of man power was a constant concern from a military point of view; the earliest *fueros* had not contemplated the existence of a formal army at all. Later the defense of the kingdom rested on a large number of small castles. To increase reserves in war the later kings (notably Charles II) enlisted large numbers of foreign knights and their retinues as *mesnaderos;* these, in return for an annual pension, undertook to serve in Navarre when summoned. Navarrese culture in the late middle ages was much influenced by the pilgrim route, and French influences were naturally predominant.

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NAVARRETE, JUAN FERNÁNDEZ: *see* FERNÁNDEZ NAVARRETE, JUAN.

NAVARRO, PEDRO (*c.* 1460–1528), Spanish soldier of fortune, the foremost military engineer of his time. The details of his birth (probably at Garde in the Navarrese valley of Roncal) and of his early career are uncertain; he is thought to have been a *condottiere* in Italy and to have operated in the Mediterranean against the Barbary pirates. Enlisted by Gonzalo (*q.v.*) de Córdoba in 1499, he went with the latter's expedition from Spain to Cephalonia in 1500 and breached the walls of the Turkish stronghold with his mines. He next followed Gonzalo to the conquest of Naples (1501). As war soon ensued between the Spaniards and their French partners in that conquest, he played a distinguished role in Gonzalo's victory at Cerignola (1503); and the success of his mines against the French-held fortresses won him international fame. Ferdinand II of Aragon rewarded him with the Neapolitan countship of Oliveto, in the Abruzzi mountains.

Having returned to Spain in 1507, Navarro won further glory in expeditions against the Barbary states. A floating battery designed by him was instrumental in the capture of Vélez de la Gomera (1508); he took part in the capture of Oran (1509); and he was commander in chief in the conquest of Tripoli (1510).

In the war of Pope Julius II's Holy league against the French in Italy, Navarro, in command of the Spanish infantry, fell into French hands at the battle of Ravenna (1512). Since Ferdinand of Aragon would not ransom him, he finally entered the service of Francis I of France and fought for him in the Milanese campaign of 1515–16 (*see* MARIGNANO, BATTLE OF). War having broken out between Francis and the Holy Roman emperor Charles V in 1521, Navarro was captured by the emperor's forces at Genoa after the battle of La Bicocca (1522). Released under the short-lived treaty of Madrid (1526), he accompanied the French expedition of 1527 to Italy and was again taken prisoner—to die in the Neapolitan fortress of Castelnuovo in 1528.

NAVE, in architecture, is the central and principal part of a church, extending from the main front to the transepts, or to the

A. F. KERSTING

NAVE OF SALISBURY CATHEDRAL, ENGLAND, 1220–65

choir or chancel (*q.v.*) in the absence of transepts. When the nave is flanked by aisles, light is admitted to the church through clerestory windows. (*See* ROMANESQUE ARCHITECTURE; GOTHIC ARCHITECTURE.) At times, a gallery was carried above the side aisles.

Ecclesiastically considered, the nave is that part of a church appropriated to the laity as distinguished from the chancel, the choir or the presbytery, reserved for the clergy. In a 14th-century letter (quoted in Gasquet's *Parish Life in Medieval England*, p. 45, 1906) from a bishop of Coventry and Lichfield to one of his clergy, the reason for this appropriation is given. "Not only the decrees of the holy fathers but the approved existing customs of the Church order that the place in which the clerks sing and serve God according to their offices be divided by screens from that in which the laity devoutly pray. In this way the nave of the church . . . is alone to be open to lay people, in order that, in the time of divine service, clerics be not mixed up with lay people, and more especially with women, nor have communication with them, for in this way devotion may be easily diminished."

NAVEL, in anatomy, the umbilicus, the depression in the abdomen which indicates the point through which the mammalian fetus obtained nourishment from its mother through the blood vessels of the umbilical cord.

See EMBRYOLOGY AND DEVELOPMENT, ANIMAL: *Human Development;* PLACENTA.

NAVIES, EARLY HISTORY OF. The term navy originally meant the whole of a country's shipping, whether used for war, the carrying of merchandise or fishing. In modern parlance, however, the word is generally taken to mean a nation's warships and craft of every kind maintained for fighting, and the personnel manning them. It includes cruisers, aircraft carriers, destroyers, mine layers, mine sweepers, gunboats and other auxiliary craft; the submarines; and the fleet air arm. Behind the actual fighting units there is, necessarily, a vast organization for their administration and upkeep.

See the sections *Defense* of the articles UNITED STATES (OF AMERICA); FRANCE; GERMANY and other countries for the modern history of naval establishments; *see* also NAVAL AFFAIRS (ARTICLES ON).

In early history navies took the form of the armed men of a tribe or town putting to sea in such large boats or ships as might be available to give battle to enemies similarly equipped or to raid territory from the sea. The craft themselves were for the most part those used for commerce, fishing or, when occasion served, for war or piracy. Only exceptionally were they built specifically for fighting. Special types of war craft appeared later. There are definite indications of long ships built for speed as distinguished from round ships for burden from the time of the ancient Greeks and Romans. In 483 B.C. the threat of Persian attack caused Athens to increase its fleet from 50 to 100 long ships which were paid for out of the proceeds of the mines of Laurium (*see* THEMISTOCLES). The effect of this was to make Athens the predominant partner in the league formed by the Greeks for their common naval defense. By the end of the 5th century B.C. the fleet had increased to 300 long ships and later to as many as 360. In peace these war vessels were kept on slips and under cover in sheds; in war a *strategos* was appointed in command and he chose the trierarchs who were deputed to commission the vessels, partly at their own expense, under the supervision of state inspectors.

In general the organization of the Athenian navy resembled closely that of the British navy in the 16th and 17th centuries. The trierarch, who was either one of a group of citizens assisting to finance one or more war vessels or someone paid to discharge the duty, answered to the captain. There were also sailing masters, petty officers, seamen and oarsmen. Soldiers or marines formed the fighting personnel. The most ancient warships were many-oared galleys (*q.v.*), each requiring a very large number of rowers. The result was that the personnel provided to man a fleet of those times had to be a considerable one. For instance, the Roman and Carthaginian forces in the first Punic War numbered approximately 150,000 men on each side. The great rowing galleys relied for their offensive powers on boarding or ramming, and they appeared in great numbers in the Mediterranean in the war fleets of Alexander, of Carthage, of Rome, of Byzantium, of the Italian republics, of the Arabs and of Aragon. (*See* also SHIP.)

In the naval organization of ancient Rome can be seen the beginning of the idea of an admiralty in the navy commissioners appointed in 311 B.C. It is interesting to note, too, that the Roman empire was faced, on a small scale, with the same kind of maritime problems that assumed such vast importance for the British government in the 19th century. Rome maintained a fleet to neutralize the threat arising from rival sea powers and to deal with pirates and protect its trade routes. Its naval organization, which was very complete, included two main fleets which guarded the coasts of Italy at Ravenna and Misenum. These were known as the praetorian. Other squadrons were allocated to Forum Julii, to the mouth of the Orontes, to Alexandria, to Karpathos (between Crete and Rhodes), to Aquileia (at the head of the Adriatic), to the Black sea and to Britain. River flotillas were stationed on the Rhine and Danube and, later, on the Euphrates. All these squadrons did not exist at the same time, but there was always a highly organized navy with a body of soldiers, the *classici*, specially assigned for service afloat.

The navy of the eastern empire may be said to have originated with the foundation of Constantine's New Rome on the site of Byzantium. The threat of attack from the Vandal kingdom of Carthage (from A.D. 428 to 524) compelled the emperors to attend to their fleet, but with the fall of that kingdom the navy was neglected until the rise of Islamic power at the end of the 7th century produced a new menace. The Byzantine navy reached a high state of efficiency under the sovereigns of the Macedonian dynasty (867–1056). It consisted of an imperial fleet commanded by the great *drungarios*, the first recorded lord high admiral, and of provincial squadrons under their *strategoi*. The imperial fleet was essentially a war organization, while the provincial or thematic squadrons were smaller but more permanent forces maintained for police purposes. It is interesting to note that this navy included a corps corresponding to the gunnery experts of a modern fleet. These were the *siphonarioi*, who worked the siphons used for discharging the Greek fire (*q.v.*).

After the disorganization of the eastern empire by Turkish invasions in the 12th century, the Byzantine navy withered. In the middle ages the Italian republics and monarchial states bordering on the Mediterranean possessed appreciable fleets, and their seamen, especially those of Genoa, were regarded as some of the finest in the world, so much so that their services were sought by the powers of western Europe and even by England. Edward III and the kings of France employed Genoese to assist them in nautical matters. The Mediterranean navies made their last great appearance in history at the battle of Lepanto, 1571 (*q.v.*). The scene then changed and the ships and fleets took on a new form—one to fit them for ocean sailing and fighting. (E. A.; X.)

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NAVIGATION, the process of conducting a craft from one place to another. In its widest sense the word thus embraces not only finding the way but also the avoidance of collision and the handling of the craft. The processes of navigation in general consist in defining the route, conducting the craft along it and finding the craft's position from time to time to check its progress.

The most common way of defining direction on the earth is in relation to its axis of rotation. Position on the earth's surface, or at points close to the surface, is usually expressed in terms of latitude and longitude. Position may be established by dead reckoning (the accounting of distance and direction traveled) or by independent fixes which establish that the craft lies along one or more lines of position. Methods of fixing used at sea and in the air today include visual fixes, astronomical navigation, radio systems and radar. Dead-reckoning methods include the compass

and distance or speed indicators of one kind or another, inertial guidance systems and systems making use of the Doppler shift.

The methods of navigation used by the ancients can be deduced from fragmentary evidence in literature, even though there are large gaps in our knowledge. Modern navigation, both at sea and in the air, relies more and more upon mechanical and electronic devices, even though the human intelligence remains as a vital link. In outer space, navigation is likely to be done solely by nonhuman means.

This article contains the following main sections:

I. Historical Background
II. Techniques and Instruments Common to Marine and Air Navigation
III. Techniques and Instruments for Marine Navigation
IV. Techniques and Instruments for Air Navigation
V. Electronic Aids Common to Marine and Air Navigation
VI. Electronic Aids for Marine Use
VII. Electronic Aids to Air Navigation
VIII. Inertial Guidance Systems
IX. Interplanetary Navigation

I. HISTORICAL BACKGROUND

Ocean voyages well out of sight of land have been made for thousands of years in every civilization. The Minoans, for example, carried on a regular trade between Crete and Egypt and built the port of Cnossus especially for it. The Phoenicians were trading to Cornwall for tin in about 600 B.C., and 1,200 years later the Vikings were making regular journeys across the Atlantic to their settlements in Greenland and North America. There is thus no evidence for the popular supposition that all early navigators clung to the coast.

Exactly how the earliest navigators found their way must remain to some extent a matter of conjecture, but we know enough to reconstruct some of their methods. Herodotus, for example, tells us that the Phoenicians used Polaris (the pole star) to find direction. Homer has the wise goddess bid Odysseus keep Ursa Major (the Great Bear) on his left hand as he crosses the sea after leaving Calypso's island. In the Acts of the Apostles and in some of the early Norse sagas there are passages that make it clear that the sun and stars were used as guides.

Divisions of the Horizon.—North, south, east and west have always been defined by sunrise and sunset and by the direction of the sun's noonday shadow. The apparent rotation of stars around the north pole of the sky, too, would have been familiar to seamen and others whose calling involved a knowledge of direction. The division of the horizon into more than these four basic directions first seems to have been made by the Greeks, who differentiated between the directions of sunrise and sunset in winter and summer, a difference of about 30° in those latitudes. For reasons of symmetry, no doubt, they also defined directions on either side of the north–south line corresponding to the lines each side of east and west, and so the twelvefold compass of classical antiquity developed. The Tower of the Winds at Athens, however, shows eight winds, and it seems more probable that seamen from the earliest times accepted this division based simply on dividing and subdividing the four basic directions. The Anglo-Saxons, for example, distinguished 8 "points," and the Portuguese in the great age of discovery abandoned the age-old Mediterranean wind rose, probably of Etruscan origin, for a 16-point system.

Early Sailing Directions.—All directions long were thought of as winds, and early pilot books give the courses between ports in these terms. Distances are given in terms of a day's sail. The earliest surviving pilot book is the *Periplous of Scylax,* which dates from about 350 B.C. These directions, which were the first aids to navigation, describe routes, headlands, landmarks, anchorages, currents, port entrances, etc. No doubt the information was originally handed down from father to son, as it is in some Arab lands today. It seems improbable that any sort of sea chart was used with these sailing directions, even though maps go back to the Alexandrian Greeks. Not until the advent of the magnetic compass was the construction of an accurate sea chart possible.

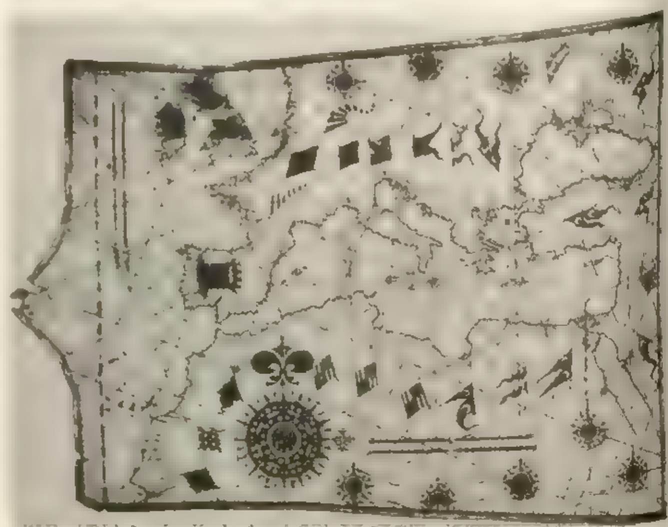
A passage from a book of sailing directions for the Arabian sea, originally written in Sanskrit in A.D. 424, gives an illuminating description of navigation before the days of chart and compass: "The pilot," it says, "knows the course of the stars and can always orient himself; he can evaluate the signs of good and bad weather; he distinguishes the regions of the oceans by the fish, the colour of the water, the nature of the bottom, and birds, the mountains and other indications."

The distance traveled was deduced from the speed. The first method of measuring speed was by timing the passage of a chip of wood (hence "log") dropped from the stem until it passed the poop. Later a triangular piece of wood, known as the log ship, was attached to a line payed over the stern from a reel, the amount of line that ran out in a given time showing the speed. Timing was first done by such devices as repeating syllables and counting the pulse, but later the sandglass was introduced, a 28-second glass being used for speeds up to 6 knots and a 14-second glass for speeds above that. The first suggestion that the line should be knotted (hence "knot") seems to have been made by Richard Norwood in 1637. Knots at 51-ft. intervals were used with the 28-second glass.

The Magnetic Compass.—The birthplace of the magnetic compass is sometimes disputed. The first written reference to the use of the magnetic needle for direction finding at sea seems to have been made by an Englishman, Alexander Neckam, writing in 1180. He speaks of "a needle placed upon a dart which sailors use to steer by when the Bear is hidden by clouds." Writing about 80 years later, a Dominican friar, Vincent of Beauvais, tells how seamen, when they can no longer see sun or stars to steer by, magnetize the needle with a loadstone and place it through a straw floating in water. The needle comes to rest, he says, pointing at the pole star.

The compass card, with its painted wind rose displaying the division of the horizon, was probably first attached to the needle in the 13th century. So familiar has this combination become that it is customary to think of the compass as the instrument itself, whereas the word originally meant merely the division of the horizon.

Later Sailing Directions.—The earliest surviving set of Mediterranean sailing directions, *Lo Compasso da Navigare* (1296), talks in terms of half points, that is, $\frac{1}{64}$ of the compass of the horizon. It was from such directions, accumulated over generations and then collected during the 13th century into a single



BY COURTESY OF THE TRUSTEES OF THE NATIONAL MARITIME MUSEUM, GREENWICH, LONDON

FIG. 1.—PORTOLAN CHART OF THE MEDITERRANEAN BASED ON RHUMB LINES, ASCRIBED TO SIMON FERNANDEZ, 16TH CENTURY

volume for the entire Mediterranean, that the first marine chart was drawn. This chart, the famous Carta Pisana, was drawn on sheepskin and is oriented toward the Stella Maris rather than Jerusalem (as most land maps were). It carried a scale of miles and a pattern of rhumb lines distinguished by coloured inks.

corresponding to the directions shown on the wind rose. To set a course on such a chart the pilot would draw a line between his departure point and destination and then, with a pair of dividers, pick out the coloured rhumb line most nearly parallel to it; when traced back to the parent wind rose the rhumb line would show the required course.

So long as navigation was simply by dead reckoning and was restricted to that area, the Mediterranean chart, unrelated to latitude and longitude, was perfectly satisfactory. It ignored the magnetic variation (the angle at any place between true and magnetic north), but since sailing was by the magnetic needle the variation could be neglected. It also ignored (though not always through ignorance) the fact that the earth is a sphere and that any flat representation of it must somehow take into account the convergence of the meridians toward the poles. But here again no great harm was done so long as sailing was still a matter of going a certain distance on a certain rhumb of the wind or compass point.

When the Portuguese under the leadership of Prince Henry the Navigator ventured farther and farther south along the African coast, they encountered navigational difficulties because they assumed that the plain charts used in the Mediterranean could simply be extended. But over long distances the rhumb lines could not be taken as straight, and the chart proved completely inadequate to the new methods of checking the dead reckoning that Portuguese astronomers and mathematicians had devised under Prince Henry's patronage. These methods demanded a chart related to latitude and longitude, not one merely built upon bearing and distance. In 1569 Gerardus Mercator published his world map on a "true projection suitable for navigation." Thirty years later, Edward Wright provided an explanation of the projection and computed tables of meridional parts so that cartographers could make use of the principle. However, a long struggle ensued between seamen who wanted to keep the "plain," simple chart, and the enlightened few who saw that only a "true" chart could be free of errors. The struggle lasted until well into the 18th century.

The Portuguese method of position finding involved observation of the altitude of the pole star in order to determine latitude. The star was observed when it was "in rule," that is, when the position of the "guard" stars in Ursa Minor (the Little Bear) showed that the pole star, which circles around the pole of the sky, was precisely at the altitude of the pole. When the navigators approached the equator, where the star of course disappears, latitude was obtained by observations of the noonday sun.

Altitude-Measuring Instruments.—The first instrument used for these observations seems to have been the quadrant, long known to astronomers. The star is observed through pinhole sights and its altitude read off where a plumb bob cuts the scale. Later it seems to have become the practice to mark the scale of the quadrant directly with the altitude of the pole star at certain locales, such as Lisbon. The pilot could thus directly observe the latitude of his destination. The ship would sail north or south until she reached the required latitude and then go east or west to her destination, making continual latitude observations.

Columbus is often credited with having discovered the variation of the compass, but it seems improbable that the Portuguese pilots, not only in making continual observation of the pole star but also in sailing east or west along a parallel of latitude, could have failed to observe the phenomenon.

Another instrument used for measuring altitudes at sea was the mariner's astrolabe, an adaptation of the astronomer's astrolabe (*see* ASTROLABE). The instrument used at sea carried only the altitude-measuring alidade, normally fitted to the back of the astronomer's astrolabe. The central part of the instrument was cut away to lessen wind resistance.

However, the mariner's astrolabe did not achieve the popularity of its 16th-century successor, the cross-staff—a simple device consisting of a staff about three feet long fitted with a sliding crosspiece that made it possible for even an unskilled observer to measure the angle of elevation of a star or the sun. The cross-staff remained in use until the 18th century despite several drawbacks, the most serious being that the sun could be observed only by looking straight at it. Coloured shades were fitted to the crosspieces, but the major improvement came in 1594 when John Davis, a navigator famous for his Arctic explorations, invented the backstaff. This instrument, with a scale divided into two and used with the observer's back to the sun, remained popular even after the introduction of the far superior Hadley's quadrant (so called, but actually an octant). John Hadley, who was a fellow of the Royal society, described his quadrant in 1731. Its virtue lay in the use of the principle of double reflection to overcome the motion of the ship. Thomas Godfrey, a Philadelphia glassworker, independently devised a similar instrument at about the same time. The sextant, a refinement of Hadley's quadrant, followed soon afterward and is in regular use today. (*See* SEXTANT.)

Almanacs and Tables.—Working at first from knowledge derived from translations of Portuguese and Spanish manuals, a flourishing school of instrument makers, chart makers and teachers grew up in Tudor and Stuart England. They quickly improved the theory of navigation and compiled more accurate tables. One of the earliest almanacs, which also set forth the principle of determining longitude by lunar distances, was the astronomical ephemeris of Regiomontanus, published in Nürnberg in 1474. The first purely national almanac was the *Connaissance des temps*, published in Paris, which contained tables for the crude determination of longitude from the eclipses of Jupiter's satellites. In 1675 the Royal observatory was founded in Greenwich with the specific object of providing the sailor with astronomical data of the required precision. In 1753 Johann Tobias Mayer published his tables of the motion of the moon, which heralded an enormous advance.

The Marine Chronometer.—Latitude could be observed by measuring the altitude of the pole star or the sun or any star when it crossed the meridian, but the great problem remained the determination of longitude at sea. Medieval astronomers knew that longitude differences could be determined by noting the local time of an eclipse, and in the 16th century the principle of determining longitude by comparing the readings of an accurate clock with local time was pointed out. However, for seamen the problem remained unsolved. In 1714, largely because of a number of disasters due to bad navigation at sea, an act of the English parliament established the board of longitude. The board offered an award of £20,000 to anyone who could discover a method of finding out longitude within 30 mi. after a voyage of six weeks. The award was ultimately won by John Harrison, whose fourth marine chronometer, made in the form of a watch, heralded the introduction of the practice of taking timed observations of heavenly bodies at sea.

The 19th Century.—Modern methods of astronomical navigation are based on two fundamental advances made in the 19th century: the discovery of the concept of the astronomical position line by an American, Capt. Thomas H. Sumner, in 1837, and the introduction in 1875 by the French naval officer Marcq St. Hilaire of the intercept method of sight reduction.

In the 20th century, radio methods of navigation at sea and in the air, from the simple direction finder to sophisticated hyperbolic systems, largely replaced older methods of position fixing.

(M. W. RI.)

II. TECHNIQUES AND INSTRUMENTS COMMON TO MARINE AND AIR NAVIGATION

Dead reckoning (the determination of position by keeping an account of the distance and direction traveled) is common to all forms of navigation. At sea the dead-reckoning position (or "estimated position," as the position corrected for set and drift is sometimes called) is customarily maintained either by plotting with parallel rules and dividers on the chart or a special plotting sheet or by means of the traverse table which can be used to derive change of latitude and longitude for course and distance traveled. The course steered must be corrected for the effects of compass error, currents or tidal streams and drift from the wind. Distance at sea is measured by the ship's log, which records distance directly, in the case of towed logs, or speed, which may be con-

verted into distance, in the case of a pressure-type log. The magnetic compass is still standard at sea, but most large ships are fitted with a gyrocompass (*q.v.*) which indicates true north.

Various considerations render the north-seeking gyrocompass impracticable in the air, but the magnetic compass may be gyro-stabilized so that it will be unaffected by turning, acceleration and other errors. Air speed is usually measured by a differential pressure gauge that records the difference between the dynamic pressure due to the aircraft's speed and the static ambient pressure. There are a number of ways of estimating wind drift. The effect of wind on the aircraft's progress is allowed for by an application of the triangle of velocities, either by plotting or by means of a dead-reckoning computer.

The instruments used in celestial navigation are an accurate timepiece, such as a chronometer (*q.v.*) or a navigational watch used in conjunction with radio time signals, and the sextant. The marine sextant is used for measuring the altitude of a heavenly body above the visible horizon. The horizon is not normally available as a reference to the air navigator, so the air sextant is fitted with an artificial horizon in the form of a bubble that defines the vertical. To eliminate the numerous acceleration errors that affect the bubble, an integrating device that automatically averages a number of sextant observations over a run of one or two minutes is generally incorporated. Although other methods of defining a horizon in the air are in use, the bubble is the most general.

In astronomical navigation the navigator adopts the concept of the celestial sphere, in which all heavenly bodies are apparently located on the interior surface of an infinitely large sphere that has the earth as its centre. The celestial sphere appears to rotate westward about the extension of the earth's axis of rotation.

The geographical position of a heavenly body is the point immediately below it on the earth's surface. The latitude of this position is defined by the body's declination and the longitude by its Greenwich hour angle. Both these values may be extracted from the nautical (or air) almanac for a particular time. In navigation the earth and the celestial sphere are considered as two concentric spheres and, since the radius of the earth is known, any angle measured in the celestial sphere can be directly related to distance on the earth's surface. A nautical mile by definition is the length on the earth's surface of one minute of arc.

A navigator making a timed sextant observation of the altitude of a heavenly body thus (subtracting it from 90°) measures the distance of his own position from the geographical position of the body. He establishes the body's geographical position for the time of the observation by reference to his almanac. The distance from this position can be laid off on the chart, in principle, as a circular position line, but in practice the distances are likely to be so large that this is not feasible. The astronomical triangle formed by the pole, the body and the observer's zenith is then solved mathematically.

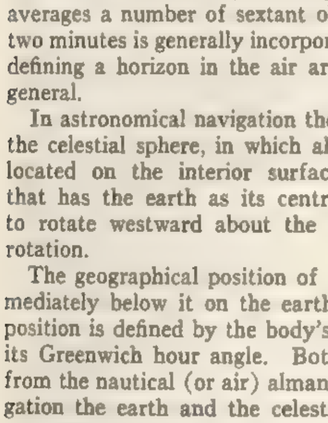


FIG. 2.—METHOD OF PLOTTING DEAD-RECKONING POSITION

Most modern solutions are based on the intercept method, in which the altitude and azimuth for any convenient position, such as a dead-reckoning position, are calculated for the instant of observation and compared with the altitude and azimuth obtained from the observations. The procedure is illustrated in fig. 2. Only the portion encircled by the dotted line need be plotted on the chart. The two circles normally differ only by a few minutes of arc, which results in the encircled position being relatively small. The line tangential to the circle of equal altitude for the actual position is perpendicular to the radius of the circle at the point of tangency. No appreciable error is involved, because a straight position line may be said to correspond over a comparatively short distance to a position circle of very large radius tangential to it. An astronomical fix is obtained by the intersection of two or more astronomical position lines.

III. TECHNIQUES AND INSTRUMENTS FOR MARINE NAVIGATION

In coastal navigation the ship's position is normally established by bearings of nearby landmarks. Lighthouses are placed in prominent positions around the coast and show lights by night with characteristic phases by which they may be identified. By day lighthouses are easily recognized landmarks, and their known heights are often used to obtain the distance by sextant angle. Light vessels are generally placed offshore either to mark some danger (such as the Goodwin Sands in the English channel) or as an aid to landfall (the Ambrose lightship off New York harbour). Lighthouses and light vessels are equipped with sound fog signals and usually with radio beacons.

Buoys are used to mark channels and off-lying dangers. The colour and shape of a buoy, and sometimes its numbering, indicate on which side it should be passed. Two systems of buoyage are in use internationally: the lateral and the cardinal systems. The cardinal system is used along coasts fringed with isolated dangers and reefs, and the marks vary according to the quadrant of true compass in which they are situated with reference to the danger. Buoys may be identified at night by their light characteristics, which are indicated on the chart.

Sailing directions or pilot books, published by national hydrographic authorities, give detailed descriptions of the coast line, landmarks, tides and currents, lights, dangers, etc., for every navigable part of a coast. They give detailed directions for entering harbours and describe the anchorages, port facilities, buoyage, etc. Light lists describe the characteristics of lights (with the exception of buoys) around the coast and the buildings that exhibit them. In strongly tidal waters, such as the English channel, a tidal stream atlas is published to show the strength and direction of the stream for every hour.

Charts are normally issued by the national hydrographic authority, which is generally a department of the navy. The hydrographic department of the British admiralty has world coverage with some 3,500 charts. The United States Hydrographic office also has world coverage. Since 1920, the International Hydrographic bureau at Monaco, of which most maritime nations are members, has standardized chart making and acted as a medium for the exchange of hydrographic information. Most sea charts are on the Mercator projection, the great advantage of which for navigation is that rhumb lines appear as straight lines. Information to keep charts up to date is published by the hydrographic offices in the form of "notices to mariners."

The directional reference most used by modern navigators is the gyrocompass. The magnetic compass is always installed as a standby, and it may be the only compass in smaller ships. The advantage of the gyrocompass is that it indicates true instead of magnetic north and is subject to fewer errors. The compass is used both for steering and for fixing the ship's position by bearings. (*See* GYROCOMPASS.)

The ship's log, which may be of the towed or submerged type, records the speed or distance steamed. The ship's speed may also be estimated from the speed of its engines.

Although the lead line, possibly the oldest navigating instrument, is still in use, sounding at any depth is normally done with the echo sounder, which gives a continuous indication of the depth of water. In well-surveyed areas the ship's position may be ascertained by comparing a continuous echo-sounding record of the bottom with the soundings shown on the chart.

IV. TECHNIQUES AND INSTRUMENTS FOR AIR NAVIGATION

The speeds involved in air transport call for quick navigational methods, even at the expense of some accuracy. It is largely for this reason that radio aids play such an important part in air navigation. It is also for this reason that the major decisions tend to

be taken on the ground in the planning stage, so that the function of cruise control and flight control in the air is to implement these decisions.

The route and the cruising altitude are selected on the basis of the predicted weather situation and various other factors. The choice of altitude will take into account the best operating altitude of the aircraft, the winds at different heights, icing, turbulence and the demands of traffic control. The route will be chosen bearing in mind winds and the weather situation, navigational facilities and traffic control. Although the shortest distance always lies along a great circle, the great-circle route is not necessarily the least-time track because the incidence of head and tail winds will depend on the local weather pattern. There are various techniques for calculating and flying along the minimal flight path, and these are grouped together under the heading of pressure-pattern flying.

When the route and altitude have been chosen, the flight plan, which is filed at the airport of departure for transmission to the airport of arrival, is drawn up. Wind triangles for various parts of the flight are solved; the heading, true air and ground speeds for each zone of the flight are determined; and the flight time and amount of fuel needed are calculated. An alternate airport is selected in case weather makes landing at the scheduled airport unduly hazardous, and a point of no return, or equitime point, is established. The flight plan is used as a guide against which the aircraft's progress in the air is constantly checked.

In contact flight the pilot uses prominent landmarks, such as highways, bridges, railroads, mountains and lakes, to establish his position. By night he uses air beacons, generally located at airfields and at intervals along more difficult portions of the civil airways. Another useful visual aid in contact flight is the runway-approach lighting, which extends for several hundred feet from the end of the runway to help the pilot make visible contact with the ground. The intensity of these approach lights can be varied from the control tower, and different settings are used for night and day use and for different types of overcast.

The scale and the amount of information displayed on an air navigation chart will depend on its purpose. A plotting chart may be on a scale of 1:2,000,000 and, in addition to such radio facilities as radio ranges, fan markers and beacons, such a chart will show airports, ground elevation, airways and control zones. It would show little topographical detail and would be used for high-speed high-altitude flight. Such charts are generally drawn on the Mercator or Lambert conformal projection (*see* MAP). The World Aeronautical series of charts, which has been recommended for international adoption by the International Civil Aviation organization, is on a scale of 1:1,000,000 and displays enough topographical and radio information for fairly high-speed pilotage. Instrument-approach-and-landing charts are designed to enable the pilot to approach and land by instruments in low visibility. The landing chart shows, on a larger scale, the airport and its immediate vicinity and is used for visual as well as instrument flying. Such a chart might be drawn on a scale of 1:250,000.

The gyroscope, although not used as a north-seeking compass in aircraft, plays a considerable part in the definition of heading in the air. Gyrostabilization is used to eliminate the acceleration errors to which magnetic compasses are subject in aircraft and to avoid interference from ferrous metals and electrical circuits in the region of the compass. The magnetic element in the remote-indicating air compass is normally housed in a position away from magnetic interference, such as the tail or outer part of the wing. The directional gyroscope is also used in place of a compass in instrument flying and in polar regions where the magnetic compass is useless. The gyroscope is subject to wandering due to precession and slowly drifts away from the original setting. During turns the drift is too small to be of any significance, but when used for steering the gyrocompass requires occasional resetting. In polar navigation the average drift rate, normally determined by the astrocompass, is generally allowed for in the courses steered.

To determine the effect of the wind on the aircraft's track, a drift meter may be used when the ground can be seen. In a typical instrument the navigator looks through an eyepiece and rotates an indicator dial until the drift lines on the reticle are parallel to the apparent motion of ground objects; a pointer on the indicating dial will then show the amount of drift. Modern drift meters are usually gyrostabilized. The gyroscopic principle is also incorporated in automatic sensing controls to achieve controlled flight.

Altitude is measured either with the barometric altimeter, which is essentially an aneroid barometer calibrated in feet or metres above sea level, or by an absolute altimeter, which employs a radar principle to measure the distance above the ground.

(H. A. PA.; M. W. RI.)

V. ELECTRONIC AIDS COMMON TO MARINE AND AIR NAVIGATION

Following the beginning of World War II, when the direction finder and its associated radio beacon and the low-frequency radio range station were the standard aids, there were enormous advances in radio aids to navigation. Systems developed during and after the war include loran, decca, consol, very high-frequency omnidirectional range (VOR or "omni"), distance-measuring equipment (DME) and radar.

Direction Finding (DF) and Omnidirectional Beacons.—The directional property of a radio antenna that is formed into a coil or loop was familiar to the earliest experimenters. As a loop is rotated horizontally its energy output, derived from the interception of a radio wave, passes through a sharp minimum that corresponds to the direction of the radio transmitter. Soon after ships were first equipped with radio, shore direction-finding (DF) stations were placed at strategic points along navigational routes and near harbour approaches. Upon receiving a request by radio from a ship, two or more shore stations determined the directions from which the ship's signal arrived by means of their loop antennas and transmitted this information back to the vessel. However, this service was limited to one vessel at a time, a serious drawback in bad weather, when demands were heavy. By reversing the process—placing the transmitter ashore and the direction finder on the ship—the system became nonsaturable and the navigator was given two further advantages: he was able to take continuous or frequent bearings on any shore beacon, and he could take bearings of any receivable signal, such as transmissions from broadcasting stations and from other vessels. This change in the system was roughly coincident with the initial growth of aviation, and the air-borne direction finder immediately became a valuable aid to air navigation.

Crossed-loop direction finders, used when it is not convenient to rotate the loop, consist of two loops mounted at right angles to each other with their terminals connected by cable to two crossed fixed coils of a goniometer; a rotatable coil in the goniometer simulates the rotation of the ordinary loop antenna. Other types of DF antennas include the Adcock (using spaced dipoles or monopoles) and spaced-loop types that have been employed ashore as navigational aids in the high-frequency and very high-frequency bands, where greater efficiency and accuracy is obtained than with the simple loop. Loops incorporating ferromagnetic cores are largely used in portable direction finders, produced principally for aircraft and small boats.

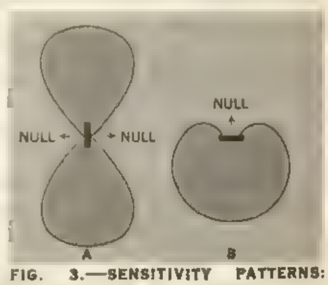


FIG. 3.—SENSITIVITY PATTERNS: (A) SIMPLE LOOP ANTENNA; (B) LOOP COMBINED WITH SINGLE VERTICAL ELEMENT

In all direction finders there exists a basic ambiguity of 180° as to the direction of signal arrival. This is resolved by combining the output of an omnidirectional "sense" antenna, usually a single vertical element, with the output of the DF elements so that the normal symmetrical figure-of-eight sensitivity pattern (fig. 3[A]) is altered to a cardioid pattern (fig. 3[B]) to show the direction of signal arrival.

Errors in Direction Finders.—The accuracy of well-designed direction finders is normally within 1° to 2°. Greater and sometimes serious errors are caused by night effect, reflection and shore-

refraction effects and local reradiation.

The term "night effect" originated when practically all direction-finding activity was in the 200–500 kc. band, utilizing the vertically polarized ground wave, which is uncontaminated in daytime. At night, however, the sky wave appears, arriving at the DF antenna at a down-coming angle and shifted both in phase and polarization, thus distorting the normal directional response of the antenna. At higher frequencies this effect exists even in daytime. The Adcock and spaced-loop antennas provide greater accuracy on sky waves than does the loop antenna.

Radio waves are refracted when crossing a boundary between dissimilar paths, such as a shore line, at angles less than 90°; likewise, mountains and similar masses may reflect the waves. Both of these effects cause the apparent direction of signal arrival to be other than the true direction of the transmitting station.

Metallic objects on the vessel, aircraft or at a land-based DF station may reradiate or reflect the incoming signal, thus causing the apparent bearing to be in error. On vessels, the offending objects are usually masts, rigging, metal guard rails and other antennas; on aircraft, other antennas and parts of the aircraft itself. Generally these errors are determined by observation and then either accounted for arithmetically or automatically corrected by special devices.

Automatic Direction Finders.—The direction finders installed on ships and aircraft are usually automatic adaptations of the manual single-loop or crossed-loop goniometer. Although the circuity used is fairly complex, the objective in most types is simply to maintain the loop or goniometer in a null position. This is accomplished by an electrical sensing circuit, which causes a motor to return the loop to zero voltage output whenever turning of the vessel causes the loop to depart from that position. The accuracy of such equipment is adversely affected by strong unwanted signals, and aural monitoring is necessary in order to detect such a condition. Instantaneous-bearing types of automatic direction finders are able to display several bearings simultaneously, in radial fashion, upon an oscilloscope. This is accomplished by rotating either a loop or goniometer synchronously with the deflection coil of the oscilloscope at a relatively high speed.

Radio-Beacon Stations.—The complementary part of a direction-finder navigational aid is a system of omnidirectional transmitting stations strategically located along navigational routes or on the approaches to harbours and airports. These beacons operate within the band 200–515 kc. The service distance is established by regulating the radiated power in accordance with area or local requirements, which range from 10 to 400 mi. Each station transmits its identifying code either by keying the carrier or by a tone modulation; the latter method is favoured because automatic direction finders operate more reliably on a continuous carrier. Because of limited radio spectrum space it is necessary in some areas for marine beacons to share time on the same frequency. The usual arrangement is for three stations to transmit one minute each, in close sequence, for two 10-minute periods in each hour. In poor visibility, however, a station is sometimes placed in continuous operation.

Loran (Long Range Navigation).—The loran system was developed in the United States during World War II to overcome the limitation in accuracy and distance of direction-finding and range systems. By changing from a continuous-wave (CW) bearing or directional array system to a pulse time-measuring system the night effect is eliminated and refractive and reflectional effects are minimized. In addition, because of the low ratio of "on" to "off" time in a pulse system, a very high peak power can be generated economically. The loran-A system covers most of the important trade routes of the world and is used by both marine and air navigators. It operates in the 1,800–2,000 kc. band. Loran-B, a refined version of loran-A designed for extremely high accuracy at lesser distances, is intended primarily for approach and in-harbour navigation. Loran-C, operating on 100 kc., provides greater range and greater accuracy than loran-A.

Loran pulse signals are short enough so that it is possible to discriminate between the highly stable ground wave and the unstable sky wave. The sky wave is delayed with respect to the ground wave at any reception point because of the greater distance it must travel—up to the ionosphere and back to earth. Although the primary service of loran-A is based upon the use of ground waves with a range of 600 to 900 nautical miles, secondary service is provided by first-reflection sky waves up to 1,400 mi. The fix accuracy within the primary area is nominally 1% of the distance from the centre of the station system; within the secondary area it is 5%.

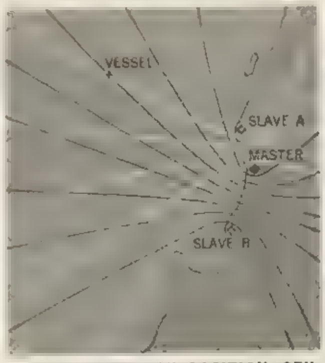


FIG. 4.—LINES OF POSITION GENERATED BY LORAN MASTER AND SLAVE STATIONS

Fig. 4 illustrates the loran system. Each pair of stations—master and slave A and master and slave B—transmits signals that generate a family of hyperbolas representing lines of equal difference in time required for a signal to arrive at a given point from each station in the pair. For example, the master station transmits a pulse signal; slave A—which may be 200–600 mi. distant—receives it, waits a predetermined interval and transmits a pulse. The pulses are about 50 μ sec. in length and are transmitted at a rate of about 20 to 34 per second. The base lines are shorter in loran-B and longer in loran-C. The loran-C pulse is much longer, and special techniques are employed to use only the early or ground-wave portion, the pulse rates are 10 to 34 per second. Since the velocity of radio waves in the atmosphere is known, it is possible to convert the difference in time of arrival of the pulses at a vessel to a difference in distance from the vessel to the loran stations.

With a conventional loran receiver, the navigator measures the time difference by observing the signals on an oscilloscope, although special equipment was developed to make the position-finding process completely automatic. On a loran chart, the hyperbolic lines of position usually are labeled in microseconds of time difference; they are spaced at convenient numerical intervals, and positions lying between lines are determined by interpolation.

Decca.—The decca system was developed in Great Britain during World War II and came into extensive use in Europe, India and Canada. Decca operates on various frequencies between 70 and 130 kc.

Like loran, decca is a hyperbolic system. Unlike loran, the signals are not pulsed. The distance difference of a point from two decca stations is measured in wave lengths and portions of a wave length or cycle phase, and the charted hyperbolic lines of position are based upon these units. Since a wave length at decca frequencies is many times smaller than the distance between the stations, there are many repetitions of the same cycle phase differences within the service area and these repetitions must be resolved for the navigator.

The master of a pair of decca stations transmits on a precise frequency, omnidirectionally. The slave station, typically located about 70 mi. distant, receives this signal and locks its own transmission in phase with it. Thus, in the service area there exist two signals whose effective relative phase is constant along hyperbolic lines of position. Since it is impossible to separate two signals that are on the same frequency at the input of a receiver at the same time, it is necessary for the stations to transmit on different frequencies. These are chosen so that with different small multiplying factors they may be converted, after reception through separate receiver channels, to the same frequency, called the comparison frequency. The two versions of the same comparison frequency derived from the master and slave stations are then applied separately to the inputs of a phasemeter. A decca system that contains as many as three slaves phase-locked to a single master would therefore employ four different frequencies with associated multipliers in the receiver to derive three different common-multiple comparison frequencies, each in pairs to actuate three line-of-position phasemeters or decometers. The decca phasemeter is of the counting type; that is, the normal limit

of 360° is extended many times by a geared counter. Thus, travel from any known point can be followed.

The relation between the action of the phasemeter and the movement of the vessel is understood by realizing that as movement takes place on the base line the change in distance with respect to the two stations is differential; therefore a movement of one-half wave length, or 180°, produces a 360° travel of the phasemeter. One of the several comparison frequencies, for example, may have a wave length of 3,000 ft. Since 280 half wave lengths may be contained in a base line 70 mi. long, serious ambiguities in position would result if the counting feature failed because of station or receiver trouble or if the receiver were turned on when at an unknown position. The ambiguity is resolved by temporarily shifting away from the pattern of fine half wave length lanes to coarse and intermediate lanes called zones and fine zones. This is accomplished by automatically shifting station frequencies and frequency-mixing circuits in the receiver for an instant each third minute in order to generate much lower comparison frequencies. The coarse zones are large enough to yield approximate positioning by means of ordinary navigational information, while the fine zones are small enough for identification of the fine lane.

Within the service area of a typical decca chain, line-of-position accuracies vary by day from 30 yd. at 100 mi. to 150 yd. at 250 mi. At night, sky wave contamination of the ground wave increases the error to 100 yd. and 800 yd., respectively, and the system becomes unreliable between 300 and 400 mi. Daytime accuracy is limited largely by small line-of-position crossing angles. However, these may be extended by using more than one chain of decca stations. Shore line and other refractional effects and obstacle reflections are inconsequential except when decca is employed in accurate surveys, when the relatively weak daytime sky waves must also be taken into account. A simple receiving antenna is adequate, and local reradiation is unimportant for ordinary navigation.

For hydrographic surveying a rearrangement of the conventional decca chain, in which the master station and receiver are situated in the survey ship with two stations on the coast, offers great advantages. In this system, known as two-range decca, the readings are a function of the distance from the ship to the stations ashore.

Consol.—Consol originated during World War II in Germany under the name of sonne. The system was further developed and transmitters installed with minor variations in Britain, France and the United States (under the name consolan). Consol is a long-range system employing various frequencies between 250 and 350 kc. No special receiver is required, except that a loop directional antenna is sometimes used to resolve certain ambiguities.

The consol system consists of a single station employing a directional antenna array that generates a multilobed horizontal radiation pattern. Over a period of one minute (or one-half minute in some applications) all lobes are rotated so that each eventually occupies the place formerly occupied by its neighbour in the direction of rotation. As the lobes are rotated they are keyed: one lobe transmits dots and its neighbour transmits dashes. The dots and dashes are alternate and contiguous. An observer located in the area of a dot lobe will hear only dots until the dot lobe moves away and the adjacent dash lobe approaches, the space between the dots of decreasing amplitude being filled in by dashes of increasing amplitude. When the dots and dashes become equal in amplitude the observer hears a continuous tone. The process of rotating the pattern is repeated after a short distinguishing interval. The navigator merely has to count dots or dashes in order to determine his line of position at the beginning of a sequence with respect to equisignal lines, or narrow zones, which are shown on a consol chart. The sum of dots and dashes for a single shift or sequence is 60, and accuracy can be improved by counting both characters and symmetrically adjusting them, if necessary, to the sum of 60. When the start of a count is on an equisignal line the count is all dots or all dashes. Semiautomatic counting devices are available.

Since there are a number of lobes and corresponding equisignal lines in the system, and the lobes enclose sectors of 10° to 15°, the navigator at times may need positive identification of the sector in which he is situated. This is accomplished by taking radio bearings on the consol station.

The range of consol is limited by spreading of the equisignal lines and by atmospheric noise that varies with latitude and season. Since sky waves are useful (more so than in direction finding) the range is greater at night. The nominal range is 1,500 mi. at night and 1,000 mi. during the day, with line-of-position accuracies ranging from 1.5 mi. at 250 mi. to 72 mi. at 1,500 mi. The accuracy is less at night over ranges of 200–400 mi. because of mutual interference between sky waves and ground waves.

Radar.—The development and application of radar progressed after World War II to make it probably the most widely used of all electronic navigational aids. Essentially, navigational radar extends the user's range of vision in darkness or poor visibility. The radar picture, however, is a symbolic one, unlike that of television, and proper interpretation requires considerable skill (*see* RADAR).

VI. ELECTRONIC AIDS FOR MARINE USE

Variations of Radar.—*Port radar* installations have been introduced in certain harbours to help traffic in poor visibility and for various subsidiary functions, such as checking the position of navigational buoys. In periods of bad visibility, pilots aboard the ships are advised of their positions in relation to the navigational marks or to the harbour configuration. However, when traffic is heavy there is sometimes difficulty in identifying a particular ship on the harbour radar display. This may be overcome in numerous ways, one of which is to take bearings on the ship's radio transmitter.

Two systems that operate on radar principles but that employ active rather than passive targets are shoran and EPI (electronic position indicator). Transponder (slave) beacons, established ashore, return strong signals of identifiable characteristics that facilitate accurate measurement of distance. Shoran, operating in the 210–320 mc. band, is a line-of-sight system. EPI is effective over a greater range, by virtue of ground waves, on about 2 mc. EPI actually is a mobile loran system that is limited to the measurement of the length of the base line between the interrogator (master) and transponder (slave) beacons. Both systems are primarily survey tools.

Sonar is the underwater counterpart of radar; however, it employs sound waves rather than radio waves. The terms echo sounder, Fathometer and depth finder are commonly applied to equipment that is designed to measure distance downward only. The employment of horizontally directed beams is generally restricted to military applications. (*See* also ECHO SOUNDER.)

Radux and Omega.—Radux, a hyperbolic system that operated experimentally in the low- and very low-frequency bands, employed base lines of approximately 2,000 mi. Advantage was taken of the relatively high stability of sky wave propagation at these frequencies to synchronize transmitters and receivers. Phase comparison and synchronization were made on a modulation frequency of about 200 cycles. Since radux was a continuous-wave system using a single radio frequency, transmission time had to be shared among the three or more stations in a single system. This was accomplished by a synchronized system of commutation in each transmitter and receiver. Phase "memory" of the transmission that had ceased was provided by a phase-controlled crystal oscillator.

Omega evolved from the experiments with radux. Phase measurement was shifted from the 200-cycle modulation of radux on a carrier frequency of 40 kc. to direct phase comparisons of 12-kc. master and slave station carriers. The lane width along the base line is thus reduced from 400 mi. to 7 mi., with an accompanying increase in line-of-position accuracies. For lane resolution a second frequency, offset from the main frequency, is transmitted alternately to give a low-frequency beat, the lane width of which is considerably greater. Together with the improved accuracy achieved by this change there were gained the advantages of greater transmission range and superior propagation stability.

Lorac and Raydist.—Lorac and raydist are short-range, continuous-wave hyperbolic systems developed primarily for accurate

surveying operations. Synchronization of the three or more stations is made unnecessary by using a single beat frequency generated between offset radio frequencies of the system. Both lorac and raydist operate principally on frequencies near 2 mc.

In lorac, phase measurements are made between two separate derivations of a beat frequency that is generated in the mobile receiver and also at one of the fixed stations of a pair and retransmitted to the mobile unit as a modulation of a third radio frequency. A fixing system is comprised of three or more stations. The number of frequencies required is reduced by time-sharing.

The raydist system is similar to loran, except that one of the transmitters is placed on the mobile station. Thus, raydist can be used as a pure distance-determining device. Neither system provides lane identification; therefore, lane count from a known position must be maintained. Accuracy is limited at night by sky wave contamination of the ground wave.

VII. ELECTRONIC AIDS TO AIR NAVIGATION

Four-Course Low-Frequency Radio Range.—The four-course low-frequency radio range system was the first electronic aid to navigation to come into general use after the development of the direction finder. It is basically a homing system, although a positional fix may be obtained by finding the intersection of the course lines of two stations. The range supplies a course on which is heard a continuous tone. As the aviator strays from the course he hears either the International Morse code character A (·—) or N (—·). By referring to a special chart, he is able to determine the direction in which he has strayed.

The transmitting antenna is a crossed loop or crossed Adcock whose four-lobed radiation pattern can be shifted by adjusting the relative amplitude and phase of the two directional elements. Along the desired course the amplitudes are made equal and since the A and N characters are interleaved, a continuous tone is heard. Elsewhere the signal amplitudes are not equal, so one character or the other predominates.

No special receiver is required for the range information. Reliable service distance is limited at night because of night effect, reflections from mountains and interference from other stations as well as from the reduction in power made to reduce that interference.

Omnidirectional Radio Range.—While the four-course range simplifies travel over established routes, the omnidirectional range serves general navigation and position-finding requirements. Historically the omnidirectional beacon had its beginning in the "talking beacon," which saw experimental service in the low-frequency band in Europe. In this device a recorded voice announced the direction of transmission of a beam, in steps of several degrees, as the beam was rotated 360°. The difficulty of generating, at low radio frequencies, the sharp rotating beam required for aural discrimination of the spoken information, together with night and refractional effects, limited the success of this system. The phase-comparison omnidirectional range, developed by the U.S. Civil Aeronautics administration on both low-frequency and very high-frequency bands, is highly sensitive to amplitude changes. It employs a rotating cardioid pattern that is compared with a fixed-phase, omnidirectional pattern, the carrier of which is modulated at the speed of rotation of the cardioid. If the relative phase of the two patterns is established at 0° when the maximum amplitude of the cardioid is pointed north, then successive positions of the cardioid will produce a direct indication of bearing from the transmitting station on a receiver phasemeter.

The very high-frequency (108–118 mc.) omnidirectional range (VOR) has been widely installed in the U.S. and, to a lesser extent, in other countries. It is sometimes combined with an interrogator-transponder beacon (DME, or distance-measuring equipment), which is similar in principle to shoran.

Dectra.—Dectra is an adaptation of the nominally short-range decca system to long-range lane guidance. A master and a slave, sharing the same frequency, are situated 70 to 80 mi. apart so that asymptotic hyperbolic lines extend along a desired traffic route. A second pair is similarly set up at the opposite end of the route and shares a second frequency. The route distance and station power are adjusted so that each pair covers somewhat more than half of the route. Distance information is provided by utilizing the signals so as to establish a base line between the two pairs of stations. When signals from either end of the route cannot be received, a highly stable crystal oscillator provides a temporary "memory" signal. A transatlantic dectra installation provides accuracies of 3 mi. laterally and 6.5 mi. along the route, the lateral accuracy improving radically as the stations are approached.

Variations of Radar.—In aircraft radar equipment of special design, use is made of the Doppler effect, which causes the received frequency of a signal reflected from the ground to differ from that of the transmitted signal by an amount proportional to the speed of the aircraft. Several downward beams having horizontal components in different directions may be utilized so that the forward lateral and vertical velocity of the aircraft may be measured by automatic means. Doppler systems have been developed using either pulse or continuous-wave methods.

The radio altimeter, which utilizes radar principles, has an advantage over barometric altimeters in that it is independent of variations in sea-level air pressure. This property enables the air navigator to relate his progress to the position of high- and low-pressure meteorological centres by noting the changes in the relative readings of his barometric and radio altimeters. Since wind direction bears a fixed relationship to pressure centres, these pressure-pattern data are useful in selecting a route. (F. B. D.)

VIII. INERTIAL GUIDANCE SYSTEMS

Inertial guidance systems are self-contained, dead-reckoning devices that are most valuable for submarine navigation and missile control, although their usefulness is not limited to these applications.

The basic data upon which the inertial system depends are the amount and direction of acceleration. If acceleration from a standstill occurs for only a short period of time, after which velocity becomes constant, then velocity becomes the product of elapsed time and acceleration per unit distance per unit time. However, velocity is seldom constant. The variations in acceleration, both positive and negative, throughout the duration of motion must be integrated. The variation in acceleration is continuously determined by measuring the inertia presented by a mass to a change of velocity. This integrated information, which is proportional to velocity, is then interpreted in a second operation to yield data that are proportional to the distance traveled. All acceleration measurements and integration operations are performed automatically. It is obvious that when very small changes in velocity are involved the detection and measurement of acceleration is an extremely delicate operation and requires that the reference mass be isolated from varying local effects. Reference axes, which are fixed with respect to free space, are established by three spinning gyroscopes mounted on gimbals whose axes are mutually perpendicular. Deviations from this reference frame are sensed and fed to a computer, where the information is consolidated and resolved into distance and direction of travel.

In guided missiles the direction and distance of travel are preselected and thereafter automatically controlled. The effects of the earth's centre of gravity, whose direction with respect to the free space reference varies with changes in geographical position and with the earth's rotation, present problems of considerable magnitude since they introduce a component into the indicated measurement of acceleration and direction. As in any dead-reckoning method, errors are accumulative with time.

IX. INTERPLANETARY NAVIGATION

The three stages of an interplanetary flight by a high-thrust rocket may be considered to be (1) the launch, when the vehicle accelerates rapidly away from the starting point; (2) the mid-course phase, when the vehicle is in free fall, subject only to the gravitational fields of the sun and planets; and (3) the approach and landing phase. The first and last phases can be controlled by radio and radar, since the distances involved are relatively small. The mid-course phase comprises the major part of

the voyage, however, and presents serious navigational difficulties. During this phase the rocket will be traveling in an orbit, the shape of which is determined precisely by the speed and direction of its motion, that is, by its initial velocity on launching. The sort of difficulty involved in determining position and velocity in space is illustrated by the fact that the distances and positions of the planets themselves are not known to accuracies of more than 1,000 mi. Measures of velocity based on such data, therefore, will clearly be even less accurate.

See also references under "Navigation" in the Index.

(M. W. Ri.)

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NAVIGATION LAWS. Historically this expression refers to laws passed at various times and places to restrict commerce to ships of a particular nationality. But the expression is also used less strictly to denote laws that lay down rules of the road and in other ways regulate the actual navigation of ships; this usage is covered in RULES OF THE ROAD AT SEA.

In England the first navigation act was passed in 1381. Policy varied thereafter until in 1651 a navigation act was passed in order to strike a blow at the maritime supremacy of the Netherlands. The system established, which required the national trade by sea to be carried in ships under the national flag, was maintained in force (with certain later statutory amendments) for a period of two centuries. By the navigation acts, ships under the national flag were required to be owned by British subjects, and shipmasters and a proportion of the seamen were also required to be British. Moreover, the national register for ships was established by Charles II in 1660 in order to ascertain which ships were to benefit from the acts. (*See* also MERCANTILE SYSTEM.)

The result of these acts was that by 1847 no produce from Asia, Africa or the United States could be imported into the United Kingdom from Europe in any ships, the object being that the trade should be direct and in British vessels. Coastal trading around the United Kingdom could be carried on only by British ships, and colonial trade was prohibited to all foreign ships except where sanctioned by a special order in council. Various restrictions were imposed on imports not carried in British ships, and orders in council laid down differential dues and restrictions on imports carried in ships of any foreign countries that imposed similar restrictions on British trade.

In 1849 the navigation acts were repealed, subject to reservation of the coasting trade and subject to the proviso, intended to secure reciprocity, that if prohibitions or restrictions were imposed on British ships by other countries the privileges of the ships of those countries in British ports might be restricted. The reservation as to coasting trade was removed in 1854.

However, despite these relaxations, it is still the law that a ship is not to be deemed a British ship unless it is owned wholly by British subjects, or by a body corporate established in some part of the sovereign's dominions. British ships are still required to be registered as such. Further, no alien can own, nor, subject to certain reservations, may he act as master or as one of the principal officers of a British ship. (Ds. B.; X.)

In the United States almost immediately after the adoption of the constitution in 1789, the first congress recognized the necessity of a merchant fleet in time of peace to carry the commerce of the new nation, as well as the necessity for shipyards from which could come ships of war in any national emergency. Thus, in 1792 it enacted a law that provided that, in order for a vessel to be registered as a vessel of the United States and to be entitled to the protection inuring to a vessel so registered, it must be built in the United States, wholly by U.S. citizens, and must be commanded by a master who was a citizen of the United States, native-born or naturalized. In 1790 a tonnage tax that discriminated in favour of U.S. vessels was imposed.

Under various statutes, provision was made for relief by way of reciprocity, and, consequently, after 1849, British ships were admitted into U.S. ports on the same terms as U.S. ships were admitted into British trade.

In 1878 the U.S. congress codified all of the laws of the United States, under appropriate chapter headings, into a compilation entitled *Revised Statutes of the United States.* Virtually all of the then existing laws of the United States affecting maritime commerce, the inspection of vessels, the licensing of merchant marine officers and the protection of merchant seamen were placed in ch. l to liii.

It appears that in 1886 congress became aware of the inroads that were being made by foreign vessels into the transportation of passengers between ports in the United States. As a result, a statutory prohibition to the carriage of passengers by a foreign vessel between ports in the United States was enacted.

Similarly, in 1920 congress made it unlawful for a foreign nation to carry merchandise between ports and places in the United States in a vessel that was not built in, and registered in, the United States and owned by U.S. citizens.

During the early 1930s, it became apparent that the World War I merchant fleet of the United States, including passenger vessels, tankers and freighters, was becoming obsolete, and that the U.S. merchant marine was rapidly disappearing from the sea because of its inability to cope with lower construction and operation costs in foreign countries. To correct this situation and to have available a modern fleet of merchant ships for national emergency, congress enacted the Merchant Marine act of 1936. Under this act, the U.S. maritime commission is authorized to pay a construction subsidy to encourage citizens of the United States to have their vessels built in U.S. shipyards. The amount of this construction subsidy is usually the difference between the cost of building a vessel abroad and the cost of building a vessel in the United States. Each ship built under a construction-differential subsidy must, when completed, be registered as a vessel of the United States. To further encourage citizens to operate vessels under the U.S. flag, the maritime commission is also authorized to award operating differential subsidies. The amount of such payment is the difference between the cost of operating a U.S. vessel in the foreign trade and that of operating a similar vessel under foreign registry in the same trade. (F. K. A.)

After World War I, and in implementation of the terms of the peace treaty, conferences were convened under the auspices of the League of Nations with the object of facilitating and maintaining freedom of communications and of commerce. Several international conventions were adopted, the most important being the Maritime Ports convention, 1923. Under this convention each of the contracting parties undertook, subject to the principle of reciprocity, to grant the vessels of every other contracting state equality of treatment with its own vessels, or those of any other state whatsoever, in the maritime ports situated under its sovereignty or authority. The equal treatment was in regard to freedom of access to the port, the use of the port and the full enjoyment of the benefits as to navigation and commercial operations that it offered to vessels, their cargoes and passengers. This convention did not apply to maritime coastal trade.

After World War II, the Provisional United Maritime Consultative council, consisting of 18 members, including the United Kingdom, the dominions and the United States, was established at

Washington, D.C., in 1946 for the purpose, among other things, of removing all forms of discriminatory action.

In 1948 a conference was held at Geneva, Switz., at which the great majority of the members of the United Nations, with the notable exception of the U.S.S.R., were present. The conference adopted a convention for the constitution of an intergovernmental consultative organization, the aims of which were to follow the lines of those of the provisional consultative council. The Intergovernmental Maritime Consultative organization (IMCO) came into existence in 1958, with its headquarters in London, Eng. Its first formal meeting was held in Jan. 1959 in London. IMCO consists of an assembly, a council, a maritime safety committee and a secretariat. It is brought into relationship with the United Nations in accordance with art. 57 of the UN charter as the specialized agency in the field of shipping. The purposes of IMCO are to provide machinery for co-operation among governments in the field of governmental regulations and practices relating to technical matters affecting shipping engaged in international trade, to encourage the general adoption of the highest practicable standards in matters concerning maritime safety and efficiency of navigation, to encourage the removal of discriminatory and restrictive practices in international trade and to consider unfair restrictive practices by shipping concerns. Membership of IMCO consists of the governments of nearly all maritime nations and of some nonmaritime countries. *See* also WATERS, TERRITORIAL.

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NAVSARI (NAOSARI), a municipality and *taluka* (administrative subdivision) of Surat district in Gujarat, India, formerly in the Navsari division of the princely state of Baroda. The town lies on the left bank of the Purna river, 147 mi. N. of Bombay by rail. Pop. (1961) 51,300 (town). It was one of the early settlements of Parsees in Gujarat, where they landed after their banishment from Persia (Iran). It is still the home of their mobeds, or second sacerdotal class, and contains their most venerated fire temples. The town also has mosques, Hindu pagodas and an old palace. (M. R. P.)

NAVY: *see* NAVAL AFFAIRS (ARTICLES ON).

NAWABGANJ, the name of three towns in India and one in Pakistan.

1. The most important lies 17 mi. N.E. of Lucknow, in Barabanki district, Fyzabad division of Uttar Pradesh, India. Pop. (1961) 27,080. It is contiguous with the district headquarter town of Barabanki (*q.v.*), with which it forms a municipality. The main market and educational institutions of the district are in Nawabganj. It is connected with Lucknow and Fyzabad by road.

2. A municipal town of Gonda district in the Fyzabad division of Uttar Pradesh. Pop. (1961) 6,249. It lies about 3 mi. from the north bank of the Gogra (Ghagra) river and 24 mi. S.S.E. of Gonda on the Fyzabad-Gonda road, and on a branch line of the North Eastern railway. The main occupation is trade in food grains. The town is named after Nawab Shuja ud-Daula, who built a market there.

3. A town of Bareilly district in the Rohilkhand division of Uttar Pradesh. Pop. (1961) 7,198. It lies 18 mi. N.E. of Bareilly on the Bareilly-Pilibhit road. It has an assembling market for food grains, and a large fair takes place there during the Dasahra (worship of the Ganges) festival. The town is named after Nawab Asaf ud-Daula.

4. A town in the Rajshahi district of East Pakistan on the Mahananda river, 25 mi. N.W. of Rajshahi. Pop. (1961) 29,725. It has rail and road connections and is a trade centre for rice, wheat, jute and silk. (B. SI.; X.)

NAXOS, a Greek island, largest of the Cyclades (about 22 mi. by 16 mi.), lies east of Paros, with which, and adjacent smaller islands, it forms an eparchy. Pop. (1961) 16,703. Rich in vines and famous for its wine, it was a centre of the worship of Dionysus. According to legend the god found Ariadne asleep on its shore, when she was deserted by Theseus. The island shared the Early Bronze Age culture of the Cyclades. Its white marble and emery were exploited for the earliest major sculpture of the 7th century B.C., and it is credited with a part in the early development of Ionic architecture. During the 6th century B.C. a tyrant Lygdamis ruled Naxos in alliance with Pisistratus of Athens. In 499 B.C. a Persian fleet attacked it unsuccessfully, but in 490 it was captured by the Persians and treated with severity. Four Naxian ships joined the expedition of Xerxes, but deserted to the Greek side at Salamis in 480. Naxos was a member of the Delian league (*q.v.*); but, after revolting in 471, it was captured by the Athenians and remained in their possession until 404. In 376 it saw the Athenian defeat of a Spartan fleet. After its capture, in A.D. 1207, by the Venetian Marco Sanudo, the duchy of Naxos flourished till the Turks took the island in 1566. After the War of Independence it belonged to Greece. Remains of a 6th-century temple are on an island (Palati) just northwest of the town of Naxos. Naxos Island is rich in fruit trees, and exports corn, wine and oil, but its most important product is emery. (J. Bo.; X.)

NAXOS, the earliest Greek colony in Sicily, was founded by Theocles from Chalcis *c.* 734 B.C., on the east coast, south of Tauromenium (modern Taormina), just north of the mouth of the Alcantara river on modern Capo Schisò. There were already Sicels at Tauromenium, but they cannot have offered any opposition. The adoption of the name of the Aegean island Naxos may show that there were Naxians among its founders. It soon founded Leontini and Catana (modern Catania). Naxos was the warmest ally of Athens in the Sicilian expedition (415–413). In 403 B.C. it was destroyed by the elder Dionysius of Syracuse and its territory given to the Sicels. Its exiles at last found refuge in 358 at Tauromenium.

Investigations from 1953 onward not only revealed the streets, buildings and walls of Hellenic Naxos but by means of stratigraphic excavation documented its history and disclosed several prehistoric (Siculan and still more primitive) periods of occupation.

See G. V. Gentili, "Naxos alla luce dei primi scavi," in *Bollettino d'Arte*, anno xli, serie iv, pp. 326–333 (1956).

NAYAR (NAIR), a Hindu caste of the Malabar coast in Kerala, southwest India. Before British conquest (1792), the region contained small, feudal kingdoms in each of which the royal and noble lineages, the militia, and most land-managers were drawn from the Nayars and related castes, who ranked below the Nambudiri Brahmans or religious authorities. During British rule Nayars tended to move into professions and became prominent in politics, government service, medicine, education, and law. Many were active in the Congress party, which won independence for India in 1947.

Unlike most Hindus, Nayars traditionally were matrilineal. Their family unit, whose members owned property jointly, included brothers and sisters, the latter's children, and their daughters' children. The oldest man was legal head of the group. Rules of marriage and residence varied somewhat between kingdoms. In central Kerala adults of the matrilineal group lived together and husbands merely visited their wives. In the extreme north and in southern Kerala, at least by the 18th century, men of the group tended to live together in the joint-family house along with their wives and immature children.

Between the 16th and 18th centuries, Nayars in the central kingdoms of Calicut, Walluvanad, Palghat, and Cochin had highly unusual marriage customs that have been much studied. Before puberty a girl ritually married a Nayar or a Nambudiri Brahman. The husband could visit her (but was not obliged to); in some cases ritual divorce immediately followed the ceremony. After puberty a woman could receive a number of visiting husbands of her own or higher caste. Nayar men might visit as many women of appropriate rank as they chose. Women were maintained by their matrilineal groups, and fathers had no rights in nor obligations to their children. Nayars of this area therefore did not institutionalize the nuclear family of father, mother, and children as a legal, residential, or economic unit. The Nayars, however, did not wholly lack concepts of marriage and paternity, for the ritual marriage was essential and, in at least some areas of central

Kerala, children were required to observe ceremonial mourning at the death of their mother's ritual husband.

Early in the British period Nayar armies were disbanded. Perhaps partly as a result, plural marital unions gradually died out in the 19th century. A law passed in 1896 permitted a man to register his marriage and provided that children of this union should inherit half of his personal property. The pre-puberty marriage became a mere initiation rite, and a girl customarily married one legal husband after puberty. Their children began to be maintained by the father, to support him in old age, and to perform the ceremonies at his death. Laws passed in the 1930s enforced monogamy, permitted division of the matrilineal estate among male and female members and gave children full rights of maintenance and inheritance from the father. By the 1960s it was increasingly common, especially in towns, for nuclear families to form separate residential and economic units.

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NAYARIT, a Pacific state of Mexico, until 1917 the federal territory of Tepic, bounded by Sinaloa, Durango, and Jalisco. The offshore Tres Marías Islands are largely undeveloped. Area 10,664 sq.mi. Pop. (1960) 389,929. The Southern Pacific Railway to Mexico and the trunk highway from Nogales to Guadalajara cross Nayarit. Running southeasterly, the Sierra Madre Occidental rises steeply from the narrow Pacific littoral and cuts the state into deep gorges and narrow valleys. Outstanding features are the volcanoes Ceboruco and Sanguangüey. Its climate is generally wet, frost-free, and healthful. Nayarit's coastal lagoons and marshes are well known as wild bird refuges. The main river is the final leg of the Lerma, rising on the main plateau of Mexico; under the name of Santiago it flows westward through Nayarit and empties north of San Blas, chief Pacific port. Its valley is extremely fertile. Mining is important in the Sierras, but Nayarit is primarily agricultural; its products include maize, tobacco, sugar, cotton, beans, coffee, woods, and medicinal plants.

Tepic (pop. [1960] 54,069) is the capital, 26 mi. SE of San Blas, with which it is connected by road. It is located in a valley 3,000 ft. above sea level, and is surrounded by ranches and small farms. Tepic is a mixture of colonial charm and bustling modernity. Small villages of Cora and Huichol Indians are scattered through the Sierras. (J. A. Cw.)

NAYLER (NAYLOR), **JAMES** (1618–1660), one of the most prominent early Quakers, was born at Ardsley, Yorkshire, in 1618. He served in the Parliamentary Army (1642–51) and was for two years quartermaster under John Lambert. During this period he began preaching as an Independent until in 1651, after a meeting with George Fox (*q.v.*) at Wakefield, he became a Quaker. For three years he worked closely with Fox and underwent a 20-week imprisonment for blasphemy in 1653. In 1655 he went to London and achieved a prominent position among Quakers there, but came under the unfortunate influence of certain overenthusiastic Quaker women who persuaded him that he was a reincarnation of Christ. Nayler and his followers traveled through the west country on their way to visit Fox in prison at Launceston, but were imprisoned at Exeter. There Fox visited him and they parted in disagreement, since Fox was then striving to free Quakers from the lawlessness of the ranters. In October 1656 Nayler and his entourage entered Bristol in procession imitating Christ's entry to Jerusalem. For this he was arrested, tried before Parliament, and sentenced to severe punishment and imprisonment. In 1658 he acknowledged his error in a letter to Parliament and was released in 1659. He was reconciled with Fox in 1660 and preached again in London until his death in October 1660.

See E. Fogelklou, *James Nayler: the Rebel Saint* (1931).

NAZARENE, CHURCH OF THE, an international religious body with headquarters in Kansas City, Mo., with over 300,000 members, largely in the United States, Canada, and the British Isles, and over 50,000 members in approximately 35 mission areas. The denomination is the product of the merger of some 15 religious bodies stemming from the 19th-century Wesleyan Holiness Movement. The first major merger was in 1907, uniting the Church of the Nazarene (organized in California in 1895) with the Association of Pentecostal Churches of America (with origins in the northeastern states from 1886 to 1896) to form the Pentecostal Church of the Nazarene. The next year the Holiness Church of Christ (with origins in the southwestern states from 1894 to 1905) joined the denomination. Later mergers brought in groups from Texas, Tennessee, Scotland, North Dakota, and England. The term pentecostal, because of its increasing association with "speaking in tongues," a practice foreign to the Nazarenes, was dropped from the name of the denomination in 1919. In polity the church combines congregational autonomy with superintendency in a representational system. In worship there is emphasis on simplicity and revivalistic evangelism. In doctrine the church stands in the tradition of Arminian Methodism and regards its unique mission to be the promotion of entire sanctification as a work of grace subsequent to conversion. It is the largest of the bodies with this professed aim.

The church operates a publishing house, a theological seminary, six liberal arts colleges, several theological colleges, and numerous mission schools and hospitals.

See *Manual of the Church of the Nazarene* (published quadrennially); T. L. Smith, *Called Unto Holiness, the Story of the Nazarenes: the Formative Years* (1962). (C. O. B.)

NAZARENES, a translation of two different Greek words, *Nazarenos* and *Nazoraios*. The first means "coming from Nazareth" (a village in Galilee) and is applied to Jesus in the Gospels of Mark and Luke. The second, of doubtful derivation, may be related to the term Nazirite (*q.v.*) and is used of Jesus in Matthew, Luke (once), John, and Acts. Matthew (2:23) treats it as the equivalent of *Nazarenos;* in other passages its meaning is not altogether clear. According to Acts 24:5, it was used of Christians by Jews. In later times there was an Ebionite sect (*see* EBIONITES) which, according to the 4th-century theologian Epiphanius, consisted of Jews who traced their ancestry back to the Jewish Christians who left Jerusalem for Pella, on the other side of the Jordan, just before the destruction of Jerusalem in A.D. 70. Epiphanius differentiates this sect of Nazarenes from a purely Jewish sect which he calls that of the Nasaraei. The relation, if any, of these sects to the Jewish Christians of the 1st century cannot be determined. (R. McQ. G.)

NAZARETH (Hebrew NATSRAT; Arabic AN NASIRA), a town in Lower Galilee in Israel, on the northern border of the plain of Esdraelon. Pop. (1961) 25,047. A cigarette factory (with its own large tobacco plantations), stone quarries, and two mineral-water factories furnish employment for most of the inhabitants.

Nazareth is not mentioned in the Old Testament. In the New Testament (it is mentioned 28 times in the Gospels and Acts) it is associated with Jesus as his boyhood home, and in its synagogue he preached the sermon that led to his rejection by his fellow townsmen. Since the 6th century a number of churches and religious houses have been built there. Legends and precarious identifications persist, and visitors are shown the church of the Annunciation, the workshop of Joseph, St. Mary's well, Christ's table, etc. Only for the well can authenticity be assured.

The crusaders captured Nazareth in 1099 and transferred there the bishopric of Scythopolis (Beisan). It was taken by Saladin (1187) and retaken by Frederick II (1229). On its capture by the mameluke sultan Baybars (1263), the Christian inhabitants were massacred. In 1517 it came into the possession of the Turks. Headquarters of the Turkish-German Army during World War I, Nazareth was captured by the British in September 1918. In 1948 it was the headquarters of the Arab forces under Fawzi Kawukji until he was defeated by the Jews, when Nazareth surrendered without a fight. Under Israeli rule the town was placed under a military governor, his staff and government officials being the only Jewish residents there. (E. Ro.; X.)

NAZIM HIKMET RAN (1902–1963), Turkish poet and dramatist, who exercised a strong influence on Turkish literature in the late 1930s by his mastery of language and by the introduction of a wide range of poetic themes and of a free verse technique. He was educated at Istanbul and in Moscow. Having gained some

early recognition with his patriotic poems in syllabic metre, he came, in Moscow, under the influence of Russian futurists and, abandoning traditional poetic forms, he indulged in exaggerated imagery and by this means and the use of unexpected associations tried to "depoetize" poetry. Later his style became quieter and his epics on Bedreddin (the 15th-century revolutionary religious leader of Anatolia) and on the War of National Liberation show real poetic power. His plays, written in vigorous prose, are mainly Marxist inspired. His poems were translated into French by Hasan Gureh (1951). He died in Moscow on June 2, 1963.

See E. Saussey, *Prosateurs turcs contemporains* (1935). (F. I.)

NAZIRITE (NAZARITE), among the ancient Hebrews, a sacred person whose separation was most commonly marked by not cutting the hair and by abstinence from wine. In Israel's early history the Nazirite was endowed with special charismatic gifts and normally held his status for life; in later times he was a man who had voluntarily vowed to undertake special religious observances for a limited period of time, the completion of which was marked by the presentation of offerings (Num. vi; I Macc. iii, 49; Acts xxi, 24).

The early Nazirite was a holy man whose peculiar endowment, credited to his possession of "the Spirit of the Lord," was displayed in unusual psychic or physical qualities marked by spontaneity, ecstasy and dynamic enthusiasm. In this respect he had much in common with the early ecstatic prophets and with diviners such as Balaam (Num. xxii–xxiv), both indigenous to the near east. This helps to explain why Amos mentions the prophet and Nazirite together as persons whose special divine vocation had been frustrated (Amos ii, 11 ff.). Both were also close to the warrior, who was likewise in a sacred state while on duty. After his anointing Saul exhibited the ecstatic qualities of the prophets he joined (I Sam. x, 9–13; *cf.* xix, 18–24), and he exhibited a similar holy fury as the warrior king who led the relief of Jabesh-gilead (I Sam. xi, 5–11). Samson the Nazirite was a holy warrior whose special power was most closely related to his unshorn locks. This association of mysterious divine power with the growth of hair and with abstinence from wine shows that the institution of the Nazirite had its historic roots in the nature mysticism of the near east. In Israel, however, such natural powers as represented by the growth of hair were no longer treated as divine force, per se, but as signs of the power of the God of Israel and vehicles for it.

The later Nazirite as described in Num. vi and in the Mishna was not a charismatic person. He simply retained the old requirements, added the prohibition against touching a corpse, and treated them as external signs of a vow. The minimum period of the Nazirite vow was 30 days.

The priest-prophet Samuel, who was dedicated by his mother (I Sam. i, 11), did not exhibit the psychic phenomena of earlier Nazirites. In many respects he represents the bridge figure marking the transformation of the institution. The Rechabites (*q.v.*), who resembled Nazirites in abstaining from wine, also combined a voluntary vow with a lifelong commitment.

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(J. C. Ry.)

NAZZAM, AL- (ABU ISHAQ IBRAHIM IBN SAYYAR IBN HANI' IBN ISHAQ) (775–846), one of the great Muslim theologians and an accomplished man of letters, historian and jurist, was born in Basra (in modern Iraq) and brought up there before moving to Baghdad. He was the most illustrious student of Abu al Hudhayl al 'Allaf (d. 840), the great Mu'tazilite theologian of the Basra school. A man of phenomenal memory, he memorized the Koran, the Pentateuch, the Gospels and the Book of Psalms; it is told that when Ja'far, the vizier of the caliph Harun al-Rashid, questioned him on Aristotle's *Metaphysics*, he recited the work verbatim forward and backward. Together with his teacher, al-Nazzam led philosophic and theological thought in Islam in one of its formative periods. He fought Islam's battles against *Thanawiyyah* (Manichaeism) and *Dahriyyah* (materialism), and argued with Muslim sectarians like the *Jabriyyah* (determinists), *Mushabbihah* (anthropomorphists), etc. He stood for thoroughgoing rationalism in philosophy and theology, but he also defended the political claims of the Shi'ah sect. This gave rise to grave concern and some misunderstanding of his work.

His major contribution was his insight into the problem of human freedom. Man is incapable of his actions, he held, inasmuch as they are acts of his body (or, in modern parlance, belong to the material order where natural law is necessary and constitutive). But, he argued, this is not to concede the point to the *Dahriyyah*. For man is equally a *ruh* (spirit) which is not subject to this necessary determination but is free to resist or to acquiesce to it, thus incurring moral desert and punishment. None of his works has survived. Knowledge of him comes from his student al-Jahiz and from the Islamic heresiological writings. *See* also MU'TAZILITES.

See "Mu'tazilah" and "Nazzam, al" in *Encyclopaedia of Islam* (1956); Albert N. Nader, *Le Système philosophique des Mu'tazila* (1956).
(I. R. AL-F.)

NDEBELE, a people also known as Matabele, northern Zulu or Landeens. One section live in that part of Southern Rhodesia known as Matabeleland (pop. approx. 300,000 in the 1960s); they speak Sindebele, a click language of the Nguni (*q.v.*) group of southern Bantu languages. The Ndebele originated as the tribal following of one Mzilikazi of the Natal Nguni clan of Kumalo. A military commander of the Zulu king, Shaka, he was obliged in 1822 to flee from the wrath of his master and migrated with his followers first to Basutoland and then northward to the Marico valley. In 1837, after conflict with settlers of the Transvaal republic, he moved across the Limpopo river into the present Matabeleland (*see* TRANSVAAL). Here Lobengula, his successor, was able to extend the Matabele power until the establishment of the British South Africa company in 1890. There followed the Matabele war of 1893 in which Lobengula was defeated, and he died soon after. No successor was recognized and the Matabele were administered by the company as a number of separate districts (*see* BRITISH SOUTH AFRICA COMPANY).

The Matabele state incorporated the various peoples it conquered and the nation became stratified into a superior class (*Zansi*) composed of the true Matabele and other peoples of Nguni origin; an intermediate class (*Enhla*) that comprised people of Sotho origin; and an inferior class (*Lozwi* or *Holi*) derived from the original inhabitants of Matabeleland. A man was ranked by his class and then by his clan or tribe. Men of all classes were organized into age regiments that were fighting units and also localized territorial groups. The men of a regiment, on marriage, continued to live in their fortified regimental village, and its area formed an administrative district within one of the four provinces into which Matabeleland was divided.

The name Ndebele is also given by their Sotho neighbours to those Nguni tribes living west of the Transvaal Drakensberg (*see* DRAKENSBERG MOUNTAINS). They numbered about 144,000 in the 1960s and are sometimes called the Transvaal Ndebele to distinguish them from the Ndebele of Southern Rhodesia. *See* also RHODESIA AND NYASALAND, FEDERATION OF.

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(G. I. J.)

NEAGH, LOUGH, in Northern Ireland, is the largest lake in the British Isles. Averaging 15 mi. wide and 19 mi. long, it covers 150 sq.mi. and has a catchment area of 2,200 sq.mi. Its chief feeders are the Upper Bann river, the Blackwater and the Main, and it is drained northward by the Lower Bann. The lake owes its origin to warping and faulting of the Tertiary basalt cover of northeast Ireland, and it is underlain by Lough Neagh clays which were deposited in a larger lake of probably Eocene age. Its average depth is less than 40 ft. and the shores are shelving and frequently boggy. Five of the six counties of Northern Ireland share the lake shores. Post-glacial fluctuations of lake level are evidenced in submerged forest peats which are of great archaeological interest because from them the oldest recorded artifacts of man in Ireland have been recovered, in Toome bay. Giraldus Cambrensis, in his *Topographia Hibernica* (*c.* 1188), records a

tradition that the lake came into being miraculously, "overwhelming the whole people and their flocks" as a punishment for their vices, and states that fishermen had seen the round towers of churches under the water. The legend is also recalled in the ballad "Let Erin Remember," one of Thomas Moore's *Irish Melodies*. Ram's Island, in County Antrim, has a ruined round tower; there are archaeological remains also on Coney Island in County Armagh, a National trust property, which is locally believed to have given Coney Island, N.Y. its name. Lough Neagh hones, once famous, were believed to be evidence of the petrifying powers of its waters, but the silicified wood from which they were made is derived from the Lough Neagh clays. The lake is celebrated for its eels and also has salmon and pollan, a freshwater member of the herring family. Flood control works have been undertaken from time to time, those in 1959 involving a lowering of the lake level to 50 ft. above sea level. The ministry of finance, Northern Ireland, is the drainage authority. (E. E. E.)

NEAGLE, JOHN (1796–1865), U.S. portrait painter, was born in Boston on Nov. 4, 1796, and spent his professional career in Philadelphia, where he died on Sept. 17, 1865. Starting as an apprentice coach painter, Neagle became a competent technician, but well below Gilbert Stuart and Thomas Sully; most of his large output is monotonous. His famous "Pat Lyon at the Forge" (Pennsylvania Academy of the Fine Arts) is well above his own average; his portrait of Stuart is the best one of that fascinating personality. He also painted a few landscapes; the only example now known is his "View on the Schuylkill" (Art Institute of Chicago).

See Virgil Barker, "John Neagle," *The Arts*, 8:7–23, no. 1 (July 1925). (Vl. B.)

NEALE, EDWARD VANSITTART (1810–1892), leader in the English co-operative movement and a Christian Socialist, was born at Bath on April 2, 1810, the son of a Buckinghamshire clergyman. He studied at Oriel college, Oxford, was called to the bar at Lincoln's Inn in 1837 and became a Christian Socialist in 1850. He founded the first co-operative store in London and advanced the capital for two builders' associations, both of which failed. On his own initiative he started the Central Co-operative agency, similar in many respects to the Co-operative Wholesale society of a later day. Also unsuccessful, this venture involved him in heavy financial loss. He was an early advocate of limited liability and company regulation, actively promoting the Consolidation act of 1862, and was associated with the movement that resulted in the Industrial and Provident Societies act of 1876. Besides publishing pamphlets on co-operation, he served on the executive committee that developed into the Central Co-operative board, took part in forming the North of England Co-operative Wholesale society in 1863 and promoted co-operative congresses, the first of them in 1869. He advocated close relations between co-operative associations in different countries. Neale died on Sept. 16, 1892. (A. Bri.)

NEANDERTHAL MAN. Human populations referred to as Neanderthal man inhabited much of Europe and the lands surrounding the Mediterranean during the extended time interval of the earlier Upper Pleistocene. The name derives from a gorge-like valley above the small stream of Düssel, a tributary of the Rhine, 7 mi. east of Düsseldorf, Ger. There in the Feldhofer cave in 1856 workers encountered portions of a human skeleton; 14 pieces were eventually salvaged by a professor at the *Realschule* in Elberfeld, Johann Carl Fuhlrott. Following the description of the remains (by Prof. H. Schaaffhausen) a lively controversy arose as to whether their unusual morphology was normal, and hence indicative of an archaic variety of man, or whether it was merely a case of pathology in modern man (*Homo sapiens*). The former view was duly proved correct, especially after the discovery in 1886 of two similar skeletons in the cave of Spy (Belgium) in association with implements of chipped stone and animal bones representative of a subarctic fauna including extinct species (or extant forms no longer in the region). In the course of over a century of research on human evolution and the prehistory of man much additional information has been gained concerning these peoples, their distribution in space and time, their origin and disappearance and their ways of life. Several distinctive populations of Neanderthal folk are now recognized. These populations differ in certain aspects of their skeletal anatomy as well as in their spatial and temporal distribution.

The first recognizedly Neanderthal peoples occur during the last half of the Last Interglacial stage, certainly in central and southeastern Europe and probably also in western Asia. Among other features they were characterized by moderately small cranial capacity; a short, narrow and well-arched skull vault; large but somewhat separate and curved supraorbital ridges; moderately large cheekbones with some hollowing beneath them; gracile and straight or only slightly curved limb bones, generally lacking enlarged ends. The general pattern of the anatomy of the face and even of the skull vault of these early Neanderthal peoples was not greatly unlike that of *Homo sapiens;* this was also true of the bones of trunk and limbs, although these are not very well known. There was nonetheless a complex of skeletal features which distinguished them from modern human populations.

Far more numerous and complete skeletal remains have been recovered of Neanderthal peoples from the succeeding initial phases of the Last Glacial stage. This is probably due in large part to the marked tendency toward utilization of cave fronts and rock shelters below cliffs for habitation sites, as well as the widespread practice of deliberate burial of the dead. Such peoples were distributed, evidently as small semi-isolated populations of relatively unsophisticated hunting and gathering bands with a Mousterian stone industry, from western Asia throughout much of Europe as well as along the Mediterranean littoral of northern Africa. (There is no evidence for such peoples either in Africa south of the Sahara or in eastern or southeastern Asia; however, broadly contemporaneous peoples in these areas have been sometimes referred to as Neanderthaloid since a number of features of their skull morphology simulate those found among Neanderthal peoples.)

Over most of this area of distribution such peoples resembled quite closely early Neanderthal populations of the preceding interglacial period. This was not the case with those groups, often called classic Neanderthals, occupying the western and southwestern periphery of Europe. Over this area, including Belgium and France and westernmost Germany, Spain and Italy, were short, stout, powerfully built Neanderthal peoples characterized by a number of distinctive skeletal characteristics which set them apart from their contemporaries elsewhere. This was true of the brain case (very large cranial capacity; long, low and wide skull vault, flattened behind; heavy biarched supraorbital ridges), of the face (projecting and large; rounded orbits; small cheekbones with no hollowing below them due to expanded sinuses; quite large teeth and palate), of the trunk (rounded broad chest; short vertebrae with large muscular processes; long slender collarbone) and of the limbs (heavy curved thigh and forearm bones; large feet and hands but short fingers and toes; arm and leg bones with enlarged ends; long heel bone). The popular conception that these people were slouched in posture and walked with a shuffling, bent-knee gait seems to have been due in large part to the faulty reconstruction of the skull base and to the misinterpretation of certain features of the limb bones of one of the Neanderthal skeletons discovered early in the 20th century.

Such were the peoples to whom the specific name *Homo neanderthalensis* was applied (by W. King in 1864) following the original discovery of the type skeleton in the Feldhofer cave. (Actually two other such skulls had been found earlier in the 19th century but went unrecognized until after the Neanderthal discovery proper.) It is now apparent, however, that these peoples represented merely the western periphery of a particular range of variation within a quite widespread human species. In fact, since such peoples were considerably like *Homo sapiens* the use of the distinct species name *neanderthalensis* may be most misleading; some workers think it might be applicable to the classic Neanderthals. It is likely that populations referred to as classic Neanderthals became relatively isolated from other such peoples in the southwesterly parts of Europe as a consequence of the increasing severity of the climate during the initial phases of the Last Glacial

stage. Such isolation would have greatly restricted gene flow between populations, would have increased inbreeding and would have tended to bring about shifts, even drift in gene frequencies, especially in certain directions because of the accidents of sampling resulting from the original population composition. Increased selection pressures under a progressively harsher environment may also have played a role, although this is still poorly understood. Since the time range of the Last Glacial is now largely within the limits of the radiocarbon (C^{14}) method of absolute dating, it is now possible to estimate the time involved in such evolutionary changes. The Last Glacial seems to have begun about $75,000 \pm 5,000$ years ago; a rather pronounced temperate interstadial amelioration began around 42,000 years ago and had a duration of about 10,000 years. The Neanderthals appear to have persisted fairly well into, perhaps almost to the end of, this interstadial; probably they had disappeared by about $35,000 \pm 3,500$ years ago. Hence the characteristics of the Neanderthals developed over a period of approximately $30,000 \pm 5,000$ years; *i.e.*, during $1,500 \pm 250$ generations.

The factors responsible for the disappearance of these and other Neanderthal peoples are unclear. In Europe nearly all cave and rock shelter sites where there was repeated human occupation reveal a sterile horizon between the last Neanderthal occupation (with Mousterian industry) and succeeding occupation by a Cro-Magnon variety of *Homo sapiens*, characteristically European in skeletal anatomy (with an early Upper Paleolithic industry). (*See* CRO-MAGNON MAN.) Hence it cannot be demonstrated conclusively whether these different human populations overlapped in time in the same territory, the indigenous Neanderthals being perhaps killed off by the immigrant anatomically modern peoples, or whether the Neanderthals were no longer present, presumably having already become extinct. In southwestern Asia there are several cave sites (Skhul and Qafzeh, in present-day Israel) where skeletal remains of fundamentally anatomically modern peoples, once regarded as a special variety of Neanderthal, have been found. These were broadly contemporaneous with other more typically Neanderthal folk. Some workers believe that the former, which were perhaps already coexisting with and were eventually to replace Neanderthals in southwestern Asia during the initial phases of the Last Glacial, represented the forerunners of the Cro-Magnon populations who later replaced the Neanderthals of Europe. *See* ANTHROPOLOGY; MAN, EVOLUTION OF. *See* also references under "Neanderthal Man" in the Index.

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NEARCHUS (d. probably 312 B.C.), an officer in the Macedonian army under Alexander the Great. A native of Crete, he settled at Amphipolis in Macedonia. In 333 Alexander made him satrap of the newly conquered Lycia and Pamphylia. In 325, when Alexander descended the Indus to the sea, he ordered Nearchus to conduct the fleet to the head of the Persian gulf. Nearchus was then entrusted with the more difficult task of circumnavigating the Arabian peninsula from the mouth of the Euphrates river to the Isthmus of Heroönpolis (Suez), a project cut short by the death of the king (323). In the allocation of commands that followed immediately in 323 Nearchus obtained his former satrapies. In the subsequent struggles of the Diadochi or "Successors" of Alexander he took the side of Antigonus I (*q.v.*). He wrote a detailed narrative of his expedition, of which a full abstract was embodied by Arrian in his *Indica*. *See* also ALEXANDER III (the Great).

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NEAR EAST: *see* MIDDLE EAST.

NEATH (CASTELL-NEDD), a metropolitan borough and industrial town in Glamorgan, Wales, pop. (1961) 30,935, lies on the river Neath or Nedd, 3 mi. from its mouth in Swansea bay and 37 mi. W.N.W. of Cardiff by road. The Vale of Neath, at the southwestern end of which the town stands, is a narrow valley running northeast from Neath for about 12 mi. with steep and lofty sides broken by small glens and waterfalls. It leads up toward the Brecon Beacons and Forest Fawr and is one of the most picturesque areas of south Wales; it has retained its beauty in spite of considerable industrialization. Although Neath is encumbered with many bleak industrial buildings, the centre of the town is pleasant, with flower beds in the public gardens and views of the hills.

The port of Neath is Briton Ferry (part of the borough since 1922), which has extensive steel and tinplate works and forms an unbroken urban continuity with Neath. The importance of Briton Ferry was enhanced by the carrying of a new road by viaducts across Briton Ferry dock and the mouth of the Neath, linking Cardiff and such towns as Bridgend, Margam, Port Talbot and Aberavon direct with Swansea and bypassing Neath itself.

Neath is a very ancient site, owing its strategic importance to its location on the river crossing and at the mouth of the Vale of Neath. The Roman fort of Nidum was established about A.D. 75 to 80 and protected the road from Caerleon to Carmarthen. Neath castle was built in the early 12th century and burned by Llewelyn ap Iorwerth in 1231; only its gateway remains. Neath abbey is an extensive 13th-century Cistercian ruin. The first known charter was granted to the town by Earl William of Gloucester, in the 12th century; other charters followed in 1280, 1340, 1359, 1397, 1421, and 1423, and the final charter was bestowed by James II in 1685. Serving as a market centre for a wide and prosperous countryside, Neath acquired further importance on account of local mineral resources and became a centre of the copper industry after a copper smelting works was established there in 1584 by Cornish miners. In the 17th century other nonferrous ores (as well as copper), for lead and silver extraction, were imported. After 1700 Swansea took up metal working and rapidly outpassed Neath as the most important Welsh port on the Bristol channel. Iron and coal figured largely in Neath's subsequent development and its modern economic importance is largely connected with the steel industry. Industrial establishments are mainly concerned with metallurgy and the production of metal goods. It has formed the nucleus of a small but substantial conurbation of industrial towns.

Exploration of the area around Neath reveals many contrasts between modern industrialization and the surviving monuments of ancient times. George Borrow, coming in 1854 upon Neath abbey with its gloomy smoke-ridden background, likened the scene to a "Sabbath in Hell." Southeast of Briton Ferry are Aberavon and Port Talbot, brought into being largely by the coal and iron of the Afon valley. And beyond these is Margam, celebrated on the one hand for its 13th-century Cistercian abbey with its exquisite chapter house and on the other for its huge modern steel plant (opened in 1951), with an annual capacity of 1,500,000 tons. For 8–10 mi. in this southeastern direction there extends from Neath through Briton Ferry an almost continuous industrial and urbanized landscape, and for a similar distance westward is the centre of the town of Swansea.

Local government in Neath is under a mayor and corporation. There are two railway stations and the town is an important road transport centre, though some of its traffic has been affected by the new Briton Ferry bypass. (HU. S.)

NEBRASKA, styled the "Tree Planter's state" by act of the legislature, 1895, and renamed the "Cornhusker state" by legislative act in 1945, is near the centre of the United States. It is bounded on the north by South Dakota, on the east by Iowa and a corner of Missouri, on the south by Kansas, on the south and west by a corner of Colorado and on the west by Wyoming. The Missouri river flows along the eastern and northeastern border. The extreme length of the state is 428 mi. and the extreme breadth 207 mi. The area is 77,227 sq.mi., of which 615 are water surface.

Nebraska was named the "Tree Planter's state" because Arbor day was originated there by J. Sterling Morton in 1872 and forestry was emphasized by the pioneers and their successors. The name "Cornhusker" originally was applied to the University of Nebraska football team. Nebraska was the 37th state to be admitted into the union, on March 1, 1867; the state capital is Lincoln. The state flower is the goldenrod, the state bird the western meadowlark and the state tree the American elm. The state flag consists of the state seal, which symbolizes commerce, industry, transportation and agriculture, and the state motto, "Equality before the law," in gold and silver, on a dark blue field.

PHYSICAL GEOGRAPHY

Physical Features.—The principal topographical feature of Nebraska, which lies approximately between 40° and 43° N. lat. and 95° and 104° W. long., is a great undulating plain, sloping gradually from the northwest to the southeast, at an average of ten feet per mile. This plain is broken along its northern and eastern borders by hilly regions. The highest point, 5,424 ft., is in Kimball county; the lowest point, 840 ft., is in Richardson county. The state's principal topographical regions are the loess, the sandhills, the high plains and the badlands, with lowlands along the Missouri and Platte rivers.

The loess region includes about 42,000 sq.mi. of excellent farmland in the eastern and south central parts of the state. The area is gently rolling except along the Missouri and Republican rivers and at some other points where moderate hills appear. The sandhills lie west and northwest of the loess region, with outliers extending to the southwest corner of the state. The main region of the sandhills includes about 18,000 sq.mi. and consists of low hills interspersed with rich valleys, lakes and fertile tablelands. The high plains, which lie west and northwest of the sandhills, include about 12,000 sq.mi. and consist of level stretches of tableland broken occasionally by deep canyons and rugged buttes. The region includes two areas of evergreen-wooded mountains, the Wild Cat range and the Pine Ridge. The badlands, used as rangeland, occupy about 1,000 sq.mi. in the northwest corner of the state.

The state is drained by the Missouri river, a navigable stream which skirts the eastern border for approximately 450 mi. The principal tributaries of the Missouri in Nebraska are the Platte and its branches; the Niobrara; the Republican; the Big and Little Blue; and the Big and Little Nemaha. The Platte is the dominant and characteristic river and with its tributaries drains more than half of the state. Its wide terraced valley, extending across the entire state and leading to mountain passes, made it an important highway across the continent. Its channel varies from one-half to one mile in width and is filled with islands. In the summer, use of water for irrigation leaves its middle course in the state entirely dry. The sandhills contain hundreds of small lakes, particularly the area near the headwaters of the Loup and the Elkhorn rivers, the Platte's principal tributaries. The recreational facilities provided by these lakes are augmented by reservoirs resulting from the construction of numerous multipurpose dams. Artesian water exists in at least ten different counties, and the sandhills provide a significant quantity of ground water, which is discharged into the lower Platte valley to supply irrigation wells.

Climate.—The climate of Nebraska is typical of the interior of large continents, and is characterized by light rainfall, low humidity, hot summers, cold winters and wide variations. The mean annual precipitation varies from 27.58 in. in the eastern part of the state to 12.65 in. in the western part. Wet and dry years run in irregular cycles. Fortunately for the state's agriculture, approximately two-thirds of the annual precipitation normally occurs in the crop-growing season, from April to August, inclusive. The mean annual temperature varies from 50.5° F. (about 10° C.) in the east to 48.3° F. (about 9° C.) in the west. The mean temperature for January is 22.5° F. in the east and 24.1° F. in the west; for July, it is 77° F. in the east and 73.8° F. in the west. The growing season between frosts varies from 164 days in the southeast to 122 in the northwest.

Soil.—A soil of remarkable fertility is Nebraska's fundamental asset. A soil map of Nebraska exhibits wide variations, which accounts in large measure for the diversified nature of its agriculture. The principal soil associations of the United States found in Nebraska—in which soils are grouped geographically rather than taxonomically—are prairie soils, chernozem soils, chestnut soils, alluvial soils, planosols, lithosols and sand. Except for the lithosols, which occur in the badlands, and the sand of the sandhills, these soils are extremely fertile and well suited to the production of cultivated crops.

Vegetation.—Grasses originally comprised the state's principal form of vegetation. Only about 3% of the state was forested, with trees occurring principally along the streams and on the low mountain ranges of the west. The grasses varied according to rainfall. In the more humid eastern part of the state, tall prairie grasses—particularly the bluestem—abounded; in the less humid western area, short grasses—notably grama and buffalo—were characteristic. Except in the range country of the central and western parts of the state, the grasslands have been converted to the production of cultivated crops.

Nebraskans have exhibited great interest in planting trees since pioneer days. Arbor day was first celebrated in Nebraska, and the Nebraska national forest in the sandhills is wholly man made. By the second half of the 20th century Nebraska still had only about 3% of its area in forest.

Animal Life.—The principal indigenous animals were those characteristic of the plains. Of these, the most plentiful was the bison, or American buffalo. Others found in great numbers were the pronghorn, mule deer, coyote, kit fox, jackrabbit, ground squirrel, prairie dog, skunk and, along the streams, the beaver. The porcupine, wood rat and red squirrel were found in the woodlands. Birds were plentiful and, in addition to hundreds of species of songbirds, included the prairie chicken, grouse and migrating waterfowl.

Historic Sites and Parks.—The principal historic sites in Nebraska are:

Homestead National Monument of America (created in 1939), located near Beatrice in Gage county, the site of Daniel Freeman's homestead, the first in the nation to be claimed, Jan. 1, 1863, under the Homestead act of 1862.

Chimney Rock National Historic Site (established 1956), in Morrill county, an important landmark on the overland trail.

Scotts Bluff National Monument (established 1919), in Scotts Bluff county, an important landmark on the overland trail; the Oregon Trail museum, associated with the monument, interprets the westward movement through the Platte valley.

Arbor Lodge State park, in Otoe county, the home of J. Sterling Morton, founder of Arbor day.

Ft. Kearny State park, in Kearney county, site of Ft. Kearny, an important military post and stage station on the overland trail.

Ft. Robinson, in Dawes county, an important military post during the period of the Indian wars on the northern plains, and the site where Crazy Horse, famed chief of the Sioux, was killed.

Ft. Atkinson, in Washington county, site of an early military post (1819–27) which furnished protection to the fur trade of the west.

Nebraska state parks, in addition to Arbor Lodge, Ft. Kearny and Ft. Robinson, are Chadron, Victoria Springs, Stolley, Niobrara and Ponca. The state game, forestation and parks commission, which supervises these areas, also maintains more than 50 lakes and recreation grounds.

HISTORY

Historical Development.—Francisco Vásquez de Coronado, the first white man to penetrate the northern plains, probably did not reach Nebraska in his fruitless search for the mythical kingdom of Quivira in the summer of 1541, but the Coronado legend has been incorporated into the literature and pageantry of the state. Approximately two and one-half centuries before 1803, when Louisiana territory, of which Nebraska was a part, was acquired by the United States, Spanish and French explorers and French fur traders occasionally entered the area that is now Nebraska. A small temporary trading post was erected by French

traders in 1795 in what is now northeastern Nebraska.

In the half-century following the Louisiana Purchase in 1803 explorers and fur traders made known to the public important facts about the region. Almost all of the early explorers were unfavourably impressed with the area, and their reports gave rise to the belief that it was little more than a desert and entirely unfit for agriculture.

The Platte valley, the state's most important topographic feature, developed into a significant thoroughfare to the Rocky mountains and the Pacific coast. It was first used by fur traders who, from 1824 until the decline of the fur trade in the 1840s, followed the Platte river route to and from the trapping grounds of the mountain region. Beginning in 1835 missionaries to the Oregon country followed the same route. In 1841 the first group of Oregon homeseekers went through the Platte valley, to be followed in succeeding years by thousands of emigrants over what came to be known as the Oregon trail following the south bank of the river. In 1847 the Mormons, led by Brigham Young, went along the opposite bank of the Platte en route to the valley of the Great Salt lake. They likewise were followed by many thousands in succeeding years. Gold seekers bound for California (1849–50) and Colorado (1859) added to the traffic on the trail.

Nebraska territory was organized in 1854, largely as a result of agitation for a transcontinental railroad. The name "Nebraska," deriving from an Oto Indian word for "flat water," had long been used to designate the Platte river and surrounding territory. The final Kansas-Nebraska bill, providing for two territories, became the centre of an intense struggle in congress between the north and south, involving the extension of slavery, the removal of Indians and rival routes for the proposed Pacific railway. The bill, signed by Pres. Franklin Pierce, May 30, 1854, provided that the new territories should be slave or free as voted by the citizens in each territory, thus reversing the policy regarding the extension of slavery established for the Louisiana territory by the Missouri Compromise (*q.v.*) of 1820.

Nebraska territory, as organized in 1854, included the vast region from 40° N. lat. to British America, and from the Missouri and White Earth rivers to the summit of the Rocky mountains. In 1861 and 1863 it was reduced by the creation of other territories to nearly its present boundaries.

Most of the early settlements were along the Missouri river. Bellevue (1823), the oldest permanent settlement, was important as a fur trading centre, as a missionary centre and in the administration of Indian affairs. Brownville, Nebraska City, Plattsmouth, Omaha and Florence, established in 1854, soon became important territorial towns. Omaha (*q.v.*) was the territorial capital. Other towns of the period included Beatrice, Columbus, Falls City and Fremont. The Pacific Railroad act and the Homestead act, both passed by congress in 1862, aided white settlement. The railroads were particularly significant to Nebraska in that they made settlement away from the Missouri river possible.

The great industry during the territorial period was transport by the overland trail. Over it ran freight wagons, stagecoaches and, in 1860–61, the famous pony express, whose services ended with the completion of the overland telegraph in the latter year. Trail transportation terminated in Nebraska with the construction of the Union Pacific railway in 1865–69.

After turning down statehood in 1860 and 1864, the voters in 1866 approved a constitution which had been drafted by the legislature, and on March 1, 1867, Nebraska was proclaimed the 37th state. The South Platte region, which had always opposed Omaha as the territorial capital, had a majority in the first state legislature of 1867 and passed an act providing for the relocation of the capital, to be named Lincoln, in that section. On Aug. 14, 1867, the capital commission, appointed by the legislature, located the capital at the little village of Lancaster and renamed it Lincoln (*q.v.*). Railroad and cow towns grew up at Grand Island, Hastings and Kearney (*qq.v.*) in the 1870s and at Alliance, Chadron and Norfolk in the 1880s.

The Democratic party was the sole political party in Nebraska from 1854 to 1858. The Republican party won control in 1860 and retained it firmly until 1890. In that year the Farmers' alliance organized the People's Independent or Populist party. A three-cornered fight resulted in the Democrats' getting the governorship and the Populists a majority in the legislature. By fusing with the Democrats under the leadership of William Jennings Bryan, the Populists won victories in 1894, 1896 and 1898. The Populist party died out after 1900, and political control fluctuated between the Democrats and the Republicans until 1930. During the 1930s the Democrats dominated the state although George William Norris, nominally a Republican, remained in the U.S. senate from 1913 to 1943. The Republicans asserted control in 1940 and remained in the ascendancy until 1958 when the Democrats returned to power, electing a governor and two congressmen In 1960, 1962 and 1964 the Democrats also elected the governor, the Republicans recapturing the governorship in 1966.

POPULATION

Nebraska's population grew rapidly from 28,841 in 1860 to 1,058,910 in 1890. After 1890 growth was slow, and between 1930 and 1940 the population declined from 1,377,963 to 1,315,834. In 1950 the population was 1,325,510, an increase of 0.7% over the population in 1940, and in 1960 the population was 1,411,330, an increase of 8.7% over that of 1950. The population per square mile in 1960 was 18.3, as compared with 49 7 for the United States.

*Nebraska: Places of 5,000 or More Population (1960 Census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	1,411,330	1,325,510	1,315,834	1,296,372	1,066 300
Alliance	7,845	7,891	6,253	4,591	2,545
Beatrice	12,132	11,813	10,883	9,664	7,875
Bellevue	8,831	3,858	1,184	675	527
Chadron	5,079	4,687	4,262	4,412	1,665
Columbus	12,476	8,884	7,632	5,410	3,522
Fairbury	5,572	6,395	6,304	5,454	3,140
Falls City	5,598	6,203	6,146	4,930	3,022
Fremont	19,698	14,762	11,862	9,605	7,241
Grand Island	25,742	22,682	19,130	13,947	7,554
Hastings	21,412	20,211	15,145	11,647	7,188
Holdrege	5,226	4,381	3,360	3,108	3,007
Kearney	14,210	12,115	9,643	7,702	5,634
Lexington	5,572	5,068	3,688	2,327	1,343
Lincoln	128,521	98,884	81,984	54,948	40,169
McCook	8,301	7,678	6,212	4,303	2,445
Nebraska City	7,252	6,872	7,339	6,279	7,380
Norfolk	13,111	11,335	10,490	8,634	3,883
North Platte	17,184	15,433	12,429	10,466	3,640
Omaha	301,598	251,117	223,844	191,601	102,555
Plattsmouth	6,244	4,874	4,268	4,190	4,964
Scottsbluff	13,377	12,858	12,057	6,912	—
Sidney	8,004	4,912	3,388	2,852	1,001
South Sioux City	7,200	5,557	4,556	2,402	889
York	6,173	6,178	5,383	5,388	5,132

*Populations are reported as constituted at date of each census.
Note: Dash indicates place did not exist during reported census, or data not available.

During the period of rapid growth (1860–90) there was a heavy immigration of foreign born into the state, particularly from Germany, Sweden, Bohemia, Ireland and Denmark. In 1960, 2.9% of the population was foreign born. Of the foreign-born population, 27.0% was born in Germany, 8.9% in the United Kingdom and 8.0% in Czechoslovakia. The nonwhite population, mostly Negro, constituted 2.6% of the total.

Of the 1960 population, 54.3% was classified as urban, as compared with 46.9% in 1950, 39.1% in 1940 and 35.3% in 1930. Of the 93 counties, 23.7% showed an increase in population between 1950 and 1960, as did all of the cities of 10,000 or more population. The percentage of the population which was under 14 years of age increased from 26.4% in 1950 to 29.4% in 1960; the percentage over 65 years of age increased from 9.9% in 1950 to 11.6% in 1960.

GOVERNMENT

Administration.—A constitution adopted in 1875 and revised by a constitutional convention in 1919–20 is the basis of Nebraska's government.

The general election, state and local, is held in even-numbered years on the first Tuesday after the first Monday in November, but municipal and school district elections may be held at other times. Judges, regents of the state university, members of the legislature and some municipal officers are elected on nonpartisan ballots.

BY COURTESY OF (TOP LEFT) UNION PACIFIC RAILROAD; PHOTOGRAPHS, (TOP RIGHT, BOTTOM LEFT) H. ARMSTRONG ROBERTS, (CENTRE LEFT) FAIRCHILD AERIAL SURVEYS, INC., (BOTTOM RIGHT) JOSEF MUENCH

SCENES IN NEBRASKA

Top left: The state capitol building, Lincoln, a 400-ft. tower on a two-story base, completed in 1932

Top right: Cattle grazing on pastures at the foot of Sheridan's Gate, buttes near Hay Springs in the western part of the state

Centre left: Scotts Bluff. Dome Rock (left) rises 4,662 ft.

Bottom left: The business section of Lincoln seen from the capitol building. In the foreground is St. Mary's cathedral

Bottom right: Chimney Rock, a conical mound of red sandstone, rises above the route of the old Oregon Trail near Bridgeport

BY COURTESY OF (TOP LEFT) THE NEBRASKA STATE HISTORICAL SOCIETY, S. D. BUTCHER COLLECTION PHOTOGRAPHS (BOTTOM LEFT) EWING GALLOWAY (BOTTOM RIGHT) A. DEVANEY

HISTORICAL AND MODERN VIEWS OF NEBRASKA

Top: A typical sod farmhouse of the late 19th century

Bottom left: The stockyards at Omaha, one of the largest cattle marketing centres in the U.S.

Bottom right: Administration building of the Municipal University of Omaha, founded in 1908

The governor, chief executive officer of the state, is chosen by direct vote of the people, as are the lieutenant governor, secretary of state, auditor, treasurer and attorney general. Constitutional amendments in 1962 provided for four-year terms for the governor and lieutenant governor. The other four officers elected at large serve two-year terms. The governor appoints, with legislative approval, heads of the code departments, members of boards and a few other officers. He fills vacancies in state offices arising from death, resignation or removal.

The unicameral legislature of Nebraska is unique among state governments. Beginning in 1937 in accordance with an amendment adopted in 1934, it consisted of a single house of 43 nonpartisan legislators representing geographic areas that had about equal population in 1935. In 1965 it was reapportioned under federal court orders with 50 members allocated on a strict population basis, giving greater representation to urban areas. The chamber is presided over by the lieutenant governor. The legislature meets biennially in the odd-numbered years, and there is no limit on the length of the sessions.

Administration of justice is vested in a supreme court, 18 district courts, county courts, municipal courts and justice courts. In 1962 the voters approved a constitutional amendment adopting the Missouri plan of judicial selection and tenure. Under this plan the governor fills vacancies from a list of nominees compiled by a commission of lawyers and laymen. The judges so appointed run on a nonpartisan ballot for election to subsequent terms. The supreme court consists of six associate justices and one chief justice. Each district court consists of from 1 to 9 judges (total number 35). County courts have one judge. Lincoln and Omaha have municipal courts. Provision is made for approximately 2,000 justice courts. The district court is the court of general, original, legal and equity jurisdiction. The jurisdiction of county, municipal and justice courts is limited. Appeal to the supreme court, the court of last resort, may not be denied in any case.

Of the 93 counties, 28 are of the township or supervisor type, governed by a board of supervisors of seven members, and 65 are of the precinct or commissioner type, governed by boards of commissioners of three or five members. There are about 100 incorporated cities and 400 incorporated villages. Two cities are governed by the commission plan, one by a modified commission plan, nine by the city-manager plan and all others by the mayor-council form of government. Government of villages is vested in a board of trustees consisting of five members elected by popular vote. Any city with a population of 5,000 or more may adopt a home-rule charter, although only Omaha, Lincoln and Grand Island have done so.

Other governmental subdivisions include 5 public power districts, about 40 rural electrification districts and almost 500 other units, including drainage districts, irrigation districts, reclamation districts, weed eradication districts, soil conservation districts, metropolitan utilities districts and rural fire protection districts.

Finance.—Nebraska has no state income tax and no general sales tax. The general property tax, established in 1867, is supplemented by taxes on corporations, gasoline, liquor and cigarettes, by state licences and fees and special taxes, and by contributions from the U.S. treasury. The state has no bonded debt.

EDUCATION

State School System.—Nebraska has provided free public education since 1855. Most of the support and control comes from the local school districts. From 1869 to 1955 the state exercised general supervision of education through a superintendent of public instruction, an elected official. In 1955, as the result of a constitutional amendment adopted in 1952, this supervision was transferred to the state department of education, consisting of an elected board of education and a commissioner of education appointed by the board.

The local school districts provide approximately 90% of the support of public schools, primarily from the general property tax. The remaining support is derived from educational lands and funds, state aid by direct appropriation and federal aid. In 1949 Nebraska made an effort to reduce the number of school districts in the state. As a result of these efforts, within ten years the number of districts declined from more than 6,500 to fewer than 4,500. At the same time, school expenditures increased more than 70%; enrollment increased almost 20%; and the number of teachers increased about 17%. Approximately 14% of the children in the state attend parochial schools.

Colleges and Universities.—The University of Nebraska, at Lincoln, established in 1869 and opened in 1871, is the state's principal institution of higher education. It is governed by a board of six regents elected by districts on nonpartisan ballots for six-year terms. The university consists of ten colleges and three schools, as follows: colleges of agriculture, arts and sciences, business administration, dentistry, engineering, graduate, law, medicine (at Omaha), pharmacy and teachers; and schools of fine arts, journalism and nursing. The university also maintains a school of agriculture at Curtis, and agricultural experiment stations at North Platte, Valentine and Alliance.

The four state teachers colleges became state colleges in 1963: they are Peru State college (established 1867); Kearney State college (1905); Wayne State college (1909); and Chadron State college (1911). Other publicly supported institutions of higher education are: Municipal University of Omaha, supported by the city of Omaha; and junior colleges at Fairbury, McCook, Norfolk and Scottsbluff, supported by local school districts.

The privately supported colleges and universities are: Concordia Teachers college, at Seward; Creighton university, at Omaha; Dana college, at Blair; Doane college, at Crete; Duchesne College of the Sacred Heart, at Omaha; Hastings college, at Hastings; Midland Lutheran college, at Fremont; Nebraska Wesleyan university, at Lincoln; College of St. Mary, at Omaha; and Union college, at Lincoln.

HEALTH, WELFARE AND CORRECTIONS

Nebraska's original Board of Health law was enacted in 1891. It was amended over the years, and in 1953 the legislature created a seven-member board of health appointed by the governor. The board of health has responsibility for maternal and child health, local health services, preventive medical services, communicable disease control, venereal disease control, dental health, tuberculosis survey, public health nursing, public health education, laboratories, sanitation, vital statistics, hospitals, cancer control, mental health, poliomyelitis control, athletics and examining boards. There were fewer than 100 hospitals in Nebraska at the end of World War II; the number was increased by more than one-third in a ten-year period.

The board of control was replaced in 1961 with a department of institutions and a department of welfare, each with its own director but having one overall advisory board. The state's charitable, educational and penal institutions, of which there are 17, include the Girls' Training school, Geneva; Home for Children, Lincoln; School for the Blind, Nebraska City; School for the Deaf, Omaha; Orthopedic hospital, Lincoln; Hastings State hospital; Lincoln State hospital; Norfolk State hospital; Nebraska Psychiatric institute, Omaha; Central Nebraska Mental Hygiene clinic, Hastings; state home, Beatrice; state penitentiary, Lincoln; state reformatory, Lincoln; state reformatory for women, York; Soldiers' and Sailors' home, Grand Island; and Hospital for the Tuberculous, Kearney.

The department of welfare administers child welfare services, crippled children's services, surplus commodity distribution and the programs of old age assistance, blind assistance, aid to dependent children and aid to the disabled.

THE ECONOMY

Living Conditions.—Nebraska, with relatively few mineral resources, has traditionally been an agricultural state. During and after World War II, however, there began a decline in the percentage of the labour force employed in agriculture, and by the second half of the 20th century about 26% was so employed. Of those not employed in agriculture about 28% was employed in trade, 20% in government, 16% in manufacturing and 11% in transportation. Total annual personal income of Nebraskans was

more than $2,500,000,000 as compared with $811,000,000 in 1929. In "constant" dollars, the income was approximately twice as great as that in 1929.

Production.—Although agriculture's relative importance declined in the years following World War II, it remains Nebraska's single most important economic activity. Livestock and livestock products normally account for approximately 70% of the gross cash income from farm marketings, which, in the years following World War II, usually were about $1,000,000,000. Cattle constitute the most important source of income from livestock. Other livestock include swine, sheep, poultry, horses and mules. Corn is the most important crop and wheat is the second most important. Other crops are oats, barley, rye, hay, sorghum, sugar beets and potatoes. The number of farms decreased from 121,000 before World War II to 101,000 in a 15-year period, while, at the same time, the average size increased from 391.1 ac. to 470.9 ac.

During the first half of the 20th century the steady progress of irrigation was of particular significance for Nebraska's agriculture, notably in combating the adverse effects of light rainfall. Water for irrigation is furnished by streams, of which the Platte, Loup, Niobrara, Republican and Elkhorn rivers are the most important, and by wells. By the second half of the 20th century more than 1,600,000 ac. were irrigated.

Nebraska's leading manufacturing activity consists of the conversion of the raw products of agriculture into marketable commodities. Other manufactures include fabricated metal products, machinery, precision instruments, apparel, lumber products, chemicals and plastics, and stone, clay and glass products. There are about 1,500 manufacturing establishments in the state, and the value added by manufacture is about $500,000,000 annually.

On Nov. 1, 1939, oil was discovered in Richardson county; in July 1949 oil was discovered in Cheyenne county. The state produced 1,800 bbl. of oil in 1939 and more than 20,000,000 bbl. in the 1960s. Natural gas was first produced in the state in 1951.

Trade and Finance.—Trade is second to agriculture as a factor in Nebraska's economy. Omaha and Lincoln are centres of wholesale trade for a large area. Numerous state and national banks and a larger number of domestic and foreign insurance companies conduct their business in Nebraska.

Transportation and Communication.—Missouri river navigation was a leading method of transportation until the construction of the railroads in the 1870s, when river traffic declined to almost nothing. During the 1940s, 1950s and 1960s it revived to a position of greater tonnage, if not greater relative importance, than in the earlier period. Ten trunk railways radiate from Omaha, five of them with a network of feeders over the state. Railway mileage was about 5,700 mi. in the second half of the 20th century, as compared with more than 6,000 mi. in 1930. There were numerous airports, many of them for public use, and scheduled local air service was extended to all parts of the state.

The most important transportation development in Nebraska in the years 1920–60 of course was the great extension of improved highways, accompanied by a rapid increase of motor vehicles.

Radio broadcasting began in 1921, and the first television station began operations in 1950. There are 20 daily newspapers and more than 250 weekly newspapers. The headquarters of the U.S. strategic air command are located near Omaha.

See also references under "Nebraska" in the Index.

BIBLIOGRAPHY.—James C. Olson, *History of Nebraska* (1955), has "Suggested Readings" at the end of each chapter, which include the principal sources of information about the state; Nebraska State Historical Society, *Proceedings and Collections* (1885 *et seq.*), *Nebraska History* (1918 *et seq.*); *Nebraska Blue Book* (biennial, 1915 *et seq.*) is particularly valuable on government; Federal Writers' Project, *Nebraska: a Guide to the Cornhusker State* (1939).

Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures are summarized annually in the *Britannica Book of the Year*, American edition. (J. C. O.)

NEBRIJA, (ELIO) ANTONIO DE (ELIO ANTONIO MARTINEZ DE JARAVA (1444?–1522?), Spanish humanist, was the author of the first grammar of a modern European vernacular language (*Arte de la lengua castellana*, 1492). Born at Lebrija, Andalusia, he signed his Latin works "Aelius Antonius Nebrissensis." As professor at Salamanca (1476–87; 1505–13), he reformed the teaching of Latin; he was also professor at Alcalá de Henares (1513–22). His Latin grammar, *Introductiones latinae* (1481), was in use in Spain up to the 19th century, and his *Dictionarium* (1492, Latin-Spanish; Spanish-Latin, *c.* 1494) and Latin-Catalan, Catalan-Latin *Vocabulario* (1507) are of primary importance in the development of Spanish lexicography. He was an editor of the Complutensian Polyglot Bible of Cardinal Francisco Jiménez de Cisneros (*q.v.*).

BIBLIOGRAPHY.—His *Gramática de la lengua castellana* was ed. by I. Gonzáles-Llubera (1926); *see* also N. Antonio, *Bibliotheca Hispana nova*, vol. i, p. 32 (1788); T. MacCrie, *History of the Progress and Suppression of the Reformation in Spain* (1829); F. Gonzales Olmeda, *A. de Nebrija* (1942). (S. G. G.)

NEBUCHADREZZAR (Babylonian NABU-KUDURRI-USUR, "The god Nabu has guarded the estate [succession]") was the name of two kings of Babylon.

NEBUCHADREZZAR I (reigned 1124–1103 B.C.) invaded and defeated Elam. His victory was so complete that the power of the hill peoples was broken for many years. For a time he was suzerain of Assyria.

NEBUCHADREZZAR II (the Nebuchadnezzar of the Old Testament) was the eldest son of Nabopolassar, founder of the Chaldean dynasty in Babylonia. He reigned from 605 to 562 B.C. In 605 B.C., as crown prince, he defeated the Egyptians under Necho II at Carchemish and won all Syria and Palestine. On hearing of his father's death, he hurriedly returned to Babylon, where he was enthroned on Sept. 6, 605 B.C. Despite the setback of a defeat by Egypt in 601 B.C., he vigorously pursued a policy of gaining full control in the west. He laid siege to Tyre for 13 years and punished Judah for its defection by capturing Jerusalem on March 16, 597 B.C. Jehoiachin was taken captive to Babylon with many Jews, and Mattaniah-Zedekiah was made king in his place (*see* JEWS).

In the following year Nebuchadrezzar fought a battle with Elam and in 595 B.C. mastered a revolt in his own country. The Babylonian chronicle, a primary historical source, is lacking after his 11th year and events must be reconstructed mainly from the Old Testament. Zedekiah rebelled in 589 B.C., and Nebuchadrezzar initiated a series of expeditions in which Lachish was captured and Judah devastated. Finally Jerusalem was sacked in 587 B.C. Five years later another expedition was conducted against Judah and the Arabs. A fragmentary text implies that Nebuchadrezzar invaded Egypt in his 37th year.

Nebuchadrezzar married Amytis, daughter of Astyages of Media, and in her honour built the "hanging gardens" at Babylon. His peaceful activities were primarily devoted to the embellishment of the capital (for a description of which *see* BABYLON). His building inscriptions from Babylon, Borsippa, Sippar, Marad and other cities, with many economic documents dated in his reign, have been published. Nebuchadrezzar died in Aug. or Sept. 562 B.C.

The title of Nebuchadrezzar was also assumed by two usurpers in the reign of Darius I. Nidintu-Bel (NEBUCHADREZZAR III) ruled at Babylon from Sept. 522 B.C. until his death three months later. In August of the following year a revolt by Araka led to his recognition as king of Babylon (NEBUCHADREZZAR IV) until his defeat and capture by the Persians on Nov. 27.

See also references under "Nebuchadrezzar" in the Index.

See S. H. Langdon, *Die Neubabylonischen Königsinschriften* (1912); D. J. Wiseman, *Chronicles of Chaldaean Kings (626–556 B.C.)* (1956). (D. J. WI.)

NEBULA, in astronomy, is a traditional term used to describe any cloudy or misty celestial object that remains fixed among the stars. Nebulae may be bright or dark, but they are generally nonstellar, luminous patches. Compared with stars, nebulae appear much fainter, because their spread-out light is more difficult to see than a point source. Thus, although there are about 5,000 naked-eye stars, only four nebulae are visible to the unaided eye. These are the two Magellanic Clouds in the southern hemisphere, and the two great spiral nebulae in the northern constellations of Andromeda and Triangulum.

Like the stars, nebulae are virtually innumerable, for their number depends upon the limiting brightness to which they are

recorded. Many hundreds are known in the Milky Way, or the galaxy. These are the galactic nebulae, masses of gas and dust associated with, and between, the stars of our own stellar system. Beyond the Milky Way are the extragalactic nebulae, entire stellar systems comparable to the galaxy, which populate the universe by the hundreds of millions. For both galactic and extragalactic nebulae, powerful telescopes employing photography are required for effective study (*see* PHOTOGRAPHY, CELESTIAL).

On the average, extragalactic nebulae have a luminosity 800,000,000 times that of our sun, the faintness of their light as we see it being due to the immensity of the distance it travels. Whereas light rays from the moon reach the earth in 1⅓ sec., those from the nearest extragalactic nebula, the large Magellanic Cloud, require 150,000 years for the journey. The most remote, observable extragalactic nebulae are estimated to be at distances of 5,000,000,000 light-years. Thus modern astronomy, in dealing with the feeblest extragalactic photons, explores with light as ancient as the oldest rocks on earth.

A widely accepted cosmological hypothesis assumes that the universe originally consisted of a small, compact mass, and that an explosion occurred approximately 10,000,000,000 years ago, thrusting the extragalactic nebulae outward in all directions. The astronomical data on which this expanding-universe theory is based are summarized in later sections of this article. (*See* also COSMOGONY.) The earth, its fellow planets and our sun—the solar system—belong to the galaxy, which is similar in form to vast numbers of spiral nebulae. As seen from another galaxy, our solar system would be located, but much too faint and small for detection, near the outer rim of the galaxy. Our sun makes a complete revolution in the galaxy in the cosmic equivalent of a year—about 200,000,000 solar years.

This article is divided into six main sections as follows:

I. HISTORICAL

Earliest Records.—Historical records of luminous patches in the sky are known to go back to Hipparchus (fl. 146–127 B.C.), who included in the earliest known star catalogue entries for the double star cluster in Perseus (h and χ Persei) and for the "Beehive" star cluster in Cancer (Praesepe). Nearly 300 years later Ptolemy (*c.* A.D. 140) listed five "cloudy stars" in his *Almagest*, but these objects, apparently nebulous to the eye, are in reality star clusters. The earliest known record of a nebula, as distinguished from a star cluster, is the one for the Andromeda nebula given by Al Sûfi (903–986) in his *Book of the Fixed Stars*, epoch 964. The spiral in Andromeda thus shares with the Magellanic Clouds the distinction of being one of the three nebulae discovered before the invention of the telescope. The Clouds of Magellan, which become visible to travelers to the southern hemisphere soon after the Torrid zone is entered, were known to the Portuguese navigators of the 15th century, and although not discovered by Magellan, the clouds are by common consent associated with his name to honour the great circumnavigator. Soon after the first use of the telescope on celestial objects in 1609 by Galileo (1564–1642), the Orion nebula was discovered in 1610 by the famous French patron of science Nicholas Peiresc (1580–1637). The Jesuit priest Cysatus (1588–1657), who began to survey the sky with a telescope in 1611, also discovered the same nebula (1618). It was Christiaan Huygens (1629–95), however, who not knowing of the earlier discoveries by Peiresc and Cysatus, gave in 1656 the first description and sketch of the brightest part of the Orion nebula. The Andromeda nebula also was soon rediscovered after the invention of the telescope, in 1611 by Simon Marius (1570–1624) who described it in the oft-quoted poetical words, "Like a candle seen at night through a horn."

Early Catalogues.—The first attempt to catalogue nebulae seems to have been made in 1715 by Edmund Halley (1656–1742), who listed six "luminous spots or patches," among them the globular star cluster in Hercules, which he had discovered in 1714. The next list, in this case of 16 "nebulous stars," was given in 1733 by the English divine W. Derham (1657–1735), apparently as a result of some observations he made in 1732, with a reflecting telescope, of such objects included in an earlier (1690) work by J. Hevelius (1611–87). In the first extensive survey of the southern skies made at the Cape of Good Hope in the years 1751–53 by Nicolas Louis de Lacaille (1713–62), a total of 42 nebulae were observed and then described in another significant list of such objects published in 1755. Shortly thereafter, another Frenchman, Charles Messier (1730–1817), while following the comet of 1758–59, noticed a nebulous object near the third-magnitude star

GREAT SPIRAL NEBULA (N.G.C. 598) IN THE NORTHERN CONSTELLATION OF TRIANGULUM, ONE OF THE FOUR NEBULAE VISIBLE TO THE NAKED EYE. HERE AS PHOTOGRAPHED WITH THE 48-IN. SCHMIDT TELESCOPE AT THE PALOMAR OBSERVATORY, CALIF.

ζ Tauri. His discovery, later to be called the "Crab" nebula in Taurus, is now known to be the expanding gaseous remnant of the 1054 supernova (*see* NOVA AND SUPERNOVA). Messier, although much more interested in comets—Louis XV nicknamed him the "ferret of comets"—found that his searches could be more efficiently prosecuted if he noted the positions of those apparently cometary objects that did not move among the stars. In this way Messier discovered most of the brighter nebulae and clusters visible from northern latitudes, and his final catalogue published in 1781 contained 103 entries.

The Catalogues of William and John Herschel.—The foregoing early catalogues of nebulae almost pale into insignificance, however, when compared with the systematic sweeps of the skies made by William Herschel (1738–1822) and his son John

Herschel (1792–1871). With a reflector of his own making, the elder Herschel began his illustrious career as the founder of sidereal astronomy by observing the Orion nebula in 1774. Its appearance so amazed him that he directed his attention to other nebulae, which then became objects for his lifelong study and interpretation. Between 1786 and 1802 he discovered and catalogued, in three lists, more than 2,500 nebulae. The younger Herschel proved to be his father's ablest successor in the field of nebular observation and discovery. Like his father, he constructed in 1820 his own telescope, an 18-in. speculum metal reflector, and began in 1825 to reobserve many of the nebulae found by his parent. The outcome of this second survey was a catalogue of about 2,300 nebulae, of which 525 were new. John Herschel found the field so fascinating that he resolved to extend his search to southern skies, and in 1834 he began on Table mountain near Cape Town, S.Af., a four-year survey that marked a new era in the study of celestial objects visible in the southern hemisphere. The Magellanic Clouds were for the first time subjected to a detailed examination, with the result that the larger one was found to contain more than 900 member star clusters, nebulae and stars associated with nebulosity, while nearly 250 similar objects were counted in the smaller cloud. The younger Herschel catalogued more than 1,700 other nebulae in southern skies, and for a number of them he made beautiful drawings. Upon his return to England in 1838, he set about systematizing all his own and his father's discoveries of nebulae, and his labours culminated in the "General Catalogue" of about 5,000 entries published in 1864 in the *Philosophical Transactions of the Royal Society*. This great work forms the backbone of J. L. E. Dreyer's *New General Catalogue of Nebulae* (N.G.C.) (1888), which augmented by the *First* (1895) and *Second* (1908) *Index Catalogues* (I.C.), with a combined total of more than 13,000 entries, constitutes the standard reference list for nearly all modern observations of nebulae.

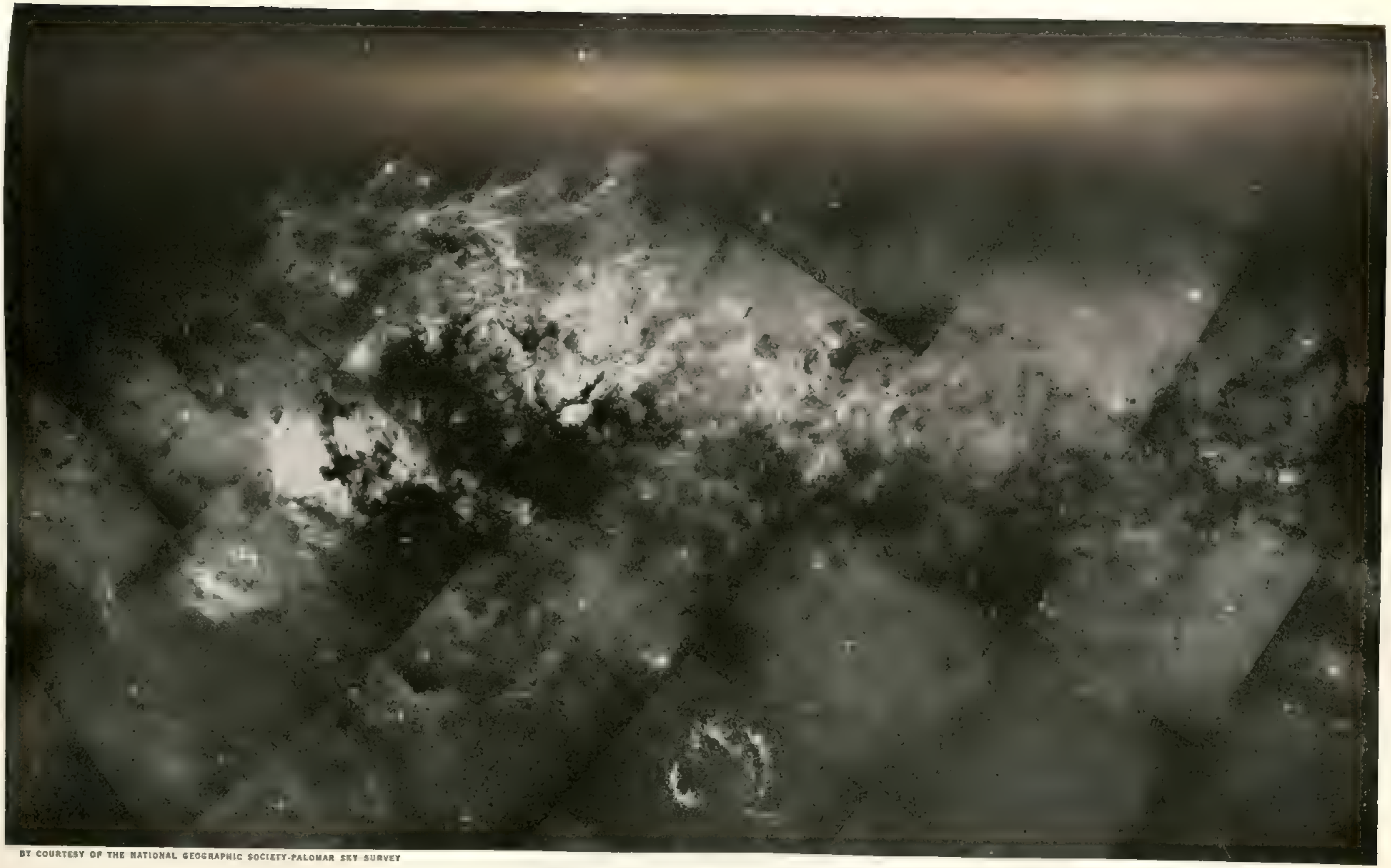
II. DEVELOPMENT OF NEBULAR PHOTOGRAPHY

The invention of photography and its application to astronomy revolutionized the study of nebulae. Since the photographic emulsion has the advantage over the human eye of being able to accumulate the effect of exposure to faint light, it is therefore possible by prolonged exposure—limited mainly by the nocturnal airglow of the earth's atmosphere—to photograph nebular detail far too fine and faint to be seen visually with a telescope. Moreover, a photograph provides a permanent record that in most cases can be measured with a much higher precision than can be obtained by simple visual methods. These advantages were exploited by astronomers as soon as the practicable dry plate became available during the last quarter of the 19th century.

Early Photographs to 1900

The Orion nebula has the distinction of being the first one to be photographed on Sept. 30, 1880, by Henry Draper (1837–82), a New England physician. Its priority as a subject doubtless was due to its brightness, which would make it visible to the unaided eye were the nebula not outshone by the involved third-magnitude group of four stars known as the Trapezium (θ Orionis). In any case, the Orion nebula was popular with pioneers, for it was also photographed in France in 1881 by P. J. C. Janssen (1824–1907) and in England in 1883 by A. A. Common (1841–1903), who was doubly venturesome by doing nebular photography with a series of silver-on-glass reflectors, up to mirror diameters of 60 in. The Pleiades nebulosity was first photographed in its brightest parts around the stars Merope and Maia by the

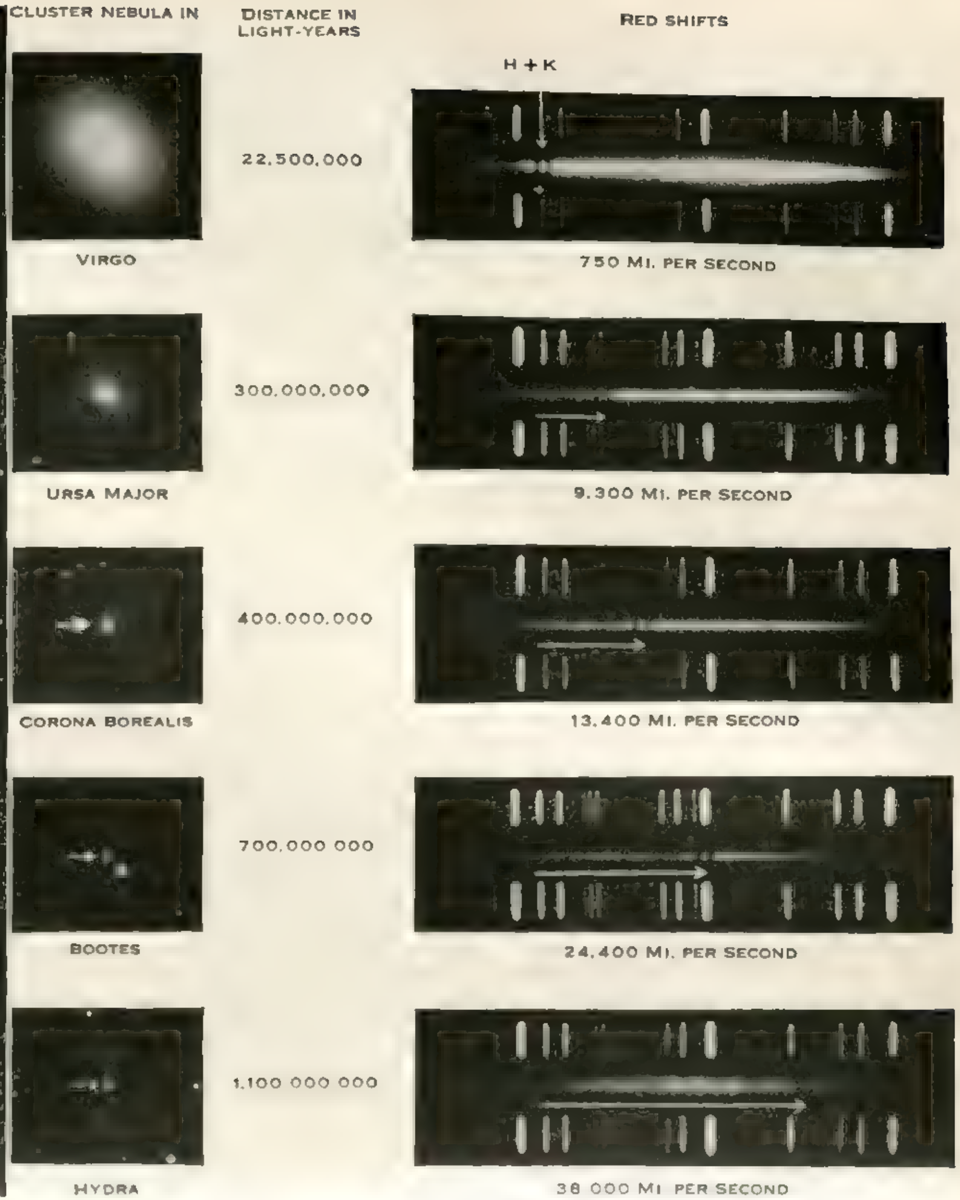
GREAT NEBULA IN CONSTELLATION OF ORION (M42, N.G.C. 1976) SURROUNDED BY GLOWING GAS CLOUD, ONE OF THE LARGER GAS-DUST COMPLEXES IN THE GALAXY. RADIATION FROM STARS EXCITES ATOMS OF GAS, CAUSING THEM TO EMIT THE FLUORESCENT LIGHT VISIBLE HERE. 200-IN. PHOTOGRAPH



BY COURTESY OF THE NATIONAL GEOGRAPHIC SOCIETY-PALOMAR SKY SURVEY

PART OF THE NORTHERN MILKY WAY

A mosaic made from red light photographs taken with the 48-inch Schmidt telescope of Palomar observatory. The clouds of stars, glowing gas and dark dust lie close to the fundamental plane of the Milky Way, or Galaxy, which here—from the left and past centre—runs through the constellation Cygnus, and on the right through Vulpecula



BY COURTESY OF THE MOUNT WILSON AND PALOMAR OBSERVATORIES

THE OBSERVATIONAL BASIS OF THE EXPANDING UNIVERSE

Left: Cluster of extragalactic nebulae in Corona Borealis. This cluster of several hundred nebulae is typical of those in which apparent brightness measurements are made to estimate the greatest astronomical distances, in this case 400,000,000 light-years. The arrow points to one of the brighter members whose spectrum was photographed to determine the red shift of its spectrum lines, as indicated in the central part of the chart at the right

Right. Direct (left) and spectrum (right) photographs of extragalactic nebulae. The direct photographs indicate the decrease in size and apparent brightness as distance increases. The right-hand column shows corresponding nebular spectra, with arrows to indicate the displacement toward longer wave lengths (red) of the principal feature, the H and K lines of calcium. These red shifts, when interpreted as motions of recession and plotted against distance, give Hubble's velocity-distance relation, which is the empirical basis for theories of the expanding universe

brothers Paul and Prosper Henry, at Paris in 1885. About the same time in England, Isaac Roberts (1829–1904) with a 20-in. reflector began a pioneering program in nebular photography that for the first time revealed the true form and extent of many nebulae. His photograph in 1886 showed that the Pleiades cluster stars are enmeshed in complex clouds of wispy filaments, and that the Andromeda nebula has a spiral structure. This last result from a small reflector was a striking example of the power of photography because the first discoveries of spiral nebular forms, made visually in 1845–50 by Lord Rosse (1800–67) and his associates at Parsonstown, York, required the use of large speculum metal mirrors, up to six feet in diameter.

It was J. E. Keeler (1857–1900), however, who firmly established the great advantages of nebular photography with a reflector. In 1898–1900 at the Lick observatory, on Mt. Hamilton, Calif., where more favourable observing conditions existed than in England, he expertly improved and operated Common's 36-in. reflector that had been donated in 1895 to the first great mountaintop observatory by Edward Crossley (1841–1905) of Halifax, Eng. Keeler's photographs recorded in finer detail hundreds of previously unknown faint nebulae beyond the bounds of the Milky Way. From study of these plates, he drew two conclusions of prime importance: (1) the number of such nebulae photographable with his equipment was at least 120,000, compared to the catalogued number of less than 13,000; (2) most of these nebulae would show a spiral form.

Star Cameras.—It was also at the Lick observatory that E. E. Barnard (1857–1923) began in 1889 his epochal photography of the Milky Way with short-focus, large-aperture portrait lenses. These wide-angle cameras disclosed as no conventional telescopes could the immense richness and structural features of the clouds of stars, gas and dust that make up the galaxy. Likewise for the first time, dark nebulae appeared in a profusion of sizes and shapes on Barnard's photographs, and his systematic study of them opened a new field for modern astronomy: interstellar matter. Others quickly adopted this efficient survey technique, notably H. C. Russell (1836–1907) at Sydney, Austr., in 1890, and Max Wolf (1863–1932) at Heidelberg, Ger., in 1891. Russell's work on the southern Milky Way supplemented Barnard's in the north, while Wolf, pioneering in the photographic charting of the extragalactic nebulae, found the first rich cluster of these objects in Coma Berenices.

Nebular Photography After 1900

Thus nebular photography began to develop by two dissimilar techniques. One was with wide-field, lens-type star cameras (astrographs), the other with small-field reflectors. The two types were the astronomical analogues of the shotgun and rifle, with photography in the role of gunpowder. Also, the beginning of the 20th century marked a world-wide mushrooming of construction and operation of both types of photographic telescopes, which increased steadily in size and number as advances were made in optics and engineering.

The Harvard College observatory, Cambridge, Mass., probably led the field in exploiting the advantages of star cameras for nebular photography. Starting about 1900 in the southern hemisphere first at Arequipa, Peru, and after 1927 at Bloemfontein, S.Af., Harvard astronomers used the largest star camera—the 24-in. Bruce—to chart the distribution of nebulae over large areas in southern skies, and to study in detail those extragalactic bonanzas, the Magellanic Clouds. At their northern station on Oak Ridge, Mass., similar work was done with a battery of star cameras ranging in size from a few inches in aperture up to the 16-in. Metcalf. Carried out under the general direction of Harlow Shapley from about 1930–50, these photographic surveys have yielded an immense amount of information on the extragalactic nebulae.

Reflectors.—At the Mount Wilson observatory, Pasadena, Calif., the reflecting telescope was developed to its potential peak of perfection, along with accessory instrumentation that has immeasurably increased our knowledge of both galactic and extragalactic nebulae. It was there that G. W. Ritchey (1864–1945) figured to the highest optical quality the first large telescope mirror, which he also used under the most favourable conditions from 1909–17 in the 60-in. Mount Wilson reflector. His nebular photographs set a new standard in photographic definition, with the result that a few of the largest and nearest spiral nebulae were resolved into their brightest stars. G. E. Hale (1868–1938), who had few peers in the perception of the value of more powerful instruments to attack fundamental astronomical problems, was able in 1919 to place in successful operation on Mt. Wilson a 100-in. reflector. Programs of nebular research with this great telescope have produced a rich harvest of results, especially for the extragalactic nebulae. With it, Edwin Hubble (1889–1953) discovered in 1923 the first Cepheid variable in the Andromeda nebula, M. L. Humason began in 1928 his measurement of large red shifts (see *Red Shifts and Expansion of the Universe,* below) in the spectra of extragalactic nebulae, and W. Baade in 1944 resolved into stars the amorphous nuclear region of the Andromeda nebula. Thus to this one telescope we owe three of the most significant observational advances in modern astronomy: (1) the first true idea of the scale of the universe, from Hubble's work on the distances and real brightnesses of extragalactic nebulae; (2)

REFLECTED AND SCATTERED STARLIGHT OF THE PLEIADES (M45), GALACTIC NEBULA IN THE CONSTELLATION OF TAURUS, 490 LIGHT-YEARS FROM THE EARTH. STARS IN THE CLUSTER PROVIDE THE LIGHT, AND SURROUNDING CLOUDS OF FINELY DIVIDED DUST PARTICLES REFLECT AND SCATTER THE RAYS FROM THE STARS. 48-IN. PHOTOGRAPH

the concept of an expanding universe, from the velocity-distance relation based on Hubble's distances and Humason's red shifts; and (3) the recognition of two distinct stellar populations of different age and evolution, from Baade's synthesis of highest-fidelity photographs in blue and red light.

Modern Developments.—Among the many large and modern star cameras, the 20-in. Carnegie astrograph at the Lick observatory deserves special mention. Installed in 1939, its basic program proposed by W. H. Wright was to provide a set of first-epoch

VEIL NEBULA (N.G.C. 6992 AND 6995) IN CYGNUS, A NORTHERN CONSTELLATION. THE NEBULA GLOWS AS IT COLLIDES WITH DUST AND GAS IN INTERSTELLAR SPACE. HOT BLUE LIGHT IS EMITTED FROM THE LEADING EDGE OF THE NEBULA WHERE THE HARDEST COLLISIONS OCCUR; LESS ENERGETIC COLLISIONS IN THE TRAILING EDGE CAUSE A RED GLOW. 48-IN. SCHMIDT PHOTOGRAPH

photographs of the northern two-thirds of the sky, for the most accurate measurement of galactic stellar motions with respect to the background of faint extragalactic nebulae. The full set of 1,246 plates was obtained in 1947–54 by C. D. Shane and C. A. Wirtanen who began in 1948 to count the several millions of extragalactic nebulae recorded. Although this set of plates maps the sky with high precision to about the 19th magnitude, its quality as a photographic sky atlas cannot compare with that obtained by a new type of star camera.

The Schmidt Telescope.—Invented about 1930 by Bernhard Schmidt ([illegible]–1935) at the Hamburg observatory, Bergedorf, Ger., the optical system that bears his name has revolutionized nebular photography. With pure genius, he placed a thin, weakly curved, aspherical lens at the centre of curvature of a spherical mirror, and in this simple but elegant way produced an optical system that would have high speed, large field and nearly colour-free images. This was a major advance in optics, and its rapid introduction in astronomy is due in large measure to Schmidt's colleague Baade, who fully realized the importance of the discovery when he came to the Mount Wilson observatory in 1931. At that time plans and programs were being made for a 200-in. reflector, and it was decided to build an 18-in. Schmidt camera as a pilot model survey instrument. Its immediate success led to the design, and construction after World War II, of the 48-in. Schmidt telescope on Palomar mountain. Its performance tests in 1948–49 so far exceeded all previous wide-field, faint-limit photographs that its first program was to survey all the sky observable from the northern hemisphere. From 1949–56, under the joint sponsorship of the National Geographic society and Palomar observatory, the 48-in. Schmidt was used to obtain the 879 plate-pairs—one exposure in blue light and one in red light—in this finest of all photographic sky atlases. Carried out under the critical supervision of R. Minkowski, this survey by the 48-in. Schmidt has recorded so much new information on nebulae that it will serve as a prime source of research programs for many years.

The 200-inch Reflector.—Closely following the initial successes of the 60-in. and 100-in. reflectors, Hale in 1928 was able to initiate the project that is of incalculable value for nebular research: the building of a 200-in. reflector. The funds were provided by the General Education board of the Rockefeller foundation, on the condition that the telescope be maintained by the California Institute of Technology, Pasadena, and be operated in full co-operation with the Mount Wilson observatory of the Carnegie Institution of Washington. A satisfactory 200-in. mirror of a special Pyrex glass was successfully cast by the Corning Glass Co. at Corning, N.Y., in 1934, and the optical surfacing was done in Pasadena during 1936–42 and 1945–47. Under the direction of I. S. Bowen the telescope with its mirror installed was given thorough optical and mechanical tests, and preliminary astronomical trials, in 1948–49. Hubble had the honour of taking the first nebular photograph on Jan. 26, 1949, with the 200-in. reflector, by this time named the Hale telescope. From about Jan. 1950 this great instrument has been in regular use on the Mount Wilson and Palomar observatories research programs, with discoveries that have already justified the cost, time and resources involved in its realization.

Three results of extraordinary interest for nebular research are: (1) the measurement in 1950 by Humason of a nebular red shift in velocity units of 38,000 mi. per second or nearly one-fifth the velocity of light; (2) the demonstration in 1952 by Baade of the need for revision upwards, by a factor not less than 2, of the extragalactic distance scale; and (3) the identification in 1953 by Baade and Minkowski of several of the brighter optical astronomical radio sources.

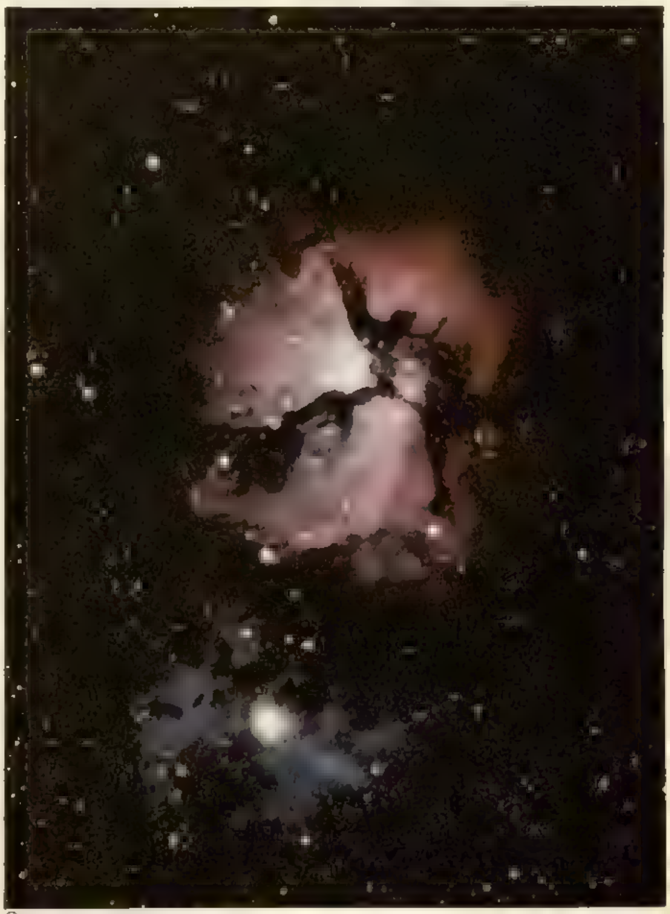
Classification of Nebulae.—As has been explained, the nebulae fall naturally into two groups designated the galactic and the extragalactic. Alternate names for the latter group—by far the largest—are nongalactic, anagalactic, or merely galaxies. Galactic nebulae are found in or near the plane of the Milky Way (the galaxy), while extragalactic nebulae or galaxies are seen, for the most part, outside the Milky Way. The division is not merely one of apparent distribution over the sky, for the two classes of objects differ fundamentally in every important respect, such as distance, intrinsic size and brightness and constitution. In fact, the two categories are so dissimilar that they should logically be separately discussed.

III. THE GALACTIC NEBULAE

These are of two types: (1) diffuse nebulae and (2) planetary nebulae. The first kind includes bright and dark nebulae, but with no clear-cut division, since the two are often found thoroughly mixed together. The second kind has a characteristic appearance, usually a round or a symmetrical structure, with a star near the centre of the nebula.

Diffuse Nebulae

Modern work on interstellar material suggests that diffuse nebulae may be regarded from the following very general point of view. Throughout our own stellar system, of which the fundamental plane is the Milky Way, there is a thin layer of nonluminous



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TRIFID NEBULA (M20, N.G.C. 6514) IN THE SOUTHERN CONSTELLATION OF SAGITTARIUS. A BRIGHT, DIFFUSE NEBULA. IT IS AN EXAMPLE OF THE OBSCURING MATTER LOCALIZED IN STREAKS OR LANES. 48-IN. PHOTOGRAPH

matter. This material, a mixture of atoms, molecules, dust particles and larger masses, is not uniformly distributed, but is relatively concentrated in some regions, and extremely tenuous or absent in others. In some cases denser clouds are situated in front of a bright, starry background. They are then revealed in silhouette, and photographs such as Barnard's record them as dark nebulae.

On the other hand, it often happens that single stars, or groups of stars, lie in the denser parts of the stratum. In this case the stars illuminate the surrounding cloud, much like street lights in a fog, and bright nebulae may be seen or photographed by the light coming from the particles composing the cloud. Mixed bright and dark nebulae occur in circumstances where a cloud is so large that the light from the involved stars does not penetrate

to its boundaries, so that a bright nebula appears to be superposed on a larger dark one; or again, the obscuring matter may be localized in streaks or lanes, which are outlined or contrasted against the brighter and less opaque parts of the cloud.

Bright Diffuse Nebulae.—The true character of these objects became known in 1864–68 when William Huggins (1824–1910) examined several of them with his spectroscope and found their light highly concentrated into a few bright radiations, typical of a rarefied gas excited to luminescence. So many more were subsequently found to have a similar spectrum that for nearly half a century it was generally supposed all diffuse nebulae were incandescent gases. In 1912, however, V. M. Slipher of the Lowell observatory announced that the spectrum of the nebulosity around the Pleiades gave an absorption spectrum, which is a continuous, coloured band of light crossed by dark lines. Furthermore, the nebular spectrum was like that of the stars imbedded in the nebula.

LAGOON NEBULA (M8, N.G.C. 6526) IN THE SOUTHERN CONSTELLATION OF SAGITTARIUS. THIS BRIGHT, DIFFUSE NEBULA IS SO LARGE THAT LIGHT FROM THE INVOLVED STARS DOES NOT PENETRATE ITS BOUNDARIES AND THE NEBULA ITSELF APPEARS TO BE SUPERPOSED ON A LARGER, DARKER ONE. 200-IN. PHOTOGRAPH

These results, which were later obtained for a number of other diffuse nebulae, provided evidence for the view that some nebulae shine by scattered or reflected light directly received from the stars, rather than by emitted light indirectly excited in the nebula by ultraviolet radiation from the stars. The latter mechanism was thoroughly analyzed by I. S. Bowen in 1927, and it is of great astrophysical importance (see *The Gaseous Spectrum of the Nebulae*, below). Before Bowen explained the origin of the nebular emission spectrum, however, Hubble in a pioneering investigation of diffuse nebulae published in 1922 discovered one of the most significant properties of these objects: whether a diffuse nebula shines by emitted light (bright-line spectrum) or by reflected or scattered light (absorption spectrum) depends upon the temperature of the star or stars concerned. Although there is some overlapping, in general it is found that stars hotter than about 20,000° C. (spectral type B1 or earlier) can excite an emission spectrum in the gases in the nebula, while cooler stars merely illuminate the nebular particles.

These results by Hubble and by Bowen stimulated an immense amount of research on the gaseous nebulae, the a[illegible]nce beginning about 1930 and continuing in accelerated fashion to the present. Observationally, Hubble's exploratory survey of known nebulae was followed by a large number of more detailed and extensive searches for fainter nebulae and involved stars; on the theoretical side, Bowen's explanation of the nebular gaseou[illegible]ectrum led to a veritable flood of analytical papers dealing [illegible] the physical processes in the nebular gases. Taken togethe[illegible]s work represents a major increase in astronomical knowledg[illegible]ot merely of the interaction between stars and interstellar [illegible]nd dust, but more generally of the structure and evolution o[illegible] Milky Way.

H I and H II Regions.—One of the stronges[illegible]diations from gaseous diffuse nebulae is the hydrogen alpha ([illegible]) line, which occurs in the red part of the spectrum at a wav[illegible]ngth of 6,563 angstroms (Å). This is a fortunate circumstan[illegible]ause red light is less absorbed than blue in the galactic dust cl[illegible] Thus most modern photographic searches for gaseous nebul[illegible]e been made in Hα light, usually with high-speed cameras of [illegible] Schmidt type employing colour filters or objective prisms to [illegible]ate a narrow band of wave lengths around Hα. This proced[illegible]lso markedly reduces the fogging effect of the night sky airgl[illegible] which chiefly limits the search for faint objects.

A notable application of this technique was that carried out by O. Struve and associates in 1937–42 at the Yerkes and McDonald observatories at Lake Geneva, Wis., and Mt. Locke, Tex. With a large and efficient nebular spectrograph of ingenious new design, they found many extremely faint Hα emission regions in the Milky Way. This observational advance was closely related to a theoretical one of high significance for galactic structure. In 1939 and in 1948 B. Strömgren at the Yerkes and Copenhagen observatories worked out and then applied the theory of hydrogen ionization (electron removal) to the case of hot stars imbedded in the galactic stratum of gas and dust. To him we owe the fruitful concept of fairly sharply bounded regions inside of which there is ionized hydrogen, H II, and outside, neutral hydrogen, H I. This theory not only accounted qualitatively for the appearance of many of the nearly circular patterns and broken arcs of gaseous nebulae, but it also gave numerical values for their radii, which depended upon the gas density and the temperatures of the exciting stars. For example, in an interstellar gas of density one atom per cubic centimetre, a very hot (30,000° C.) O-star could produce an H II region about 500 light-years in diameter, but a cooler (10,000° C.) A-star, one of only 1.5 light-years.

The practical value of these "Strömgren spheres" became apparent as other Hα surveys of the Milky Way, in both northern and southern hemispheres, revealed new gaseous nebulae in large numbers, in a great range of sizes, and of spectacular complexity. But this puzzling pattern in general could be resolved into a hierarchy of interlocking, or overlapping, H II regions, each with its responsible one or more hot stars. In this way, important corroborative evidence was obtained of galactic spiral structure, first found in 1951 in another manner by W. W. Morgan of Yerkes observatory. For these H II regions, as shown by W. Baade's work in 1947–50 on the Andromeda nebula, follow fairly faithfully the windings of its spiral arms.

Variable Nebulae.—These are of two kinds: (1) those associated with unusual variable stars, and (2) those observed to form around novae after outburst. The former may be termed irregular, because of their structure and variability in light, while the latter are described as expanding, because their sizes increase with time.

The irregularly variable nebulae comprise a small group of less than a dozen known members. Without exception, they occur in dark regions of the Milky Way and are close to peculiar variable stars. In appearance they are diffusely irregular, like Hind's nebula (N.G.C. 1555) with T Tauri, or fan-shaped like Hubble's (N.G.C. 2261) with R Monocerotis and N.G.C. 6729 with R Coronae Australis, or double-bowed like that with R Aquarii. Although

all these objects have been repeatedly photographed, there is little evidence that their parts have moved, or that their light variations correspond with those of the involved stars. Spectroscopic study of these nebulae and stars has shown that they are fundamentally different from the gaseous H II regions, for the nebular spectra are generally continuous as for reflection nebulae, while the stellar spectra are characteristic of average or dwarf stars. These results, obtained prior to 1945 mainly by V. M. Slipher and C. O. Lampland at the Lowell observatory in Arizona, and by E. Hubble and A. H. Joy at the Mount Wilson observatory in California, directed attention to stars involved in dense clouds of dust and gas in the galaxy. Modern studies of their mutual interaction have provided information that probably bears directly on star formation (see *Dark Nebulae*, below).

Expanding nebulae result from probably the most violent of all celestial phenomena: the novae. These are stars that suddenly release enormous amounts of energy when they reach a critical or unstable state in their evolution. In only a few hours a normal star may flare up until it shines with a power of thousands of suns, if a common nova, or blazes with a brilliance of millions of suns, if a supernova. These are respectively the cosmic counterparts of the terrestrial A- and H-bombs, for they explosively pour out radiation and gases at fantastically high rates. The radiation [illegible] the nova with the speed of light, 186,000 mi. per second, w[illegible]e ejected gases move outward with velocities of a few hundr[illegible] thousands of miles per second. Thus there is a time lapse between discovery of the nova and direct observation of its expanding gaseous nebula, which is known from spectroscopic observations to originate at the time of outburst. Depending on the amount and velocity of the gases, and the distance of the nova, the expanding nebula may not be seen or photographed until months or years after outburst. But when it can be distinguished from the fading star, measurement of the nebula's size provides one of the best estimates of the nova's distance. For the diameter of the nebula (in seconds of arc) divided by the time since outburst gives the angular rate of expansion, whereas the spectroscopic observations, by Doppler's principle, give the linear rate of expansion (in miles per second). Whenever both angular and linear valu[illegible] the same quantity are known for a remote object, a simple calculation gives its distance.

In this way distances ranging from 1,000 to 5,000 light-years have been determined for some of the best-observed common novae. With these distances and certain reasonable assumptions, it has been calculated that the expanding nebulae probably have masses nearly negligible compared to the stars that produced them. Thus the common novae, despite their spectacular performance, are not disastrously affected. They merely blow off some thin, outermost atmospheric layers, which become invisible in the astronomically brief time of less than 100 years.

The Crab Nebula.—Supernovae are so rare that adequate observations of their nebular gases are available for only one of the galaxy's three known supernovae—that of A.D. 1054. Its cloud of expanding gas is the remarkable Crab nebula in Taurus, which is unique in being so long-lived and so large and bright compared to any possible stellar remnant. Studies by Baade and Minkowski in 1942 showed that the nebula consists of two distinct parts. One is a complex filamentary structure, possibly a distorted thin shell, known to be composed of ionized gas, while the other is a diffuse amorphous mass thought to be mainly electrons. Although a central 15th-magnitude star, whose temperature was computed as 500,000° C., was considered as the energy source, this interpretation has been supplanted by a much more interesting one. In 1949 the Crab nebula was found by the Australian radio-astronomers J. G. Bolton, G. J. Stanley and O. B. Slee to be one of the brightest radio sources in the sky, and in 1952–53 its light was discovered to be polarized, by the Russian astronomers M. A. Vashakidze and V. A. Dombrovsky of the Burakan observatory. They followed up a suggestion by the Russian astrophysicist I. S. Shklovsky, who proposed to account for the unique brightness of the nebula in both optical and radio regions as the radiation of electrons accelerated in a magnetic field—like that in a synchrotron. This explanation was given considerable support in a compre-

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CRAB NEBULA (M1, N.G.C. 1952) IN THE CONSTELLATION OF TAURUS, A GASEOUS REMNANT OF THE GALACTIC SUPERNOVA OF A.D. 1054. THE NEBULA IS 5,000 LIGHT-YEARS AWAY AND IS EXPANDING AT 700 MI./SEC. IT IS AN INTENSE RADIO SOURCE WITH PART OF ITS LIGHT BEING POLARIZED. PHOTOGRAPHED WITH THE 200-IN. TELESCOPE AT MOUNT PALOMAR OBSERVATORY, CALIF.

hensive investigation published in 1956 by J. H. Oort and T. Walraven, of Leiden University observatory. From analysis of their photoelectric polarization measurements, they concluded that the magnetic field probably lies in the filamentary structure, and that the energies of particles accelerated in it may be high enough to make the Crab nebula a strong source of cosmic rays.

This expectation was realized in 1963 when H. F. Friedman and his colleagues at the U.S. Naval Research laboratory, Washington, D.C., found that the Crab nebula is one of the brightest X-ray sources in the night sky (the sun, of course, being the strongest one in the entire sky). This discovery, which opened up the entirely new field of X-ray astronomy, was made by launching Aerobee rockets beyond the earth's atmosphere to a distance of more than 100 miles. By firing a stabilized rocket at just the right instant and by remarkable split-second timing of their observations, the same group measured the variation in the X-ray source's intensity as the moon occulted the Crab nebula on July 7, 1964. The X-ray intensity did not suddenly disappear but instead gradually declined to zero as the moon's edge passed in front of the nebula. Thus, it was possible to conclude that the source is not stellar but has a diameter of about 1 minute of arc, or a real size of about 1 light-year near the centre of the nebula.

Dark Nebulae.—The Milky Way contains a great number of dark patches or markings, some nearly devoid of stars. A few were first noted by the Herschels, who thought they were holes giving a view into empty space beyond. Although Barnard at first agreed with this idea, his extensive photographic surveys convinced him and others that the dark nebulae are due to nonluminous matter. Their range in apparent size is enormous: from small patches of a

few seconds or minutes of arc, and long lanes of several degrees like those in Ophiuchus and Scorpio, up to the great rift that bifurcates the Milky Way for some 120° from Cygnus to Centaurus.

It might be thought that little could be learned of objects that are discerned by their apparent lack of light, but this natural impression is far from true. Much has been found out about dark nebulae from their effects on the light of stars seen through or within them. For the nonluminous material is composed of dust or smoke particles—a space smog that scatters, dims, reddens and polarizes passing photons of light, as in the familiar phenomenon of sunset in a hazy atmosphere. All these effects are susceptible of measurement, and the results give information on the distances and dimensions of dark nebulae, and, of equal importance, on the particle size, density, shape and orientation.

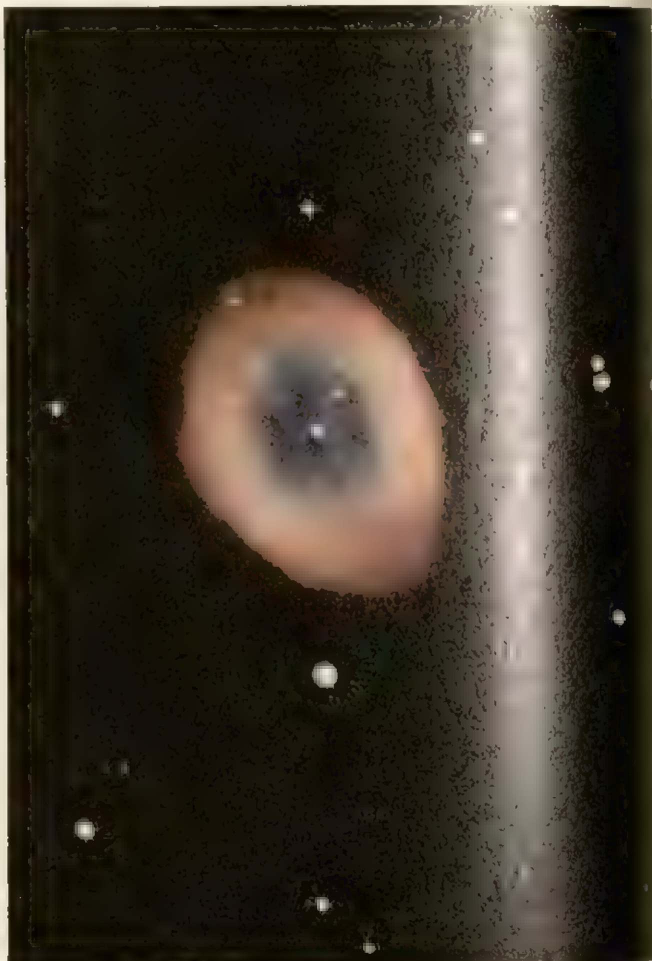
Max Wolf in the last decade of the 19th century was first to show how star counts around and in a dark nebula could be used to estimate its distance and absorptive power. Outside the nebula the number of stars increases steadily with faintness; inside, at some level of brightness, the number falls below that outside. The magnitude at which the deficiency appears indicates the distance, while the percentage deficiency gives the total absorption. The method is crude because of the great range in real brightness of stars, but by certain statistical refinements A. Pannekoek of Amsterdam showed that it could give reliable relative distances, and, with a count to faint limits, accurate absorptions. Most of the prominent dark nebulae have been investigated by this star-count method, and it has been found that the nearer ones such as those in Aquila and Taurus and the southern Coalsack are only 400 to 500 light-years distant, while the more remote ones like those in Cygnus, Orion and Monoceros are 2,000 to 3,000 light-years away. The total absorptions generally are in the range from 30% to 95%, although there are some dark nebulae that scarcely obscure and others that are nearly opaque.

Cosmic Dust.—The physics of finely divided material has become a subject of major importance in astronomy because of its bearing on distance estimates, and on theories of star formation and evolution. Obviously, if the intensity of starlight decreases faster than inversely as the square of the distance, as would happen for light passing through obscuring matter, then distances derived from apparent brightness would be too large. It is likewise plain that the most promising place to seek an understanding of stellar origin and early development probably is in a dark nebula, where conditions are favourable for formation of stars by condensation, contraction and accretion processes in the clouds of cosmic dust particles. In both cases, it is vital to have as much knowledge as possible of the physical properties, chemical composition and environmental conditions of this interstellar matter.

Pioneering investigators of the properties of small cosmic grains were H. von Seeliger (1849–1924) of Munich, Ger., and H. N. Russell (1877–1957) of Princeton, N.J. As the result of some work on the swarms of meteorites that form Saturn's rings, Seeliger in 1901 made a theoretical study of the reflection of light from small bodies, and his formulation of the problem strongly influenced much later work on reflection nebulae. Russell, however, in 1922 worked out a theory of submicroscopic particles for which reflection was small compared to scattering or absorption of light. He obtained formulas that gave absorption as a function of particle size, and concluded that dimming was most pronounced for a size about 1/150,000 in., or one-third the wave length of visual light. This theory was considerably extended during 1930–35 by C. Schalén of Uppsala, Swed., who included more specific particle properties in the equations. From the colours and spectra of stars involved in dark nebulae, he inferred that the chemical composition is mainly metallic, with compounds of iron, zinc and copper. Studies of bright reflection nebulae, on the other hand, notably in 1935–40 by O. Struve, J. L. Greenstein and L. G. Henyey of the Yerkes and McDonald observatories, tended to support the hypothesis of a nonmetallic make-up, with icelike compounds of the much more abundant elements hydrogen, oxygen, carbon and nitrogen.

Although there was, and still is, some uncertainty regarding the principal chemical constituents, evidence has steadily accumulated that the mixture of particle sizes is much the same throughout the galaxy. This is an extremely important result for nearly all astronomical researches involving distances beyond the range of direct survey, or trigonometric, methods. The reasons for the significance of this result, and how it was obtained, deserve to be detailed.

Space Reddening of Starlight.—Nearly everyone knows that the sun seems redder near the horizon than overhead, and that the sky around it is blue at normal altitudes. Both effects are due to atmospheric particles that absorb and scatter blue light much more than red. The process is known as Rayleigh scattering, after Lord Rayleigh (1842–1919), who found that the atmospheric absorption varied inversely as the fourth power of the wave length. For example, since deep red light has twice the wave length of deep blue, it is absorbed only $(\frac{1}{2})^4 = \frac{1}{16}$ as much, and objects observed through long atmospheric paths appear reddened by this selective absorption. Moreover, Rayleigh also showed that this particular absorption law is characteristic of particles mainly of dust size, or somewhat less than the wave length of light. Thus the particle mixture is more typical of the chemical composition than of contaminating larger-size dust particles, and it may be considered the same throughout the earth's atmosphere.



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RING NEBULA (M57, N.G.C. 6720) IN THE NORTHERN CONSTELLATION OF LYRA, CONSISTING MAINLY OF GASES THROWN OFF BY THE STAR IN THE CENTRE. 200-IN. PHOTOGRAPH

This wave length-selective effect on light that has passed through a nontransparent medium is the means by which astronomers have been able to determine a general interstellar absorption law, to estimate the sizes and kinds of particles, and to correct distances of obscured objects. For example, particle sizes of dust dimensions are estimated from colour observations of reflection nebulae, which are not nearly so blue relative to their illuminating

stars as the daylight sky is to the sun; the elements composing the particles are inferred from much modern work on their abundances in stars and nebulae. To correct a distance of an obscured object, it is necessary to know the total absorption, which can be found from the selective if the absorption ratio = total/selective is known. To determine this ratio and to find out whether it is essentially the same throughout the galaxy, colour observations for a large number of objects and for a long range of wave lengths are required.

The most comprehensive series of programs that provided many of the basic data on space reddening and absorption are those carried out from about 1930–50 by J. Stebbins, C. M. Huffer and A. E. Whitford, of the Washburn observatory, Madison, Wis. By developing and applying photoelectric techniques of precision and of great sensitivity, they first determined accurate colours for more than 1,300 distant high-luminosity O- and B-stars and for most of the globular star clusters. Next, for limited lists of the brighter stars, they obtained six-colour measurements ranging from the ultraviolet to the infrared. Finally, in 1947 Whitford extended the selective absorption curve to the extreme astronomical infrared at 21,000 Å, and showed that a good approximation is a law giving the absorption as the reciprocal of the wave length. Although this law had already been anticipated by previous work on reflection nebulae, and from spectrophotometry of stars in dark nebulae, it was Whitford's far-infrared work that established its validity over the entire astronomical optical spectrum. This inverse wave length law provided the basis for confident calculations of the ratio of total to selective absorption, while the six-colour observations of widely distributed stars gave assurance that it was valid in many Milky Way regions. Since a few apparent exceptions have not stood the test of time, as additional and more precise data were obtained, it may be said that the discolouring dust of space possesses a remarkable uniformity of particle-size distribution, and probably of chemical composition.

Interstellar Polarization.—A significantly new property of the particles composing dark nebulae was discovered in 1949 by J. S. Hall of the U.S. Naval observatory at Washington, D.C., and W. A. Hiltner of the Yerkes and McDonald observatories. They found by precise photoelectric measurements that the light of highly space-reddened stars is polarized. This result means that the interstellar particles are so shaped and oriented in space that they cause passing light waves to vibrate in a preferential plane. By 1956 polarization observations had been made for hundreds of stars of many kinds, in the northern Milky Way principally by Hiltner and by Hall with A. H. Mikesell, in the southern by Elske van P. Smith of the Harvard College observatory. This work showed that: (1) the strongest polarization occurs only for highly reddened stars whose light has been strongly absorbed; (2) the orientation of polarization planes is often closely the same for fairly large regions, of the order of several hundred to 1,000 light-years; (3) there is an over-all strong tendency, along nearly the entire Milky Way, for alignment parallel to the galactic plane. Interpretation of these results indicates, first, that the particles probably are elongated, some four to five times longer than wide, with their major axes generally at right angles to the Milky Way plane, and second, that there is some large-scale mechanism, possibly of galactic dimensions, producing this long-axis alignment. The various explanatory theories of the phenomenon differ chiefly in the chemical composition assumed for the particles. If these are nearly nonconducting or dielectric, hypotheses involving spinning spicules and streaming gases have been advanced; if mainly metallic, a magnetic field. Although the mechanism of alignment cannot be considered uniquely identified, there is increasing evidence, such as the Crab nebula polarization, magnetism in stellar atmospheres and high-energy cosmic rays, that magnetic fields in the galaxy may be important elements in its structure.

Star Formation.—The relationship of nebulae to stellar origins has long been one of astronomy's prime problems, dating from the earliest visual observations of associated nebulae and stars. Little progress beyond philosophical speculation was possible, however, until a great deal of data on distances, dimensions, real brightnesses (luminosities), motions, masses and radiating properties became available for both stars and nebulae. These data demonstrated that the stars of highest luminosity are generally found associated with nebulae both bright and dark, that they radiate energy at such spendthrift rates they can last only a few million years and that their motions in space average among the slowest in the galaxy. Such facts point with more than strong suspicion to a nebular origin for these stars; otherwise their association would not be so close. For the age of the galaxy is reckoned a thousand times greater, and there has been sufficient time for these stars to have moved from nebulae and to dim to comparative obscurity on the cosmic scene.

While this concept seems satisfactory for supergiant stars, they represent but a small part of the galactic population. To be applicable in general, a theory of star formation needs to account for the great bulk of average-type stars like the sun, whose hydrogen mass and energy output can sustain it for several thousand million years. Since many nebulae contain clusters of stars of a wide range of brightness, it seemed reasonable to look closer at some of the fainter ones, and particularly at those whose irregular light variations seemed unique for stars in dark nebulae. From extensive studies of groupings of these fainter nebular variables, the Russian astronomers V. Ambartsumian and P. Kholopov concluded in 1950 they are young stars of unstable behaviour, and termed them T-associations, after the prototype variable T Tauri, the illuminating star of Hind's variable nebula (N.G.C. 1555). In 1945 A. H. Joy of the Mount Wilson observatory reported spectroscopic observations for a number of T Tauri variables that led to their recognition as a distinctive class of emission-line objects found only in dark nebulae. Subsequent surveys to much fainter magnitudes, especially by G. Haro at the Tonantzintla observatory, Mex., and by G. H. Herbig at the Lick observatory, resulted in the discovery by 1950 of hundreds of generally similar stars, without exception in dark nebulae. By 1952 Herbig's detailed studies of the emission-line objects, which comprise only a portion of the variables, revealed for these stars two significant facts that are consistent with the hypothesis of recent formation. First, these stars appear to be rotating abnormally fast for their size and mass; second, they are abnormally bright in blue and ultraviolet light for their temperatures. Both these properties have been predicted in theories of star formation from cosmic dust clouds: as residual rotation from turbulent motions, and as excess radiation from a contracting nebula-star interaction.

Radio Observations of Dark Nebulae.—The development of radio astronomy after World War II provided a powerful new technique for the study of dark nebulae, for two reasons. First, radio waves pass through dense dust clouds that practically blot out ordinary light. Second, the relationship between the dust and involved hydrogen gas may be found as the result of a brilliant prediction in 1944 by the young Dutch astronomer H. C. van de Hulst of the Leiden observatory. He pointed out the possibility of observing radio radiation of 21 cm. wave length from neutral hydrogen, or H I, and it was first detected in the galaxy in 1951 by H. I. Ewen and E. M. Purcell, Harvard university physicists. This discovery, potentially comparable in its consequences with the invention of the telescope, has made possible detailed astrophysical investigations of some of the larger gas-dust complexes in Perseus, Taurus, Orion and Ophiuchus, notably by B. J. Bok and his younger colleagues A. E. Lilley, D. S. Heeschen and T. K. Menon. Working with the 24-ft. radio telescope at the Agassiz station of Harvard College observatory, they reported results in 1954–56 relating to the relative distributions of dust and neutral hydrogen gas, the density ratio of gas/dust and total masses. Over large areas the H I gas emission is prevalent wherever the optical obscuration by dust is evident, but the smaller darkest nebulae are not necessarily the best radio emitters—the dust is apparently more locally concentrated than neutral hydrogen gas. In the Orion-Taurus complex the gas/dust density ratio in the mean is 100, but with a big range from 35 to 250. The average value would indicate, for an estimated total H I mass of 21,000 suns, that all the dust amounts to only about 200 solar masses. These figures, however, involve a number of simplifying assumptions

that are normally unavoidable in a new field. For example, the H I gas/dust density ratio could be appreciably reduced if evidence for molecular hydrogen H_2, or for hydrides like OH, NH or CH were found by improved microwave techniques and larger radio telescopes.

Planetary Nebulae

These are so named because their appearance in a telescope resembles that of planets, for they show disks with definite edges. But unlike the planets, these nebulae show no appreciable motion among the stars, since they are generally more distant than the stars seen in the same field. Compared to diffuse gaseous nebulae, planetaries are apparently and actually much smaller, and they ordinarily have a distinguishing bright-line spectrum.

Numbers and Distribution.—Planetary nebulae as a class are relatively scarce and unique in the galaxy. Only about 130 were known prior to 1940, but prismatic and Schmidt camera surveys by R. Minkowski, G. O. Abell and A. G. Wilson at Mount Wilson and Palomar observatories, by G. Haro at Tonantzintla, Mex., and by K. G. Henize at Bloemfontein, S.Af., by 1956 had increased the number known to nearly 600. Many of these later discoveries appear starlike except on photographs taken with the largest telescopes, and a large majority are in heavily obscured regions. For these reasons there are probably many more undiscovered planetaries, and the galactic total has been estimated as high as 10,000, a small number compared to the stellar population of thousands of millions. Although some planetaries are found all along the Milky Way, but with much less concentration than the stars and gaseous diffuse nebulae, there is a marked grouping of many of the faintest ones in the Sagittarius-Scorpio region, as is the case for the globular star clusters. This distribution means that the planetaries as a system cluster around the centre of the galaxy, at distances ranging up to 30,000 light-years.

Apparent Size and Structure.—In apparent size planetary nebulae range from the large Helical nebula in Aquarius, N.G.C. 7293, which is about half the diameter of the moon, down to objects of a few seconds of arc, so small they can hardly be picked out among stars, unless their spectra are available. In nearly all planetaries that are sufficiently large and bright, a central blue-white star can be found. The few exceptions are more apparent than real, because these central stars are among the hottest celestial sources. They have temperatures in the range from 50,000° to 150,000° C. so that most of the energy is radiated in the far ultraviolet where it is not only invisible but also blocked off by the earth's atmosphere. The nebular gases, however, have a much lower temperature, of the order of 10,000° C. Thus the nebula may be considerably brighter to the eye or on a photograph than the central star.

When planetaries are examined visually or on photographs taken with average-size telescopes, they tend to show a regular structure, which has encouraged classification and interpretation according to simple geometrical forms. The most common of these are shells, rings, spirals and helices. H. D. Curtis (1872–1942) of the Lick observatory pioneered in this approach with the 36-in. Crossley reflector, and found in 1918 that oblate spheroidal or truncated shells, thinner at the equator than at the poles, accounted satisfactorily for the regular appearance of many planetaries. For the brighter ones in the southern hemisphere, A. D. Thackeray and D. S. Evans in 1950 reported a similar survey based on plates taken with the 74-in. reflector of the Radcliffe observatory, Pretoria, S.Af. They described the observed forms in terms of a simple disk and ring, with central symmetry about two perpendicular axes; but for about 30% of the objects they gave the classification as irregular.

These idealized geometrical models, although useful in the exploratory or survey stages, are found to be inadequate when confronted with the most recent material obtained with the largest telescopes and improved techniques of photography and spectroscopy. R. Minkowski's photographs taken since 1950 with the 200-in. Hale telescope reveal in most cases a complex arrangement of filaments, knots, streamers and arcs that are difficult to fit into simple geometrical figures. These difficulties are due to at least two properties of the nebular gases. First, the ions (atoms minus electrons) of different gases are distributed differently, as shown by colour-filter photographs or slitless spectrograms that isolate individual emission lines of the various elements. Second, when the emission radiations are studied with slit-spectroscopic methods, internal motions of different amounts are found for different ions.

Internal Motions.—These were first found convincingly in 1916–18 by W. W. Campbell (1862–1938) and J. H. Moore (1878–1949) of the Lick observatory. They observed that the chief nebular lines of oxygen are not strictly single (monochromatic) in a number of planetaries. The lines appeared broadened or split into two components, which by Doppler's principle points to different velocities in the line of sight. The measured differences ranged from 10 to 60 mi. per second among the planetaries studied, and were considered due to rotation of the nebulae. Later developments showed, however, that the effects were produced by gases that move generally outward from the central stars, the expansion velocities being half the observed velocity differences. These observations were far ahead of their time and remained unapproached in accuracy and completeness for nearly 30 years.

In 1946 O. C. Wilson of the Mount Wilson and Palomar observatories began a systematic program of spectroscopic investigation with much more powerful equipment. First with the 100-in. and after 1953 with the 200-in., he used the large-scale slit spectrographs at the coudé foci of these reflectors to obtain greatly dispersed spectra of the brighter planetaries. By 1950 he had found that no unique expansion velocity could be assigned to the same nebula, but that instead there are systematic motions related to the type of ion: those most highly excited (produced with highest energy) show smaller velocities than those of low excitation, except for hydrogen. Despite these additional complexities, Wilson found a model that showed promising agreement with the observations. These could be accounted for if it were assumed that the expansion velocity of any ion is the same as the hydrogen-helium velocity in the region where the ion is produced. To test this and other models, it was desirable to obtain radial velocities for a large number of points in each nebula. In 1953 the 200-in. coudé spectrograph was therefore provided with a multislit. This device consists of a series of closely spaced slits by which radial velocities for as many as 31 sections of a nebula may be obtained from a single exposure. In preliminary reports to 1956, observations made this way strongly support the view that several of the regular planetaries are ellipsoidal because the expansion velocity varies in a regular fashion from the centre. It seems that the constituent gases are arranged in space according to their velocities, the fastest ones being found farthest out.

Motions in the Galaxy.—The emission-line spectrum of planetaries has made possible the fairly accurate determination of radial velocities for even the faintest ones, and to Campbell and Moore is likewise due the first extensive list published in 1918. These data were thoroughly analyzed in 1937 by L. Berman of the Lick observatory, who concluded that the planetaries participate in the general rotation of the galaxy, and that those having the highest velocities are farthest away, as expected from the simple theory of circular motion. But the location of so many of the newly discovered fainter planetaries in the region of the galactic centre suggested an alternative interpretation of the largest velocities as motions in highly eccentric orbits. These could reasonably be inferred if additional radial velocities of a large and more random character were found for the numerous faint planetaries around the galactic centre. In 1953 a co-operative program to provide these new velocity data was undertaken at the Lick and Mount Wilson-Palomar observatories. From a preliminary report given in 1955, it seems likely that these new velocities may indicate less galactic rotation among the planetaries than formerly found, and a larger velocity dispersion in the direction of the galactic centre. Since these circumstances are similar to those for the globular star clusters, it is probable that they and the planetary nebulae belong to the same population group: Baade's type II.

Distances, Dimensions and Densities.—Planetary nebulae are so far from the sun that direct trigonometric distance deter-

BY COURTESY OF THE MOUNT WILSON AND PALOMAR OBSERVATORIES

GREAT SPIRAL NEBULA IN ANDROMEDA (M31, N.G.C. 224). ABOUT 2,000,000 LIGHT-YEARS DISTANT AND ABOUT 150,000 LIGHT-YEARS IN DIAMETER. PORTION OF THE GALAXY SEEN HERE, ALSO VISIBLE TO THE NAKED EYE, IS LESS THAN 100,000 LIGHT-YEARS ALONG ITS MAJOR AXIS. 48-IN. SCHMIDT PHOTOGRAPH

minations are useless, while statistical treatments of transverse or proper motions are unreliable, because the field comparison stars used in the measurements are at comparable distances. In an effort to minimize these difficulties, Berman derived a set of internally consistent distances from proper motions, angular diameters and galactic rotation theory applied to the radial velocities. In this way he obtained a scale of distances ranging from 3,000 to more than 30,000 light-years, but the values for individual nebulae are uncertain in some cases by factors of 2 or 3, because of the large dispersions in velocity, luminosity and diameter, and the irregular galactic absorption.

Berman's distance scale appears to be statistically of the right order, however, because of two independent but indirect checks on it. In 1950 Minkowski discussed the angular diameters of planetaries, with special reference to the more than 100 newly found ones in the direction to the galactic centre. By assuming them to be at the average distance of 30,000 light-years, he obtained the distribution of linear diameters, and found agreement with the corresponding one obtained from Berman's distance scale. Then in 1955 Baade discovered several of the brightest planetaries in the Andromeda nebula, on plates taken with the 200-in. Hale telescope. These planetary nebulae in the spiral have apparent magnitudes of 22, which is very nearly the brightness to be expected if the galactic planetaries, with luminosities based on Berman's distance scale, were viewed from a distance of 2,000,000 light-years.

The average linear diameter of the planetaries discussed by Minkowski is 30,000 astronomical units (1 a.u.=93,000,000 mi.), but this figure fails to tell the whole story of sizes of planetary nebulae. It does not include, for example, the faint outer extensions that are often observed in the nearer and brighter ones, which may reach 200,000 a.u. in size. Also, as Minkowski points out, the observed sizes represent only the ionized part of the nebular mass, and the neutral part may be much larger, as found for the diffuse gaseous nebulae in radio observations. On the other hand, there are a number of semistellar, dense planetary

nebulae, whose small diameters and spectroscopic characteristics suggest comparison with peculiar stars having extended atmospheres. Thus there is in reality a great range among planetary diameters, and size may be meaningless unless it is specified in terms of a particular density, element or degree of ionization.

The densities and masses of planetary nebulae can be fairly well estimated from theories of the physical processes in gaseous nebulae, since some of the most important atomic quantities are obtainable independently of the distance. For example, the density and temperature of electrons in the nebular gas may be deduced entirely from spectroscopic observations and astrophysical theory. In fact, the procedure may be reversed and, with the addition of absolute surface brightness measurements, used to estimate distances, as first indicated by D. H. Menzel in 1931 before there was a generally accepted distance scale. For some of the best-observed planetaries, moreover, the astrophysical results derived with and without distances are in substantial agreement. Thus there is reasonable reliability for the following estimates: density of a typical bright nebula: 1,000 to 10,000 ions per cubic centimetre; mass: one-tenth to one-fifth that of the sun. In the faint outermost parts the density may be only 100 atoms per cubic centimetre. This value has been brought down to earth by L. H. Aller of the University of Michigan observatory, who obtained and critically analyzed (in 1956) much of the best material in the field, by the statement that the density represents "a tenuity comparable to that of a few tablespoonfuls of air expanded to the size of Pikes Peak."

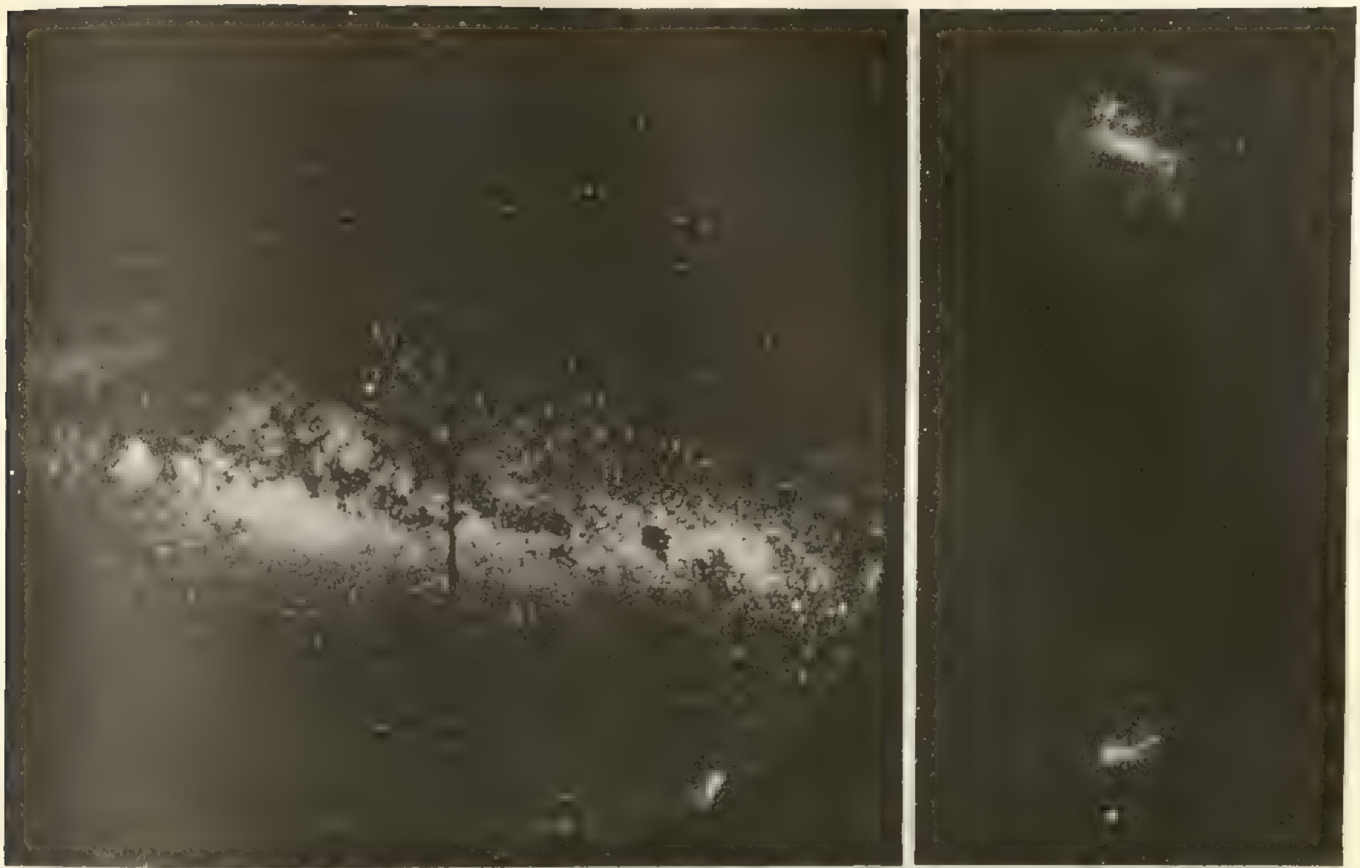
Origin and Evolution.—Planetary nebulae are so rare on the cosmic scene—less than one per 10,000,000,000 stars—that on the grand scale their evolution cannot be regarded as an important stage in general stellar evolution. Instead, planetaries serve best to draw attention to a particular process in stellar atmospheres: the ejection of material from the hottest stars. Since this phenomenon has been repeatedly observed in modern novae, it was natural to postulate that perhaps planetaries resulted from and represent the remnants of prehistoric nova outbursts. Apparent support for this view came from M. L. Humason's report in 1938 that 16 faint "old" novae are hot, blue stars like the nuclei of planetaries. This analogy, however, breaks down completely when subjected to quantitative analysis. For the gas masses, velocities of expansion and lifetimes of the nebular shells are of different orders of magnitude for novae and planetaries. Despite the many assumptions involved, reasonably computed values for a typical nova outburst are: 1/100,000 solar mass for the thrown-off gas, 1,000 mi. per second for the velocity of ejection and 50 to 100 years for the visible lifetime of the expanding nebula; corresponding figures for a representative planetary are 1/10 sun, 10 mi. per second and 10,000 years. Thus a planetary nebula requires for its origin and development a prolonged ejection process, one that may operate for a substantial fraction of the nebular lifetime. Although both novae and planetaries are transient phenomena on the general evolutionary scale of millions and billions of years for stars, the relative ages of nova and planetary nebular shells are those of an explosion and a slow burn.

The Gaseous Spectrum of the Nebulae.—The spectra of all gaseous nebulae, diffuse and planetary, are very similar in appearance, the differences consisting chiefly in the relative intensities of the bright lines. The lines in the spectra are sharp, a fact indicating a gas of low density; those of hydrogen are prominent and those of helium are usually present. But for more than 60 years following 1864, when William Huggins first observed the spectrum of a nebula, there were several lines (a wide pair in the green at 5,007 and 4,959 Å, and a close pair in the ultraviolet at 3,726 and 3,729 Å), among the strongest in the spectrum, which remained unidentified. Their origin was one of the most puzzling mysteries in astronomy, and for lack of a better name, they were attributed to a hypothetical element called "nebulium," although it was generally realized, because of advances in chemistry and physics that left no place in the table of known elements for foreign ones, the occurrence of the strange lines probably was due to some familiar element existing under conditions peculiar to the nebulae. That this explanation is the correct one was established in 1927 by I. S. Bowen. He showed on the basis of laboratory work and quantum theory calculations that the chief nebular lines are due to singly and doubly ionized oxygen atoms, which radiate light under conditions of extremely low density and long light paths—a combination unmatched on the earth.

Forbidden and Permitted Lines.—To understand why certain lines occur in the nebulae and not in terrestrial sources, it is necessary to mention a few of the fundamental principles of modern atomic theory. In this concept, atoms exist in certain definite energy states, depending on their environment. The energy states may be likened to orbits in which electrons move about the nucleus, and when an electron jumps from one orbit to another, energy is absorbed, or emitted, depending on whether the jump is from an inner to an outer orbit, or the other way around. The electrons, however, do not remain in the different kinds of orbits for equal times, and it is this property of the atom, together with its environment, which is responsible for the characteristic nebular radiations. The latter represent jumps to orbits in which electrons can move for hours and days, whereas radiations observed in terrestrial light sources correspond to transitions between orbits in which electrons remain for only 1/100,000,000 of a second. Spectral rays from long-lived orbits are called "forbidden" lines, those from the short-lived orbits "permitted" lines, and the reason only the latter are obtained in the laboratory is that collisions between atoms, even with the lowest obtainable densities, are so numerous (millions per second) that electrons are almost always knocked from the long-lived orbits before they have a chance to jump to an inner orbit, with the resultant emission of a forbidden line. In the nebulae, however, the extremely low densities and long light paths allow sufficient electrons to accumulate in the long-lived orbits (called "metastable states") to yield intense forbidden lines.

Physical Processes and Sources of Energy.—In addition to demonstrating the existence of an almost perfect vacuum in gaseous nebulae, the forbidden lines due to ionized atoms indicate the presence in planetaries of a very high-temperature source of energy. Evidence for this conclusion is provided by two apparently unrelated features of the nebular spectrum: (1) the size of a nebula is different in different radiations, and (2) only certain of the permitted lines of neutral oxygen and nitrogen are observed. The first of these properties, originally noted in 1908 by M. Wolf, and later (1918) extensively studied by W. H. Wright in his classically thorough investigation of the spectra of the gaseous nebulae, shows that the smallest nebular diameters correspond to the most highly ionized atoms, and the largest to the least, in just the way to be expected from Bowen's high-temperature theory of the structure of planetary nebulae. The second feature was likewise explained by Bowen as the result of an intense concentration of energy in the far ultraviolet, characteristic of a high-temperature source, which selectively excites the observed lines by a fluorescent mechanism. That the central stars of planetary nebulae are in reality among the hottest objects known was also established by Wright's observations of the spectra of planetary nuclei. Subsequent theoretical investigations by H. Zanstra, A. S. Eddington (1882–1944) and D. H. Menzel have fully substantiated Wright's earlier deductions from observations, and Bowen's conclusions from identification of the chief lines, that the dominating physical conditions in gaseous nebulae are extremes of low density in the nebulae and of high temperature in the central stars, which are the ultimate sources of all nebular radiations.

Abundances of the Nebular Gases.—Following his explanation of the origin of the nebular lines, and the mechanism of their production, Bowen in 1934 concluded that the gaseous nebulae, like most astronomical bodies, are largely made up of hydrogen, with helium the next most abundant element. Further information on their chemical composition was obtained in 1939 by Bowen and A. B. Wyse (1909–42) at the Lick observatory. By using an especially powerful spectrograph in combination with an "image slicer" (invented by Bowen to overcome certain observational difficulties), and exposures of 12 to 20 hours, they were able to record in two planetary nebulae a number of faint radiations due to the



BY COURTESY OF (LEFT) A. D. CODE AND T. E. HOUCK, WASHBURN OBSERVATORY, UNIVERSITY OF WISCONSIN; (RIGHT) G. DE VAUCOULEURS, MOUNT STROMLO, CANBERRA

THE MILKY WAY AND MAGELLANIC CLOUDS. NEBULAE CONTAINING INNUMERABLE STARS AND MASSES OF GAS AND DUST: (LEFT) CENTRE OF THE MILKY WAY STELLAR SYSTEM. THE GALACTIC CENTRE LIES 30,000 LIGHT-YEARS IN THE DIRECTION OF THE BRIGHTEST STAR CLOUD TO THE LEFT AND SLIGHTLY BELOW THE CENTRE OF THE PHOTOGRAPH. (THE DARK LINES IN THE PHOTOGRAPH ARE SHADOWS OF THE PHOTOGRAPHIC PLATE HOLDER AND ITS THREE SUPPORTS.) AT THE BOTTOM RIGHT ARE THE MAGELLANIC CLOUDS, THE NEAREST EXTRAGALACTIC NEBULAE, 150,000 LIGHT-YEARS AWAY. (RIGHT) DETAILED VIEW OF THE MAGELLANIC CLOUDS

metallic and other elements. Analysis of the intensities of these lines, and comparison of results with similar work by H. N. Russell

Abundances of Elements

Chemical Element	Relative Numbers of Atoms	
	Planetary Nebula	Star
Hydrogen	10,000	10,000
Helium	1,740	(1,600)*
Nitrogen	2.8	2.3
Oxygen	6.6	7.5
Fluorine	(0.003)	—
Neon	1.3	11.0
Sulfur	0.65	0.25
Chlorine	0.035	0.14
Argon	0.080	0.45
Potassium	(0.008)	0.0005
Calcium	(0.010)	0.014

*Figures in parentheses are uncertain.

on the sun, led to the conclusion that the abundance of many elements in the nebulae and sun are not significantly different. Wyse in 1941–42 extended the program to include ten additional planetary nebulae and the Orion nebula, and deduced that the chemical compositions in both types of nebulae are similar to those of the sun.

This finding of a common chemical composition, especially for objects so apparently dissimilar as gaseous nebulae and an ordinary star, stimulated many modern researches on the cosmical abundances of the elements. Gaseous nebulae, and particularly planetary nebulae, continued to play prominent parts in both theoretical and observational developments. For the astrophysics of such low-density high-temperature sources are more amenable to mathematical treatment, while planetaries have the highest surface brightnesses. Thus the theory used by Bowen and Wyse was greatly extended during 1937–45 at Harvard College observatory by Menzel and his colleagues J. G. Baker and L. H. Aller; and, after World War II, further investigations of several of the brightest planetaries were carried out at the Mount Wilson and Palomar observatories by Aller, Bowen and Minkowski. In 1952–54 they used the powerful spectrographic equipment of the 100-in. and 200-in. reflectors to obtain much new material on the wave lengths, intensities and identifications of several hundred of the fainter radiations previously only suspected or unrecorded. From these spectrochemical analyses, Aller and Minkowski in 1956 found that the abundances of elements in seven planetary nebulae (1) do not differ significantly, and (2) the average composition is essentially the same as in stars (*see* table, adapted from compilations by L. H. Aller, University of Michigan observatory, Ann Arbor, Mich.).

IV. THE EXTRAGALACTIC NEBULAE

The extragalactic nebulae are found over the entire sky, except within the close confines of the Milky Way, or galaxy, where the cloudy stratum of interstellar matter blots out the light from more distant objects. This surface distribution hints of distances beyond the galaxy—extragalactic—and it is a clue reinforced by the observed ranges in size, brightness and numbers. These attributes all strongly support the suggestion of a perspective progression of objects. For extragalactic nebulae are found smaller, fainter and more numerous, as the more powerful telescopes reach ever farther into space. In diameter and brightness they range from the great 10°, 1st-magnitude Large Magellanic Cloud to the small 1-second-of-arc, 23rd-magnitude specks scarcely distinguishable from stars, even with the large 200-in. Hale telescope. Their number is enormous and depends upon the limiting brightness to which they are counted. Thus some 1,000 are catalogued to the 13th magnitude, and they increase approximately by a factor of 4 for each fainter magnitude: 4,000 to the 14th; 16,000 to the 15th, etc. If this geometric rate of increase were main-

tained to the optical threshold of the 200-in. reflector, the enumerable extragalactic nebulae would total 1,000,000,000. This number, however, has to be corrected downward because of the different quality of light from the faintest extragalactic nebulae. Although the smaller corrected number is not precisely known, it is of the order of hundreds of millions, and this figure represents a population parameter of the universe that challenges the imagination. For each one of these millions of faint flecks of light is a stellar system, or "island universe," composed of myriads of stars. Many also contain interstellar gas and dust, and some are giants in size, population and real brightness comparable to our own galaxy. Since the most numerous extragalactic nebulae are literally vanishingly faint, even the largest telescopes are hard pressed to provide data much above the margin of error. The farthest reaches of the universe are accordingly only sketchily scouted observationally, and there are hosts of unsolved problems and unanswered questions at this dim astronomical horizon. Chief among these is the extragalactic distance scale, which even in the mid-1960s was uncertain by a factor of 2. But it is a real achievement of the largest telescopes that the distances of the faintest extragalactic nebulae may be estimated reliably as to order of magnitude: about 5,000,000,000 light-years.

Classification.—The most generally accepted scheme of classification for the extragalactic nebulae is the one proposed by Hubble in 1926. It is represented schematically in fig. 1. This system arranges in a single homogeneous pattern nearly 98% of the numerous regular nebulae that are sufficiently large and bright to show appreciable structure on photographs taken with telescopes of moderate power; the remaining 2% or 3% that do not readily fall into the system are called irregular nebulae. The basic feature of the classification is, in Hubble's words, "conspicuous evidence of rotational symmetry about dominating, central nuclei."

As may be seen from fig. 1, the regular nebulae begin the sequence as elliptical nebulae, denoted by E. Their forms range from globular to lenticular, with the degree of ellipticity indicated by numerals from 0 to 7, which are obtained from the relation $10(a-b)/a$, where a and b are the major and minor axes, respectively. Statistical analysis of the frequency of occurrence of the different forms shows that there are actually globular or spherical nebulae, and that not all of the apparently round ones can be accounted for as flattened nebulae with polar axes in the line of sight. The analysis shows, however, that the lenticular objects are much more common, and that there is a definite limiting ellipticity with ratio of axes 3 to 1. When the flattening becomes greater, the nebulae no longer appear as smooth, unresolved objects, and, at a certain stage of the sequence, indicated by So, they begin to show structure that in general is of spiral character. Two different spiral forms are found, however, so that the spiral nebulae are separated into two groups: the normal spirals, designated by S, and the barred spirals, symbolized by SB.

Among the regular nebulae large and bright enough to classify, the spirals outnumber the ellipticals by more than 4 to 1, and this fact stresses the importance of deciding which features in spirals are best suited for further subdivision, such as central concentration, relative size of arms and nucleus or number and character of condensations. After an examination of hundreds of nebulae on photographs taken with the Mount Wilson reflectors, Hubble concluded that the most significant characteristic for classifying spirals is the degree of resolution. Depending upon circumstances, the resolution may be only into spiral structure, into clusters or clouds of stars or, at best, into individual stars. To indicate the degree of resolution the letters a, b or c are placed after S or SB; thus, a well-resolved normal spiral would be referred to as Sc, a barred one as SBc.

When the 200-in. Hale telescope, completed in 1948, came into operation, its greater light-gathering and defining power showed so much more detail in the brighter extragalactic nebulae that Hubble initiated a program to refine his classification system, particularly in the transitional So stage between ellipticals and spirals. Although he obtained a number of plates and made numerous notes, his death in 1953 left this work incomplete and unpublished. His younger colleague, Allan Sandage, undertook to finish the job with the result that in 1961 the Carnegie institution of Washington, D.C., was able to issue a memorial volume, the *Hubble Atlas of Galaxies*.

This folio of photographs contains high-quality reproductions of dozens of the best plates taken with the 200-in. reflector, with a systematic discussion of the structural features of ellipticals, spirals and irregulars. It is, in fact, an atlas and gazetteer of most of the larger and nearer systems observable from the northern hemisphere.

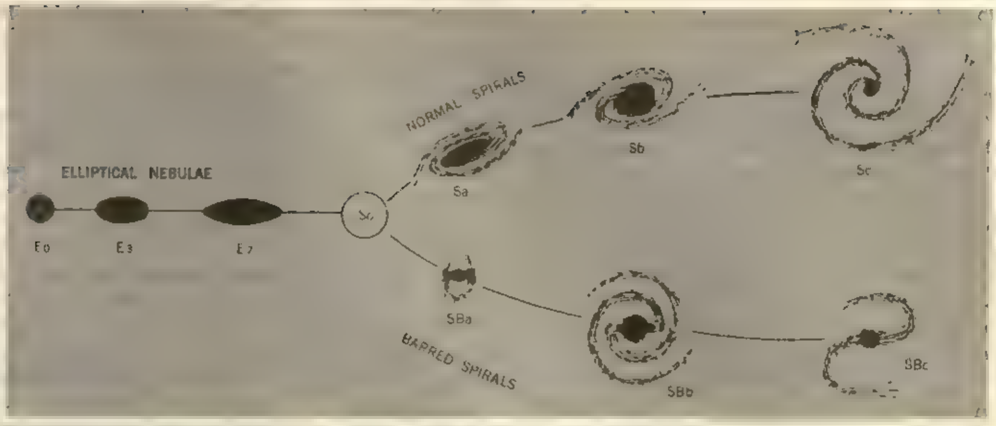
Distribution.—As the result of extensive counts of extragalactic nebulae on photographs taken chiefly at the Mount Wilson, Palomar and Lick observatories in the northern hemisphere, and at the Harvard college observatory station in the southern hemisphere, it is known that the distribution is nonrandom over the sky and approximately uniform in depth. This last result, of great theoretical and practical value for cosmological studies, was established chiefly by Hubble's survey that quantitatively elucidated the effects of galactic obscuration, and of several great clusters of nebulae, upon the true distribution.

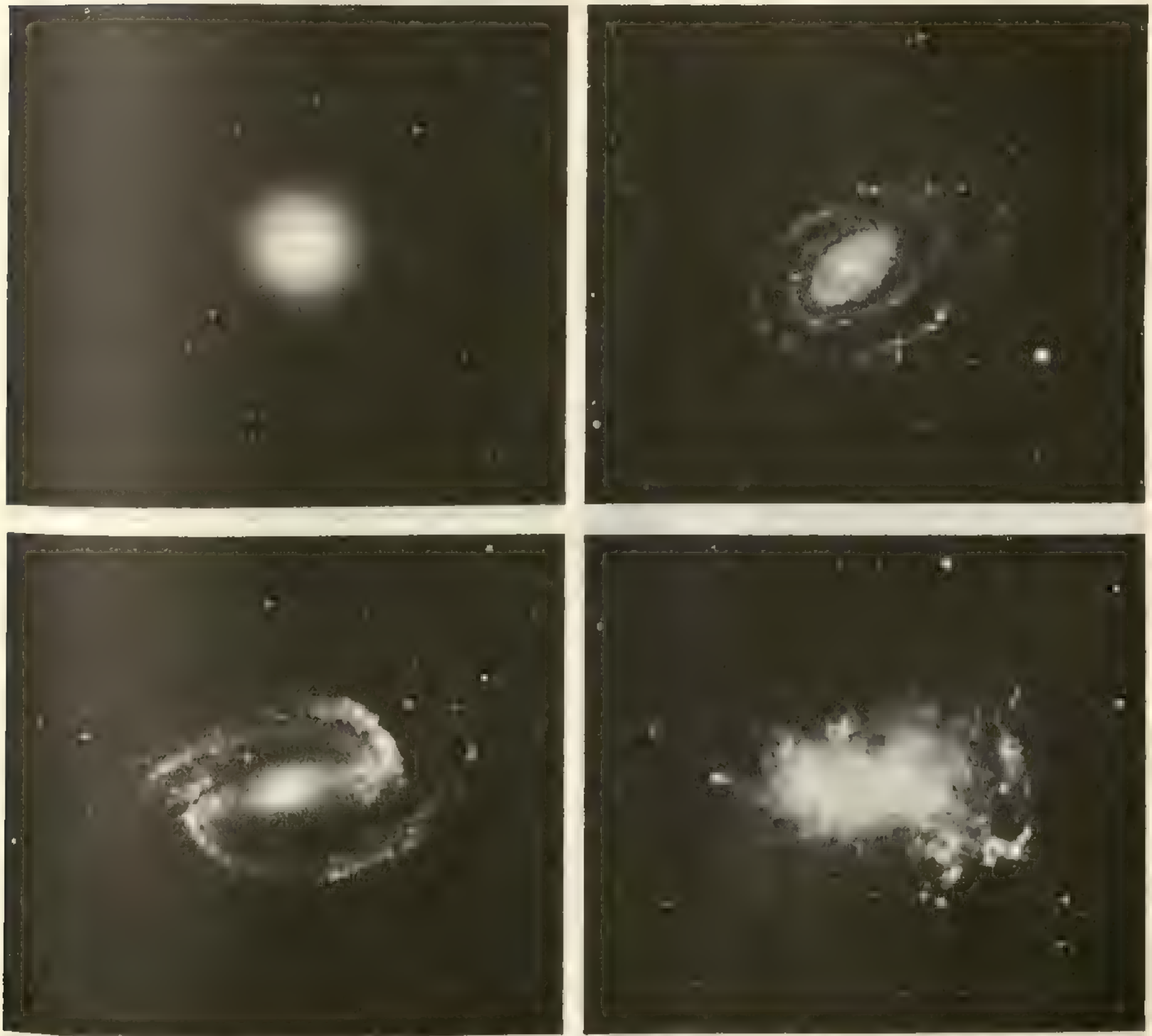
Counts.—Long before the advent of photography it was generally known from visual observations that the "white" nebulae, now called extragalactic, tended to avoid the Milky Way, and that there was appreciable clustering in high galactic latitudes, especially in Coma and Virgo close to the north pole of the galaxy. With the development of photography, more and ever more nebulae were counted, and the galactic zone of avoidance and the regions of clustering became more precisely defined. A number of early counts, among them those of J. E. Keeler (1899), E. A. Fath (1914) and H. D. Curtis (1918), suggested the general outlines of the distribution and gave hints as to the total number of nebulae within reach of certain telescopes, but the problem of nebular counts was not put on a firm quantitative basis until 1934. In that year Hubble published the results of surveys, made with the Mount Wilson reflectors, in which more than 44,000 nebulae were counted in 1,300 sample regions rather evenly distributed over three-fourths of the sky. For the first time, the counts were calibrated and referred to specified limiting magnitudes. With all the data reduced to standard conditions, it became clear that the numbers of nebulae decreased in a very regular way as the Milky Way was approached. The rate of decrease, in fact, was just that to be expected from a thin obscuring layer in which the absorption is proportional to the light path in the stratum—a familiar analogy is the dimming of stars as they approach the horizon. The zone of avoidance along the galaxy is thus but the effect of looking in the plane of the stratum, where the absorption is a maximum that approaches complete opacity; toward the galactic poles, the absorption is a minimum, with the light reduced by only 20%. The more populous areas, on the other hand, represent a conspicuous tendency for the nebulae to cluster. They occur in pairs, in small to large groups of several to 100 nebulae and in great clusters that include more than 500 members, as in the Coma and Virgo aggregations.

Hubble's classical counts to faint magnitude limits in small sample areas stimulated much interest and work in this field, but these other investigations were necessarily of a different type, as they involved surveys over wider regions to brighter limits, as befitted less powerful equipment than the 60-in. and 100-in. Mount Wilson reflectors. Modern sequels in which astrographs (star cameras) and Schmidt telescopes were used are: (1) the extensive two-hemisphere Harvard surveys carried out from about 1930–50; (2) the Palomar-Schmidt programs begun in 1937; and (3) the Lick comprehensive counts undertaken in 1948.

Harvard Counts.—In 60° diameter zones centred on the equatorial and galactic polar caps, the Harvard counts to the 18th magnitude yielded three important results for what Shapley has called the Inner Metagalaxy, a sphere of diameter 300,000,000 light-years. First, the region of the north equatorial polar cap around Polaris appears to be thinly veiled by galactic obscuring matter, as shown by subnormal counts compared to the surroundings. This result provided independent supporting evidence that some of the International Polar Sequence stars of standard brightness and

FIG. 1.—HUBBLE'S SYSTEM OF CLASSIFICATION FOR EXTRAGALACTIC NEBULAE





BY COURTESY OF THE MOUNT WILSON AND PALOMAR OBSERVATORIES

PRINCIPAL TYPES OF EXTRAGALACTIC NEBULAE: (TOP LEFT) AN ELLIPTICAL (E) NEBULA IN THE CONSTELLATION OF VIRGO (M87, N.G.C. 4486). EXCEPT FOR A FEW OF THE NEAREST ONES, THESE NEBULAE ARE UNRESOLVABLE INTO STARS, EVEN BY THE LARGEST TELESCOPES. THEY RANGE FROM THE GLOBULAR FORM SHOWN HERE TO THE FLATTER LENTICULAR SHAPE. (TOP RIGHT) SPIRAL (S) NEBULA (N.G.C. 5364) IN VIRGO. THIS IS A NORMAL SPIRAL, RESOLVABLE INTO ITS BRIGHTEST STARS UNDER CERTAIN CONDITIONS. (BOTTOM LEFT) BARRED SPIRAL (SB) NEBULA (N.G.C. 1300) IN THE SOUTHERN CONSTELLATION OF ERIDANUS. IT IS AN EXAMPLE OF A SPIRAL THAT SHOWS A BAR AS THE MOST CONSPICUOUS STRUCTURAL FEATURE. (BOTTOM RIGHT) IRREGULAR (IRR) EXTRAGALACTIC NEBULA (N.G.C. 4449). LIKE THE MAGELLANIC CLOUDS, THIS TYPE OF NEBULA SHOWS LITTLE REGULARITY OF STRUCTURE, ALTHOUGH IN MANY CASES THERE APPEAR TO BE INCIPIENT BARS AND SPIRAL ARMS. 200-IN. PHOTOGRAPHS

colour probably are dimmed and reddened, as had previously been suspected from precise photometric work. Second, the survey of the southern equatorial polar cap containing the Magellanic Clouds gave the first clear-cut indication, from wide, continuous-area counts, that extragalactic nebulae may have a higher degree of organization than clustering: arrangement in great, rich clouds extending throughout vast regions of space, of dimensions up to 100,000,000 light-years. Third, comparison of the counts for the galactic polar caps showed a systematic difference between them. In the southern cap the distribution is remarkably smooth over the sky and uniform in depth. But in the northern it is conspicuously irregular, with numerous clusters of both bright and faint nebulae that give an average population in the north nearly twice as large as in the south. This excess is particularly pronounced for the brighter objects, which are found in a broad band running through Ursa Minor and Major, Canes Venatici, Coma, Virgo and Centaurus, to which H. D. Curtis has given the apt name "canopy of galaxies."

Palomar Counts.—The Palomar programs, carried out by F. Zwicky and his collaborators at the California Institute of Technology, Pasadena, used photographs taken with the Palomar observatory Schmidt telescopes: since 1937 with the 18-in. and after 1949 with the 48-in. Special attention was given to the phenomenon of clustering of extragalactic nebulae, particularly as related to the question of the presence of material between nebulae, "intergalactic matter." By 1953 Zwicky had become convinced of the existence of such matter in both the "luminous" and "nonluminous" states. Intergalactic luminous matter was inferred from a variety of faint phenomena newly discovered by the powerful Palomar Schmidt telescopes: (1) large numbers of faint blue stars distant up to 30,000 light-years from the Milky Way plane; (2) some intrinsically very faint and small dwarf nebulae, all within about 2,000,000 light-years of the galaxy; (3) hundreds of streamer-connected double and multiple nebulae out to distances of the order of 200,000,000 to 300,000,000 light-years; (4) exceedingly faint and unresolved luminous patches in clusters and groups of nebulae. Intergalactic dark matter, on the other hand, was inferred from fewer numbers of faint background nebulae counted within foreground clusters, as if the latter contained material that absorbed the light of distant objects. Zwicky has boldly generalized these results as indicating a continuous progression of intergalactic matter ranging from a gas, through dust particles, to individual stars and dwarf stellar systems. But whether this internebular substratum comprises the major portion of the extragalactic population, as advocated by Zwicky, remains more of a question than an answer.

BY COURTESY OF THE MOUNT WILSON AND PALOMAR OBSERVATORIES

GROUPING OF EXTRAGALACTIC NEBULAE: SMALL GROUP IN CONSTELLATION OF LEO (LEFT TO RIGHT: N.G.C. 3185, 3190, 3187, 3193) ABOUT 20,000,000 LIGHT-YEARS AWAY, SHOWS HOW THE MOST DIVERSE NEBULAR FORMS ARE FOUND IN CLOSE ASSOCIATION

Lick Counts.—Begun in 1948 by C. D. Shane and C. A. Wirtanen, these represent the most comprehensive plan so far undertaken to achieve uniformity and completeness over the sky from the north equatorial pole to a southern declination of 23°. The basic material consists of a set of 1,246 astrograph plates on which nebulae could be counted to a limiting magnitude of nearly 18.5. Each plate was exposed two hours and covers an area of 6° × 6°. With plate-centres 5° apart, an overlapping border at least 1° wide all around each plate provided the means—duplicate counts in a common region—for reduction of the counts to a homogeneous system.

Nebulae were counted in 10-minute-of-arc squares, the numbers summed by square degrees, averaged in groups of four and used to construct "contour maps" of nebular surface density. For practical reasons, the sky was divided into nine approximately equal areas. By 1960 the counting was complete, with the final census totaling about 2,000,000 nebulae. This work, of monumental proportions in concept and effort, provides by far the best basic data for many researches in which a detailed knowledge of the distribution of extragalactic nebulae is important. The published counts delineate, much more exactly than before, the extent and transparency of the obscuring clouds in and around the Milky Way; also, they confirm with a wealth of new data previous indications that clustering of nebulae is not only common but that clusters often are but subsidiary condensations in larger clouds (*see* sections *Clusters* and *Superclusters,* below).

Numbers and Distribution in Depth.—Of equal or greater importance than the delineation of regions of avoidance and of clustering is the conclusion, first reached by Hubble, that the extragalactic nebulae populate space with an approximately constant density as far as telescopes can reach. This result was obtained from counts of nebulae to successively fainter limiting magnitudes. For the brightest objects, it is only necessary to total to each limiting magnitude the number of nebulae whose magnitudes have been individually determined, as for example in the extensive Harvard surveys reported by Shapley. For the faintest objects, on the other hand, it is much simpler to count nebulae to limiting magnitudes determined by exposures of different lengths, or by telescopes of different light-gathering power. This indirect procedure is expedient because the faintest nebulae are overwhelmingly too numerous to estimate their individual brightnesses. With the numbers of nebulae established to increasingly fainter magnitudes, it is relatively easy to test the hypothesis of constant space density. This is done by noting whether the numbers of nebulae counted are proportional to the volumes of space in which they are found. More precisely, a simple calculation shows that the rate of increase is by a factor of four when the limiting brightness decreases by one magnitude. On the basis of all the available material, Hubble found that this condition was satisfied to about the 18th magnitude. At this point the red shifts in the nebular spectra begin to make photographic magnitudes abnormally faint, with the result that the observed number falls below that expected on the basis of a uniform distribution. The following table, obtained from Hubble's counts of faint nebulae, illustrates the total numbers involved:

Apparent photographic magnitude	18	19	20	21	22	23
Uniform distribution, millions	2.3	9.3	37	150	(590)	(2300)
Observed numbers, millions	1.8	5.6	18	57	(180)	(560)

Although the numbers in parentheses represent extrapolations beyond the actual counts, it is evident that the deficiency of the observed to the expected uniform count is by a factor of 3 to 4. In his classical treatment of the subject, Hubble in 1936 used these differences to interpret the nature of the red shift. He concluded that either there is a probable uniform distribution of nebulae in depth, with the red shift not representing recession; *i.e.*, no universal expansion, or, if outward motion is involved, "some vital factors have been neglected in the investigation."

Subsequent developments disclosed these factors, and reopened the entire matter. In the vanguard of progress was the perfection of photoelectric methods of magnitude measurement for faint sources. New observations with this technique, made in 1947–49 by Stebbins and Whitford, left little doubt that the photographic magnitude standards available to Hubble possessed serious systematic errors. With the 100-in. reflector they were able to reach magnitude 18.5, where they found the previous standards too bright by 0.5 magnitude. Extension of the photoelectric measurements to the range of the faintest nebular counts required the use of the 200-in. Hale telescope, and in 1955 W. A. Baum reported the determination of a stellar magnitude of 23.9. However, such observations are difficult and slow, even with the largest telescope, for which Baum estimated two nights of good conditions would be required for an accuracy of 2% at magnitude 23. Nevertheless, by 1955 photoelectric standard magnitudes, in three selected areas and ranging over 10 magnitudes in two colours to magnitude 22 or 23, were reported to have been determined with satisfactory precision and freedom from systematic error. In this way the groundwork was prepared for further counts of the faintest nebulae. But by 1965 no systematic program using the largest-reflector photographs, comparable to Hubble's 1936 reconnaissance, had been undertaken. In 1952, however, J. Neyman and E. L. Scott of the University of California statistical laboratory, initiated a broad, theoretical program using statistical methods to predict the numbers of faint nebulae expected to different magnitude limits. Their formulation included a wide variety of models, with and without clustering, red shift or expansion. As a result of this work, there was available by 1960 a theoretical framework especially adapted to the comparison of forthcoming nebular counts with various theories of the distribution in depth. An example of results from the calculations is given in fig. 2. This shows that the surface density of extragalactic nebulae near the faintest magnitude limits attainable with the largest reflectors is astonishingly high—of the order of 10,000 nebulae per square degree. In the higher galactic latitudes there will thus be more nebulae than stars, as predicted by Hubble in 1934, and verified by him with the 200-in. reflector in 1949.

The observed distributions of the faintest extragalactic nebulae and stars therefore present complementary aspects of the sky, related to our position in the galaxy. In its plane the rich star cloud provides the limiting background of threshold sources, while at its poles the piled-up population of faintest nebulae produces the distant and hazy horizon. There, strangely as at sunset, these extragalactic beacons are aglow with a ruddy hue—the universe's "stop signal," the red shift.

Clusters.—Extensive surveys first by astrographs and later by Schmidt cameras have shown that clustering of extragalactic nebulae is by far the rule rather than the exception. The most modern program, which is F. Zwicky's with the Palomar 48-in. Schmidt telescope, indicates that these clusters are to be counted in the thousands. He reported in 1952 that on one plate covering about 40 square degrees in Coronae Borealis nearly 100 clusters could be identified. So many clusters suggests that they, instead of individual nebulae, may be the fundamental building blocks of the universe. If this is the case, then clusters of nebulae promise to provide significant information on the structure of the universe, in addition to having served as stepping stones for Hubble's extragalactic distance scale.

On the observational side, Zwicky's extensive cluster material obtained with the Palomar Schmidt telescopes from about 1937–56, led him to a number of conclusions regarding clusters of nebulae. In 1956 he summarized these results, some of which are

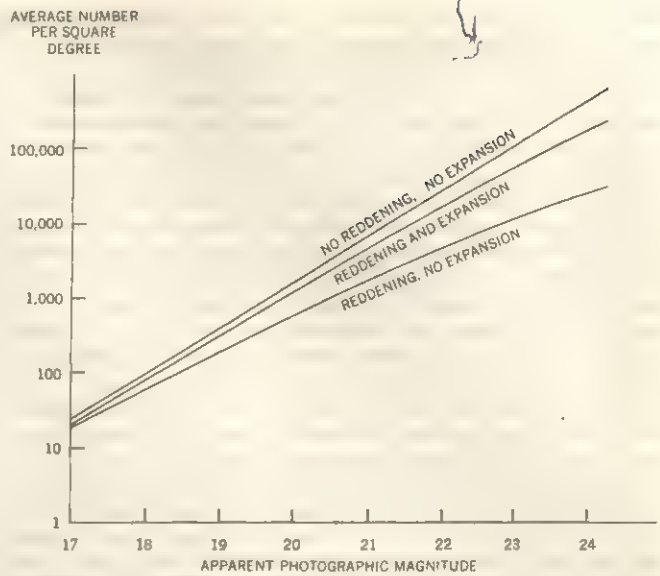


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FIG. 2.—NUMBERS OF EXTRAGALACTIC NEBULAE TO VARIOUS LIMITING MAGNITUDES, FOR DIFFERENT ASSUMPTIONS AFFECTING THE DISTRIBUTION IN DEPTH. NUMERICAL DATA FROM HUBBLE'S OBSERVATIONS

the following: (1) clusters exist as open clouds, medium compact swarms and spherically symmetrical condensations, with isolated nebulae clearly in the minority; (2) the richest clusters may have (a) as many as 10,000 members within the range from the brightest to those seven magnitudes fainter, and (b) an internal velocity dispersion of 1,500 mi. per second; (3) both luminous and dark clouds of intergalactic matter have been found concentrated toward the centres of large clusters; (4) clusters appear to be distributed uniformly and randomly in a nonexpanding universe, as inferred from studies of brightnesses and diameters of nearly 1,000 rich clusters; (5) there is no systematic clustering of clusters. Some of these and other findings by Zwicky are subject to confirmation by further, independent observations, or are susceptible of alternate interpretations. Nevertheless, Zwicky and his collaborators have shown that the Palomar Schmidt photographs are in a class by themselves as regards the recording of the faintest nebulous sources in the extragalactic regions.

On the theoretical side, J. Neyman and E. L. Scott in a series of papers beginning in 1952 assumed that all extragalactic nebulae are members of clusters. Using mathematical statistical methods, they sought to formulate the problem of spatial distribution of nebulae in such a way that as many as possible of the basic assumptions and related postulates could be tested separately by nebular counts. They found it convenient to classify the postulates into three groups: (1) those concerned with the distribution of nebulae in space; (2) those that relate events in space to what may be seen on a photograph; and (3) those connected with the unavoidable errors of counting. For the observational tests of the deductions from the theory, they used C. D. Shane's and C. A. Wirtanen's comprehensive counts of nebulae on the Lick 20-in. astrograph plates. In 1954 Neyman and Scott reached the conclusion that a hypothesis of simple clustering could represent the observations in some, but not all, respects. In particular, they found that frequencies of counts in 1° squares agreed closely with theoretical expectations, although for an unsatisfactorily large range of the observational parameters. For the same parameters, however, frequencies of counts in 10′ squares could not be reconciled with those in 1° squares. The discrepancy was in the sense of the observations showing an excessive number of clusters with small angular diameters, as compared with theoretical prediction. They suggested that the most promising modifications of the model of simple clustering in order to reach agreement with observations, appeared to be inclusion of the additional hypotheses of expansion of the universe and of multiple or superclustering, together with a more thorough investigation of the

effects due to errors of counting. They also found from further analysis that it was not necessary to assume the existence of clouds of internebular absorbing material.

Superclusters.—If only the brighter extragalactic nebulae to the 12th or 13th magnitude are considered, they show a tendency first noted in 1923 by J. H. Reynolds (1874–1949) to occur in a great-circle band around the sky. It is a belt of average width 12° that runs nearly perpendicular to the Milky Way, which it crosses in the northern constellation of Cassiopeia and again in the southern one of Circinus. The northern arc includes the Virgo cluster with its extensions to the south in Centaurus and to the north in Coma, Canes Venatici and Ursa Major. The southern part is less populous, but there are series of groups of bright nebulae in Andromeda, Pisces, Cetus, Sculptor and beyond into far-southern skies.

The possibility that these brightest nebulae may form in space an extended "metagalactic" system or cloud, which may also include the galaxy, has been suggested by a number of investigators. Chief among these are three Swedish astronomers of the Lund University observatory, K. Lundmark, E. Holmberg and A. Reiz. From studies during 1927–41 of single, double and multiple nebulae they concluded there is good evidence for such a large-scale organization. In shape it would be a flattened system of some tens of millions of light-years in diameter and one-tenth as thick. But this interpretation of the observations depended largely upon individual nebular magnitudes that later were found in some cases, and suspected in many others, to have large errors. Also there was some doubt about the completeness of the basic data for far-southern nebulae.

In 1952 G. de Vaucouleurs, at the Australian Commonwealth observatory, Mount Stromlo, Canberra, began a thorough reexamination of the question of a local supercluster, on the basis of newer and more accurate data. He redetermined the magnitudes of many of the brighter southern nebulae, and revised to a modern photometric system the magnitudes for most of the brighter catalogued nebulae. The aim was to achieve photometric consistency and completeness over the whole sky to about magnitude 12.5. His 1956 detailed discussion of this material gave strong support to the concept of a "local supergalaxy" that includes our own Milky Way stellar system. He proposed a model in which the great Virgo cluster may be "a dominant condensation not too far from its central region." If this is a valid assumption, then the galaxy in addition to being close to the principal plane of the supersystem, would be about three-fourths of the way from the centre to the edge, since the bright nebulae in the Coma-Virgo region around the north galactic pole were estimated to be three times more distant than some groups of large spirals in the opposite direction toward the south galactic pole. The over-all size of the supersystem was computed to be, on Hubble's distance scale, of the order of 25,000,000 light-years in diameter and one-tenth as thick. As additional independent evidence for a local supergalaxy, de Vaucouleurs pointed out the similarity in position and extent of a broad maximum of cosmic radio noise, reported in 1952 by R. Hanbury-Brown and C. Hazard, of Manchester, Eng., and also in 1953 by J. D. Kraus and H. C. Ko, of Ohio State university.

A local supercluster of bright nebulae including the galaxy may not be unique, for among the fainter ones Shapley in 1934 reported a distant, double supergalaxy in Hercules. Moreover, de Vaucouleurs' work in the southern hemisphere led him to suspect the presence of another supergalaxy, from a great, elongated swarm of nebulae extending through Cetus, Dorado, Fornax, Eridanus and Horologium. He estimated its distance to be only slightly greater than the Virgo cluster, and, from its apparent dimensions of 10° by 50°, a thickness and diameter of 1,600,000 and 8,000,000 light-years, respectively. De Vaucouleurs noted that the relative sizes and separations of this southern supergalaxy and the local supergalaxy appear to be comparable with Shapley's double supergalaxy in Hercules.

All the foregoing observational evidence, when added to that of the theoretical analysis of Neyman and Scott, suggests that superclustering, if not the dominating characteristic in the distribution of extragalactic nebulae, is a phenomenon that cannot be ignored in attempts to infer the structure of the universe.

V. THE EXTRAGALACTIC DISTANCE SCALE

Distances of extragalactic nebulae are most accurately determined from studies of objects within them that may be recognized and compared with their counterparts in the galaxy. These objects may be brightest stars, variable stars, star clusters, gaseous nebulae or novae. When these can be identified, their apparent magnitudes, m, are measured and compared with their absolute magnitudes, M, which are assumed to be the same as those for corresponding galactic objects. How the absolute magnitudes are obtained for the "comparison" galactic objects is a long story in itself. Here it will suffice to note that ultimately all astronomical absolute magnitudes depend upon distance determinations that in principle are equivalent to trigonometric surveying. By definition, M equals m at a distance of 32.6 light-years.

Once an extragalactic object's apparent magnitude is measured and its absolute magnitude assumed known, the distance, d, is computed from the simple formula

$$\log d = (m - M + 5) \div 5,$$

which assumes that the apparent brightness of an object varies inversely as the square of the distance. If there is reason to believe that somewhere along the line of sight to the extragalactic object there is matter that absorbs some of the light, a correction is determined or estimated for the apparent magnitude, which, of course, is made too faint by any obscuring material. Such matter may be present in the galaxy, in the extragalactic nebula whose distance is sought or, as Zwicky advocates, in internebular space. Correction for its effect often is difficult to make, and there may be considerable uncertainty even by the best procedure.

In practice, the use of individual objects within extragalactic nebulae for distance determinations is limited to a few hundred of the nearest and brightest nebulae. The vast numbers of extragalactic nebulae are so far and faint that even the largest telescopes cannot single out objects within them for individual study. Thus it is necessary to use other distance criteria, which may be apparent diameter, total magnitude (entire light of a nebula) and red shift. These quantities all have to be calibrated, or evaluated in terms of the distance criteria used for the nearer nebulae, before they can be used to obtain distances on an absolute scale of light years.

Hubble's Distance Scale.—In 1923 Hubble made the crucial observations with the 100-in. Mount Wilson reflector that are generally accepted as the first proof of the extragalactic nature of spiral and elliptical nebulae. He discovered in the great spiral nebula in Andromeda (Messier 31) a number of Cepheid variables. These are pulsating, intrinsically bright stars whose light varies characteristically, in periods ranging from a few days to months. Their importance as distance indicators depends upon the remarkable property that their periods are closely related to their brightnesses, in the sense that longer periods are associated with higher luminosities, as first found in 1912 by Henrietta Leavitt (1868–1921) of Harvard College observatory. She noted that for similar variables in the Small Magellanic Cloud, their periods were closely correlated with their apparent magnitudes, which meant with absolute magnitudes because the Cloud Cepheids are at essentially the same distance. Hubble compared the apparent magnitudes of Cepheids in M31 with those in the Cloud, and determined an average difference of nearly five magnitudes, equivalent to a relative distance factor of 10. Thus the Andromeda nebula was found to be ten times more distant than the Small Magellanic Cloud.

The estimation of distances in light-years for the spiral and Cloud, however, involved determination of Cepheid absolute magnitudes or luminosities. These had to be obtained from measurement of the motions of galactic Cepheids, and here, as became evident in 1952, was the surveying chain's weakest link. For galactic Cepheids are distant supergiant stars whose motions across the sky are so small that they are nearly lost in the errors of measurement. Nevertheless, their luminosities were estimated as early as 1913 by E. Hertzsprung of Potsdam. He had immediately

recognized the significance of Miss Leavitt's discovery for the determination of greater astronomical distances. It was his analysis of the available scanty data that yielded the first calibration of the invaluable Cepheid period-luminosity law. This result meant that in whatever object a Cepheid variable could be identified, determination of its period and apparent magnitude would yield a distance estimate in light-years. With this Cepheid criterion, Hubble in 1924 obtained a distance of 900,000 light-years for the Andromeda nebula.

Hubble's work on M31, and on several other large spirals and nearby systems in which Cepheids could be identified, represented only the opening gambit in his celebrated "preliminary reconnaissance of the observable region of the universe." Although he also discovered numerous novae and star clusters in the nearest extragalactic systems, and used them to supplement distance estimates based on Cepheids, he made the most far-reaching extension of the distance scale by developing two other distance criteria. These were brightest stars and total luminosities of extragalactic nebulae. The first meant what he judged to be the upper limit in luminosity for stars that could be individually distinguished on the best photographs with the largest telescopes. The second represented the average, intrinsic light of an entire extragalactic nebula.

These three criteria of Cepheids, brightest stars and total luminosities permitted establishment of the distance scale, with the 100-in. reflector, to about 1,000,000, 6,000,000 and 250,000,000 light-years, respectively. The last large leap was, of course, much more uncertain than the first small steps. Real brightnesses of entire stellar systems, unfortunately, are far from being nearly the same: they range over many magnitudes, probably as many as ten. Hubble ingeniously met the difficulty by using clusters of nebulae, for which average values of the apparent total magnitudes could be more reliably determined. He also was able to make reasonable estimates of the luminosities of the brightest cluster members. These were the only ones that could be detected at the optical limit of the 100-in. reflector: 500,000,000 light-years.

Revision of the Distance Scale.—In 1952 Hubble's colleague W. Baade reported to the International Astronomical union meeting in Rome that his observations with the 200-in. Hale telescope indicated the previously accepted distance of the Andromeda nebula was too small, probably by a factor of 2. A larger distance of 1,500,000 to 2,000,000 light-years seemed necessary to account for the fact that the 200-in. reflector was unable to reveal the RR Lyrae or cluster-type variables in M31. To understand the reason for this result, and its significance for the extragalactic distance scale, it is necessary to describe the background of the modern Cepheid period-luminosity law, which was formulated by Shapley on the basis of variable stars in the galactic globular clusters and Magellanic Clouds.

In the over-all picture of the astronomical distance scale for objects well beyond the possibility of distance determination by trigonometric techniques, the pulsating or Cepheid variables have long occupied a prominent position. Following Miss Leavitt's and Hertzsprung's work, Shapley in 1918 repeated the calibration of the Cepheid period-luminosity law and revised it from visual to photographic magnitudes. One of his purposes was to obtain distances of the galactic globular star clusters, in which large numbers of variable stars had been found photographically by Harvard workers, beginning in 1895 with S. I. Bailey (1854–1931). The great majority of these variables, however, generally had much shorter periods, in the range from a few tenths of a day to several days, and their fast light fluctuations resembled those of the noncluster bright variable star RR Lyrae. They were accordingly termed cluster-type or RR Lyrae variables, and sometimes "short-period" Cepheids. But the globular clusters also had a few variables of longer period, comparable to the "classical" galactic Cepheids. Shapley therefore made the assumption, which seemed reasonable on the basis of all available relevant data, that the cluster-type and classical Cepheid variables conformed to the same period-luminosity law. In form, its lower luminosity (short-period) end thus was fixed by the cluster-type variables observed in galactic globular clusters, and its middle and upper luminosity (longer-period) parts by the Cepheids in the Magellanic Clouds. Its calibration, or zero point, depended upon about a dozen classical galactic Cepheids for which proper motions, or across-the-line-of-sight velocities, had been measured.

From 1918–52 this "composite" Cepheid period-luminosity law was widely used, notably by Shapley in his comprehensive globular cluster investigations that established the size and extent of the Milky Way as a giant stellar system in which the sun was far out from the centre, and by Hubble in his extragalactic exploration that brought cosmology within the purview of observational astronomy. From time to time the details of the relationship were changed, but only slightly, by new, additional data, principally from the Magellanic Clouds. The zero point, or absolute magnitude calibration, also was intently scrutinized, without convincing conclusions that it was incorrect. But Baade's 1952 Rome report forced a re-examination of the roots of the relationship. As might be expected, the difficulty lay in the basic assumption that the same period-luminosity law is valid for both cluster-type and classical Cepheids. It was nature's sly trick to make it difficult for astronomers to find, in the same system, both types of variable star. Thus no cluster-type variables had been found in the Clouds prior to 1952, and even by 1965 none had been found in the Andromeda nebula with the 200-in. This failure to find cluster-type variables at the expected apparent magnitudes, about 17.5 in the Clouds and 22.5 in M31, meant there is a much greater difference in absolute magnitude between cluster-type and classical Cepheids than assumed in the composite period-luminosity law. The related questions of how much is the difference, and whether only the absolute magnitudes of the cluster-type variables, or only those of classical Cepheids, or both, need correction, had to be answered from other observations.

Baade's 1952 negative result for cluster-type variables in M31 was accompanied by a positive one that simultaneously yielded the size of the correction to the absolute magnitudes and indicated to which type of variable it should be applied. His 200-in. observations of M31 showed that the brightest, red giant stars like those in globular clusters—his population type II—have an apparent photographic magnitude of 22.5. Now this is just the figure to be expected from the accepted period-luminosity law if the brightest nonvariable stars in globular clusters average 1.5 magnitudes brighter than the cluster-type variables. This difference had already been found to be a good average value from previous observations in many galactic globular clusters. Finally, therefore, the cluster-type variables would be expected at magnitude 24 in M31, at 19 in the Clouds, and a zero-point correction of 1.5 magnitudes—in the brighter sense—should be applied to the absolute magnitudes of the classical Cepheids.

These results were revolutionary in nature and immediately led to a whole series of investigations concerned with other and independent checks on the suggested revision, and with the consequences for many of the problems of modern astronomy. Thus Baade's younger colleagues A. R. Sandage and W. A. Baum used the 200-in. to its limit to study in globular clusters stars so faint that they could be directly compared in colour and magnitude with similar nearby stars whose absolute magnitudes were known from trigonometric measurements. In this way they obtained in 1952–53 an apparently good check on the previously accepted absolute magnitudes of the cluster-type variables in the same clusters. Then in 1953, A. D. Thackeray and J. Wesselink discovered, with the 74-in. reflector of the Radcliffe observatory, Pretoria, S.Af., the first cluster-type variables in the Magellanic Clouds, at the expected apparent photographic magnitude of 19. Finally, for the classical Cepheids, A. Blaauw and H. R. Morgan in 1954 used more accurate proper motions for 18 of these variables and obtained a zero-point correction to their absolute magnitudes of 1.4 magnitudes, which agreed well with Baade's estimate.

By 1954 it was, therefore, quite clear that distances derived from classical Cepheids needed to be doubled. However, there still remained the question of how reliable are extragalactic distances for nebulae too far for detection of Cepheids, but close enough to show separately brightest stars. Their use as distance

indicators required: first, identification as single stars; second, determination of their apparent magnitudes; and third, knowledge of their absolute magnitudes. Since the latter could be estimated from counterparts in the galaxy, Magellanic Clouds and the spirals in Andromeda (M31) and Triangulum (M33), the problem was one of threshold discrimination and photometry with the largest telescopes. From observations with the 200-in., Sandage gave preliminary reports in 1954 and 1956 that strongly suggested still greater upward correction of Hubble's distance scale. On 100-in. reflector plates, many resolved objects that appeared to Hubble as stars were shown on 200-in. plates, taken by newer colour-filter techniques, to be gaseous nebulae—Strömgren's H II regions. Also, the old scale of apparent magnitudes was found to be seriously in error at the faintest limits. Both effects combined to give too small distances. These modern observations, however, require such critically good observing conditions that in 1956 Sandage had been able to obtain revised distances for only two spirals: 9,000,000 light-years for M81 in Ursa Major, and 20,000,000 light-years for M100 in Virgo. These distances are greater than Hubble's by factors of 4 and 3, respectively. When more of the nearer systems have been similarly observed, a more reliable average correction factor will result. Then it will be possible to rederive the absolute total magnitudes of nebulae for a more precise survey of the universe to its distant limits. But enough has already been learned from the 200-in. Hale telescope observations to demonstrate that astronomers have broken, by a significant margin, the billion (1,000,000,000) light-year distance barrier.

VI. RED SHIFTS AND EXPANSION OF THE UNIVERSE

In 1912 V. M. Slipher of the Lowell observatory, Flagstaff, Ariz., made the first spectroscopic observation of an extragalactic nebula for radial velocity. This is the speed in the line of sight obtained from measurement of spectral lines. According to Doppler's principle, when the lines are found to be of shorter than normal wave length, the source is approaching; when of longer, it is receding. Since the longer wave lengths are in the red part of the spectrum, a receding object exhibits a red shift of the lines in its spectrum. Because of their generally faint surface brightness, extragalactic nebulae are difficult objects for spectroscopic observations. Thus Slipher was able to obtain radial velocities for only a small number of the brightest spirals and ellipticals. At first he found radial velocities of approach and recession in about equal numbers, although the average velocity was appreciably greater than for stars. However, when he observed some fainter ones, with exposures of 20 to 30 hr., he obtained a most remarkable result: the velocities without exception were of recession and very large, some over 1,000 mi. per second. This discovery naturally aroused much interest, and numerous attempts were made to relate the recessional velocities to other characteristics of the nebulae, such as diameters and apparent magnitudes. But no convincing correlations were found, mainly because of the intrinsically large dispersions in these quantities. Progress toward understanding these red shifts came, as so often has happened in astronomy, from the establishment of a consistent distance scale.

Hubble's Law of Red Shifts.—Following his discovery of Cepheids in the Andromeda nebula in 1923, Hubble used the criterion of brightest stars to estimate distances of spirals. By 1929 he had distance data for 22 objects for which radial velocities also were available, chiefly from Slipher's work. The correlation between the two quantities was so close that Hubble in 1929 reported a velocity-distance relation for extragalactic nebulae. It was in the sense that the greater the distance, the larger the velocity of recession. Such a relationship had to some extent been foreshadowed from observational correlations of fewer and less precise data discussed by K. Lundmark and C. Wirtz, and by W. de Sitter's mathematical work using relativity theory. Hubble's new approach, however, clarified an obscure situation and laid a firm foundation for a spectacular advance involving very faint and distant nebulae. From 1928–36 Hubble measured total brightnesses of numerous nebulae in clusters to obtain increasingly greater distances, while his colleague M. L. Humason determined radial velocities with a spectrograph of radically new design. The results were of unprecedented interest: a straight-line relationship out to a distance of 250,000,000 light-years, and up to a velocity of recession of 26,000 mi. per second. Since this speed is nearly one-seventh the velocity of light, Hubble preferred the noncommittal term red shift and referred to his and Humason's results as the law of red shifts. It meant, in their 1936 formulation, that the distance of an extragalactic nebula, in millions of light-years, could be obtained by dividing its red shift, expressed in miles per second, by 100. With this work, the limit of the 100-in. reflector was reached, and the possibility of following the red shift still farther into space required more powerful optical resources. These were provided with the completion of the 200-in. Hale telescope in 1948.

In 1951 Humason resumed his red shift determinations, with the 200-in. and a nebular spectrograph in which more efficient Schmidt cameras and diffraction gratings were used instead of lenses and prisms. With this new equipment, Humason by 1955 had observed 20 extremely faint cluster nebulae whose red shifts are in the range from 25,000 to 38,000 mi. per second, in addition to many others of smaller red shifts. As an extension of Hubble's work, A. R. Sandage during the same interval measured apparent magnitudes of many faint cluster nebulae. All this work represented a very considerable increase in the amount, precision and range of the basic red shift-magnitude data, which justified a new analysis of the problem of the expanding universe.

Expansion of the Universe.—In relativistic cosmological theories it is generally assumed that the red shifts in nebular spectra represent velocities of recession, and that the universe is therefore expanding. On this basis modern cosmologists have worked out the details of a number of "model" universes. These differ in such properties as space curvature—whether the universe is bounded or infinite—and variation with time—whether it is static or evolving. In many cases the possibility of a model agreeing with the "real" universe depends upon departures from linearity of the relationships between observed quantities. A prime example is the red shift-magnitude relation: is it linear or is it curved, and in what sense? In 1956 Sandage reported the results of an analysis of his and Humason's data. He found that the relationship is essentially linear, except possibly at the extreme end where red shifts are of the order of one-fifth the velocity of light, and distances are of the order of a billion light-years. At this point there was some evidence that red shifts are getting larger than expected from a straight line fitted to the rest of the observations. If the effect is real, and correctly interpreted, it would be of high cosmological interest, because an apparently abnormal acceleration in red shift with distance could imply a deceleration in the expansion. This paradoxical result follows from the fact that when we go far out in space we also go far back in time. Thus if the most distant nebulae are found to be expanding faster, compared to the near ones, then the expansion in our own part of the universe has slowed down during the last billion years. Other important corollaries would be that the universe is not static but is still evolving, and that it is bounded rather than infinite.

Stellar Populations and Evolution.—In 1944 W. Baade, using the Mount Wilson 100-in. reflector to maximum advantage in a sky darkened by the wartime blackout, reported the resolution for the first time of the amorphous nuclear region of the Andromeda nebula into myriads of faint stars. His technique involved the use of photographic plates very sensitive to red light and long exposures under critically good conditions. At the same time he also resolved the several fainter elliptical companions of the large spiral. These were results of great importance, for they showed that the generally smooth and featureless light in elliptical nebulae and in nuclei of spirals comes from stars of a different kind than those forming spiral arms. In the latter the brightest stars are blue-white supergiants often enmeshed in dark matter, while in the nuclear regions and in elliptical nebulae the brightest stars are yellow-red giants. Since supergiant stars may be hundreds of times intrinsically more luminous than giants, it is easy to understand why elliptical nebulae were, and still are, so difficult

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BAADE'S STELLAR POPULATIONS I AND II: (LEFT) DETAIL OF THE SPIRAL ARMS OF THE ANDROMEDA NEBULA (INSET) SHOWING THE GIANT AND SUPER-GIANT STARS OF POPULATION I. THE HAZY PATCH AT THE UPPER LEFT IS COMPOSED OF UNRESOLVED POPULATION II STARS. (RIGHT) N.G.C. 205, COMPANION OF THE ANDROMEDA NEBULA SHOWING STARS OF POPULATION II. THE BRIGHTEST STARS ARE RED AND 100 TIMES FAINTER THAN THE BLUE GIANTS OF POPULATION I. 200-IN. PHOTOGRAPHS

to resolve into stars, even with the largest telescopes.

Although Baade's observations represented a real telescopic triumph, his interpretation of them proved to be of surpassing significance. First, he stressed the close association of blue supergiants, interstellar material and diffuse gaseous nebulae in spiral structure, which he termed stellar population I. Second, he emphasized the similarities of the spherical distributions, colours and luminosities of the galactic globular cluster stars with the elliptical nebulae and nuclear region red giants, which he called stellar population II. These two populations also have dissimilar dynamics: type I participates primarily in the general rotation in the principal plane and has a small internal velocity dispersion; type II, on the other hand, shows little tendency toward general rotation and has a high internal velocity range. Thus type I is essentially a disk or fundamental-plane population, while type II is a halolike population surrounding and permeating the entire system. The distinction between the two populations, however, goes even deeper than their differences in spatial distribution and dynamics. As the result of much modern work stimulated by Baade's discoveries, it is known that the two populations represent separate stages in stellar evolution: type I is young, type II is old, and the age difference is measured in billions of years.

The blue supergiants of population I pour out radiation at so high a rate that they consume their hydrogen fuel in the astronomically short time of a few millions or tens of millions of years. These relatively brief lifetimes mean that some supergiants are continually forming in the spiral structure, otherwise we should not see them over such a long range in time as inferred from their distances. Since their formation and fleeting cosmic existence require enormous quantities of the basic fuel, hydrogen, the conclusion is almost inescapable that they originate from the hydrogen-rich interstellar gas and dust. The red giants of population II, by contrast, have reached a more mature state of life. They coolly maintain a high but not profligate standard of energy dispensation, thereby being rewarded with lifetimes hundreds of times longer. If they likewise originated from an interstellar medium, then their present properties suggest that they did so at a time far in the past, when the entire parent system consisted largely of a primeval and turbulent mass, rather than of a well-defined rotating thin disk.

Consideration of the evolutionary differences between Baade's stellar populations I and II leads naturally to the more general question of how a whole extragalactic system may evolve. In particular, it may be asked whether Hubble's classification scheme corresponds to an evolutionary sequence. Our knowledge still is too scanty, however, to provide a satisfactory answer, although there are indications that the problem of nebular evolution eventually may be successfully attacked by the same procedures used in studies of stellar evolution. Remarkable success was obtained during the decade 1950–60 by applying in astronomy the results from the rapidly developing field of physics concerned with element synthesis and atomic nuclear reactions. In this way astronomers obtained estimates of the ages of stars in galactic nebulae, open and globular clusters. Observationally, progress depended on the determination of precise colours and magnitudes for many stars in the groups, and upon more detailed spectroscopic analysis of their light. But such information for extragalactic nebulae is more difficult and takes longer to obtain, even with the largest telescopes.

This procedure involving colours, magnitudes and spectra of nebulae and their constituent parts represents a significantly different effort to understand nebular evolution. It studies the population characteristics and relates them to the observed nebular structure. Thus if the age properties of the populations are known, the structure may be related to age, and the various kinds of structures may be arranged chronologically. It remains to be seen, however, whether the great variety of nebular forms means a great range in age, or, as seemed more probable in 1965, whether the different structures denote the presence, in different proportions, of various age groups in the same system.

Rotation of Spiral Nebulae.—The most casual glance at photographs of spiral nebulae suggests rotation, which is readily revealed spectroscopically by Doppler's principle for systems tilted toward the line of sight. V. M. Slipher and Max Wolf in 1914 and F. G. Pease (1881–1938) in 1916 pioneered in proving that the central parts of several of the brightest spirals, including the Andromeda nebula (M31), have a component of rotation in the line of sight. Because of the extreme faintness of the nebular light, further progress was slow, and even by 1950 only the two nearest and apparently largest spirals, M31 and M33, had been studied in any detail, chiefly by observations made at the Lick observatory by H. W. Babcock, L. H. Aller and N. U. Mayall. They obtained radial velocities for a number of gaseous nebulae located in the plane of each spiral, and were able to follow the character of the rotation out to the extreme limits shown on photographs. Except for a faster spin in a small nuclear region in M31, they found that the two spirals rotated similarly: out to a certain distance from their centres, the rotational motion increased nearly uniformly, as for a solid body, but farther out the rotational velocity decreased, as for the planets in the solar system.

These two kinds of rotational motion reflect the distribution of mass: if it is more nearly spread out, solid-body rotation results; if highly concentrated toward the centre, Keplerian or planetary motion prevails. Comparison of these results with similar ones for the solar region of the galaxy, wherein an outwardly decreasing rotational motion is observed, gave additional support to the concept that the sun is located far from the galactic centre and beyond the main mass. Periods of rotation for the main bodies of M31 and M33 are 180,000,000 and 120,000,000 years, respectively, on the revised distance scale; for their outer parts, about 200,000,000 years, which is comparable to that for the sun's galactic orbit.

On the reasonable assumption of circular motion for the gaseous nebulae observed in the spirals, the latter's masses could be computed and compared with that of the galaxy. It was found that M31 and the galaxy are comparable giants, each having a total mass equivalent to 100,000,000,000 to 200,000,000,000 suns, but that M33, a more average spiral, contains mass aggregating about 3,000,000,000 to 4,000,000,000 suns. These rather crude optical observations, however, seem likely to be supplemented, or possibly replaced, by the more precise measurements made with the radio radiation from neutral hydrogen (*see* below).

Direction of Rotation in Spirals.—Closely allied with the character of the rotational motion of spirals is the question of how the movement takes place with respect to the curvature of the spiral arms; in other words, do the arms appear to be winding or unwinding? Slipher pioneered in this field, and on the basis of his rotation measures and his inferences of the true spatial orientation of the nebulae from their apparent or projected forms, he concluded that all spirals probably rotate in the same manner, namely, that the central part turns into the spiral arms like a coil spring being wound up. The interpretation of photographs of spirals to determine how the systems are located in space is not easy, however, and the criteria used by Slipher—asymmetries in the pattern of dark matter—were later (1934–40) construed in the opposite sense by Bertil Lindblad, whose theory of spiral stellar systems suggested a rotation with the arms leading instead of trailing.

The question was completely re-examined in 1942 by Hubble, whose study of the file of hundreds of large-reflector photographs disclosed four spirals suitable as test cases. In these the spiral pattern was plain, and the sense of tilt was unambiguously determined by primary and secondary dark lanes silhouetted against the bright nuclear region. From spectrographic observations of these four crucial-test spirals, made at the Mount Wilson and Lick observatories, it was found that, in each case, the arms trailed. With supporting, but not decisive, evidence provided by similar modern observations of 11 other spirals, Slipher's earlier conclusion now may be accepted as fairly well established, namely, that all spirals rotate in the same way: as the central part turns, the arms lag behind.

VII. RADIO OBSERVATIONS AND QUASI-STELLAR RADIO SOURCES

Neutral Hydrogen Radiation.—The first detection in an extragalactic source of neutral hydrogen radio radiation of wave length 21 cm. was accomplished in 1953 by the Australian radio astronomers F. J. Kerr and J. V. Hindman. They observed both Magellanic Clouds with a 36-ft. antenna that resolved regions about 1.5° in diameter, which is small enough to give information for individual areas of the considerably larger Clouds. They found that the amount of neutral hydrogen (H I) is about the same in both Clouds, but from the optical observation that there is apparently much more obscuring dust in the Large Cloud than in the Small, they concluded that the ratio of gas to dust is very different in the two systems.

The surface distribution of the H I gas in the Large Cloud was found to be similar in extent to the stars, while in the Small Cloud it appeared to extend well beyond the central body of stars, with a protuberance toward the Large Cloud. The depth distribution of the H I gas suggested an irregular and flattened disk seen nearly face-on for the Large Cloud, and a more regular, possibly spheroidal form for the Small Cloud. Kerr and Hindman also obtained radial velocity measurements of relatively high precision that made possible detailed studies of systematic motions in both Clouds.

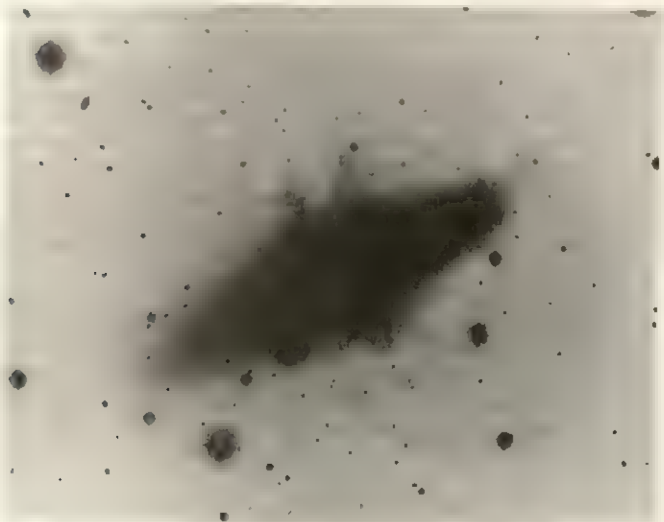
Radio Red Shifts.—In order to test as severely as possible by spectroscopic means the possibility that the red shifts observed in nebular spectra are due to recession, it is desirable to measure over as long a wave length range as possible the ratio of $\Delta\lambda/\lambda$. In this case $\Delta\lambda$ is the shift and λ the normal wave length of any spectral feature identified and measured. Doppler's principle predicts that if a shift is due to motion in the line of sight, then $\Delta\lambda/\lambda$ must be the same for all wave lengths. In the optical spectra of nebulae, it has been possible to investigate this ratio over a range of wave lengths that differ only by a factor of 2. Although $\Delta\lambda/\lambda$ has always been found constant to within the errors of measurement, even for the largest red shifts, astronomers realized that it would be of extraordinary cosmological interest if a fairly large red shift could be measured in the radio range of wave lengths, which are longer than light waves by a factor of several hundred thousands.

Although in 1955 and 1956 radio observations were reported of absorption lines of 21-cm. H I in Cygnus A and in the Coma cluster of nebulae, and their radio red shifts of 10,400 and 4,350 mi. per second, respectively, agreed closely with the optical values, subsequent work failed to confirm these first results. Nevertheless, more recent 21-cm. work on the brighter and nearer radio galaxies, chiefly by M. S. Roberts first with the 60-ft. antenna at the Agassiz station of Harvard university, and later with the 300-ft. transit-type antenna at the National Radio Astronomy observatory, Green Bank, W.Va., has shown excellent agreement between optical and radio red shifts. Thus, by 1965 Roberts had observed nearly 100 radio galaxies and had detected neutral hydrogen radiation in about 50% of them. Their red shifts ranged up to 1,000 mi. per second, and the comparison with optical values indicated that, within the observational errors, $\Delta\lambda/\lambda$ is constant for a radio-optical wave length ratio of 500,000. These observations of radio red shift greatly strengthened the interpretation of nebular red shifts as velocities of recession.

Discrete Sources.—A few years after the end of World War II radio astronomers found that the sky contains a number of discrete radio sources. These are distinguished from the general background of continuous cosmic radio radiation by their higher and localized intensities. But the first observations of the discrete sources gave only very crude positions and indications of size—much too imprecise to yield reliable correspondences with optical sources. The uncertainties were rapidly reduced, however, with the construction of larger antennas and by the development of interferometer techniques. In this way the Australian radio astronomers J. G. Bolton, G. J. Stanley and O. B. Slee in 1949 pinpointed two of the discrete sources with sufficient accuracy to make reasonably certain their correspondence with two known extragalactic objects. They suggested identification of the radio

sources Centaurus A and Virgo A with two peculiar elliptical nebulae: N.G.C. 5128 and N.G.C. 4486 (M87), respectively. The first of these is anomalous in having a great amount of lanelike dark matter, and the second is odd in showing a raylike jet extending from the nucleus. Why should these two elliptical nebulae, which are not exceptionally bright or large in the optical sky, be outstandingly bright in the radio sky? The most probable answer involves the recognition of two new phenomena in the universe beyond the Milky Way: (1) large-scale magnetic fields and (2) explosive events in nuclei of nebulae.

Large-Scale Magnetic Fields.—The discovery of polarized light from the galactic Crab nebula (*see* above) and the reasonable explanation of it as radiation from electrons accelerated in a magnetic field, raised the question of whether a similar phenomenon would be observed on the extragalactic scale. This possibility was considered by a number of investigators attending the International Astronomical Union symposium on radio astronomy, held



BY COURTESY OF THE MOUNT WILSON AND PALOMAR OBSERVATORIES

EXPLODING EXTRAGALACTIC NEBULA M82 (N.G.C. 3034) IN THE CONSTELLATION OF URSA MAJOR

Light from the outermost filamentary structure above and below the principal part of the nebula is nearly 100% polarized, as would be true for electrons moving in a magnetic field. Spectroscopic measurements of the radial motions of the inner-region filaments, composed mainly of hydrogen atoms, indicate that they were ejected from the nucleus about 1,500,000 years ago in nebular time, or 11,500,000 years ago in earth time, since the nebula's distance is 10,000,000 light-years. The farthest filaments are more than 20,000 light-years from the nucleus, and the total mass thrown out is equivalent to 5,000,000 suns. The photograph is a composite of three exposures in blue-violet light, taken with the 200-in. telescope

in 1955 in Manchester, Eng. The discussions led to a suggestion that Virgo A (N.G.C. 4486, M87) might be another case of a cosmic synchrotron because of the high ratio of radio to optical radiation, as in the case of the Crab nebula. The suspicion for M87 was effectively confirmed observationally by Baade. He reported in 1956 that 200-in. reflector photographs showed that the light in the raylike jet is polarized, probably to the order of 30%, and that the plane of vibration of the electric vector is nearly along the line of the jet.

A much more spectacular example of a cosmic magnetic field, and the first really convincing case for an explosive event that originated in the central region of an extragalactic nebula, is represented by N.G.C. 3034 (M82). This is an irregular-type nebula that is a distant and fainter companion to the large spiral in Ursa Major, N.G.C. 3031 (M81). Radio astronomers had located a faint source in the region and had naturally identified it with the larger and brighter M81. However, in 1961 C. Roger Lynds, working with more powerful equipment at the National Radio Astronomy observatory, Green Bank, W.Va., found that his more accurate position of the radio source put it very close to M82. Furthermore, he also observed that the intensity of its radio energy is nearly the same over a wide range of frequencies. Since such a "flat spectrum" is very rare, with the best-known examples being the Crab nebula and M87, he predicted that, like them, the light of M82 might be polarized. This prediction was confirmed in 1962 by Aina Elvius at the Lowell observatory, Flagstaff, Ariz., in the course of a more extensive program to detect polarization in extragalactic nebulae. She found that the light of the outer parts of M82 shows polarization up to 15%, a figure much higher than in any of the other nebulae on her program. It was the 200-in. Hale telescope, however, that revealed in 1964, by new photographic methods devised by A. R. Sandage and W. C. Miller of the Mt. Wilson and Palomar observatories, the 100% polarization of light in the very faint, extensive outer filamentary structure of M82, partially discovered in 1963 by H. M. Johnson using the old 36-in. Crossley reflector at the Lick observatory. These 200-in. telescope observations showed that this light from M82 met the two conditions required for synchrotron radiation from electrons moving in a magnetic field: (1) it is continuous, *i.e.*, comes from all wave lengths; and (2) the direction of the light vibrations is predominantly perpendicular to the pattern of filaments.

Explosive Events in Nuclei of Nebulae.—In 1943 C. K. Seyfert, working at the Mt. Wilson observatory, carried out a classical investigation of the spectra of a number of nebulae having a very high concentration of light toward their centres, or nuclei. His observations showed that these small and very bright regions contained, in addition to the usual increased numbers of stars, great masses of gas in violent motion, with velocities up to several thousand miles per second. At that time, the observations were able to indicate only that the gas motions in the nuclei are radial rather than rotational; the data were incapable of demonstrating a preference for inward or outward motion. The phenomenon was so unique, however, that this class of relatively rare nebulae came to be known as "Seyfert galaxies," and they directed attention toward nebular nuclei as sources of some kind of strange activity.

Baade's 200-in. telescope observations of the polarization of light in the jet of M87 led D. E. Osterbrock in 1960 to use the same telescope for spectroscopic study of the jet. He found its spectrum to be continuous, except at the very centre. There a radiation due to doubly ionized oxygen gas appeared to be composed of two parts: one that could be ascribed to the nebular nucleus, and another to a cloud moving outward with a velocity of nearly 600 mi. per second. The most reasonable interpretation of this abnormal velocity was that some of the ions and atoms of the jet structure, apart from the relativistic electrons, are being thrown outward at a high velocity by some unknown explosive process in the nucleus of M87.

By far the best-documented case of a nebular nuclear explosion is M82. In 1962 C. R. Lynds and A. R. Sandage reported spectrographic and photographic observations, made with the world's two largest telescopes, that left little doubt as to the occurrence of an enormous explosion in the centre of M82. Lynds used the 120-in. reflector of the Lick observatory to obtain spectra along the minor axis of the nebula to investigate any radial gas motions in the system. In this way he minimized the effects of general rotation in the principal plane, as reported by N. U. Mayall, of the Lick observatory, in 1960 from spectrographic observations along the major axis. Measurements of the $H\alpha$ line recorded on Lynds' spectrograms gave a remarkable result: the radial velocity increased linearly with distance from the centre, as would be expected for gas ejected in a single giant explosion. In the other part of this notable work, Sandage used the 200-in. telescope at Palomar observatory to obtain photographs with light from a narrow spectral region around $H\alpha$. These photographs showed a great, complex pattern of filaments fanning out from the centre of the nebula to large distances above and below the principal plane. Detailed study of both sets of data yielded estimates for the characteristics of the explosion: mass of material ejected = 5,000,000 suns; energy to accelerate this mass = 2×10^{55} ergs, or that equivalent to the thermonuclear conversion of hydrogen to helium for about 1,000,000 suns; energy of relativistic electrons = 10,000 Bev (billion electron volts); magnetic field strength = 1/100,000 to 1/1,000,000 gauss (earth's average mag-

netic field is $\frac{1}{2}$ gauss); and the time since outburst = 1,500,000 years. These results indicated a phenomenon of energy release on a scale fantastically greater than anything previously known, and they posed a real puzzle for astrophysicists to explain by known physical processes.

The case of M82, however, proved to be only the prelude to even more significant developments that came about by virtue of continued co-operation between radio and optical astronomers. These developments related to the so-called "radio stars," or discrete sources so small in angular size that radio telescopes could only place upper limits of a few seconds of arc on their diameters. For this reason such objects were referred to as "quasi-stellar radio sources." The recognition of their real nature in 1963 represented a major advance in modern astronomy as described in the next section.

Quasi-stellar Radio Sources.—The story of these phenomena may be said to have begun with the optical identification of one of the strongest and smaller radio sources known in 1951. In that year F. G. Smith of Cambridge university, Eng., determined a highly precise position for the discrete radio source Cygnus A, and he communicated the result to W. Baade and R. Minkowski, of the Mt. Wilson and Palomar observatories. Using the 200-in. Hale telescope, they were able to make an unambiguous identification of the radio source with a small 18th-magnitude nebula, on the basis of its unusual appearance and spectrum containing a number of emission radiations typical of a highly ionized gas. They also determined the red shift to be 10,500 mi. per second, which at once raised the hope that similar identifications of the fainter radio discrete sources would offer the best chances of obtaining red shifts greater than the largest one, 38,000 mi. per second, or 0.2 the velocity of light, known at that time (1952).

This expectation was realized eight years later when Minkowski in 1960 reported optical observations with the 200-in. telescope of the radio source 3C 295 (this designation refers to radio source number 295 in the third catalogue of such objects published by the radio astronomers of the Mullard Radio observatory, Cambridge, Eng.). This source is $\frac{1}{10}$ as bright and less than $\frac{1}{10}$ as large as Cygnus A; its optical counterpart was found to be the brightest member in an extremely faint cluster of nebulae, and of photovisual magnitude 20.5. So faint a magnitude meant that the light-gathering power of the world's largest telescope was strained to its utmost to yield a single spectral feature, an emission radiation from doubly ionized oxygen, for measurement of a red shift of 0.46 the velocity of light. Since optical spectra for objects fainter than magnitude 20 are bound to be nearly drowned out by the night-sky airglow, it seemed that a limit had been reached for red shifts of very distant extragalactic nebulae. This limit, however, had been extended in distance by at least a factor of 2, so that by 1960 astronomers could say that the universe had been probed out to a hazy horizon of several billions of light-years.

In the early 1960s radio observations of the fainter radio discrete sources rapidly became more precise in position and in indication of size. Also, many of the brighter and larger ones were definitely identified with elliptical, spiral and irregular extragalactic nebulae. In general, it was found that these radio sources could be put into two classes, weak or strong emitters, with the latter showing a marked preference for very small size. In fact, even with antenna arrays of several miles extent and used as interferometers, large numbers of the discrete radio sources often could not be resolved. However, the position accuracy could now be given to better than 1 min. of arc, which encouraged optical astronomers with access to large telescopes to use them for further identifications. It was in this way that A. R. Sandage, working closely with T. A. Matthews, of the Owens Valley Radio observatory, operated by the California Institute of Technology, Pasadena, Calif., found on photographs taken late in 1960 with the 200-in. telescope, that 3C 48 is a stellar object of 16th magnitude. Although there is some very faint and small nebulosity around it, 3C 48 was first thought to be a peculiar kind of galactic star.

During 1961–62 several more "radio stars" were identified with apparently stellar optical objects, some of which also had associated with them extremely faint wisps of nebulosity. The most interesting of these is 3C 273, identified by M. Schmidt of the Palomar and Mt. Wilson observatories, with the unexpectedly high brightness of 13th magnitude. Spectrograms of all these radio stars were obtained, and their spectra were found to be peculiar, with strong ultraviolet light and faint emission bands that defied identification. Nevertheless, there was little reason to regard these radio stars as other than galactic objects, possibly old novae or a different type of planetary nebula.

It was Schmidt who finally found the key to the puzzle of the "peculiar and uniquely new" spectra of the optical radio stars: certain emission bands in the spectrum of 3C 273 could reasonably be ascribed to the Balmer lines of hydrogen, but red-shifted by 0.158 times the velocity of light. This result meant that these quasi-stellar radio sources are extragalactic objects in which there is occurring a release of energy on a scale far beyond any previously found or imagined. If their distances are estimated from their red shifts, the quasi-stellar sources are intrinsically brighter by factors up to 100 times greater than any previously known extragalactic stellar system. If quasi-stellar radio sources with larger red shifts can be identified, astronomy has the means to probe to a distance many times farther than by observation of ordinary extragalactic nebulae. A step in this direction was taken in 1964 when Schmidt and Matthews reported a red shift for 3C 147 of 0.545 the velocity of light. Since this object is of the 18th magnitude, there was good reason to expect that in future years radio and optical astronomers will extend their discoveries to still greater distances in the universe. *See* QUASI-STELLAR RADIO SOURCES.

See also references under "Nebula" in the Index.

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NEBULAR THEORY: *see* COSMOGONY.

NECESSITY. For ethical implications of this term *see* FREE WILL and DETERMINISM. For logical necessity *see* first SYLLOGISM, and then LOGIC; LOGIC, HISTORY OF. For God as the Necessary Being *see* THEISM; also RATIONALISM. For mythology *see* FATE.

NECHO (NEKO; Gr. NEKOS; Assyrian NIKU) was the name of two Egyptian Pharaohs of the 26th dynasty:

NECHO I, perhaps a Libyan by origin, was installed by the Assyrians as prince of Sais and Memphis *c.* 670 B.C. He rebelled and was carried captive to Nineveh but was reinstated by Ashurbanipal.

NECHO II (Wahibre), the son of Psamtik I, reigned 610–595 B.C. Herodotus (ii, 158) tells of his attempt to link the Nile with the Red sea by a canal, and states (iv, 42) that under his patronage Africa was first circumnavigated. His ambition to revive Egyptian influence in Asia led him to march to the help of the Assyrians making their last stand at Harran. On the way he defeated and killed King Josiah of Judah, who attempted to bar

his way at Megiddo (II Kings xxiii, 29). After some successes in the Euphrates area, his army was decisively beaten at Carchemish (*q.v.*) in 605 B.C. Four years later a Babylonian force under Nebuchadrezzar II threatened Egypt but was driven back. Necho died in 595 B.C. *See* also EGYPT: *History: Ancient Period.*

See D. J. Wiseman (ed.), *Chronicles of Chaldaean Kings (626–556 B.C.) in the British Museum* (1956). (M. S. DR.)

NECK, in geology, the denuded stump of an extinct volcano. Beneath every volcano there are passages or conduits up which the volcanic materials were forced, and after the mass has been leveled by erosion there is a more or less circular pipe which marks the site of the crater. This pipe, filled with ashes or lava, is the characteristic of a volcanic neck.

In regions of former volcanic activity necks are the most persistent of all volcanic structures because the active volcanic magma is located deep within the earth's crust and the pipe by which it rises to the surface is of great length and traverses a great thickness of strata. This extensive pipe was usually vertical and nearly uniform in diameter for great depths; when exposed by denudation it has a circular ground plan, or if shown in vertical section (or elevation) in a cliff it is a pillar-shaped mass crossing the bedding planes of the strata nearly at right angles. It terminates upward in the remains of the volcanic cone and communicates below with the reservoir from which the lavas were emitted, represented in most cases, where it has been exposed, by a large irregular mass (a batholith or boss) of coarsely crystalline igneous rock. The site of such a neck is generally indicated by a low conical hill consisting of volcanic rock, surrounded by sedimentary or igneous strata of a different kind. The low cone is due to the greater hardness and strength of the volcanic materials and is not connected with the original shape of the volcano. Two splendid sugar-loaf cones known as the Pitons of St. Lucia, in the West Indies, rising from the sea with almost vertical sides to a height of nearly 3,000 ft., are old volcanic necks. In the United States (in Texas, New Mexico, Arizona, California and other western states) geologists have observed conical volcanic hills having all the features which belong to necks. In the British Isles examples are found in Derbyshire, Fife, the Lothians and the Glasgow district with the remains of Carboniferous volcanoes in every state of preservation.

Some have the conical hills of lavas and ashes well preserved (*e.g.*, Largo Law in Fifeshire); others retain only a small part of the original volcanic pile (*e.g.*, Arthur's Seat, Edinburgh; the Binn of Burntisland); and of the larger number nothing remains but the neck.

Where the volcanic rocks are soft and easily disintegrated the position of a neck may be indicated by a cup-shaped hollow.

The size of necks varies considerably; the smallest may be only 20 or 30 yd. in diameter, the largest are several miles. Occasionally a whole neck is composed of solid crystalline rock representing the last part of the magma which congealed within the crater. The Castle rock of Edinburgh is a neck occupied by a plug of crystalline basalt. Necks of this kind weather down very slowly and tend to form prominent hills. A particularly famous example is Devils Tower National monument (*q.v.*), in Wyoming.

After the eruptions terminate, gases or hot solutions given out by deep-lying masses of molten rock may find a passage upward through the materials occupying the crater, greatly modifying their mineral nature and laying down fresh deposits (*see* METASOMATISM). A good example of secondary deposits within a volcanic neck is provided by the Cripple Creek mining district of Colorado. The ore-bearing veins are connected with volcanic rocks and part of these occupy a vertical circular pipe which is a typical volcanic neck. A phonolitic breccia, greatly altered, is the principal rock and is cut by dikes of phonolite, diabase (dolerite), etc. The country rock is mostly granite and gneiss, and blocks of these are common in the breccia. A large volcano was built up in Tertiary times on the granite plateau and has since been almost entirely removed by denudation. The gold ores were carried upward by currents of hot water derived from the volcanic magma and were deposited along cracks and fissures in the materials which occupied the crater, and also in the surrounding rocks. *See* also GEOLOGY; ORE DEPOSITS. (J. S. F.; X.)

NECKAM, ALEXANDER (1157–1217), English schoolman and scientist, author of *De naturis rerum*, was born at St. Albans, Hertfordshire, in Sept. 1157 on the same night as King Richard I. His mother, Hodierna, was foster mother to the prince, who later gave her lands in Wiltshire, which long bore her name: Knoyle Odierne. Alexander was educated at the school at St. Albans and studied at Paris (*c.* 1175–82). Returning to England, he was master at a monastic school at Dunstable (*c.* 1183–84) and then at St. Albans. He taught theology at Oxford (*c.* 1190) and entered the Augustinian abbey of Cirencester (*c.* 1200), of which he became abbot in 1213. He died at Kempsey, Worcestershire, early in 1217. His earliest work, *De nominibus utensilium*, is a school book, a list of words having to do with daily life, strung together to form sentences. It contains the earliest European notice of the use of the magnetic compass as a guide to seamen. His other voluminous works, in prose and verse, which are mainly unpublished, were theological or moral. They include a grammar for biblical students (*Corrogationes Promethei*) and commentaries on the Psalms, Proverbs, Ecclesiastes and the Song of Solomon. The two introductory books of the commentary on Ecclesiastes are entitled *De naturis rerum*. In the course of moralizing comments on the heavens, on animals, birds, fishes and on man he shows that he was acquainted with the new scientific knowledge that was becoming available in western Europe through the efforts of translators from the Greek and Arabic, and in his case especially through writers of the medical school of Salerno. The commentaries also show that he knew well a wide range of Latin classical writers. His works were copied and read in England till the end of the middle ages. The name Neckam is a late corruption of his nickname "Nequam."

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(RI. W. H.)

NECKAR, a river of Germany, 371 km. (230 mi.) long and a right-bank tributary of the Rhine, rises in the Black Forest near Schwenningen am Neckar and close to the headwaters of the Danube. It flows north and then northeast along the foot of the Jurassic scarp of the Swabian Jura mountains, passing Rottweil, Rottenburg and Tübingen. At Plochingen it changes its course, flowing away from the scarp edge to Bad Cannstatt near Stuttgart. The valley at this point is very picturesque. It becomes broader and deeper and lies between vine-clad hills. Continuing north past hills crowned by feudal castles, it flows by Heilbronn and Bad Wimpfen to Eberbach. It there takes a tortuous westerly course and cuts through the wooded hills of the southern end of the Odenwald. Winding by Neckarsteinach and Neckargemünd between wooded heights, it sweeps beneath the Königsstuhl (1,857 ft.), washes the walls of Heidelberg, and enters the Rhine trough from the right at Mannheim. The Neckar is canalized as far as Plochingen, and is navigable for 1,000-ton barges. The construction of a canal to link Stuttgart with Ulm is being undertaken (*see* RHINE). (R. E. DI.)

NECKER, JACQUES (1732–1804), the French king Louis XVI's minister of finance, overpraised in his lifetime for his somewhat dubious skill with the public finances and unduly depreciated by historians for his alleged vacillation and lack of statesmanship in the opening phases of the French Revolution. He was born in Geneva on Sept. 30, 1732, the younger son of C. F. Necker, a lawyer from Küstrin in Brandenburg who, after appointment to the chair of German public law in the University of Geneva, had become a citizen of the Genevan republic in Jan. 1726. At the age of 16, Jacques Necker entered the bank of his father's friend Isaac Vernet as a clerk; and in 1750 he was transferred to the bank's headquarters in Paris. On Vernet's retirement in 1762 his nephew Pierre Isaac Thellusson promoted Necker to the position of junior partner. As a result of adroit speculation in the public funds and in the grain trade, Necker became a prominent and wealthy banker. In 1764 he married Suzanne Curchod, the cultivated and talented daughter of a former Vaudois pastor

(among her earlier suitors had been the historian Edward Gibbon). She encouraged him to embark on a public career. Geneva appointed him its resident minister in Paris in 1768; and he also became a director of the French East India company. In 1772, at his wife's suggestion, Necker transferred his banking responsibilities to his brother Louis. He then acquired a reputation as a writer on financial topics by an éloge of Colbert, which won the approval of the Académie Française (1773), and by an attack on Turgot's free-trade policy in corn (1775). Though he was a foreigner and a Protestant, Necker was placed in virtual control of French finances, as director of the royal treasury, on Oct. 22, 1776; and this position was recognized by his appointment as director general of the finances on June 29, 1777.

In his first ministry Necker made several cautious experiments in social and administrative reform. He abolished *mainmorte* (mortmain) on the royal domains in Aug. 1779; reduced the numbers of the general tax farmers from 60 to 40; and established "provincial assemblies" for Berry and for Haute-Guienne with administrative powers in which the third estate had as many representatives as the clergy and the nobility combined and voting was by head (1778–79). The first and the last of these experiments met with opposition from the privileged orders and were not extended, as had been hoped, to the country as a whole. The main mistake made by Necker, however, was his misguided attempt to finance French participation in the American War of Independence without recourse to additional taxation. In trying to raise the necessary loans, Necker published in 1781 his celebrated *Compte rendu au roi*, claiming a surplus of 10,000,000 livres in the hope of concealing an actual deficit of 46,000,000. The opposition of the leading minister, Maurepas, and the hostility of the queen, Marie Antoinette, forced Necker to resign on May 19, 1781. He retired to St. Ouen, where he wrote his *Administration des finances* to justify his policy (1784).

After both Calonne and Loménie de Brienne had failed to solve the financial problems, for which Necker was at least partially responsible, Necker himself was recalled as finance minister on Aug. 26, 1788. As the decision to summon the estates-general for 1789 had already been taken (*see* FRANCE: *History;* FRENCH REVOLUTION), Necker's main preoccupation lay in the field of politics rather than in finance, though he was too complacent in assuming that the surrender of the fiscal immunities of the nobility would remove his financial anxieties. In preparing for the meeting of the estates-general, Necker had to steer a difficult course between the claims of the third estate for double representation, which were conceded by the royal council on his recommendation in Dec. 1788, and the insistence of the privileged classes on the traditional method of debate, order by order. He has often been blamed for not having clearly laid down the government's proposals for political as well as financial reform in his opening speech to the estates-general on May 5, 1789. He did, however, propose a reasoned program of social and constitutional reforms which were lost sight of in the struggle over procedure. Even the latter struggle might have been avoided if Necker's suggestion for conciliation had been adopted. Similarly his program of liberal concessions to the National Assembly (formed between June 10 and June 17) was drastically modified by the court reactionaries just before the "royal session" of June 23, 1789. His objective was a limited constitutional monarchy with a bicameral legislature on the English model. His dismissal, on July 11, 1789, an overt sign of court reaction, did much to provoke the disturbances in Paris which culminated in the storming of the Bastille. Having retired to Switzerland, he received the summons to return to office on July 20, 1789.

In his third ministry Necker struggled ineffectively with the rapidly mounting deficit and was overshadowed by Talleyrand and Mirabeau, who dictated revolutionary finance at that stage. Necker's chief weakness as a politician was his vanity and his anxiety to preserve his popularity at all costs. After his final resignation (Sept. 18, 1790), he lived in retirement at Coppet near Geneva with his daughter Germaine, Mme de Staël (*q.v.*). Necker died at Coppet on April 9, 1804.

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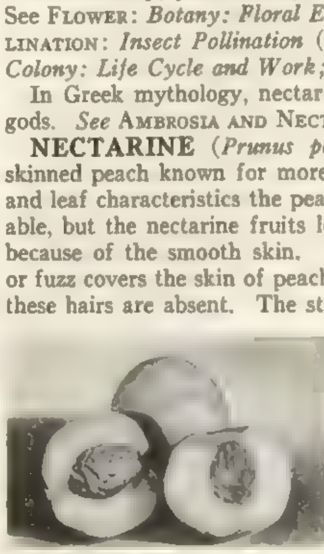
NECROSIS is a term used in pathology to describe the death of a circumscribed area of tissue. It may result from loss of blood supply to an area, from toxic agents, from physical trauma or from the action of bacteria. The characteristic changes of necrosis are due to the activity of intracellular enzymes and consist for the most part of a breakdown of organic material of the nucleus and cytoplasm of the cell. *See* also GANGRENE. (F. L. A.)

NECTAR, in botany, a sweet, variably viscous liquid secreted by certain glands called nectaries in plants. Nectar serves as an insect attractant and thus aids in effecting pollination. It is the basis of honey, produced by enzymatic action in the honeybee. See FLOWER: *Botany: Floral Envelope* (*Accessory Organs*); POLLINATION: *Insect Pollination* (*Entomophily*); BEEKEEPING: *The Colony: Life Cycle and Work;* HONEY.

In Greek mythology, nectar refers to the nourishment of the gods. *See* AMBROSIA AND NECTAR.

NECTARINE (*Prunus persica* var. *nectarina*), a smooth-skinned peach known for more than 2,000 years. In tree shape and leaf characteristics the peach and nectarine are indistinguishable, but the nectarine fruits look more like plums than peaches because of the smooth skin. A velvety mat of epidermal hairs or fuzz covers the skin of peaches, while on the skin of nectarines these hairs are absent. The stones and kernels of the two fruits are alike in appearance. Like peaches, nectarines have red, yellow or white flesh and have a characteristic aroma and flavour. They are adapted to the same soil and climatic conditions suitable for peaches and require the same cultural treatments for successful production. There are clingstone and freestone nectarines. When some peach clones are crossed or self-pollinated, the resulting seeds that carry the factor for smooth skin may give rise to nectarines, while those that do not carry this factor will be peaches. Nectarines may sometimes appear on peach trees as a result of the process of bud variation or bud sporting, a vegetative deviation from the normal. Peaches occasionally occur spontaneously on nectarine trees in the same manner.



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NECTARINE (PRUNUS PERSICA VAR. NECTARINA)

Fruits of the nectarine are more subject to fungus diseases than peaches, particularly brown rot, and when grown in humid regions must receive frequent sprays of fungicides and insecticides to control diseases and insects. Stanwick, Quetta, Gold Mine, Fireglobe and Le Grande are well-known kinds in California. In the eastern United States, Cavalier and Garden State are better-adapted varieties for humid conditions. Cultivation of nectarines is essentially the same as for peaches (*q.v.*). (F. P. C.)

NEDIM, AHMED (1681–1730), Turkish poet, whose poems present a vivid picture of the wealth and elegance of early 18th-century Istanbul. Born in Istanbul, the son of a judge and brought up as a scholar, he won the patronage of the grand vizier Ibrahim Pasha, who gave him an appointment, and became a prominent figure in the so-called "Tulip age" under Ahmed III. He died in obscure circumstances in 1730, the year of the revolution led by Patrona Halil. He was that rare thing—a poet of the old school who freed himself sufficiently from its fetters to be able to express his personality in a style of great beauty. His *Kasides* (odes) and *gazels* (lyrics) are bright and colourful, and he excelled in his gay and lively *sharkis*, which are still sung. His masterly handling of the language has made him the most popular of divan poets.

His *Divan* was edited by Halil Nihad in 1922.

See E. J. W. Gibb, *A History of Ottoman Poetry*, iv (1904). (F. I.)

NEDIM PASHA, MAHMUD: *see* MAHMUD NEDIM PASHA.

NEEDLE: *see* CLOTHING MANUFACTURE; KNITTING; NET; SEWING MACHINE.

NEEDLEWORK, or work done with a needle and thread, generally implies a handcraft. Art needlework includes the decorating of fabrics by embroidery stitches or patchwork; and the various methods of forming a single thread into fabric or lace, the best known of which are knitting, crocheting and tatting.

Embroidery.—Embroidery is an art, or craft, known to all countries and periods of history; and modern embroidery, it may be pointed out, is regaining the status of an art expression. The old techniques are used with new fluidity and freedom, often with stunning effect.

The design is usually marked on the fabric first, except in canvas embroidery or cross-stitch work, in which the commonest practice is to copy the design by counting stitches and background threads. Embroidery stitches, beginning with the basic ones (*see* fig. 1), have an infinite number of variations, combinations, uses and methods of execution. For instance, tent stitch is also the petit point of canvas embroidery, and cross-stitch (*gros point* in canvas embroidery) looks like tent stitch crossed; the two, however, are executed differently and have distinctive needle directions. Chain stitch is commonly seen in single lines, but many oriental hangings and rugs are made of chain stitch worked in close-laid rounds or back and forth.

Satin stitch and long-and-short stitch, almost invariable additions to "white work" and eyelet embroidery, are also responsible for the most opulent silk- and metal-thread effects in church vestments, hangings, etc., as well as for the colourful crewel work and for most of the older "pictures in stitches" not done in petit point. Couching stitch allows heavy yarns, even cords, to be attached without being passed through the fabric. Buttonhole stitch is used to edge cut-out designs and form bars in cut work, done on linen.

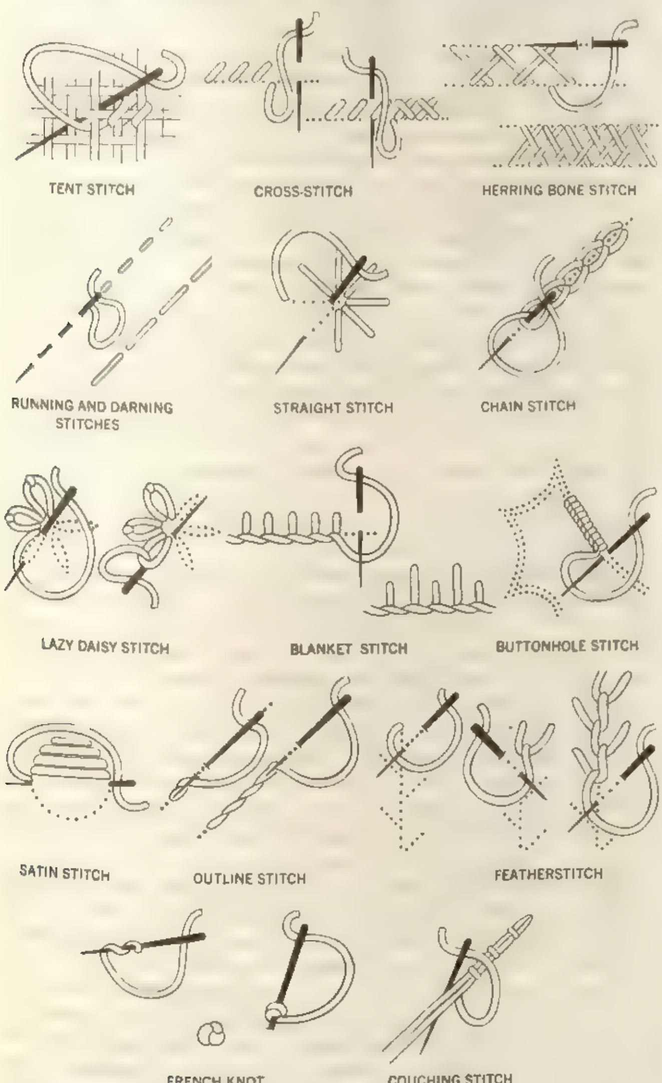

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FIG. 1.—BASIC EMBROIDERY STITCHES

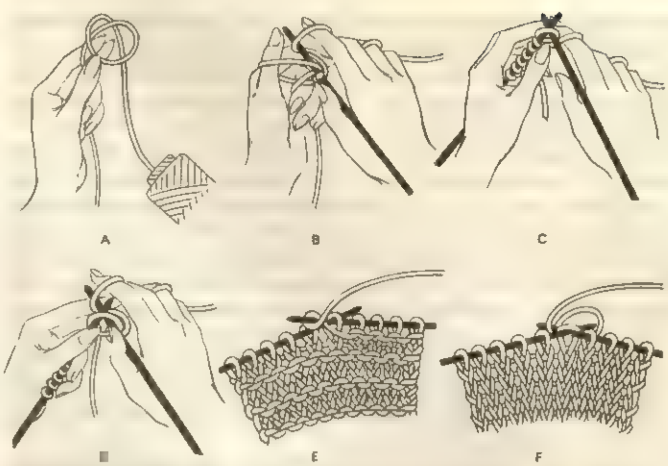

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FIG. 2.—STEPS IN KNITTING: (A) MAKING THE FIRST STITCH, (B) CASTING ON FIRST ROW OF STITCHES, (C) SECOND NEEDLE INSERTED INTO FIRST STITCH, (D) YARN BROUGHT AROUND NEEDLE TO START SECOND ROW, (E) PURLING AND (F) STOCKINETTE STITCH

Other forms of decoration through stitches are (1) drawnwork, in which threads are pulled out of the fabric in a design (this includes hemstitching); (2) smocking, in which gathers are drawn up and assembled, with the help of decorative stitches, into groups to form a design; and (3) appliqué, in which pieces of fabric, usually in contrasting colours, are cut into designs and attached to the background with either a sewing or an embroidery stitch. (*See* also EMBROIDERY.)

Knitting and Crocheting.—Both these forms of needlework require forming loops out of thread or yarn and drawing them through each other. The slender rods (needles, hooks; *see* below) by means of which this work is done range from wire thin (metal), used with fine thread, to finger thick (wood or plastic), for heavy yarns. Medium-sized plastic or metal needles and hooks and medium-weight yarns are most commonly used. Knitted fabrics have much more elasticity and pliability than crocheted ones, hence, knitting commonly is used for close-fitting garments, such as stockings and sweaters, and draped ones, such as dresses. Crochet work, on the other hand, offers greater variety in stitch design.

The information that follows should enable a person to work from printed instructions for making a simple knitted or crocheted article. The "gauge" (number of stitches and rows per inch) given in such instructions results from the combination of size of yarn, size of needle and the tightness or looseness with which an individual worker forms her stitches. Ideally a stitch is just loose enough to allow the needle or hook to slip through easily.

Knitting.—Knitting is done with knitting needles, which come either in pairs, used for flat, back-and-forth work; or in sets of four or more, used for work in rounds, such as socks and mittens. Large circular work, such as a skirt, is done on a circular needle. Flat work is easiest, and the beginning knitter should practise flat knitting first.

The work begins with casting on, or placing the first row of stitches on the needle. After making the first stitch (fig. 2A) and drawing it up, proceed as in fig. 2B for as many stitches as needed. The needle with the stitches on it is then changed to the left hand, the empty needle inserted into the first stitch (fig. 2C) and the yarn brought around (fig. 2D); the empty needle then forms a loop with the yarn and slips the old stitch off the left needle. This motion is repeated until all the stitches have been worked off the left needle and a second row is formed. The needles again change

hands for the next row, and so on. This plain back-and-forth knitting is called garter stitch. Purling is knitting in reverse, the yarn being held in front and the needle going through from back to front, as shown in fig. 2E. Alternately knitting one row and purling one row is stockinette stitch (fig. 2F).

To increase in knitting, the knitter knits two stitches in one stitch of the preceding row. To decrease, the needle is put through two stitches in the preceding row to form one new stitch. To slip a stitch means to lift it from the needle without knitting it. To pass slipped stitch over (another way of decreasing), the knitter knits one more stitch and with the left needle brings the slipped stitch over the knitted stitch and over the tip of the needle. To cast off or bind off the knitter knits or purls two stitches and passes the first stitch over the second; knits or purls another stitch; and repeats until only one stitch remains. The yarn is then broken off or cut and the end drawn through the loop. (*See* also KNITTING.)

Crocheting.—Crochet is the French word for "hook," the implement with which crochet work is done. The work starts with a crocheted chain (figs. 3A and B), except in cases where it is done

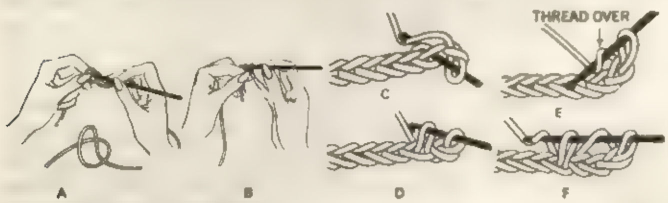

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FIG. 3.—STEPS IN CROCHETING: (A) MAKING THE FIRST LOOP ON THE HOOK; (B) STARTING THE CHAIN; FOR SINGLE CROCHET, (C) PUTTING THE HOOK THROUGH A STITCH IN THE PRECEDING ROW TO CATCH THE THREAD AND DRAW IT THROUGH; (D) CATCHING THE THREAD AGAIN AND DRAWING IT THROUGH BOTH LOOPS ON THE HOOK; FOR DOUBLE CROCHET, (E) WINDING THE THREAD AROUND THE HOOK AND (F) CATCHING THE THREAD

on an existing article (a handkerchief, a garment, a covered ring, etc.). When the chain is made to the length indicated, the work proper begins. (Note: in counting stitches, the loop on the hook is omitted).

For single crochet, the hook is put through a stitch in the chain or the preceding row, the thread or yarn is caught (fig. 3C) and drawn through, then caught again (fig. 3D) and drawn through both loops on the hook. For double crochet, the thread is wound once around the hook ("thread over," fig. 3E) before the hook is put through the stitch; the thread is then caught (fig. 3F) and drawn through two loops at a time until one loop remains on the hook. In treble crochet the thread is wound twice around the hook before it is put through. Half-double crochet starts the same way as double crochet, but after the first three loops are placed on the hook the thread is caught and drawn through all three at once.

Tatting.—Tatting, although classed as needlework, is done with a shuttle, with which knots and loops are formed into designs. Braids for upholstery and clothing formerly were done in tatting, but nowadays this work is mostly limited to fine white edgings

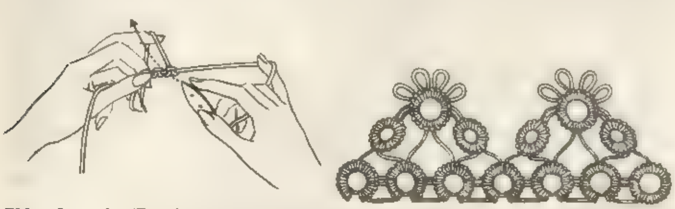

FIG. 4.—(LEFT) A CHARACTERISTIC HAND POSITION IN TATTING AND (RIGHT) A SAMPLE OF FINISHED WORK

for handkerchiefs, blouses and fine linens. Instructions cannot be given within the limits of this article; fig. 4, however, shows a characteristic hand position and finished work. *See* also LACE.

See Gladys W. Fry, *Embroidery and Needlework*, 4th ed. (1950); Mary Thomas, *Book of Knitting Patterns* (1949). (SE. PE.)

ÑEEMBUCÚ, the southwestern department of Paraguay, is bounded by the Paraná and Paraguay rivers which provide a 250-mi.-long river frontage and separate it from Argentina to the south and the west. Its area (5,355 sq.mi.) of flood plain provides the terrain for a cattle-raising economy, but subsistence agriculture also supports many of the people ([1962] 58,621); one-tenth of whom live in or near Pilar, the departmental capital. This town is linked to the Asunción-Encarnación road, but otherwise Ñeembucú lacks the transport routes which would enable its fertility to be utilized more fully. (G. J. B.)

NEENAH: *see* MENASHA.

NEER, the family name of several Dutch artists of whom the following are the two most important.

AERT (AERNOUT) VAN DER NEER (1603/04–1677) was born in Amsterdam but as a youth was in the service of a noble family at Gorinchem. He may have begun to paint before leaving Gorinchem but does not seem to have devoted himself to it seriously until he moved to Amsterdam, probably soon after 1630. At about this time he married Elisabeth Goverts, who bore him six children. He continued to live in Amsterdam until the time of his death (Nov. 9, 1677), but was unable to make a reasonable living from his art. From 1658 to 1662 he kept a wineshop, but this venture ended in disaster, and he went bankrupt in Dec. 1662, being discharged the following year. Subsequently he appears to have reverted to painting, for he is described as a painter in the inventory that was made of his few belongings at the time of his death. The artists who most influenced his early period were the Gorinchem painters Govaert and Raphael Camphuysen, while another noticeable influence is that of Esaias van de Velde.

Apart from a number of accomplished winter scenes with skaters, he specialized in canal and river landscapes seen by the light of late evening or early dawn, or (most characteristic of all) by moonlight. Within this limited range he has no rival among his contemporaries, his best pictures being distinguished by his sensitive grasp of composition as well as his delicacy and tenderness in handling the problems of subdued light, with its reflections on water and in the windows of riverside houses.

EGLON HENDRICK VAN DER NEER (1634–1703), eldest son of Aert van der Neer, was born in Amsterdam. He studied first under his father and then under the genre and portrait painter Jakob van Loo, but he does not betray the influence of either of them to any extent in his own paintings. He found his inspiration mainly in the works of artists of an older generation, producing genre pieces in a manner reminiscent of, though inferior to, Gabriel Metsu and Gerard Terborch and landscapes, sometimes with biblical or classical themes, in a style which seems with little doubt to have been based on that of Adam Elsheimer. He married three times and traveled extensively, working at different periods in Amsterdam, The Hague, Rotterdam and Brussels.

In 1687 he was accorded the title of court painter to Charles II of Spain. He died on May 3, 1703, in Düsseldorf, where he had been appointed court painter in 1690. (R. E. W. J.)

NEERWINDEN, a village of Belgium, famous for two battles, is situated 2 mi. N.W. of Landen, between Liège and Louvain. Pop. (1961) 1,009. It was in the duchy of Brabant during the period of Habsburg (Spanish and Austrian) rule in the Netherlands but is now in the Belgian province of Liège.

At the first battle of Neerwinden, in the War of the Grand Alliance, the allies under William III of England were defeated by the French under the duc de Luxembourg on July 29 (new style; 19, old style), 1693. At the second battle of Neerwinden, in the French Revolutionary Wars, the French under Dumouriez were defeated by the Austrians under Prince Josias of Coburg and Graf von Clerfayt on March 18, 1793.

NEES VON ESENBECK, CHRISTIAN GOTTFRIED (1776–1858), German botanist and entomologist best known as a mycologist, was born at Erbach on Feb. 14, 1776, and was educated at Darmstadt and at Jena, where he took the degree of M.D. After practising medicine he was appointed professor of botany in Erlangen in 1816, in which year appeared his *System der Pilze und Schwämme*. In 1819 he became professor of natural history in Bonn. Nees von Esenbeck was one of the early workers on the functions of spores in fungi. In 1820 he sowed *Rhizopus nigricans* on bread and obtained ripe sporangia in three days. He discovered

the spermatozoids of *Sphagnum* in 1822. In 1831 he was made professor of botany in the University of Breslau. He became one of the chief representatives of nature philosophy. His best-known works are those dealing with the fungi, the Hepaticae and the Glumiferae. He was the first to use the term "ascus" (or sac-containing spores) to characterize one of the three main divisions of fungi. For his political activities in 1848, a year of revolution and riots, Nees von Esenbeck was deprived of his professorship in 1851. He died in Breslau on March 16, 1858.

NEFERTITI (NOFRETETE), wife of the Egyptian king Ikhnaton (*q.v.*), is renowned for the beauty of her portrait busts, the best known of which, of painted limestone, is in the Dahlem museum, Berlin. The heads were found in a sculptor's workroom at Akhetaton (Tell el-Amarna). Of unknown parentage, she shared her husband's reforming zeal and in Akhetaton and elsewhere is represented by his side, worshiping the Aton (the sun's disk) in domestic scenes with their infant daughters. There is some evidence that *c.* 1367 B.C. she fell from favour and thereafter lived in retirement. (M. S. DR.)

HIRMER VERLAG, MUNICH

BROWN QUARTZITE HEAD OF QUEEN NEFERTITI FOUND AT TELL EL-AMARNA (ANCIENT AKHETATON) IN 1933. IN THE CAIRO MUSEUM

NEF'I (pseudonym of ÖMER; also known as NEFI OF ERZURUM) (d. 1635) is considered to be one of the leading Turkish classical poets. He was born at Hasankale, near Erzurum. Very little is known about his early life. He was in Istanbul during the first years of the reign of Ahmed I and, after serving as a minor government official, succeeded in gaining the favour of Sultan Murad IV, himself a poet of some distinction. But he made many enemies and, in 1635, one of these, Bayram Pasha, then deputy grand vizier, secured his execution. In his satires, the *Siham-i Kaza* ("Arrows of Fate"), he attacked even the highest public figures, without mercy; sometimes with wit, but often with obscene vulgarity. These works are now interesting mainly as character sketches of the period. Nef'i's *Kasides* (odes), of which editions appeared in 1836 and 1853, are distinguished by considerable dignity of style. They show him to have been a man of vigorous personality and imagination.

See E. J. W. Gibb, *A History of Ottoman Poetry*, iii (1904). (F. I.)

NEGEV (NEGEB), the triangular-shaped southern part of Israel reaching to the Gulf of Aqaba at Elath, is bordered on the west by the United Arab republic (Egypt) and on the east by Jordan. It is traditionally the frontier or desert land south of Beersheba. Its northern limit is undefined but it coincides approximately with that of the Beersheba administrative subdistrict. Its area is about 4,633 sq.mi., *i.e.*, about 60% of Israel; and its population in 1962 was about 100,000 or 5% of the population of the country. There are about 20,000 nomadic Bedouin Arabs.

The northwestern Negev is a low plain covered with desert scrub, sand dunes and gravel. Southeastward the country rises to the central Negev limestone ridges (maximum height exceeding 3,000 ft.). The centre is mainly above 1,000 ft.; eastern Negev slopes to the Ha'arava ('Arabah) rift valley and the Dead sea. The south, centre and east are desolate and rugged and much dissected by wadies which carry torrential streams after the occasional winter storms.

The area has been greatly developed since 1949, and there are numerous experimental agricultural settlements in the north and west. Without irrigation only extensive grazing of camels, goats and sheep is possible. There is considerable mineral wealth. At Sodom (Sedom, Sdom) potash and bromine are produced by evaporation of Dead sea water, and phosphates are mined at Oron. Small quantities of iron ore, copper, manganese, gypsum and kaolin are mined. Beersheba (*q.v.*) is the main town and has industries based on local minerals. Elath is Israel's port on the Red sea and from there a pipeline transports crude oil to the north; both Elath and Dimona are expanding towns. There are good roads from Beersheba to Elath and Sodom, and the railway is being extended south from Beersheba.

The Negev had numerous small frontier and trading posts in Roman and Byzantine times, supported by ingenious systems of water conservation and irrigation. In the Old Testament period it was at times under the control of the kings of Judah (*see* JUDAEA; JUDAH). *See* also ISRAEL; JORDAN.

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NEGLIGENCE is a concept found in all law. As a basis of liability in Anglo-U.S. law, it is set off against intent on the one hand and mischance or accident on the other. It is broadly defined as a failure to take care in view of foreseeable danger. It is determined by the standard of conduct of the ordinarily prudent man under similar circumstances—a question for jury determination unless the conduct in litigation can give rise to only one reasonable inference. In the latter case it is for the judge to draw the inference.

The negligence concept came into great importance early in the 1800s when it became the basis of the negligence action, superseding the earlier actions of trespass *vi et armis* ("with force and arms") and trespass on the case for physical injuries to person and property resulting from unintended hurts. The action arose out of highway horse and buggy collisions but was quickly extended to inland waterway traffic collisions, railway casualties, industrial master and servant cases, and by the end of the century had been extended to landowners with respect to injuries to highway travelers as well as to persons who came upon landowners' premises, to contractors, manufacturers, users of firearms, municipal corporations (especially for defective streets), to physicians, in some instances to charitable hospitals, and practically to all cases of unintended physical injuries to person and property. By statute it had also been extended to injuries resulting in death.

The action is not infrequently employed to recover damages for injuries resulting from defective performance of professional services, as for example those undertaken by lawyers, brokers, accountants, abstracters and the like. But the action in these cases stems from a different source and bears little resemblance to the negligence action for physical injuries.

The displacement of the action of trespass for physical injuries by the negligence action was the most radical revolution in common-law history. It was the courts' response to the Industrial Revolution. Financially weak industry and enterprise, with their dangerous and imperfect machines and processes and numerous untrained and inexperienced employees, could not do business under the strict liability of medieval tort law. The severity of the early law was completely reversed by the negligence action, under which at every point of an extended and complicated formula the burden was placed upon the victim to sustain his case. The defenses available to defendants became so numerous and exacting that they cannot be catalogued in any brief summary. Suffice it to say that the action of negligence became a great favourite of defendants and the more skilled advocates of the profession. Doctrines were spun infinitely in the fashion of religious doctrines, architectural designs, dress, manners, oratory, writing and ornamentation of every sort of that century. Even though a victim might win a jury verdict the chances were that his verdict could not run the gauntlet of appellate review. In brief, through the doctrines of negligence law there was a practical moratorium on legal liability for unintended personal physical injuries for almost three quarters of the 19th century.

Shortly after the middle of the century a reaction set in which has continued to increase in strength. In every area of activity brought under negligence law its doctrines have undergone numer-

ous modifications by court or by statute. Practically the whole area of injuries suffered by industrial employees was brought under workmen's compensation acts in England in 1897 and in the U.S. states in the early 1900s. Numerous immunities once enjoyed by landowners, railroads, charitable institutions, municipal corporations and other governmental divisions, manufacturers, suppliers, contractors, public service companies, physicians and surgeons have fallen by the way. Broad comparative negligence statutes in all the Commonwealth of Nations and in some of the U.S. states and limited statutes in numerous specific instances in most of the states have made inoperative many of the sweeping defenses once available to defendants. Jury trial, especially in England, has either been foregone in negligence cases or greatly modified, thus reducing trial errors once relied on for reversals of trial court judgments. Appellate courts by various doctrinal devices exercise an increasingly stronger hand in the disposition of negligence cases. Modern scientific techniques for making proof of nervous and psychic injuries and for evaluating all injuries to the person have removed much of the guesswork in measuring damages in personal injury cases. Of importance also is the rise of a claimants' bar equal in education and training to offset the advantages so long enjoyed by the superior advocates of corporate clients.

Only in the area of motor vehicle traffic injuries has the negligence action failed to respond to the demands of modern conditions. Here is found the overwhelming mass of negligence litigation. Liability insurance is a factor in nearly every litigation following traffic casualty. In many cases there is no basis of liability; in many others the defenses are so clear that litigation would be futile; many others are settled for a pittance; some are settled equitably; the serious cases as a rule are hard fought with the results utterly unpredictable. Negligence doctrines in these cases, however modified, are too refined for juries and in many instances too complicated for trial and appellate processes. The courthouses of all the larger centres of population are choked with cases and the trial dockets are years in arrears. Much of the time and energies of appellate judges are absorbed in the examination of extended records and briefs and in writing extended doctrinal dissertations or in minute regimentation of factual detail. The negligence law that so largely had its source in the horse and buggy traffic of the 19th century has run its course as a means of litigating the motor vehicle casualties of the 20th, and some better remedy is as urgent here as it was in the industrial injuries of the early part of the century. *See* also TORT; CASUALTY INSURANCE.

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NEGOMBO, a coastal town of Western province, Ceylon, 23 mi. N. of Colombo, to which it is connected by rail and road. Pop. (1953) 38,628. Two-thirds of the people are Christians, mainly Roman Catholics. It lies at the entrance to a large, palm-fringed lagoon, and has always been important for its fisheries (crabs and prawns). In Dutch times it was a principal centre for cinnamon, but this, having declined, has been largely replaced by coconuts. Negombo has a fine rest house and some 17th-century Dutch buildings including a gateway (1672). Four miles away is Katunayaka airport, formerly a Royal Air Force base, which was developed commercially in the 1960s. (B. H. F.)

NEGOTIABLE INSTRUMENT, in law, a term employed to describe a number of different instruments or documents, each having most, if not all, attributes of negotiability; *i.e.*, transferability, protection of bona fide purchasers and so on. These include bills of exchange, checks, promissory notes, bonds, debentures, share certificates, bills of lading and warehouse receipts. *See* COMMERCIAL PAPER; INVESTMENT PAPER. (R. T. S.)

NEGRÍN, JUAN (1889–1956), the last republican prime minister of Spain, was born in the Canary Islands. He became a physiologist of repute and held a chair at Madrid university (1923–31). Turning to politics (1929) as a moderate socialist, he was elected to the *Cortes* in 1931, 1933 and 1936. In the civil war, as minister of finance under Largo Caballero from Sept. 1936 to May 1937, he was held to be responsible for sending most of the Bank of Spain's gold reserves to the U.S.S.R. He succeeded Largo Caballero as prime minister in May 1937. In Sept. 1938 he gave orders for the withdrawal of the International brigade, but, with Communist support, he urged resistance even after the collapse of the Catalan front. In March 1939 the setting up of a council of defense in Madrid brought about Negrín's departure and the capital surrendered. He was in exile in Paris until the German occupation, then in Great Britain and the United States. He resigned as head of the government in exile in 1945 after attacks led by Indalecio Prieto. He died in Paris on Nov. 12, 1956. Negrín was accused of subservience to the Soviet Union, but it has been contended that, in the face of the nonintervention policy and the republic's need for arms, he had no alternative. His political pronouncements were liberal and sophisticated in tone.

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NEGRI SEMBILAN, a state of Malaya in the Federation of Malaysia (*q.v.*), bounded north by Pahang, south by Malacca, east by Johore and west by Selangor and the Strait of Malacca. Area 2,565 sq.mi.; pop. (1957) 364,524. A loose confederation in the late 18th century, it accepted British protection after 1874 and joined the original Malayan federation in 1895. The state is ruled by a constitutional sultan (Yang di-Pertuan) selected from the territorial chiefs, a system unique among Malay states reflecting its origins as a league of immigrants from areas including central Sumatra and Celebes. It has a short coastline and its indigenous people are spread through the steep-sided valleys around the southern end of Malaya's central range which breaks down into discontinuous mountains, creating a landscape like the Italian lakes except that the valley bottoms are under paddy.

Malays form 42% of the population, Chinese 41% and Indians 15%. In all the townships Chinese and Indians predominate. Seremban (pop. [1957] 52,091), the state capital, controls the road network, and completely overshadows Kuala Pilah (12,024), an old political centre east of the hills and now little more than a local market town. Negri Sembilan has had prolonged external associations because it borders Malacca, the source of its first modern economic impulses, with which it had rail connections until 1942. Port Dickson, midway along the coastline, was an experiment in port development which failed. With a population of 16,609 it is now used as a holiday resort and only on a small scale as a port. Nineteen new villages were created between 1948 and 1952 in an attempt to isolate Chinese farmers from guerillas in the jungle war, which was more bitter in the east of this state than in most other parts of Malaya; these farmers total nearly 20,000 (92% Chinese).

Negri Sembilan has a complex economy. Along some western valleys and toward the coast are a few declining alluvial tin mines, yielding barely 1,000 tons of tin concentrates annually. It has more than 200,000 ac. of rubber, equally divided among estates and smallholdings and producing 40,000 tons annually, and about 30,000 ac. under paddy. There is a higher proportion of roads and railways than in any other Malay state, and the state contains part of the road network of the west coast "tin and rubber belt," one of Malaya's two east-west roads and the junction of the railway lines on either side of the mountains, at Gemas (7,000). Non-Malays have largely caused the displacement of the indigenous rice-growing economy. (E. H. G. D.)

NEGRITO (Span. for "little Negro"), the name originally given by Spaniards to some aboriginal groups of the Philippine Islands but now applied also to a hypothetical element of the population of southeast Asia, Indonesia, New Guinea and other parts of Melanesia, Australia and Africa. This element is said to be represented in purest form by the Andamanese (*see* ANDAMAN ISLANDS) and in various degrees of admixture by the Aeta (*q.v.*) of the northernmost part of Luzon in the Philippines, the Semang (*q.v.*) of the Malay peninsula, the Tapiro, Aiome, Ekari and other tribes of the central New Guinea mountains and by the African pygmies (*see* PYGMY). On the basis of geographical distribution and certain physical differences these pygmy groups

have been referred to as Negrillo (Africa) and Negrito (Asia and Oceania).

Negritos are characterized by short stature, dark-brown to black woolly hair, yellowish-brown to black skin; nose shape varies from broad and flat to straight and moderately broad with the tip directed upwards. Lips generally are thick, the upper lip tending to be deep and convex; eyes are often large and prominent and the face is short; body and facial hair is scanty. Skulls may be brachycephalic or mesocephalic but dolichocephalic types occur in Africa and New Guinea. Height ranges from about 1.36 m. (54 in.) among pygmies of the equatorial forests of Africa to about 1.52 m. (60 in.) among the Semang and the Ekari. Some groups practise horticulture, while others live by hunting and food-gathering, using the bow as a main weapon. They also make effective use of simple stone axes.

Differences of opinion exist as to the origin of the Negritos and their relationship to other peoples. One view is that the Negritos were early inhabitants of Asia who were driven by later-evolved hordes to Africa, southeast Asia, and to the Pacific area, where they represent one of the major genetic components among Australian aborigines and other Oceanic peoples. But it has also been held that there are no close links among pygmy groups from different parts of the world, and much evidence supports the view that pygmies in some areas at least are modified representatives of the local general populace.

Studies of blood group gene frequencies and data for the sickle-cell trait in various Negrito groups have shed new light on these theories. The sickle-cell trait, a gene marker common among African peoples and associated with sickle-cell anemia (*see* ANEMIA), has not been found in the Pacific peoples; this is regarded as evidence that African pygmies do not share Negrito elements with Asian and Oceanic Negritos. The extensive data now available on blood-group gene frequencies make it appear unlikely that African, Asian and Oceanic pygmy groups are related. Blood studies indicate that Papuan pygmies or Negritos differ widely from pygmy groups in other parts of the world, but that they are closely akin to neighbouring Papuans. Similar relationships have been found for other Negrito populations and their taller neighbours.

See also DWARFISM AND GIGANTISM; RACES OF MANKIND; and references under "Negrito" in the Index.

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NEGRO, a member of a group of human populations either derived from or autochthonous to Africa south of the Sahara (excluding groups recently migrated from Europe or Asia). The derivation of the word is from the Latin *niger* ("black") but its use as denoting a particular subgroup of mankind comes from the Spanish-Portuguese term *negro* ("dark") dating from the time of the African slave trade.

In the United States the substantial Negro population represents a migration from Africa during historical times. Biologically it differs from its African ancestral groups by an important hybridization with the local white population. The white genetic component among U.S. Negroes has been evaluated as approximately one third (*see* NEGRO, AMERICAN).

Characteristics and Distribution.—The general characteristics of Negro populations are: a dark skin, woolly hair, thick lips and a very high frequency of the cDe (Ro) blood group (*see* BLOOD GROUPS). Most of these populations are characterized by a short and broad nose, a protruding lower part of the jaw (prognathism) and legs that are long compared with the trunk. The dark skin is not confined to Negroes; it also exists in quite different human stocks in Australia and India, and seems to result from an evolution of the gene pool in a warm and sunny climate.

Adaptive selection seems to be one of the most important differentiating factors within the group of Negro populations. Those living in the prairie and savanna zone extending between the Sahara and the equatorial forest (the so-called Sudanese zone) are tall and slender, of very dark skin with little body hair. Such are, for example, the Wolof and Hausa (*q.v.*) of west Africa. These characteristics are, however, most marked in the Nilotic populations living in the marshes and grasslands around the junction of the Nile and Bahr-el-Ghazal rivers (*see* NILOTES). The inhabitants of the equatorial forest, on the other hand, are short, of lighter skin, with more body hair. These features are extreme in the pygmies who, from strong evidence, seem to have lived much longer in the forest than the other forest Negroes. The pygmies are very short (averaging 1.444 m. or 56.9 in. for the Bambuti [*q.v.*] of the Ituri forest), with stocky bodies, large heads and relatively short legs; the face is low with a large mouth under a very broad nose (*see* PYGMY).

Apart from the pygmies, there are two distinct groups of African populations. The first one, comprising the Bushmen and the Hottentots, is called Khoisan (*q.v.*). The difference between Bushmen and Hottentots is mainly that Bushmen are shorter (averaging 1.52 m. or 59.8 in.). They are confined to the Kalahari desert in south Africa. Their yellowish-brown skin tends to be much lighter than in other Africans. The hair is so tightly curled that it forms little individual spirals (peppercorn hair), leaving much scalp exposed (*see* HAIR). The skull is five-cornered and the face is flat and small with wide and prominent cheekbones. The eyelid gap is narrow; the nose is broad and the lips full. Several of these characteristics give the Khoisan a mongoloid appearance, but this correspondence seems to be merely fortuitous. Women among the Hottentots (and to some extent the Bushmen) display steatopygia, an accumulation of fat in the buttocks which gives a pronounced protrusion (*see* BUSHMAN; HOTTENTOT).

The second group, often called the Hamitic group, comprises different populations of east Africa (for example, the Tutsi of the Rwanda area, the Hima of Uganda, the Masai of Kenya, the Somali); linguistically it includes some Hamites, Nilotes, Nilo-Hamites and even Bantu. They are tall and slender, with all vertical dimensions emphasized—long narrow faces, noses and skulls, long arms and legs. The skin is very dark, the hair is woolly or curly. The orthognathous (square-jawed) face with its narrow nose contrasts with that of the classical Negro type. (*See* HAMITE; NILO-HAMITES; BANTU LANGUAGES.)

Natural History.—The differences between the Khoisan and other Africans are so great that some authors do not consider the Khoisan as Negroes but as another major differentiation within modern mankind. But if, as many anthropologists believe, the Khoisan derive from the Negro trunk, they must have parted from it a long time ago when it was still generalized, before the differentiation of the other types. There is strong evidence that several fossil men of normal stature found in south Africa are ancestral to the Bushmen; *e.g.*, the Boskop skull (*q.v.*), which supposedly dates from the middle Stone Age.

The area occupied by the Khoisan was much larger in the past than today; it covered at least the whole of southern Africa and a part of east Africa. They were forced southward by the waves of migration of Bantu-speaking tribes; such a move was still going on at the time of the arrival of Europeans in south Africa; the final confinement of the Bushmen to the Kalahari desert occurred during historical times.

Some objections have also been raised against the inclusion of the Hamitic group in the Negro subdivision of mankind. The association of a black skin and long legs on one hand, and orthognathous face and narrow nose on the other, has led several authors to consider the Hamitic peoples as having resulted from an ancient Negro-white mixture. They are, however, very different from mulattoes and it appears more reasonable to attribute their fea-

tures merely to a long independent evolution from some generalized stock. Archaeological data show them as established in Kenya long before the arrival of the typical Negroes. Their morphology suggests a hot, sunny and dry country of origin.

The homeland of the typical Negroes (the sub-Saharan Africans with the exception of the Khoisan and the Hamitic group) probably lies in a strip of country south of the Sahara, between the Atlantic coast and the Nile. Excepting the pygmies, the expansion of the typical Negroes toward southern and eastern Africa is relatively recent. The most spectacular known phase of this expansion is that of the Bantu-speaking tribes who, starting approximately 4,000 years ago from a restricted area in west Africa, invaded most of central, east and south Africa and probably would have reached the Cape of Good Hope if they had not been stopped by the Europeans already settled in south Africa.

If independent evolution of an isolated group is one of the main factors of differentiation of the Negro populations, hybridization between different groups coming into contact is another; it has occurred in many places and at several times. The influence of white elements from Arabia is clear in the Horn of Africa. An Indonesian migration reached Madagascar and mingled in various proportions with the local Negroes, the Negro component being discrete or absent in the most aristocratic class. The Hamitic peoples were great travelers; the Fulani (*q.v.*) of west Africa display an important Hamitic component; the Hamitic influence is clear also in the physical appearance of many Bantu-speaking tribes with whom they are in contact (in the Lake Victoria area, for example) or with whom they have been in contact in the past (several tribes of south Africa, for example); such contact has possibly influenced the physique of the Nilotic populations. Conversely, the Hamitic peoples are hybridized to a certain extent by their neighbours. Hybridization also occurs in the equatorial forest between pygmies and normal-statured Negroes.

Another factor of differentiation lies in mutations (changes in genes to induce new hereditary features). A typical example is the sickle-cell trait, a hereditary abnormality of the hemoglobin, giving to the red blood cells a sicklelike shape when deprived of oxygen. The feature seems to have arisen by mutation in the Negro stock; its frequency varies much from one African population to the other and seems to depend on the severity of malaria in earlier generations, since those who carry one sickle-cell gene have a relative immunity to malaria. This advantage for the population is counterbalanced by the fact that the (homozygous) presence of two such genes kills the affected child. The sickle-cell gene has somewhat diffused outside Africa; frequent in the American Negroes, it is also found in some malarial districts of Greece and Italy, where its introduction needed only a very minute Negro admixture. It is also present in southern Arabia and in a few tribes of India (where its significance is more hypothetical) and was even interpreted by some authors as an indication of an Indian component in the Africans (*see* ANEMIA).

Negritos and Melanesians.—Several small groups of people (*see* NEGRITO) apparently similar to the African pygmies live in different places in Asia. New Guinea and other Melanesian islands are inhabited by populations with a negroid appearance (Melanesians). Whether these Melanesian and Negrito populations are related to the African Negroes is not established with certainty; in particular, they lack the typical high Ro frequency of the Africans. If such a relation were proved, the problem of the origin and diffusion of the Negroes would be much more complicated than indicated by the scheme given above.

See RACES OF MANKIND; AFRICA: *Ethnography* (*Anthropology*); *see* also references under "Negro" in the Index.

BIBLIOGRAPHY.—Works on physical traits of Negroes are in general restricted to articles in scholarly journals; a summary will be found in G. Lefrou, *Le Noir d'Afrique* (1943). An excellent general book on the story of human evolution is W. W. Howells, *Mankind in the Making* (1959). For Hottentot and Bushman physical traits *see* I. Schapera, *The Khoisan Peoples of South Africa: Bushmen and Hottentots* (1952). On the physical characteristics of Negroes in the United States, *see* M. J. Herskovits, *The American Negro* (1928). *See* also R. Biasutti, *Le razze e i popoli della terra* (1959); W. S. Pollitzer, "Hemoglobins, Haptoglobins, and Transferrins in Man," *American Anthropologist*, vol. 65 (1963).

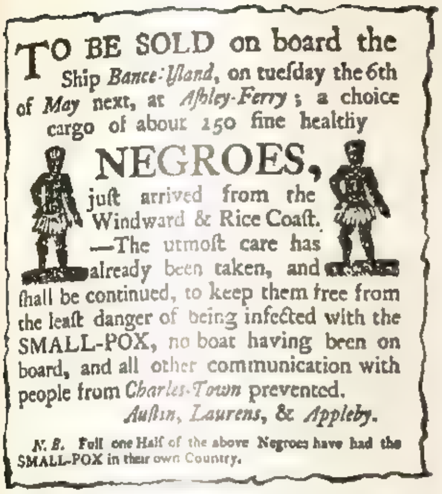
(J. R. HI.)

NEGRO, AMERICAN. In the United States a person is popularly regarded as a Negro if he possesses any Negro ancestry, regardless of the number of white or Indian ancestors he may also possess. In states concerned with the problem of race, identification of a Negro by physical appearance or by reputation has been insufficient, and the law has defined a Negro with considerable precision. For example, the Virginia law of 1930 defined a Negro as any person in whom there is ascertainable any quantum whatever of Negro blood. That the concept of who constituted a Negro was not by any means unchanging is attested by the fact that in 1910 Virginia changed its definition of a Negro from a person with one-fourth Negro blood to one with one-sixteenth Negro blood and then to its definition of 1930. The problem of the definition of a Negro began early in the American colonial period. The social and legal status of the children resulting from the union of whites and Negroes, usually illegal and outside the marriage bonds, was frequently open to question. They were usually defined as Negroes regardless of the amount of white blood; and they were defined as slaves if their mothers were slaves. Efforts to control miscegenation by law were notably unsuccessful during the slave period, and although many states had laws against intermarriage in the second half of the 20th century, miscegenation persisted. The loosely defined mulatto element, the product of unions of Negroes and mulattoes as well as of whites and Negroes, continued to provide the legally defined Negro element with a range of physical types that defied any precise, scientific classification.

After a survey of the growth of the Negro population in the United States this article is organized according to the following outline:

Population.—At the time of the first decennial census in 1790 the 757,208 Negroes in the United States constituted approximately one-fifth of the total population. More than 90% of them were concentrated in the south, but within that region there were great variations in the proportions of Negroes to the white population, because of the concentration of the Negro population in the areas of the plantation economy. By 1860 the Negro population had increased to 4,441,830 and was about one-seventh of the total population. With the spread of the plantation, there was a significant shift of the Negro population to the states of the southwest, notably Alabama, Mississippi and Louisiana. The increase continued in the years following emancipation, the figure having reached 8,833,994 by 1900 and 11,891,143 by 1930. When the Negro population reached 18,871,831 in the census of 1960, it constituted 10.5% of the total population.

One of the most remarkable facts about the Negro population in the 20th century was the movement of large numbers to urban communities in the south and out of the southern states altogether. Although the movement was rather steady, it was greatly accelerated during World Wars I and II, and during the 1950s and early


TO BE SOLD on board the Ship *Bance-Island*, on tuesday the 6th of *May* next, at *Ashley-Ferry*; a choice cargo of about 250 fine healthy

NEGROES,

just arrived from the Windward & Rice Coast. —The utmost care has already been taken, and shall be continued, to keep them free from the least danger of being infected with the SMALL-POX, no boat having been on board, and all other communication with people from *Charles-Town* prevented.

Austin, Laurens, & Appleby.

N. B. Full one Half of the above Negroes have had the SMALL-POX in their own Country.

Announcement for a sale of 250 healthy Negroes aboard an anchored ship to avoid contamination by a smallpox epidemic then raging ashore


Slaves were chattels and subject to chattel law. The slaveowner's property rights were absolute. He could chain, harass and even destroy his "property" at will


An engraving by Paul Revere showing the British firing on the colonists during the Boston massacre in 1770 which presaged the American Revolution. Crispus Attucks, a Negro, was the first to die


Capture of Nat Turner, a Negro who led one of several determined but abortive slave uprisings of the early 19th century. More than 3,000 armed men were required to put down Turner's rebellion in 1831


A network of barns and stables used as places of concealment for fleeing slaves became known as the Underground Railroad. This is Levi Coffin's farm in Indiana through which more than 300 fugitives passed on their way to freedom in the west or Canada


Dred Scott, who sued for his liberty in 1846 after his master had taken him into free territory. The supreme court ruled against Scott in 1857 and upheld the right of slaveholders to take their property into any federal territory

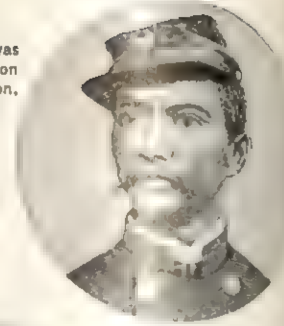
SLAVERY TO THE TIME OF THE CIVIL WAR

BY COURTESY OF (CENTRE LEFT) NATIONAL ARCHIVES; PHOTOGRAPHS, (TOP LEFT, BOTTOM RIGHT) MILTON MELTZER, (OTHERS) THE BETTMANN ARCHIVE, INC.

NEGRO, AMERICAN

In a major Civil War engagement, the 54th Massachusetts Colored regiment is shown charging Ft. Wagner, a Confederate stronghold commanding a stretch of the Charleston, S.C., harbour

Major A. T. Augusta was a senior surgeon, Union forces, at Camp Stanton, Md.



Sgt. William H. Carney, Company C, 54th Massachusetts, received the Medal of Honor in the assault on Ft. Wagner

Before and during the Civil War, crudely built shacks, many with dirt floors and corn shuck beds, sheltered slave families such as this one. Later, the slave families were emancipated by law but their living conditions scarcely improved in fact

Robert Brown Elliott of South Carolina speaking on civil rights in the U.S. house of representatives on Jan. 6, 1874. It was a celebrated speech and contributed to Elliott's reputation as a leading Negro orator and politician

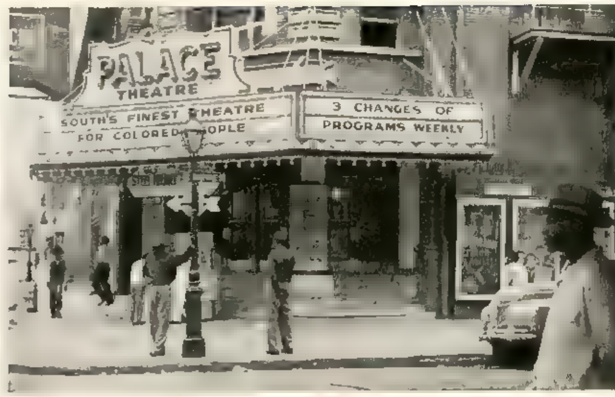
The jury impaneled in May 1867 to try Jefferson Davis, the president of the Confederacy. It was the first jury to include Negroes ever selected in the South. The trial was never held

John Willis Menard of Louisiana, the first Negro to claim election to the U.S. house of representatives; his election was challenged and he did not serve

CIVIL WAR AND RECONSTRUCTION

BY COURTESY OF (TOP LEFT) NATIONAL ARCHIVES; PHOTOGRAPHS, (OTHERS) MILTON MELTZER

The all-Negro 369th infantry regiment was cited 11 times for bravery in World War I. The entire regiment received the Croix de Guerre for gallantry in combat. Shown here are some of the men returning to the U.S. in 1919



Jim Crow theatre on Dauphine street in New Orleans

Negro troops of the U.S. 93rd division remove their wounded after combat on the island of Bougainville during World War II. The division also saw action in the Dutch East Indies and the Philippines

Police battle a Negro in the 1943 Detroit race riot which began at the suggestion that Negroes be moved into Sojourner Truth homes, a housing project

Brig. Gen. Benjamin O. Davis, the first Negro to attain this rank in the U.S. army; standing is Lt. Col. Benjamin O. Davis, Jr., who subsequently attained the rank of major general in the U.S. air force

Isaac Woodard (dark glasses) was blinded during a beating by a South Carolina policeman while still in military uniform after service in World War II. Civil rights leaders protested the incident and one of them, Walter White, then executive secretary of the N.A.A.C.P., is at Woodard's left

IN WAR AND IN PEACE

PHOTOGRAPHS, (TOP LEFT, CENTRE LEFT AND BOTTOM RIGHT) MILTON MELTZER, (TOP RIGHT) JAQUES—PHOTO RESEARCHERS, INC. (CENTRE RIGHT) UPI—COMPIX, (BOTTOM LEFT) WIDE WORLD PHOTOS

NEGRO, AMERICAN

Spottswood T. Bolling, Jr., central figure in one of two key supreme court school desegregation cases in 1954

Negro attorneys figured prominently in the 1954 supreme court cases that outlawed legal segregation in public schools. The attorneys were: George E. C. Hayes, left, Thurgood Marshall and James Nabrit, Jr., right

Mrs. Rosa P[illegible]ks, whose refusal to give up her s[illegible] a white person on a Montgom[illegible]la., bus precipitated the succ[illegible] antisegregation bus strike in t[illegible]ty in 1955

Lt. Gov. Paul Johnson of Mississippi, centre left, confronts U.S. marshal in defiance of a U.S. court order directing the University of Mississippi to enroll Negro James Meredith, right. Object of Meredith's enrollment in 1962 was to breach segregationist practice in higher education in the South

The march on Washington by 200,000 Negroes and white sympathizers in 1963 was the largest of its kind in U.S. history. The marchers called for the ending of segregation practices throughout the nation

Negro leaders confer with Pres. Lyndon B. Johnson. From the left: Roy Wilkins, National Association for the Advancement of Colored People; James Farmer, Committee on Racial Equality; Martin Luther King, Jr., Southern Christian Leadership conference; Whitney Young, Urban league

PROGRESS THROUGH PROTEST

PHOTOGRAPHS, (TOP LEFT, TOP CENTRE) UPI—COMPIX, (CENTRE ROW) FLIP SCHULKE—BLACK STAR, (OTHERS) WIDE WORLD PHOTOS, INC.

1960s. The 1940s saw the Negro population increase by 44.2% in the northeast, 50.2% in the north central states and 237.4% in the west. During the next decade the increase was 50.6% in the northeast, 54.7% in the north central states and 89.3% in the west. As late as 1920 the proportion of Negroes living in the south was 85%, but by 1950 it was approximately 68% and in 1960, 60%. In 1910 no city in the nation had as many as 100,000 Negroes, but in 1950 there were 14 such cities, and in 1960 there were 24: Atlanta, Baltimore, Birmingham, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Houston, Kansas City, Los Angeles, Memphis, Miami, Mobile, Newark, New Orleans, New York, Norfolk-Portsmouth, Philadelphia, Pittsburgh, Richmond, St. Louis, San Francisco-Oakland and Washington.

These shifts in the Negro population materially affected the relationships between the southern white population and the Negroes. The steady urbanization of the Negro population also had considerable economic, political and social consequences for the group as a whole. The migration of Negroes to the cities of the south, north and west widened the range of economic opportunities for Negroes, but it also created new racial tensions in numerous social and economic areas. The greater opportunities for Negroes to vote in northern communities noticeably increased their political power by giving more of them an opportunity not only to hold public office but also to affect the outcome of close elections.

At the beginning of the 20th century there was some thought that the Negro problem would solve itself by the gradual disappearance of the Negro as a racial group. The growth of the Negro population in the first half of the century, however, and the vigour of its participation in American life while retaining its separate identity seemed to indicate that this was not likely to occur. The Negro must be accepted as a permanent part of the body politic, and his status must be considered within the framework of the American social order.

I. THE SLAVE PERIOD

As explorers and servants with the Spanish and Portuguese, Negroes were in the new world by the early 16th century. In the beginning the European settlers gave no serious consideration to the use of Negroes to solve the problem of the acute labour shortage, but the idea eventually took hold. Their easy identification because of colour, combined with the apparently inexhaustible supply of Negroes and their non-Christian background, convinced the enterprising settlers that Negroes would be the ideal permanent workers in the task of developing the new world. Although the precedent for Negro slavery in America had been established by the Spanish and Portuguese, the English were slow to adopt the practice.

The first Negroes that landed at Jamestown in 1619 were actually indentured servants; and even after slavery was legally established in the English colonies the Negro population grew slowly. At the end of the first century there were fewer than 25,000 Negroes in Virginia, while Maryland had approximately 40,000 a century after the settlement of that colony. In the New England and middle colonies the Negro population was much smaller, with 5,000 in Massachusetts and 19,800 in New York at the time of the American Revolution.

Proposals for the abolition of slavery began in the late 17th century and increased in number before and during the American Revolution in both north and south. The Northwest Ordinance of 1787 forbade slavery in the territory northwest of the Ohio river. On the other hand the federal constitution recognized the existence of slavery by providing that three-fifths of the slaves would be counted when determining the apportionment of representatives and direct taxes among the states. The constitution also provided that the importation of slaves should not be forbidden before the year 1808.

The significant increase in the number of Negroes began with the demand for cheap raw materials, primarily cotton, created by the Industrial Revolution. The discovery of the short staple variety of cotton made possible the cultivation of the crop in a much larger area of the southern United States than had hitherto been possible, and the invention of the cotton gin (1793) made practicable the extensive cultivation and processing of the raw material for the factories of England and other countries. Within a generation, the vast area that came to be known as the cotton kingdom was settled and developed; and the Negro population began to shift from the upper south to the southwest and to increase enormously, thanks to smuggling of Negroes from the Caribbean and Africa and to the encouragement given to slaves to increase their own population. This was achieved, in part, by deliberate slave breeding.

Opposition to proposals for the abolition of slavery increased in the south; justification of the region's "peculiar institution" prevailed. Southern apologists turned to the Bible and to the history of ancient Greece to find authority for slavery. As antislavery criticisms by northerners grew in intensity, southern spokesmen heatedly defended the plantation system and contended that slavery was indispensable to it. They buttressed their arguments with assertions that the Negro was innately inferior to the white man and incapable of rising above a servile status.

Slaveholding in the United States was always confined to a small segment of the population. Only 384,000 southerners, out of a population of more than 8,000,000, held the 3,900,000 Negroes who were in slavery in 1860. Most owners, moreover, had small numbers of slaves. Approximately 330,000 held fewer than 20 slaves, while more than 200,000 had 5 slaves or less. At the same time only 1,700 owners held as many as 100 slaves. By 1860 the price of slaves was prohibitive for all but the most affluent; the cost of a prime field hand—a healthy male between 16 and 25 years of age—had risen to $1,800 on the New Orleans market.

Because the owner had to be protected in his property and because the community had to be protected from the possibility of violence at the hands of slaves, a great body of laws commonly known as the slave codes grew up in each of the slave states. There were considerable variations, to be sure, but certain provisions were to be found in all of them. Slaves could not be away from the premises of their owner without written permission; they were incompetent to make contracts and their testimony was inadmissible in any litigation involving a white person; they could not own property; they could not be taught to read or write; and they could not assemble together unless a white person was present. These laws were not always strictly enforced, but whenever there was fear that the slaves might become ungovernable, the enforcement machinery of the state was alerted and, for a while, the laws were carefully observed.

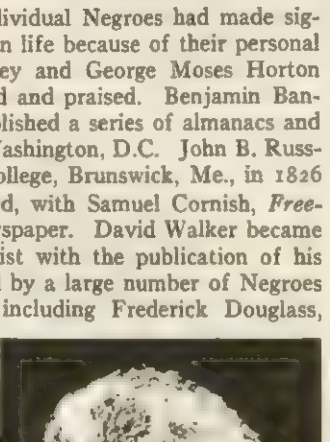
Whether they were on a cotton, rice or sugar plantation or in urban communities (where approximately 500,000 were living by 1860), the slaves' principal duty was to provide income and comfort for the owners. Field hands, working in gangs or on task assignments, laboured for long hours in the cultivation and harvesting of the crops. House servants, tending to be more numerous than the owner actually needed, performed a variety of chores. Town slaves were engaged in many tasks which required considerable skills, as indeed were some of the plantation slaves. Geared as it was to the making of profits the slave economy was constantly in search of ways to cut production costs. Thus, only the barest essentials for the subsistence of the slaves were provided. Food was simple, though adequate in quantity; clothing was made of the cheapest materials or, as was frequently the case for house servants, was discarded attire of the owner and his family; and housing consisted of crude huts that barely protected the slaves from the weather.

The majority of the slaves accepted their degraded lot with no outward manifestation of dissatisfaction. Some, however, such as Gabriel Prosser in 1800, Denmark Vesey in 1822 and Nat Turner in 1831, planned or executed revolts that terrorized the white population for miles around. Others registered their resentment by destroying farm implements or animals or, occasionally, by murdering their owners. Many more ran away, either by means of the Underground Railroad (*q.v.*) with the help of abolitionists or by means ingeniously devised by themselves. Those who remained in bondage secured some satisfaction through improvising the spirituals that became a significant contribution to American culture, or embracing the religion of their owners, or through recrea-

tional activities provided by social intercourse with other slaves or with free Negroes.

In 1860 approximately half of the 488,000 free Negroes lived in the slave states, where they were subjected to proscriptive laws hardly less severe than those in the slave codes. Their contact with slaves was especially frowned upon lest they contaminate them with ideas of freedom, while in the economic sphere they were carefully circumscribed, lest their activities work a serious hardship on their white competitors. In the north they were concentrated in such cities as Cincinnati, Philadelphia, New York and Boston, where hostility to them often resulted in riots such as those in Philadelphia in 1834 and in New York city in 1839. From the early colonial period, however, they enjoyed some educational opportunities in the north and some freedom to organize social and religious institutions of their own.

Before the Civil War many individual Negroes had made significant impressions upon American life because of their personal accomplishments. Phillis Wheatley and George Moses Horton wrote poetry that was widely read and praised. Benjamin Banneker, an able mathematician, published a series of almanacs and assisted in laying out the city of Washington, D.C. John B. Russwurm graduated from Bowdoin college, Brunswick, Me., in 1826 and in the following year founded, with Samuel Cornish, *Freedom's Journal*, the first Negro newspaper. David Walker became the first militant Negro abolitionist with the publication of his *Appeal* in 1829. He was followed by a large number of Negroes who vigorously fought slavery, including Frederick Douglass, who edited his own newspaper and traveled extensively in the United States and abroad; William Wells Brown, the author of several books and a lecturer for the Western New York Anti-slavery society; and Harriet Tubman, who is credited with having guided more than 300 slaves to freedom.



EBONY MAGAZINE

FREDERICK DOUGLASS

Among the Negro organizations that sprang up before the Civil War the Negro church was, perhaps, the most important. Some local Baptist groups were organized during the American Revolution in Savannah, Ga., and Petersburg and Richmond, Va. In Philadelphia, Pa., Richard Allen and others founded the African Methodist Episcopal Church in 1794, while in New York city, two years later, James Varick and his associates founded the African Methodist Episcopal Zion Church. Fraternal organizations made their appeal to Negroes through the Masons, organized by Prince Hall in 1784, and through numerous local groups such as the Boston African society, organized in 1796. Beginning in 1830 Negroes held national conventions almost annually in which they sought to make known their grievances and to plan for the future. By the time of the Civil War this typically American institution had become a most effective means of articulating the aspirations as well as the accomplishments of Negroes in American life.

II. ECONOMIC LIFE

1. Agriculture.—The vast majority of the almost 4,000,000 slaves were field hands and domestic servants. The failure of the federal government to provide "forty acres and a mule" for most of the freedmen and prohibitions of some southern states against land-owning by freedmen kept most of them agricultural workers. In 1900, 192,993 Negroes owned farms, of which 54,017 were encumbered. Three-fourths of the Negroes living on farms were tenants who paid rent or sharecroppers who received a portion of the sale of the crop. Most of them, but particularly the sharecroppers, were compelled to obtain advances from the country merchants for food, clothing, tools, farm implements, etc., at an increase in price from 40% to 100%. Since the value of the crops was sometimes less than the advances and since the books were kept by the merchants, many tenant farmers and croppers started the new year in debt. At the beginning of the 20th century, in some parts of the south, nine-tenths of all farmers fell into debt.

In 1920, the last census year before the depression set in, there were 700,439 Negro tenant farmers. Of these, 333,026 or 47.5% were sharecroppers. Negro farmers operated 40,884,199 ac., or 12% of all the farm land in the south. The various measures of the New Deal to provide relief for farmers did not benefit Negroes as much as they did whites. In 1940 the number and percentage of Negro farm owners were about the same as in 1900. On the other hand, the percentage of tenants among farm operators remained about the same and the proportion of croppers among tenants increased.

In the period from 1940 to the early 1960s the number of Negroes engaged in agriculture in the South declined. The revolution in agriculture required technical skills which few Negro tenants and sharecroppers possessed. Moreover, like other farm workers, many Negroes were attracted to the newly industrialized southern cities. They sought better opportunities for employment and education, improved living conditions and fuller protection of the law. These better conditions, together with larger enjoyment of civil rights, impelled many Negroes to continue migrating to the north.

2. Domestic and Personal Service.—Of the total number of employed Negroes, the proportion of those in domestic and personal service increased from 21.6% in 1910 to a little over 30% in 1940 while the proportion of white workers in these fields remained fairly constant. Between 1940 and 1960 the proportion of private household servants decreased by 26.6% among whites and 6.3% among nonwhites (mainly Negroes). On the other hand, during the same period the proportion of workers in other personal service fields—beauticians, barbers, cooks, counter clerks and waitresses—increased by 61.4% among whites and 101.2% among nonwhites. These statistics suggest that new opportunities in personal service, clerical, sales and kindred occupations enabled workers of both races to leave domestic service and that the change was greater among Negroes than among whites.

3. Industrial Workers.—After slavery was abolished many of the Negroes who had held skilled jobs lost them to white workers. Moreover, barbering, waiting, etc., formerly known as "Negro jobs," increasingly attracted large numbers of white workers. This displacement and the reluctance to accept Negroes in the new mechanical industries in the south spurred some migration to the north and the west but there whites also began to take "Negro jobs." The rapidly expanding industries in the north preferred European immigrants to Negroes, both as skilled and as unskilled workers. The American Federation of Labor (A.F. of L.) denied membership to most of the few skilled Negro workers or it organized them in separate unions, thus pitting Negro and white workers against each other. The fact that Negroes were first brought into some industries as strikebreakers increased racial antipathy in the ranks of labour. The Knights of Labor in the latter part of the 19th century and the Industrial Workers of the World in the early part of the 20th century, both of which included a considerable number of Negro workers, disappeared, largely because these organizations were considered revolutionary. (*See* also LABOUR [TRADE] UNION.)

The first opportunity for Negroes to enter northern industry in force came during World War I. The acute need for labour, resulting from the departure of many white workers for military service and the virtual cessation of immigration, brought new jobs in iron and steel mills, coal mines and automobile factories to substantial numbers of Negroes, many of them from the south. Proving to be, on the whole, efficient workers, they fortified their position during the 1920s. During the depression of the 1930s, however, they were "the last to be hired and the first to be fired."

Their plight was ameliorated by the emergence in 1935 of the Congress of Industrial Organizations (C.I.O.) which, unlike the A.F. of L., organized skilled, semiskilled and unskilled workers in an entire industry. The growing increase in the membership of the C.I.O. led the A.F. of L. perforce to liberalize its membership policies; the number of Negro union members soon reached more than

EBONY MAGAZINE

A. PHILIP RANDOLPH

2,000,000. In 1955 these two major trade union federations merged; one of their chief objectives was to double their membership of 15,000,000. The attainment of this objective would necessitate the inclusion of more Negro workers. The merged unions, unlike the two components, for the first time elected two Negroes to the executive council. A notable Negro union official was A. Philip Randolph, president of the Brotherhood of Sleeping Car Porters. He became a vice-president of the A.F.L.-C.I.O. and was an influential leader in other Negro organizations. Opposition to unionization of Negroes continued in the south as part of the reaction against the supreme court decisions of 1954 and 1955 that invalidated segregation in the public schools. An additional problem that came to the forefront in the 1960s was the prediction that the displacement of manpower by automation would bear most heavily on Negro workers.

In June 1941 a group of Negroes proposed to march on Washington, D.C., for the purpose of obtaining governmental action to reduce the widespread discrimination against Negroes in the rapidly expanding war industries. On June 25 Pres. Franklin D. Roosevelt issued an executive order declaring that there should be no discrimination in the employment of workers in defense industries or government because of race, creed, colour or national origin. All contracting agencies of the federal government were to include in defense contracts a provision obligating the contractor not to discriminate against workers for those reasons. The order established a Committee on Fair Employment Practice (F.E.P.C.) to receive and investigate complaints in violation of the order. Although the order met widespread opposition in the south, it resulted in considerable gains in the north. The work of the committee ended in June 1946 when congress failed to appropriate the necessary funds for the ensuing year. Pres. Dwight D. Eisenhower by an executive order dated Aug. 13, 1953, appointed a committee to make recommendations to the government contracting agencies for improving and making more effective the nondiscrimination provisions of government contracts. The order also required the head of each contracting agency to take appropriate procedures to carry out the responsibility of obtaining compliance with the nondiscrimination agreement entered into by government contracting agencies. One of the members of the committee was a Negro. President Eisenhower also called in 1955 a conference of representatives of about 50 of the largest firms in the United States to discuss means of extending nondiscrimination in employment. In some instances contractors encountered difficulties because many trade unions refused to refer Negroes for skilled jobs. Negroes contended that the lack of skilled Negroes was due largely to the fact that many trade unions refused to permit Negroes to become apprentices.

President Eisenhower by an executive order dated Jan. 18, 1955, created the President's Committee on Government Employment Policy to assist the federal agencies in developing a policy to prevent discrimination on the basis of race, colour, religion or national origin in the hiring, promotion, and discharge of federal civilian employees. It served as a review board on complaints of discrimination and rendered advisory opinions to the agencies for corrective action. About 85% of the complainants were Negroes. Despite local community attitudes, especially in the south, the committee reported in 1959 that it had made progress. In 1958 a Negro became chairman of the committee. Pres. John F. Kennedy on March 6, 1961, issued an executive order establishing the President's Committee on Equal Employment Opportunity. This abolished President Eisenhower's two committees and centralized in one committee the responsibility for effectuating a policy to eliminate discrimination in employment by the federal government, by government contractors and by labour organizations.

While congress during the 1950s failed to pass an F.E.P.C. law to prevent racial discrimination in industries, about 18 states and 30 cities enacted "little" F.E.P.C. laws and ordinances. In New York state, which adopted the first of these laws on March 12, 1945, violation of the law was punishable by imprisonment for not more than a year or a fine of not more than $500, or both. In those states which carried similar punitive provisions, Negroes obtained more and better jobs. But most of the laws and ordinances provided only for consultation and recommendation.

The National Urban league, founded in 1910, sought to organize effective community interest toward the solution of community problems resulting from inequality in employment, education and training for jobs, and family welfare. Its commerce and industry council included officers of some of the largest business corporations; and its trade union committee included representatives of many of the most powerful trade unions. It received support also from such organizations as the National Conference of Christians and Jews. Working in co-operation with the various presidential committees formed to combat discrimination in employment, it helped a growing number of Negroes to obtain better jobs.

4. Professional and Business Men.—The number of Negroes engaged in professional, technical and kindred services increased from approximately 192,000 in 1950 to approximately 352,000 in 1960. In the latter year teachers constituted about 47% of the total; clergymen about 5%; doctors and dentists together less than 4% and social workers about 4%. They depended almost entirely on a Negro clientele. Especially after World War II large white firms employed a few Negro architects, engineers, scientists, buyers, sales and public relations representatives and a smaller number in middle-management and executive positions. Negro insurance companies and banks, which had firmly established themselves in the first half of the 20th century, accelerated their growth. In spite of the unfavourable position of the Negro worker in industry and agriculture, and the comparatively small number of Negroes in the professions and in business, the total annual income of all Negroes in the 1960s was approximately $20,000,000,000.

5. Housing.—Housing had always constituted a problem for urban Negroes. The flood of migration away from the south in the first half of the 20th century brought to northern cities over 2,000,000 Negroes, in addition to many white migrants from the south. The newcomers crowded into slums where low-income white and Negro families were already living. Upper-class and middle-class whites fled from the cities to the suburbs and to farms. Blighted urban areas were razed and modern apartments, both private and public, with high rentals, were constructed. The former occupants of these areas swarmed into new ghettos where juvenile delinquency, illegitimacy, dropping out of school, and other social ills were aggravated. Unemployment was rife; a disproportionately large number of Negroes were on the relief rolls. Frustration and rejection by the community bred apathy, bitterness and even criminality. In New York city especially, the influx of Puerto Ricans complicated the problems, as did the large number of Mexicans in Houston, Dallas and Los Angeles.

The first federal conference that studied housing as a national problem was called by Pres. Herbert Hoover in Dec. 1931. Of the eleven volumes of its findings and recommendations, one was devoted to the problems of housing for Negroes. Federal housing policy had been focused on facilitating credit and relieving economic conditions until the Public Works administration and later the U.S. Housing authority provided housing for the underprivileged at rents they could afford. In 1942, the National Housing agency announced a basic policy of "no discrimination . . . on account of race, creed, color, or national origin." This was not an antisegregation policy but a policy aimed at assuring equitable shares for Negroes in housing as it became available. A semblance of an equitable share of low-rent housing was secured for Negroes, although principally on a segregated basis. In governmental-built wartime housing developments, Negroes received almost six times as many units as were provided for Negro occupancy under the larger Federal Housing authority (FHA) program of privately built wartime housing—84,000 as compared with 15,000 units.

Even so, the federal housing policy really sanctioned segregation by leaving its determination to the jurisdiction of local public housing authorities. The first real change came as a result of a 1948 decision of the U.S. supreme court which stated that restrictive covenants (agreements by property owners not to sell to Negroes) could not be enforced in state courts. In Dec. 1949 the FHA ruled that it would not provide mortgage insurance for property on which restrictive covenants were recorded. In 1954 the FHA took steps to encourage the development of demonstration open-occupancy projects, but little progress was made during the rest of the decade. Sen. John F. Kennedy in his 1960 campaign speeches announced his opposition to the use of federal funds for segregated housing and expressed his conviction that such use could be abolished "by a stroke of the pen." After taking office he appointed a Negro, Robert C. Weaver, an authority on housing and a staunch supporter of open occupancy, as administrator of the Housing and Home Finance agency. On Nov. 20, 1962, President Kennedy issued an executive order forbidding discrimination in housing built under loans or mortgages insured by the FHA and the Veterans Administration. The order also included low-rent public housing, housing in urban renewal projects subsidized by the federal government, and housing built with federal loans (such as homes for the elderly, community facilities and college dormitories). Since the order was not applicable to conventional home financing through banks and savings and loan associations whose deposits are federally insured, it did not cover most of the new housing in the nation. Thus, while the federal government's housing policy had progressed somewhat toward the goal of "a decent home and a suitable living environment for every American family," segregation in housing still remained the rule rather than the exception.

III. POLITICAL HISTORY

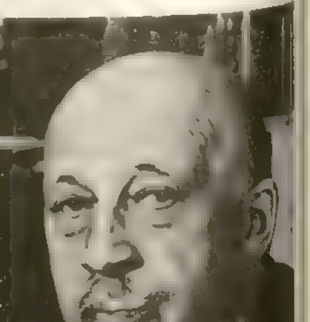
1. From the Civil War to 1900.—The political and civil rights of Negroes have been determined primarily by conflicts between the federal government and state governments. Since about nine-tenths of Negroes lived in southern states until 1900 and about two-thirds in the 1960s, most of the issues involved the federal government and these states. The conflict began immediately after the Civil War. The 13th amendment, effective as of Dec. 18, 1865, abolished slavery and involuntary servitude. But the southern states in 1866 adopted new "black codes" that sought to keep the freedmen close to their former servile status. Congress was dominated by radical Republicans who had inherited the abolitionist tradition and by other Republicans who wanted to maintain political control of the south and the north's economic superiority established during the Civil War. In 1866 congress adopted a Civil Rights act which declared that Negroes were citizens of the United States and were entitled to equal treatment before the law. The "Great Reconstruction acts" in 1867 provided for the establishment of state constitutional conventions in the former confederate states, with the requirements that Negroes should be eligible to vote for members and to be elected as members. A further requirement was that the new constitutions drafted by these conventions should grant to Negroes the right to vote. Plebiscites, in which one requirement was that Negroes should vote, approved the proposed constitutions, thus giving state sanction to the federal grant of franchise.

The 14th amendment was adopted by congress, ratified by three-fourths of the states and declared in effect as of July 28, 1868. Its first section strengthened the Civil Rights act by making Negroes citizens of the states in which they resided and also citizens of the United States. No state was to take any action that would violate the rights that this section sought to protect. The second section gave each state the choice between granting suffrage to adult male citizens and suffering a reduction in its representation in the house of representatives and in the electoral college proportionate to the number denied the right to vote. Congress was given the right to enforce this amendment. The state legislatures, elected after the approval of the new constitutions, were required to ratify the 14th amendment before the states could be restored to the Union. The 15th amendment, declared in effect on March 30, 1870, stated that the right of citizens of the United States to vote should not be denied or abridged by the United States or by any state on account of race, colour, or previous condition of servitude and that congress was given the power to enforce this amendment. The enforcement acts of 1870 and 1871 sought to protect Negroes from armed attacks. Finally, the Civil Rights act of 1875 prohibited individuals from discriminating against Negroes in public places and on public carriers.

During the period of Reconstruction, 1866–77, southern Negroes were elected as members of the U.S. house of representatives, the U.S. senate and some state legislatures. In Feb. 1870 Hiram R. Revels of Mississippi took the senate seat formerly occupied by Jefferson Davis. Four years later another Negro, Blanche K. Bruce, was elected to the U.S. senate from Mississippi. A few Negroes also served as high-ranking state officials. After the organization of the Ku Klux Klan in 1866, however, southern whites used force, intimidation and fraud to prevent Negroes from exercising many of the rights granted them. By 1876 whites had largely "redeemed" their state governments from Negro participation except in Florida, South Carolina and Louisiana. A compromise agreed to by Pres. Rutherford B. Hayes in 1877 between northern and southern industrialists and other northerners and southerners who had grown weary of federal intervention in the south completed the redemption and inaugurated a hands-off policy by the national government.

A bill passed by the house of representatives in 1890 on the recommendation of Pres. Benjamin Harrison, but defeated in the senate, 1891, for the federal supervision of federal elections led Mississippi to adopt in 1890 the first state constitutional amendment for the disfranchisement of most Negroes. Several decisions of the United States supreme court, especially from 1873 to 1910, also gave the south virtually a free hand in fixing the status of the Negro. These decisions nullified the reconstruction laws and the clauses in the 14th and 15th amendments for the protection of the civil and political rights of Negroes. In the famous case of *Plessy v. Ferguson*, 1896, the court for the first time sanctioned a state segregation law on the ground that it was a reasonable use of the police powers of the state, provided that the separate accommodations were "equal." The court also refused to intervene against state constitutional amendments that disfranchised most Negroes. But the court did hold that state action excluding Negroes from juries was unconstitutional.

This hands-off policy of presidents, congress and the supreme court encouraged the southern states to pursue their own policies. Early in the 20th century the southern states extended legislation, conforming to growing custom, that segregated Negroes in public places. One of the most extreme of the laws prohibited the storage together of textbooks used in white and Negro schools. By 1910 all the southern states had adopted constitutional amendments or laws that disfranchised most Negroes while permitting many equally unqualified whites to vote. Booker T. Washington, the

EBONY MAGAZINE

(LEFT) BOOKER T. WASHINGTON; (RIGHT) W. E. B. DU BOIS

Negro principal of Tuskegee institute, Alabama, had deemed it necessary in 1896 to seek a compromise based upon friendship with southern whites in place of federal action to provide job opportunities, schools and a limited participation in the suffrage. While the various amendments and laws were aimed at disfranchising some whites as well as Negroes, they affected the latter more than the former. In Louisiana, for example, the number of white registrants was reduced by only about 24% from 1897 to 1900 while the number of Negroes was reduced by more than 90%. An even larger percentage of Negroes was disfranchised by an Alabama amendment. While these were extreme cases and while there had been a general trend toward nonparticipation in elections, the amendments and laws, despite Washington's plea, disfranchised the vast majority of Negroes throughout the south.

Even before the adoption of these amendments and laws, force and intimidation had so reduced the number of Negro voters that the number of Negroes in congress and in the state legislatures had steadily declined. There had been seven in the house of representatives and one in the senate, 1875–77. The largest number thereafter had been three representatives and one senator, 1877–79. After 1891–93 there had been only one representative, and in 1901 George H. White of North Carolina was the last until Oscar DePriest was elected from Illinois in 1928. Whereas in 1877–78 there had been 39 Negroes in the South Carolina senate and house, at the end of the century there was only one. In the 20th century there were no Negro members of a southern state legislature until 1962 when LeRoy R. Johnson was elected to the Georgia senate.

Since there were fewer Negroes in the north, race relations created less friction there. Negroes voted more freely but they were so few in number that they did not have the power, as did some racial and religious blocs, to elect members of their race to congress, to state legislatures or to municipal councils. Negroes in the north suffered less segregation, discrimination and nonrecognition of their dignity as human beings. Following the supreme court decision of 1883 that declared unconstitutional the Civil Rights law of 1875, 15 northern states adopted new civil rights laws against discrimination by individuals in public places and three strengthened the provisions of existing laws.

2. The 20th Century.—World War I altered the status of the Negro in both the north and the south, and the process of change was accelerated during the New Deal era, during World War II and during the cold war with the Soviet Union. The migration of approximately 2,000,000 Negroes from the south to the north reduced the proportion of Negroes in the south and thereby facilitated the acceptance by southerners of the changes created by the improved economic status of Negroes and by the decisions of the U.S. supreme court. The migration provoked a few race riots in northern cities. The growing number of Negro voters gave them the balance of power in some elections; together with greater recognition of the capacities of Negroes, it increased their number in elective and appointive offices. For example, a Negro was elected as president of Manhattan borough, New York city, another as judge of the New York supreme court, and a third as deputy mayor of Cincinnati, O. By the early 1960s there were no Negroes in the U.S. senate and only five Negro members of the house of representatives, but there were about 50 Negro members of state legislatures and many Negro members of municipal councils. Negroes were appointed as state attorneys, circuit court judges and ambassadors; others held such posts as assistant secretary of labour, governor of the Virgin Islands, commissioner of the District of Columbia and director of the U.S. Information agency. In 1966 Robert C. Weaver was appointed secretary of the newly created department of housing and urban development.

3. Civil Rights.—Even before World War I the U.S. supreme court had handed down decisions that strengthened the civil and political rights of Negroes. In 1915, in its first decision in opposition to disfranchisement, the court had outlawed the "grandfather clause." This clause had made voting more difficult for persons who had not themselves voted on Jan. 1, 1866, or had a grandfather who had voted on that date. Another disfranchising device was the exclusion of Negroes from Democratic primaries in southern states. In a series of decisions beginning in 1927 and culminating in *Smith* v. *Allwright* (1944), the supreme court declared such exclusion unconstitutional. As a result of these decisions, Negro voting increased in almost all of the southern states.

In line with the supreme court's decisions of 1954 and 1955 outlawing segregation in public schools, and the Interstate Commerce commission's (ICC) ruling (1955) forbidding the segregation of interstate travelers on trains, buses and in waiting rooms, a few congressmen proposed bills to protect the civil and political rights of Negroes. President Eisenhower, on Jan. 5, 1956, called for the establishment of a bipartisan commission to investigate allegations of the denial of civil rights to Negroes in some localities.

On Aug. 29, 1957, the senate approved a house bill which for the first time in 82 years sought to protect the civil rights of Negroes. It established in the executive branch a six-member bipartisan Commission on Civil Rights, with subpoena powers, to investigate alleged deprivation of voting rights because of colour, race, religion or national origin; to study legal developments constituting a denial of equal protection of the laws; and to appraise federal laws and policies regarding equal protection of the laws. The law made interference with the right to vote in federal elections actionable at the discretion of the U.S. attorney general under injunctive proceedings in the U.S. district courts. The law also permitted federal judges to issue injunctions or other orders to protect the right to vote; and it maintained the courts' powers through civil contempt proceedings, without a jury, to secure compliance with, as distinguished from punishment for, violation of such orders. The commissioners, one of whom was a Negro, were directed to make a final report to congress within two years.

In several southern states in the early 1960s many Negroes were voting without special impediments, but in others such was not the case. Five states, for example, required the poll tax as a prerequisite for voting until adoption of the 24th amendment to the U.S. constitution in 1964 outlawed the poll tax as a requirement for voting for federal offices. On Nov. 2, 1954, Mississippi had adopted a new "grandfather clause" with Jan. 1, 1954, as the privileged qualifying date. On that date only 22,000 Negroes out of 500,000 of voting age had been registered. Alabama in 1957 gerrymandered the town of Tuskegee so as to exclude almost all of the Negro voters from the township. On Feb. 17, 1961, a lower federal court, acting on an order of the U.S. supreme court in *Gomillion* v. *Lightfoot*, ruled that this gerrymander was discriminatory and hence violated the 15th amendment. Alabama then adopted devices similar to those in other southern states, such as denial of registration for "bad writing," "bad character" or reasons unspecified, and the changing of the place of registration without proper notice. In some areas of Alabama with large Negro populations no Negroes at all were permitted to vote.

In order to forestall all such subterfuges and otherwise strengthen provisions dealing with discrimination, congress passed a second civil rights law in 1960. It provided: (1) that if a registration official resigned or was replaced prior to the institution of a suit to permit Negroes to vote, the proceeding might be instituted against the state; (2) that voting records be preserved for a period of 22 months following any general or special elections and that the attorney general of the U.S. be given access to records before a suit was filed; (3) that, where discrimination against Negro voters had been a practice, a federal judge might himself determine or might appoint referees to determine the eligibility of Negroes to vote.

Increased registration by Negroes produced tensions. In Fayette and Haywood counties, Tenn., in 1960, Negroes who registered to vote were evicted from the farms on which they worked and were subjected to economic reprisals. Action by the U.S. department of justice stopped some of the evictions and eased the economic reprisals. In Terrell county, Ga., Negro college graduates were not permitted to register, because they failed to pass reading tests. A U.S. district court in 1960 found that 30 Negroes had been denied the right to register because of their race, ordered four to be registered, and issued an injunction against further discrimination. In 1962, when Negroes again attempted to register, county officials used violence against them. At about the same time, a federal judge ordered that Negroes in a Louisiana parish

be registered in accordance with the terms of the 1960 civil rights law.

In Nov. 1963, when he became president, Lyndon B. Johnson made a strong appeal to congress for enactment of the civil rights bill that had been proposed by President Kennedy. After the bill passed the house in Feb. 1964, southern senators, organized by platoons, conducted a filibuster against it for 75 days; then on June 10, 1964, for the first time in history, cloture was invoked to end a filibuster on a civil rights bill. As in the house, bipartisan agreement, strongly supported by President Johnson, prevented any significant weakening of the bill in the senate. President Johnson signed it into law on July 2. The new law provided for strengthening federal authority to guarantee the voting rights of Negroes, to forbid racial discrimination in places of public accommodation and to encourage further desegregation of schools.

Voter registration drives were launched in southern states during the summer of 1964 but little progress was made in the face of determined opposition by white election officials. In Mississippi three civil rights workers (one Negro and two white men) were murdered and their bodies buried in an earthen dam near the town of Philadelphia. In March 1965, while Negro demonstrations against denial of the vote were being held in Selma, Ala., peaceful demonstrators attempting to march to Montgomery, the state capital, were clubbed and beaten by law enforcement officers. Later the Rev. James J. Reeb, a northern clergyman who had come to Selma to join the demonstrators, was attacked on the street by white men and fatally beaten. As tension mounted throughout the nation President Johnson addressed a special joint session of congress and made a fervent appeal for prompt enactment of a new and stronger right-to-vote law. After lengthy debate the new bill was passed during the summer of 1965.

Disproportionate representation of rural counties in state legislatures reduced the power of the more liberal urban voters and made doubly difficult the enactment of state legislation in support of civil rights laws. The U.S. supreme court's decision *Baker* v. *Carr* (1962) in effect ordered legislative reapportionment in Tennessee to eliminate rural dominance. Following this decision, suits were filed in several other states and on June 15, 1964, the supreme court ruled that representation in both houses of state legislatures must be based on population. But the big question still remained: if reapportionment did occur, would it greatly affect the rights of Negroes? One of the first fruits of reapportionment was the election of a moderate, Carl Sanders, as governor of Georgia over Marvin Griffin, a die-hard segregationist. Another fruit was evidence that, in Georgia, reapportionment also influenced elections to congress as well as to state legislatures. Reapportionment of the U.S. house of representatives after every census as prescribed by the constitution had been consistently effected. Reapportionment to reduce the number of southern representatives in accordance with the second section of the 14th amendment, however, had never taken place. The failure to enact this latter type of reapportionment, the use of the filibuster in the senate, the seniority of southern congressmen on important committees, and the inadequacy of support by the administration prevented the enactment in 1962 of any new civil rights legislation. On the other hand, a constitutional amendment prohibiting the requirement of a poll tax (*q.v.*) for voting in federal elections was ratified in 1964.

The virtual disappearance after 1950 of lynching (which had taken a toll of almost 900 persons, most of them southern Negroes, in the first decade of the 20th century) made an antilynching law less urgent. Negroes received added protection from supreme court decisions: over a span of years the court ruled that a Negro did not receive a fair trial in a court dominated by mob violence, in a court where Negroes were excluded from the jury, and in a court where Negro defendants were not adequately represented by counsel. (*See* LYNCHING AND LYNCH LAW.)

Several southern states sought to require the state branches of the National Association for the Advancement of Colored People (N.A.A.C.P.) to disclose the names and addresses of their members but on June 30, 1958, in *N.A.A.C.P.* v. *Alabama*, the U.S. supreme court struck down a $100,000 contempt fine imposed by Alabama because of refusal to disclose this information. In 196[illegible] the supreme court held unconstitutional Virginia laws which tried to restrict the activities of the N.A.A.C.P. on the grounds that they engaged in illegal barratry and unlawful solicitation of cases.

4. Nonviolent Protest.—Nonviolent protest against segregation by white and Negro individuals and groups in the United States has a long history. In the early 1940s protests that had largely been individual and sporadic became systematized and continual. About 1943 the Fellowship of Reconciliation organized small numbers of Negroes and whites to sit together in restaurants and other places of public accommodations to obtain service in Chicago, Cleveland and Washington. Members of this fellowship also flouted segregation on interstate buses and trains; at Chapel Hill, N.C., in 1947, participants in a "Journey of Reconciliation" were almost lynched. The Quakers and other church groups encouraged young people's activities against segregation. In 1953 the U.S. supreme court declared that the "lost laws" of the District of Columbia of 1872 and 1873 were valid. These stated that "a respectable, well-behaved person" had to be served without regard to race, colour or previous condition of servitude by keepers of hotels, restaurants and certain other public places.

Student "sit-ins" were organized in 1958 by N.A.A.C.P. youth councils in Wichita, Kan., and Oklahoma City, Okla. A sit-in of four Negro students from North Carolina Agricultural and Technical college at a Greensboro, N.C., lunch counter on Feb. 1, 1960 set off a succession of similar demonstrations. Within six months large numbers of Negroes, mostly students, accompanied by whites, peacefully protested against segregation. During the early 1960s several thousand students were arrested, a large number were jailed and hundreds were expelled from school.

Before the appearance of the sit-in movement, impatience at the slow rate of desegregation had spurred an assault upon the practice of requiring the use of separate facilities in interstate and intrastate travel. In 1955–56 the Rev. Martin Luther King, Jr. led a dramatic boycott against segregation on buses in Montgomery, Ala. When the bus company attempted to enforce state statutes and local ordinances requiring segregation, the U.S. district court in 1956 declared such statutes and ordinances unconstitutional. This decision, which was affirmed in the same year by the U.S. supreme court, formulated a ruling that was extended to the use of other public facilities such as swimming pools.

At the end of 1955 the Interstate Commerce commission ruled that the segregation of interstate travelers on trains or buses, and in waiting rooms, was forbidden as of Jan. 10, 1956. The "Freedom Rides," which began in May 1961, tested the compliance with this ruling by bus and railroad companies and law-enforcement officers in the south. Outside of Anniston, Ala., mobs attacked and burned a Freedom Riders' bus; in Birmingham, Ala., the police either stayed away from the place where the mob had gathered or did not protect the riders from vicious beatings; in Jackson, Miss., the police arrested the Freedom Riders on charges of disturbing the peace as soon as they arrived at the bus station. Violence, wholesale arrests and imprisonment led Atty. Gen. Robert F. Kennedy to request the ICC to issue a strongly worded set of regulations amplifying the ban on segregation in interstate travel. The ruling was issued in Sept. 1961. The attorney general also sent U.S. marshals and agents of the Federal Bureau of Investigation to guarantee protection to the Freedom Riders where inadequate protection was provided by local authorities; in Montgomery, Ala., the U.S. marshals used tear gas to protect a Negro church meeting from a mob. On May 24, 1961, the attorney general publicly requested a "cooling off period" in which the demonstrations and the violent responses to them should be discontinued. Although the events in Alabama and Mississippi became less sensational, the Negro's impatience with segregation did not appreciably cool, but was manifested in other areas.

The "Albany movement" grew out of rising indignation at the long-established and almost total segregation in this quiet city in southern Georgia. In early 1961 the city commissioners ignored a request by Negro leaders to desegregate certain city facilities and the mayor refused to appoint a biracial committee. The Atlanta-based Student Nonviolent Coordinating committee and the

Youth Council of the local N.A.A.C.P., restive at the slowness of change in the patterns of segregation and discrimination, served as a catalyst for the Albany movement, which was formally organized on Nov. 17, 1961. Headed by W. G. Anderson, the movement attacked discrimination on buses, in bus and train stations, libraries, parks, hospitals, public and private employment, and on juries, and denounced police brutality. A series of nonviolent, direct-action protests to test the validity of the ICC prohibition of segregation resulted in arrests, imprisonment and fines and was climaxed by the arrest at the railway terminal of nine Freedom Riders (Negro and white) on Dec. 10, 1961. Two days later about 300 demonstrators were arrested on charges of parading without a permit, unlawful congregating on the sidewalk and unlawful assembly. As the demonstrations continued and the jails filled up, Gov. Ernest Vandiver called 150 national guardsmen to duty in Albany and assured Attorney General Kennedy that he and the mayor could handle the situation. Negotiations between the leaders of the movement and city officials resulted in an oral agreement on Dec. 18 that: (1) the city would desegregate train and bus facilities; (2) all of the imprisoned, with the exception of the nine Freedom Riders, would be released from jail on the signing of simple property bonds; (3) the bonds of the Freedom Riders would be reduced; (4) further demonstrations would be called off; and (5) the city would hear the Negro community's case at the first business meeting of the new city commission. In little more than a month, however, Negroes contended that the officials had not lived up to their agreement and instituted a boycott of the city buses and a "selective buying" campaign. National attention was stirred by further demonstrations and arrests. The department of justice sent FBI agents to the scene and directed its lawyers to file a brief in U.S. district court opposing a request by Albany officials to bar demonstrations. The ministers of the nation were especially concerned, organizing a picket line at the White House and pilgrimages to Albany. One interracial group from the New York and Chicago areas, comprising Jewish, Protestant and Catholic clergymen and laymen, visited Albany in protest against the jailings. All 75 were arrested and jailed. The burning of churches and the intimidation of Negro registrants in neighbouring counties provoked Pres. John F. Kennedy on Sept. 13, 1962, to denounce the "outrageous" actions, and caused investigations by the justice department.

During April 1963 civil rights demonstrations began in Birmingham, Ala., led by the Rev. Martin Luther King, Jr., among others. Hundreds of demonstrators were arrested by policemen whose use of fire hoses and police dogs aroused public revulsion. The situation became so serious in May that President Kennedy stationed 3,000 federal troops near Birmingham to be on hand if needed to maintain law and order. During the following months there were protest demonstrations in many other towns and cities, often accompanied by violence. In June the Mississippi state field secretary for the N.A.A.C.P., Medgar Evers, was shot and killed as he entered his home in Jackson, Miss. A white Mississippian was later arrested and charged with the killing.

The high point of the year's demonstrations came in August when more than 200,000 Negro and white citizens staged a "march on Washington," the largest demonstration of its kind ever held in the nation's capital. The marchers gathered at the steps of the Lincoln memorial to hear speakers voice the Negroes' demand for equal rights. Leaders of the movement conferred with President Kennedy and with members of congress.

In 1964 several civil rights groups attempted to break down the barriers to Negro voting in the deep south. They organized volunteers to go to Mississippi to take part in a statewide effort during the summer to educate Negroes in "freedom schools" and have them registered as voters. They met with resistance at every turn and, as noted above, three of them were murdered. More than a score of Negro churches in Mississippi were totally or partially destroyed by fire during the summer. Unable to register Negroes to take part in Democratic party primary elections, the civil rights workers registered thousands of Negroes on the rolls of the Mississippi Freedom Democratic party and sent delegates to the Democratic national convention where they unsuccessfully challenged the seating of the all-white Mississippi delegates.

The campaign to gain voting rights for Negroes was renewed in 1965 and soon reached a climax in March at Selma, Ala., where police officers were charged with using undue force to stop a proposed protest march to the state capital. A federal district judge upheld the right of the Negroes and their white sympathizers to carry out the march. When the governor of the state pleaded inability to provide protection all along the 50-mile route from Selma to Montgomery, President Johnson called the Alabama national guard into federal service to cooperate with U.S. marshals, FBI agents, some U.S. army troops and local police officials to protect the marchers. Led by two Nobel prize winners—the Rev. Martin Luther King, Jr., and Ralph J. Bunche—and supported by thousands of white and coloured citizens from all over the nation, the march reached the Alabama capital on March 25. That evening, as the marchers were dispersing to their homes, Mrs. Viola Liuzzo of Detroit, Mich., was shot and killed in her car after having taken demonstrators back to Selma. Within a matter of hours President Johnson announced on radio and television that FBI agents had taken into custody four members of the Ku Klux Klan who were thought to be responsible for the slaying. He further stated that legislation to bring the activities of the Klan under "effective control of the law" would soon be submitted to congress and he called upon all members of the Klan to withdraw from it "and return to a decent society before it is too late."

5. Extremist Movements.—Black chauvinism had reached its height in the United States during the 1920s when Marcus Garvey, a Jamaica-born Negro, won a large number of adherents to his "back-to-Africa" and separatist movements. After his deportation in 1927, Garveyism declined. During the 1930s the Communist party of the United States advocated the creation of a separate nation in the southern black belt; most Negroes repudiated this type of solution.

At the beginning of World War II a few Negroes proclaimed themselves "Muslims" in a vain attempt to evade the draft. The leader of this group, who called himself Elijah Muhammad, exploited the legitimate grievances of Negroes, and with oratorical and organizational skill developed a cult which in the early 1960s numbered about 70,000. Although the Islamic Church repudiated them as not being true followers of its faith, the "Black Muslims" practised discipline and asceticism, and professed certain Islamic beliefs. Their leaders preached black supremacy and complete separation of the races, including a black nation within the United States. This preachment provided ammunition for segregationists and white supremacists but alienated most Negroes and their supporters. The greater appeal of the cult lay in fervid exposure of the white man's inhumanities. *See* also BLACK MUSLIMS.

IV. EDUCATIONAL DEVELOPMENTS

1. Post-Emancipation Years.—When the 13th amendment emancipated all slaves in the United States in 1865, the vast majority of Negroes were illiterate. Some free Negroes had learned to read and write, and even some privileged slaves had illegally secured the rudiments of an education. The education of the freedmen was, therefore, one of the urgent tasks before the nation at the end of the Civil War. As early as 1862 religious and philanthropic organizations began the task of establishing schools for Negroes. Freedmen's relief associations in northern cities and Quakers, Congregationalists and other church groups founded schools in the wake of the Union armies in the south. In the last year of the war at least a thousand northern men and women were teaching and caring for former slaves. In 1865 the major responsibility for educating the emancipated Negroes was assumed by the Freedmen's bureau although denominational and philanthropic agencies continued to maintain schools. By 1870, when the educational work of the bureau stopped, there were 247,333 Negro pupils in 4,329 schools; and more than a dozen of the major institutions for the higher education of Negroes had been founded, including Fisk university, Howard university and Atlanta university, all of which provided a liberal arts curriculum, and Hampton institute, which emphasized vocational training.

Meanwhile, as the Republican party established "radical" gov-

ernments in the southern states and disfranchised those who had supported the Confederacy, new constitutions were written in all the former Confederate states. One of the most important features of these new frames of government, to which Negro delegates to conventions contributed, was the provision for free public education. In a few states, such as South Carolina and Louisiana, there were some experiments with mixed schools, but whites were generally opposed to them. When Reconstruction ended in 1877 and "home rule" was restored, the southern whites in control of their state governments continued to support programs of public education, but they soon developed practices of discriminating against Negro schools in buildings, equipment, teachers' salaries and the like. By 1877, for example, Alabama was spending 50% more on the education of each white child than on the education of each Negro child, and the figure rose to 514% by 1909. It became necessary, therefore, for Negroes themselves to supplement public support of their schools through private assistance of various kinds. They were aided by numerous philanthropic agencies such as the Slater fund, the Peabody fund and the Jeanes fund (*see* FOUNDATIONS, PHILANTHROPIC). During this period new schools and colleges for Negroes were established, including Tuskegee institute and several land-grant colleges.

By 1900 there were 1,500,000 Negro children enrolled in school, and there were 28,560 Negro teachers. At the same time more than 2,000 Negroes had graduated from college, while 700 were enrolled in institutions of higher learning. Despite large contributions from philanthropists and other donors, both Negro and white, schools and colleges for Negroes were unable to attain equality with those provided for whites.

2. The 20th Century.—In 1900, for every $2 spent by the southern states for the education of Negroes, $3 was spent for whites. This disparity worsened with time; in 1930 for every $2 spent by the southern states for the education of Negroes, $7 was spent for whites. Outraged at the travesty of the doctrine of separate but equal as seen in inequitable allocation of state funds, inferior schools, shorter terms, lower salaries, and the lack of provision for graduate and professional education, Negroes instituted anti-discrimination suits.

In 1935 the Maryland court of appeals ruled that a Negro should be admitted to the state university's law school and that out-of-state tuition grants made to obviate such admission were a denial of equal protection of the laws. In 1938 the U.S. supreme court confirmed this ruling in a case involving the University of Missouri law school and held that substantially equal facilities must be provided within the state. Two years later the U.S. circuit court of appeals ruled that a double salary standard in Norfolk, Va., based on race was unconstitutional. Southern states feverishly set up graduate and professional schools for Negroes and strengthened the public schools and colleges for Negroes in the hope that the court would approve their efforts to fend off, by "equalizing" within the state, the loss of separateness. Their efforts were futile. In 1950 the supreme court ruled that Negroes had the right to attend the same professional schools that whites attended, under the same conditions. On May 17, 1954, the supreme court unanimously ruled (*Brown* v. *Board of Education*) that, even though Negro and white public schools had been or were being equalized with respect to buildings, qualifications, salaries of teachers and other "tangible" factors, segregation in public schools solely on the basis of race was unconstitutional. The court thus reversed the "separate but equal" doctrine of *Plessy* v. *Ferguson*. Racial segregation in states violated the equal protection clause of the 14th amendment; in the District of Columbia it violated the due process clause of the 5th amendment. On May 31, 1955, the court ordered the states which had separate public schools to desegregate "with all deliberate speed." This decision was resisted by most governors and legislators of southern states, by southern members of the U.S. congress, and by newly formed White Citizens Councils and vigilante groups.

Every southern state attempted to circumvent the decision, some by devious legislation and policies, and others by outright defiance. In Little Rock, Ark., in Sept. 1957, Gov. Orval Faubus ordered the national guard to prevent Negro children from attending Central high school. In December President Eisenhower sent federal troops to the scene; they dispersed mobs and guarded the Negro children on their way to and from school, and within the school. Governor Faubus ordered Central high school closed during the school year 1958–59. On Sept. 29, 1958, the supreme court ruled that the desegregation of public schools could not be nullified openly and directly by state legislators or state executive or judicial officers, nor indirectly by them through evasive schemes. It was not until 1959 that school desegregation was uninterrupted in Little Rock. Prince Edward county, Va., which closed its public schools rather than desegregate, was a striking illustration of resistance tactics. After years of litigation the U.S. supreme court on May 25, 1964, ruled that one county in a state cannot abandon public education to avoid desegregation while public schools are supported elsewhere in the same state.

Disregarding the lesson of Little Rock, Gov. Ross Barnett of Mississippi defied federal court orders to admit a Negro, James H. Meredith, to the state university at Oxford. The registration was thrice denied by the governor or by the lieutenant governor acting as college registrar. On Sunday, Sept. 30, 1962, Meredith was escorted to a dormitory on the campus of the university by U.S. marshals, FBI agents and department of justice lawyers. That evening President Kennedy, in a nationwide telecast, stated the primacy of federal law and the government's determination that Meredith would be enrolled in the university, and appealed for calmness and restraint. While he was speaking, an unruly mob of both students and outsiders attacked the federal marshals, who were forced to use tear gas to protect themselves. After the state police withdrew, the federalized national guard and regular army troops were called in to disperse the mob. They restored order in Oxford and the surrounding countryside and provided close protection to Meredith during his first weeks on the campus. Governor Barnett's refusal to comply with the orders of the circuit court of appeals not to obstruct Meredith's attendance at the university caused him to be charged with contempt of court.

By the summer of 1964—ten years after the supreme court's decision—Mississippi was the only state that had not desegregated its public schools below the college level, though desegregation had barely started in South Carolina and Alabama. Elsewhere the decree of the supreme court met with greater compliance, but desegregation was only on a token basis. Of the 2,265 school districts in the states of the old Confederacy that had been segregated before 1954, only about 250 had started desegregation and many of these had only a scattering of Negro pupils. Of the 2,800,000 Negro children in the south, fewer than 10,000 were estimated to be in classes with white children. The rate of desegregation was higher in the border states and in the District of Columbia.

In northern cities, segregated schools, though without legal sanction, increased because of the concentration of Negroes in restricted residential areas. Such methods as establishing attendance zones, controlling transfers and assignments, selecting new sites for schools, and gerrymandering of school districts created or helped to preserve segregation in public schools in the north. In some cities strong forces opposing this *de facto* segregation succeeded in having Negro children and, in fewer numbers, white children transferred to schools outside their residential school districts.

By the early 1960s more than 300,000 Negroes had graduated from college; the majority were graduates of Negro colleges, but a sizable number were graduates of predominantly white colleges of the unsegregated states. Over 1,000 Negroes attended "white" tax-supported institutions in the south and another 1,000 attended southern private institutions of higher learning. The instructional staffs of most Negro colleges were interracial, and Negro professors in increasing numbers were appointed to the faculties of leading northern, midwestern and western universities; a few served as heads of their departments.

V. MILITARY HISTORY

Negroes fought in all the wars waged by the colonies and the United States. Crispus Attucks, a runaway slave, was the first to fall in the Boston massacre, 1770. About 5,000 Negro soldiers, free and slave, served in the Revolutionary army and others in

the navy, especially as coastal pilots. A few served as sailors during the hostilities with France, 1798–1800. Negro soldiers and sailors participated in the War of 1812, notably with Capt. Oliver H. Perry on Lake Erie and with Gen. Andrew Jackson at New Orleans. A very small number saw service in the Mexican War. Pres. Abraham Lincoln doubted whether the Union would have won the Civil War had it not been for the effective conduct of more than 178,000 Negro troops. After the war the federal government organized six regiments which were consolidated into the 9th and 10th cavalry, the 24th and 25th infantry. These troops helped conquer the Indians during the 1870s and the 1880s. With six volunteer state regiments and four raised by the war department, they gained distinction during the Spanish-American War.

About 342,000 Negro soldiers served during World War I, approximately 100,000 overseas. Two infantry divisions, the 92nd and 93rd, fought in several important battles, especially in the Champagne and the Argonne sectors. Most, however, were in labour battalions that unloaded ships and sent supplies to the front. After World War I most of the combat troops were reduced to service units, and the navy assigned most Negroes to be mess attendants. On the other hand, largely as a result of pressure by Negro veterans and the Negro press, the United States Military academy at West Point, N.Y., and the United States Naval academy at Annapolis, Md., admitted and graduated qualified Negroes. In 1940 President Roosevelt promoted Col. Benjamin O. Davis to the rank of brigadier general of the army, the first Negro to attain general officer rank.

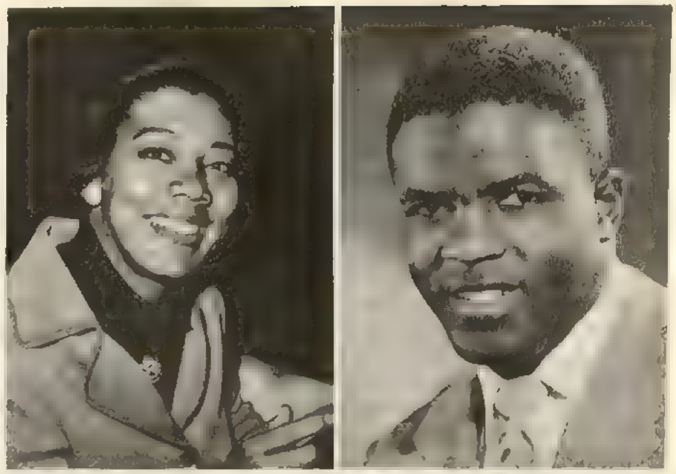
During World War II, 1,174,000 Negroes were inducted and enlisted in the army, navy, the marine corps (for the first time in 167 years) and the coast guard. Approximately 700,000 fought in most of the theatres of war from Pearl Harbor to the surrender of Germany and Japan. Negro and white officers, except in the air force, were trained together. The number of Negro officers rose to a peak of 7,768. Toward the end of the war a beginning was made toward integration of Negro and white troops. Integration was continued in all branches of the service after the war, was increased during the Korean War and accelerated after it. The integration included almost all the public schools on military installations, even in the south. Despite significant gains, however, Negro army officers were only about 2% of the total in the early 1960s. The proportion of enlisted men was considerably higher. In 1959 President Eisenhower promoted Brig. Gen. Benjamin O. Davis, Jr., son of the first Negro general in the army, to the temporary rank of major general of the air force. General Davis served in 1959 as deputy chief of staff of the U.S. air force in Europe and in 1962 was director of manpower and organization in the office of the deputy chief of staff of the air force. Each year a few Negroes were admitted to the U.S. Military academy, Naval academy, Air Force academy and Coast Guard academy.

VI. SPORTS

In sports, where the United States achieved one of its best publicized manifestations of democracy, Negroes won much recognition. In boxing, Negro fighters were remarkably successful. In 1908, Jack Johnson became the first Negro to win the world heavyweight title. Joe Louis (*q.v.*) won this title in 1937 and held it until he retired undefeated in 1949, a longer tenure than that of any other heavyweight champion. Other Negro boxers—Ezzard Charles, "Jersey Joe" Walcott, Floyd Patterson, Charles "Sonny" Liston and Cassius Clay—held the heavyweight title at various times after Louis' retirement. Among the Negro champions in other boxing classes were Henry Armstrong, "Sugar" Ray Robinson and Archie Moore. (*See* also BOXING.)

WIDE WORLD

JOE LOUIS



(LEFT) WIDE WORLD; (RIGHT) MILTON MELTZER

(LEFT) ALTHEA GIBSON; (RIGHT) JACKIE ROBINSON

In track and field events the record of the Negro was not as extensive as in boxing but it was equally impressive. The outstanding star was Jesse Owens, who won four events—breaking three records and tying a fourth—before the startled eyes of Adolf Hitler in the Berlin Olympics of 1936. Other Negroes, both men and women, have been stars in track and field events in national and international meets, and since before World War II have been mainstays of the U.S. Olympic teams. Wilma Rudolph dominated the women's sprints in the Olympics of 1960. Another Negro woman athlete to achieve eminence was Althea Gibson; in 1957 and 1958 she won the British women's single tennis championship at Wimbledon and the United States women's singles championship at Forest Hills.

Baseball, the national sport, broke a long tradition in 1947 when Jack Roosevelt ("Jackie") Robinson was signed up by the Brooklyn Dodgers as the first recognized Negro to play on a major league team. Negro players were soon generally accepted in both major and minor leagues and were prominent in the all-star games. Among the best known were Roy Campanella, Don Newcombe, Larry Doby, Willie Mays, Hank Aaron, Ernie Banks, Maury Wills, Elston Howard, Vic Power and Orlando Cepeda.

Football was long the favourite sport in Negro colleges but the Negro players who became nationally known were those on the teams of leading northern, midwestern and western colleges and universities. Among the many Negro professional football players the following became outstanding stars: Marion Motley, Jim Brown, Buddy Young, Len Ford, Lenny Moore, Bobby Mitchell, Ollie Matson, John Henry Johnson, Eugene ("Big Daddy") Lipscomb, Roosevelt Grier and Roosevelt Brown. In basketball, both amateur and professional, Negroes were also prominent. One all-star collegiate team included four Negroes; in professional basketball Bill Russell, Elgin Baylor, Oscar Robertson and Wilt "the Stilt" Chamberlain were among the most-feared competitors, and the Harlem Globetrotters gave amazing exhibitions in the United States and around the world. The ability of the Negro in sports, especially as communicated to the nation by way of radio and television, was a force that increased respect for the Negro race.

VII. CULTURAL AND INTELLECTUAL DEVELOPMENTS

1. Religious and Social Organizations.—From the end of the 18th century the Negro church has been an important agency in the social and cultural development of Negroes. During the post-Reconstruction years, Negro Baptists and Methodists were most numerous, but newer Protestant denominations and the Roman Catholic church attracted increasing numbers. In the 20th century the Roman Catholic church's intensified proselytizing of Negroes enlarged the proportion of Negro Catholics to Negro Protestants. Organized cults and random "store-front" churches appealed to many Negroes who did not feel at home in the more conventional denominations and were attracted by flamboyant,

prophetic personalities. Although Christian churches for a long time had perpetuated segregation, some church leaders after World War II recognized and supported steps toward integration. The Roman Catholic church went further than the Protestant churches in desegregating churches, but the Unitarian, the Christian Congregationalist and the Presbyterian churches were also active in opposing segregation. Occasionally interracial congregations and pastorates were found; one notable instance was the Church for Fellowship of All Peoples, in San Francisco. Negro churches had long rendered social services by maintaining nurseries, employment bureaus and evening schools; in the 20th century their activities extended to economic and political programs. Fraternal orders, such as the Masons, Knights of Pythias, the Elks and secret benevolent societies, emerged to meet the social needs of Negroes.

2. Literature.—The intellectual growth of the Negro and his progress toward greater assimilation in American life were notably reflected in the literary activity of the post-Reconstruction years. Frederick Douglass, who had first published a sketch of his life in 1845, issued the final version of his autobiography, *The Life and Times of Frederick Douglass*, in 1892. In 1901 Booker T. Washington brought out his *Up From Slavery*, which rapidly became one of the classics of American biography. The first outstanding Negro historian was George Washington Williams, whose groundbreaking volumes, *History of the Negro Race in America* and *History of the Negro Troops in the Rebellion*, were published in 1883 and 1887 respectively.

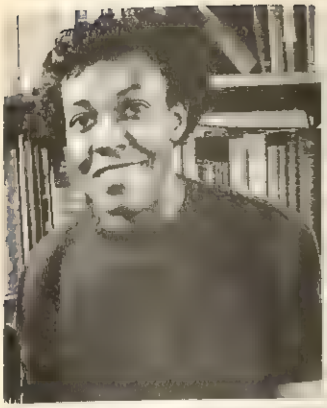
At the end of the century the most popular Negro writer yet to appear was Paul Laurence Dunbar, often called the poet laureate of his people. Such volumes as *Oak and Ivy* and *Lyrics of Lowly Life* interpreted the Negro folk in their own dialect with humour and pathos. Dunbar also wrote poems in standard English on traditional themes; in many of these poems he protested against injustice. Dunbar also attempted prose fiction but was less successful than Charles W. Chesnutt, who dealt engagingly with folk beliefs in *The Conjure Woman* and trenchantly with problems of the new freedmen in *The Marrow of Tradition* and *The Colonel's Dream*. Chesnutt's social concern was shared and deepened by W. E. B. Du Bois (*q.v.*), whose "The Suppression of the African Slave-Trade to America" (1896) was the first monograph in the *Harvard Historical Studies*. In 1903 he published *Souls of Black Folk*, a book unmatched in its impact upon Negro intellectuals. Publications such as *The Philadelphia Negro* (1899) and the *Atlanta University Studies* (1897–1911) were models of sociological investigation. As editor of the *Crisis*, the organ of the N.A.A.C.P., for over a score of years he castigated the conscience of America and strengthened the protest of younger generations. His *Black Reconstruction in America*, by stressing economic factors and the constructive, though thitherto underestimated, participation of Negroes in American history, gave new impetus to historiography. *Black Folk Then and Now*, tracing the history of the Negro in the old world and the new, revealed not only Du Bois' scholarship but also his polemical power in its exposure of colonialism and racism. His other works—poetry, autobiography, biography and fiction—revealed his versatility. But the wide range, the diverse styles and the combination of passion, irony and learning in his works did not conceal the unity of his purpose: a new and truer emancipation from discrimination and misunderstanding. A pioneer at the end of the 19th century, he continued as an influence on the cultural life of America throughout the first half of the 20th century.

Negro editors of newspapers and magazines were preoccupied with fighting for justice and fuller opportunities for Negroes in American life. Magazines like the *Southern Workman*, published at Hampton, Va., after 1872, and the *A.M.E. Church Review*, begun in 1884 in Philadelphia, Pa., were concerned primarily with educational, literary and religious matters. In Boston in 1901 George Forbes and W. Monroe Trotter began publication of the *Boston Guardian* which, in contrast to the prevailing conciliatory program of Booker T. Washington, demanded immediate equality for the Negro. Such crusading, combined with growing race consciousness and a coverage of racially relevant activities that were neglected in white newspapers, brought about a flourishing, vigorous Negro press. The *Age-Defender* and *Amsterdam News* (New York city), the *Afro-American* (Baltimore, Md.), the *Journal and Guide* (Norfolk, Va.), the *Pittsburgh Courier* (Pa.) and the *Chicago Defender* (Ill.) enjoyed large national circulations, while hundreds of small weekly papers served other communities. In the 20th century there have been many Negro magazines; two of the most influential of these have been *Opportunity*, published for many years by the National Urban League and *Crisis*, the official organ of the N.A.A.C.P. The John H. Johnson publications, *The Negro Digest*, *Ebony* and *Jet*, were the most popular among Negro magazines. Scholarly journals published by Negroes included the *Journal of Negro History*, created in 1916 and first edited by Carter G. Woodson for the Association for the Study of Negro Life and History; the *Journal of Negro Education*, published since 1932 at Howard university, and *Phylon*, published since 1940 at Atlanta university. The influence of these Negro publications, both the widely popular newspapers and the learned journals, has been significant.

In the years following World War I the number of recognized Negro poets, essayists and novelists was so large that together they constituted what was known as the "Harlem Renaissance." Many of them published their first works in *Crisis* and *Opportunity*, which were edited by W. E. B. Du Bois and Charles S. Johnson respectively. In 1925 Alain Locke edited *The New Negro*, a representation and interpretation of the new literary and social movements. As influential as these three editors was James Weldon Johnson, who served as model and mentor to the newer generation of writers. Johnson's *Fifty Years and Other Poems* (1917) combined Dunbar's genre portraiture and more militant interpretations and credos; his *Autobiography of an Ex-Coloured Man* (1927), presented with a quiet but effective irony, was a pioneering novel that anticipated the themes of much later fiction. Of special value was Johnson's informed and sympathetic presentation of ragtime, of Negro folk music and religion, and in general of the Negro's creative genius. Johnson's position—that the Negro had made real contributions to American culture—was supported by his editing of *The Book of American Negro Poetry* (1922, revised and enlarged 1931) and two books of Negro spirituals. Johnson's own creative career was climaxed by *God's Trombones* (1927). His *Black Manhattan*, an informal history of the Negro in New York, and *Along This Way*, an autobiography, were important revelations of the Negro's role in America. A portion of the latter work, dealing with the revolution in Nicaragua (1909), together with his protests against the U.S. occupation of Haiti, and such domestic injustices as disfranchisement and lynching showed that Johnson, like his colleague Du Bois, was a master of both creative and polemical styles.

Poets of the "Harlem Renaissance" included Claude McKay, alternately bitter at America's injustice and nostalgic for his native Jamaica, who urged racial solidarity; Georgia Douglas Johnson, who published lyrical poetry in *The Heart of a Woman* and *Bronze;* Countee Cullen, who expressed the emotions and ideas of the "New Negro" in technically finished traditional verse in *Color*, *Copper Sun* and *The Black Christ*. Writing in a freer form, Langston Hughes with his *Weary Blues* (1926) started a poetic career of interpreting Negro life, especially the urban masses, that extended through *Montage of a Dream Deferred* (1951) and *Ask Your Mamma* (1961). The poetry of the "Harlem Renaissance" was race conscious; its best achievement was the communication of sincere and thitherto unexpressed feelings and attitudes. Later Negro poets were influenced by the regionalism and social awareness of the 1930s and afterwards. They included Sterling Brown's *Southern Road* (1932), Margaret Walker's *For My People* (1942), Owen Dodson's *Powerful Long Ladder* (1946), and M. Beaunorus Tolson's *Rendezvous With America* (1944) and *Libretto for the Republic of Liberia* (1953), and Gwendolyn Brooks's *Street in Bronzeville* (1945) and *Annie Allen* (1949), for which she was awarded the Pulitzer prize for poetry.

The union of literary and propagandistic interests seen in Du Bois and James Weldon Johnson was continued by Walter White in his protest novel, *Fire in the Flint* (1924), and his *Rope and Faggot: a Biography of Judge Lynch* (1929). Jessie Fauset, in such novels as *The Chinaberry Tree* (1931), and Nella Larsen




MILTON MELTZER

(LEFT) GWENDOLYN BROOKS; (RIGHT) RICHARD WRIGHT

with her *Quicksand* (1928) wrote of the Negro middle class and its problems. Harlem life was delineated in such fiction as Claude McKay's *Home to Harlem* (1926), Rudolph Fisher's *Walls of Jericho* (1928), George Schuyler's *Black No More* (1931) and Wallace Thurman's *Infants of the Spring* (1932). Jean Toomer's *Cane* (1923) was a poetic rendition and interpretation of Negro life in both rural Georgia and border cities.

Much of the literature about Harlem was marked by hedonism and lightheartedness; the fiction written by Negroes in the 1930s and after was more sober and grounded in social reality and history. Arna Bontemps' *Black Thunder* (1936) dealt with a slave revolt in 1800; Richard Wright in all of his fiction from *Uncle Tom's Children* (1931) through *Native Son* (1940) to *The Outsider* (1953) dealt with the Negroes' revolt and alienation. Zora Neale Huston recorded Negro folk material in *Mules and Men* (1935) and used folk backgrounds for her best fiction. The plight of the urban masses and frustrated Negro intellectuals was grimly handled by Chester Himes and Ann Petry. Willard Motley's naturalistic novels such as *Knock on Any Door* (1947) and *We Fished All Night* (1951), and Frank Yerby's long series of historical novels, beginning with *Foxes of Harrow* (1946), were instances of books by Negroes that do not deal mainly with Negro characters; both novelists were popular in their respective fields. Concern for the meaning of Negro life in America is central in the *Invisible Man* (1952) by Ralph Ellison, an avant-garde novelist. This concern and complexity of interpretation were found in the essays, *e.g., Nobody Knows My Name* and *The Fire Next Time* (1963), and the fiction, *e.g., Go Tell It on the Mountain* (1953) and *Another Country* (1962), by James Baldwin.

Two novelists who might be considered representatives of the angry young men school were Julian Mayfield, author of *The Hit* and *The Grand Parade*, and John O. Killens, author of *Youngblood* and *And Then We Heard the Thunder* (1963). Langston Hughes made use of a cutting folk irony and humour in his anecdotes of a Harlem character misnamed Simple.

3. The Dramatic Arts.—In the dramatic arts, as subject, playwright and actor, the American Negro played a significant role. *Uncle Tom's Cabin*, adapted from Harriet Beecher Stowe's novel, was one of America's most popular plays; black-face minstrelsy loosely based on Negro song and dance was long America's favourite theatrical fare. After World War I interest in Negro life was shown by Eugene O'Neill in *The Emperor Jones* (1920), by Paul Green in folk plays of Negro life in the south, and by DuBose Heyward and Dorothy Heyward in *Porgy*. The collaboration of George and Ira Gershwin with the Heywards transformed this play into the folk opera *Porgy and Bess*, which won national and international acclaim. Of the few plays by Negro authors that were seen on Broadway, the most notable were *Mulatto* by Langston Hughes, *Native Son*, a collaboration between Paul Green and Richard Wright, *A Raisin in the Sun* by Lorraine Hansberry and *Purlie Victorious* by Ossie Davis. All of these plays brought greater perception of Negro life to the stage.

Drama flourished in Negro colleges; the dramatic troupes of Howard university and of Florida Agricultural and Mechanical State university were governmentally sponsored for visits abroad, the former going to Denmark and Norway and the latter to west African countries. Outstanding Negro actors on the professional stage included Charles Gilpin, famous for the title role in *The Emperor Jones;* Paul Robeson, for his role in O'Neill's *All God's Chillun Got Wings* and the leading role in *Othello;* and Richard B. Harrison for his role as "De Lawd" in Marc Connelly's *The Green Pastures.* Actresses included Rose McClendon, Abbie Mitchell, and, after long years as a jazz singer and entertainer, Ethel Waters; actors included Frank Wilson, Canada Lee and Sidney Poitier. In 1964 Poitier became the first Negro to win the best-actor award of the Academy of Motion Picture Arts and Sciences. He won the award for his performance in *Lilies of the Field.*

The song-and-dance tradition among Negro performers extended as far back as the all-Negro shows at the end of the 19th century, when such stars as Bert Williams and George Walker entertained America. The mimicry of Bert Williams became so famous that Ziegfeld broke historic precedent by featuring him in his *Follies*, and phonograph records of his clowning were best sellers. Musical revues such as *Shuffle Along, Blackbirds* and *Carmen Jones* were highly successful. Many Negroes became well known on the stage, in motion pictures and on television; these included Bill Robinson, "Pegleg" Bates, Fredi Washington, Hattie McDaniel, Louise Beavers, Lena Horne, Dorothy Dandridge, Juano Hernandez and Frank Silvera. Hattie McDaniel won the 1939 Academy award as best supporting actress for her performance in *Gone With the Wind.* Diahann Carroll, who played a leading role in *No Strings*, a musical comedy by Samuel Taylor and Richard Rodgers, became a star on Broadway. The new respect and knowledge about authentic Negro folk music stimulated by the discoveries of Leadbelly (Huddie Ledbetter) and Josh White and the Library of Congress folk archives, led to the wide acceptance of such performers as Harry Belafonte and Odetta. (*See* FOLK SONG, U.S.) The influence of the Negro on American popular, ballroom and stage dancing had started with blackface minstrel shows; in the 20th century two able students and performers of the dance, Katherine Dunham and Pearl Primus, illustrated the relationship between the dances of Africa, the Caribbean countries, South America and the United States.

4. Music.—In the early decades of the 20th century a vogue was established on the concert stage by such singers as Harry Burleigh, Roland Hayes, Paul Robeson, Marian Anderson and Dorothy Maynor. Negro singers continued to achieve distinction. Mattiwilda Dobbs, Robert McFerrin and Leontyne Price performed with the Metropolitan Opera company. The choral singing of Negroes had been well received ever since the years shortly after the Civil War when the Fisk Jubilee singers successfully toured in the United States and abroad. The Howard university choirs, under the direction of Warner Lawson, frequently sang in joint concerts with the Washington National Symphony orchestra. The 60-voice Howard University choir, under


(LEFT) EBONY MAGAZINE; (RIGHT) MILTON MELTZER

(LEFT) MARIAN ANDERSON; (RIGHT) W. C. HANDY

EBONY MAGAZINE

(LEFT) GEORGE WASHINGTON CARVER; (RIGHT) RALPH J. BUNCHE

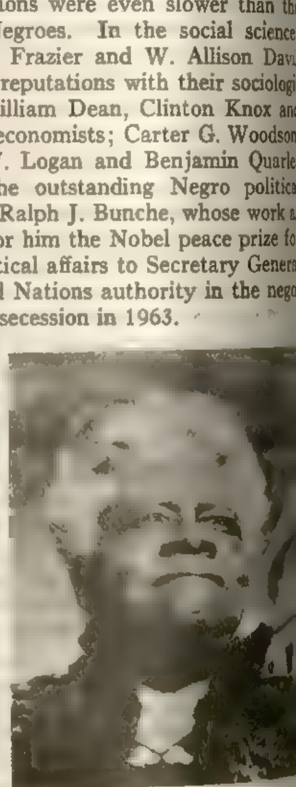
the auspices of the president's special international program for cultural presentations, gave concerts in 15 countries of Central and South America and in three Caribbean countries. Other distinguished choral groups were the Hall Johnson choir, the Eva Jessye choir, and the De Paur Infantry chorus. Many fine voices, such as those of Todd Duncan, Anne Brown, Laurence Winters and Camilla Williams, were revealed to America at large in *Porgy and Bess* and the choral singing in that opera was highly praised.

Negro folk music and jazz (*q.v.*) were accorded careful study, documentation and critical appreciation in the United States, Europe and Asia. The spirituals had been accepted and praised since the Civil War, but it was not until the 20th century that Negro work-songs, reels, ballads and blues won esteem and understanding. Evolving from Negro folk songs (sacred and secular), Spanish, French and Anglo-Saxon popular music, and marching band music, jazz became America's most distinctive musical form. King Oliver, Louis Armstrong, Ferdinand "Jelly Roll" Morton and W. C. Handy played key roles in its origin; Fletcher Henderson, Duke Ellington, Jimmy Lunceford, Cab Calloway and Count Basie brought about its evolution into swing; Lester Young, Charles Parker, Dizzy Gillespie and Miles Davis represented advance-guard styles variously known as "bop" and "progressive." Noted among the arts as one of the most democratic, jazz was no longer chiefly the American Negroes' but was the national music, and because of its international popularity was one of the U.S. department of state's most valuable art forms for overseas presentations.

5. Art.—In painting, several Negroes were outstanding. Henry O. Tanner's pictures were winning medals as early as 1900, and by mid-century many of them were in the leading galleries of the United States and Europe. After World War I, Aaron Douglas received recognition for his black-and-white drawings and illustrations. Laura Wheeler Waring painted scenes from life among upper-class Negroes while Edward A. Harleston confined himself to genre painting. Later, Hale Woodruff, Romare Bearden and Charles Alston of New York city and James Porter and Lois Jones of Washington, D.C., proved to be careful observers as well as skilled and versatile artists. One of the most widely acclaimed artists was Jacob Lawrence, whose rigorously modernistic paintings concentrated on Negro history and experience. E. Simms Campbell and Ollie Harrington were illustrators and socially penetrating caricaturists. In the field of sculpture, Meta Warrick Fuller won recognition before World War I and continued to do significant work thereafter. Elizabeth Prophet and Augusta Savage executed pieces that reflected the successful use of Negro subjects in this difficult medium. Sargent Johnson also enjoyed success as a sculptor. Richmond Barthé became the foremost Negro sculptor in the United States and was commissioned to do the bust of Booker T. Washington for the Hall of Fame at New York university.

6. Science, Law and the Social Sciences.—In the sciences the best-known Negroes were George Washington Carver, chem urgist; Percy Julian, chemist; E. E. Just, biologist; Elmer Imes physicist; and Daniel Williams, William A. Hinton and Charle Drew in the medical sciences. Many Negro college teachers o science were dedicated to both teaching and research. Many phy sicians and surgeons by passing their specialty boards earned th title of diplomate; some were at long last admitted to local medi cal societies. Negro lawyers, especially Charles Houston, Thur good Marshall, James M. Nabrit, Jr., and Constance Motley, wer prominent in winning key civil rights cases; William Hastie an Thurgood Marshall were circuit court judges and other Negroe were on district, state and municipal benches. Significant contri butions to legal literature have been written by Charles Quick William Robert Ming and Dorsey Lane. In spite of the prove competence and services of Negro lawyers, the American Bar as sociation and some local associations were even slower than th medical societies in admitting Negroes. In the social science Charles S. Johnson, E. Franklin Frazier and W. Allison Davi gained national and international reputations with their sociologi cal studies; Abram L. Harris, William Dean, Clinton Knox an Robert C. Weaver were noted as economists; Carter G. Woodson John Hope Franklin, Rayford W. Logan and Benjamin Quarle were well-known historians. The outstanding Negro politica scientist at mid-20th century was Ralph J. Bunche, whose work a a United Nations mediator won for him the Nobel peace prize fo 1950. As undersecretary for political affairs to Secretary Genera U Thant, he was the chief United Nations authority in the nego tiations concerning the Katangan secession in 1963.

In education and public service the outstanding Negro woman of her generation was Mary McLeod Bethune (1875–1955), president for many years of Bethune-Cookman college at Daytona Beach, Fla.



EBONY MAGAZINE

MARY MCLEOD BETHUNE

7. International Relations.—Interest in Africa had been shown by American Negroes since the colonization ventures of the 19th century and Pan Africanism had engaged the attention of Negroes since the beginning of the 20th century. Several African leaders, notably Kwame Nkrumah of Ghana, Nnamdi Azikiwe of Nigeria and Hastings Banda of Nyasaland, were educated in the United States. After Ghana won its independence in 1957, American Negroes becam more and more involved in the struggles and achievements Africa; several Negro scholars were counted among the rapid growing number of American Africanists. The American Societ of African Culture, organized by Negro scholars and writers, he conferences and symposia, and published reports. The visits the United States of the presidents, prime ministers and oth leaders of the new African nations, and the dignified respect a corded to them by U.S. officers of state, gave many Negro Ame icans a sense of pride they had not previously known. Mo African students appeared on the campuses of American college

Many American Negroes were employed in various capaciti by African, Asian and South American nations; others were e ployed by private concerns, and still others held U.S. governme posts. Among the latter were three Negro ambassadors: Clift Wharton, ambassador to Norway; Carl T. Rowan, ambassador Finland for a time; and Mercer Cook, who was appointed amb sador to Senegal after having served as ambassador to Nig There were also a few Negro consuls and other foreign serv officers. Although such employment indicated that the policy the department of state was becoming less discriminatory in t recruitment and employment of American Negroes, the first Am ican Negro leadership conference held in 1962 at Arden Hou Harriman, N.Y., called upon the department of state to liberal

this policy further. Carl T. Rowan was head of the U.S. Information agency from Feb. 1964 to July 1965.

VIII. CONCLUSION

On Jan. 1, 1863, Abraham Lincoln signed the Emancipation Proclamation. Even this incomplete liberation was viewed with misgivings and forebodings by some, and hosannas and dreams by others. A century later neither the direst prophecies nor the rosiest dreams had come true. The struggle for first-class citizenship had been arduous. The Negro was aided in the struggle by white men of good will and democratic belief; to it he brought his own courage, stoicism, ambition, intelligence and foresight. His attainment of liberty and equality was not yet complete, his citizenship not yet first-class, but his progress had been strong and sure, and his saga one of the high points of American history.

See also INTERRACIAL RELATIONS; SEGREGATION, RACIAL; SLAVERY; and references under "Negro, American" in the Index. For current developments see *Britannica Book of the Year.*

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(J. H. FN.; R. W. LN.; S. A. BR.)

NEGRO RIVER (Río NEGRO), one of the principal tributaries of the Amazon (*q.v.*), 1,056 mi. long. Its principal headwater affluents, the Vaupés (Uaupés) and the Guainía, rise in the rain forest of eastern Colombia. After turning southward the latter forms the Venezuela-Colombia border for more than 100 mi., becoming the Negro where it joins the Casiaquiare canal at San Carlos. Manaus, regional capital of the Amazon valley and a port for ocean-going vessels, is located on the high left bank of the Negro 12 mi. above its junction with the Solimões or Amazon. Near Manaus the Negro is an island-free estuary 4 mi. wide and at least 100 ft. deep, but farther upstream it is up to 20 mi. wide and filled with a labyrinth of lenticular islands formed by deposits of materials derived from its silt-laden, left-bank tributaries.

The clear, jet-black water of the Negro, from which it derives its name, contrasts dramatically with the yellowish, silt-laden water of its major tributary, the Río Branco, and with that of the Amazon. As it carries no sediment in its lower course the Negro has no flood plain. The low marginal areas (*igapós*), which its waters cover during much of the year, are forest covered. Dissolving humic acid, from the decomposition of organic matter in the soils of these swamps, gives the Negro its black colour.

Most of the drainage area of the Negro is of subdued relief, interrupted by occasional monadnocks reaching from 300 to 1,200 ft. above the forested plain. Through that strange natural waterway, the Casiaquiare canal, the Negro appears to be capturing the headwaters of the Orinoco system. (Js. J. P.)

NEGROS OCCIDENTAL, a province on the western and northern sides of Negros Island, Republic of the Philippines, facing the Island of Panay across Guimaras strait. Area 3,058 sq.mi.; pop. (1960) 1,332,323. The province has a large coastal plain built from sediments eroded from the igneous mountain mass in the interior.

The northern and northeastern portions of the province are less level, with rolling hills; the southern end is part of a grassy plateau that is shared with Negros Oriental. Mt. Canlaon (8,035 ft.) is an impressive volcanic peak near the centre of the island and Mt. Maldalgan (6,165 ft.) is the principal mountain in the north. Negros Occidental is the wealthiest province in the republic and probably the province with the greatest political influence in the national government.

Negros Occidental produces between 55% and 60% of the Philippine commercial sugar. There are ten modern *centrals* (mills for making raw sugar out of cane): Binalbagan, Victorias, La Carlota, Hawaiian-Philippine (near Saravia), Talisay-Silay, Ma-ao, Bacolod-Murcia, San Carlos, Lopez (at Sagay) and Danao (near Escalante). There is a large modern lumber mill at Fabrica, but the workable forests in that area have been largely exhausted. Other crops include coconuts, rice and corn (maize). There is a minor coal deposit near Escalante.

Bacolod, the capital and principal urban settlement, is a regional commercial centre and in the 1960s it was beginning to rival Cebu and Iloilo as a centre of political influence in the Visayans. Pop. (1960) 119,315. *See* BACOLOD, CITY OF. (AN. C.)

NEGROS ORIENTAL, a province on the eastern and southern sides of Negros Island, Republic of the Philippines. Area 2,217 sq.mi.; pop. (1960) 597,761. Peopled principally by Cebuanos and separated from the nearby island of Cebu by narrow Tañon strait, it is more closely related to Cebu both culturally and commercially than to the other side of Negros, from which it is separated by a rugged mountainous core of volcanic origin. The southern part of the province is principally a grassy plateau and is sparsely populated. The eastern portion grades from a discontinuous coastal plain into rolling limestone hills and then into forested mountain slopes. The principal crops are corn (maize), rice, sugar cane and coconuts.

Dumaguete city (pop. [1960] 10,528), the capital, is a minor regional centre with regular air service. It is a port of call for both interisland ships and ocean freighters. The community is probably best known as the site of Silliman university, a mission school with an excellent liberal arts college.

Siquijor Island (130 sq.mi.), a subprovince of Negros Oriental, lies directly opposite Dumaguete. Bais, 25 mi. N. of Dumaguete, is the site of a large sugar *central* (mill), the only one in the province, with a distillery for converting the by-product molasses into

industrial alcohol and a paper mill using bagasse (sugar-cane fibres) as its raw material. Other municipalities are Tanjay, Guihulñgan, Calamba, Zamboanguita and Siaton. (AN. C.)

NEHEMIAH (in the Douai version of the Bible, NEHEMIAS), governor of Judaea under Artaxerxes (*q.v.*), who was generally thought to be Artaxerxes I (465–424), although he could possibly have been Artaxerxes II (404–359 B.C.). The book of Nehemiah (II Esdras in the Douai version) forms the concluding portion of the great compilation Chronicles–Ezra–Nehemiah. Nehemiah's own account, written after 432 in the first person and confined to ch. i–iv, is the only authentic information which remains in regard to his life and work.

See further EZRA AND NEHEMIAH, BOOKS OF; JEWS: *Exile and Restoration: Nehemiah.*

NEHRU, JAWAHARLAL (1889–1964), the first prime minister of independent India, was born in Allahabad on Nov. 14, 1889, of a prosperous Brahman family from Kashmir which had migrated to India early in the 18th century. His father, Motilal, was a highly successful and cultivated lawyer, with a house which contained a numerous family of cousins and a procession of guests, many of them English. Jawaharlal grew up with English governesses and tutors, one of whom, an Irish theosophist, Frederick T. Brooks, had considerable influence on his developing taste for poetry and science. When he was 16, he was sent to school at Harrow, Middlesex, Eng., and remained in England for more than seven years. These were divided between Harrow and Cambridge (where he took a degree in natural science), with two subsequent years at the Inner Temple in London. When he obtained his law degree in the summer of 1912, he was widely though not deeply acquainted with the culture of the time and had been influenced by Fabian socialism, the Irish Home Rule movement and the arguments for women's suffrage. He also had made some acquaintance with the European continent. His interest in Indian affairs had been only sporadically aroused at Cambridge by the news from home as debated by other Indian students there.

© KARSH, OTTAWA

NEHRU

The Indian National Congress, which he attended on his return to India in 1912, was still an annual assembly of moderate, upper-class Indians speaking the English of the law courts. Their striped trousers and frock coats startled him. Jawaharlal found no appeal to his sensitive but fiery temperament in their measured discussions, nor could he feel at ease in the atmosphere of the law courts. His intellectual development owed more to his rapidly growing companionship with his own father, Motilal, although the elder Nehru was at this time by no means ready for the bold courses Jawaharlal's instinct already had suggested.

They both became aware at this period (1912–14) of M. K. Gandhi (*q.v.*) because of the success his method of voluntary sacrifice (*satyagraha*) was obtaining in South Africa. Gandhi returned to India in 1915, just before the outbreak of World War I, but took little part in public affairs. Jawaharlal met him in Dec. 1916, at the Lucknow session of the National Congress, but found him "very remote." Successive *satyagraha* campaigns by Gandhi for specific purposes, such as the relief of the workers on indigo plantations in north Bihar, made his distinctive principles of collective action more familiar to the whole country thereafter. By the end of the war it was becoming apparent that the main political question in India would be, as it was for 30 years, what Gandhi was going to do next.

In 1919 the Rowlatt act, dealing with sedition, and Gandhi's reply in the form of a call to all Indians to stop work and fast in protest were followed by serious disturbances in the Punjab, particularly in Amritsar, where heavy casualties were caused when troops opened fire on a crowd at Jallianwalla Bagh. From then on the Nehrus, father and son, were firmly committed to the national movement and to Gandhi's leadership in it. The next Indian Congress met at Amritsar under Motilal Nehru's presidency (1920) but already the centre of moral authority had settled in Gandhi.

From then until the transfer of power from British to Indian hands (Aug. 15, 1947), the struggle for independence was nearly incessant, although subject to strange suspensions and interruptions, Nehru often thought, by the will of Gandhi. The relationship of these two strongly diverse yet mutually sympathetic men is one of the fascinating human dramas of the time. Nehru's mind could not accept the religious basis for many of Gandhi's decisions and the apparent lack of reasoning that led to them. Slowly he came to see that the Mahatma had a knack of being right in the end and, furthermore, that the Indian masses understood him and would have no other leader. Their frequent disagreements in the 1920s and 1930s seem to have made no difference to their loyalty and affection. Gandhi repeatedly said, "Jawahar is my political heir." On one occasion Nehru sent him a telegram of dissent from a decision taken, ending, "But who am I to argue with a magician?"

Nehru's father died in 1931, having been swept along by his son and Gandhi into a position far more extreme than he had been willing even to consider a few years before. Jawaharlal counted them both (his "two fathers") as supreme influences in his life, but he added also the influence of his lovely wife, Kamala, whom he married in 1916; she died in Switzerland of tuberculosis in 1936. Their only child, Indira, married to the late Feroze Gandhi, was to become president of the Indian National Congress in 1959, like her father and grandfather before her.

Nehru went to jail for the first time in 1921 in obedience to the Gandhian precepts, and was released for the last time in 1945, not long before he became prime minister. In all he spent almost 10 years in jail out of 27 years in the national movement.

The negotiations between British and Indian leaders that led to the transfer of power were conducted with Nehru as chief negotiator for the National Congress. When partition seemed inevitable, at least in preference to civil war, he accepted that, also. He became interim prime minister in 1946. At midnight on Aug. 14–15, 1947, the transfer was accomplished, and two new countries came into being, India and Pakistan. Thenceforward Nehru's biography merged with the history of contemporary India, of which it might be regarded as a decisive if not sovereign element.

Partition had dire results. Much public disorder and bloodshed brought on a mass exodus of Hindus from Pakistan and of Muslims from India. The refugee problem thus created was a primary claim on the energies of the new government and drained its resources for more than a decade. The princely states, once regarded as an insuperable obstacle to Indian unity, were unexpectedly amenable, and most of their rulers adhered to one or the other of the new nations without debate. Exceptions were Kashmir and Hyderabad, the first with a Hindu ruler over a predominantly Muslim state and the second with a Muslim ruler over a predominantly Hindu state. Faced with an invasion of Pathan tribesmen from the North-West Frontier Province, the maharaja of Kashmir acceded to the Indian union in Oct. 1947 and appealed to Nehru for help. Pakistan supported the tribesmen, and a vexatious conflict ensued, ending with virtual partition in the cease-fire of Jan. 1, 1950, with India occupying two-thirds of the state and Pakistan the rest. Hyderabad, after prolonged disorder, was occupied by military force in Sept. 1948 and acceded to the Indian union by treaty in the following year. All the states were subsequently reorganized with revised frontiers, the second time in accordance with predominant local languages, but by 1960 their divisive tendencies seemed curbed and their constitutional relation to the central government stabilized.

Nehru's part in the consolidation of the country was great, but after the crises of the early years were surmounted, his attention and energy were spent mainly upon two great concerns: domestically, on the successive Five Year plans, and, internationally, upon the evolution of a distinctive foreign policy aiming at friendship with all countries regardless of their systems and the preser-

vation of peace when possible. The assassination of Gandhi (Jan. 30, 1948) had by no means removed his influence, and Nehru was often quoted as saying the Mahatma was more powerful in death than in life. This was to be felt at every twist and turn of international affairs, where India consistently took positions governed by the nonviolent principle. Nehru's personal diplomacy involved state visits to the United States, the U.S.S.R. and Communist China, as well as his regular visits to England for commonwealth conferences; with all of these he managed to keep on good terms for the first decade. The ideal of coexistence between countries of different or opposing structures was put to the test in India's relations with China from 1953 to 1956 but was strained in that year by the Chinese pretensions in Tibet. In 1959, when China absorbed Tibet completely and the 14th dalai lama fled to India, the two Asian giants came to sharp disagreement and, at various points around the Tibetan border, into local hostilities. China's ethnic claims, arising from the theory that Tibet was an integral part of China, took in a part of northern India and the predominantly Buddhist border states of the Himalayas. There seemed little likelihood of a permanent settlement in the absence of any principle common to both sides, but in the teeth of much popular agitation Nehru characteristically continued to try. At the same time he repeatedly declared that India's frontiers would be defended against all comers.

His foreign policy was often criticized in Europe and the United States, and the word "neutralist" was applied to it. Nehru said that his policy was not neutralist but independent, claiming the prerogative of decision and judgment on each question as it arose. He voted for the U.S. resolution on Korea (1950) at the UN, and after the ensuing war he sent Indian troops to supervise the exchange of prisoners that made the armistice possible. He was quick to oppose the Anglo-French action at Suez (1956) but slow to condemn the subsequent Soviet action in Hungary, owing, he said, to lack of full information. His visits to all countries evoked popular demonstrations, and within a few years of independence Delhi had become a favourite resort of peace delegations and conferences of all sorts. The moral influence India acquired through Nehru's policy was displeasing at times to one side or the other in the "cold war," but its reality at the UN and throughout the world, particularly in Asia and Africa, was a recognized element in the international situation.

Nehru visited the UN in New York in 1960 (15th general assembly) and in Feb. 1961 supported its efforts in the Congo against a Soviet demand that they cease. He was even willing to send Indian combat troops there in the UN service, a remarkable departure from previous policy. Some observers saw indications of a pro-western evolution in this and other respects, perhaps related to India's difficulties with China. Nehru's precepts and definitions remained unchanged: India would participate in no military pacts and no other alignments or groupings except the British Commonwealth, with which, chiefly by his own efforts, the sovereign republic of India was freely associated after 1950.

As prime minister, Nehru showed skill and resilience in parliamentary debate, the ability to yield gracefully when necessary, and great respect for the speaker and the house. His vast power in India arose chiefly from his popularity with the masses. Thus he did not control either parliament or his own party by patronage and discipline, to which he was often indifferent, but by the fact that few could consistently oppose him and survive before the electorate. His gifts as a speaker were not for formal eloquence, although he could rise to it on occasion. Rather he seemed to talk as if he were thinking aloud and taking his audience into his confidence. In spite of the dangers of misquotation, he often spoke without a text or notes. This direct and familiar approach to the people, reminiscent of Gandhi's methods, was irresistible to the masses in India and, along with his services through many years, made the merest hint of his resignation or retirement a shock to the public and a signal for nationwide protest. He never believed it the part of a leader in democracy to dictate his own successor and died (May 27, 1964) without having done so.

Nehru received valuable support from his sister Vijaya Lakshmi Pandit, who had also been very active in the nationalist movement. She was leader of the Indian delegation to the UN general assembly, 1946–48; Indian ambassador to Moscow, 1947–49, and to Washington, 1949–51; president of the UN general assembly, 1953–54; and Indian high commissioner in London, 1954–61.

His writings include *An Autobiography*, third revised edition (1948); *Nehru on Gandhi* (1948); *The Discovery of India*, fourth edition (1956).

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NEKRASOV, NIKOLAI ALEKSEEVICH (1821–1878), Russian poet and journalist, whose main theme was compassion for the sufferings of the peasantry, though he could also express the racy charm and vitality of peasant life in his adaptations of folk songs and poems for children. Born at Yuzvin, near Vinnitsa in the Ukraine, on Dec. 10 (new style; Nov. 28, old style), 1821, he was brought up in the government of Yaroslavl, where his father was a landowner. He studied at St. Petersburg university, but his father's refusal to help him forced him into literary and theatrical hack work at an early age. An able businessman, he published and edited literary miscellanies and in 1846 bought from Pëtr Pletnev the magazine *Sovremennik* ("The Contemporary"), which had declined after the death of its founder, Aleksandr Pushkin. Nekrasov managed to transform it into a major literary journal and a paying concern. Both Turgenev and Tolstoi published their early works in it, but after 1856, influenced by its subeditor, Nikolai Chernyshevski (*q.v.*), it began to develop into an organ of militant radicalism. It was suppressed in 1866, after the first attempt to assassinate Alexander II. But in 1868 Nekrasov, with Mikhail Saltykov (Shchedrin), took over *Otechestvenniye zapiski* ("Fatherland Annals"), remaining its editor and publisher until his death in St. Petersburg on Jan. 8, 1878 (N.S.; Dec. 27, 1877, O.S.).

Nekrasov's work is uneven through its lack of craftsmanship and polish and a tendency to sentimentalize his subjects, but his major poems have lasting power and originality of expression. *Moroz krasny-nos* (1863; Eng. trans., "Red-nosed Frost," in *Poems*, 1929) gives a vivid picture of a brave and sympathetic peasant woman, and his large-scale narrative poem, *Komu na Rusi zhit khorosho?* (1879; Eng. trans., *Who Can Be Happy and Free in Russia?*, 1917), shows to the full his gift for vigorous realistic satire. (R. HA.)

NEKTON, a Greek word meaning "swimming" and used in biology as the collective term for large free-swimming (rarely floating) aquatic animals. Nekton is distinguished from the drifting plankton (*q.v.*) and the bottom-dwelling benthos (*q.v.*). *See* MARINE BIOLOGY.

NELLORE, a town and district in Andhra Pradesh, India. The town, headquarters of the district, lies on the right bank of the Penner river, 95 mi. N. of Madras on the Southern railway. Pop. (1961) 106,776. It was made a municipality in 1866. The arts and science college, founded by the raja of Venkatagiri in 1876, and a Sanskrit college are both affiliated to Sri Venkateswara university at Tirupati. There are also seven high schools and three training schools. The American Baptist mission and the Roman Catholic mission started educational work in Nellore in the 19th century. The town is noted for the manufacture of ceramics. The national highway passing through the town is the main traffic route from Madras to Vijayavada.

NELLORE DISTRICT has an area of 7,974 sq.mi. Pop. (1961) 2,033,679. It comprises a tract of low-lying land extending from the Eastern Ghats to the sea. Its general aspect is forbidding: the coastline is a fringe of blown sand through which the waves occasionally break. Farther inland the land rises, but the soil is not naturally fertile. The chief rivers are the Penner, Kandaleru, Swarnamukhi, Musi, Paleru and Monneru. About 50% of the total area is cultivated, of which about half is irrigated. The dis-

trict is noted for mica mining and ceramic manufacturing. The chief crops are millets, rice and pulses. The local breed of cattle is well known. Nellore, with the rest of the Carnatic, passed under direct British administration in 1801. (B. S. R.)

NELSON, HORATIO NELSON, VISCOUNT (1758–1805), duke of Brontë in Sicily, British naval hero, was born at Burnham Thorpe, in Norfolk, on Sept. 29, 1758. His father, Edmund Nelson, was rector of the parish and his mother, Catherine Suckling, was related to Sir Robert Walpole (1st earl of Orford). His uncle, Capt. Maurice Suckling, later became comptroller of the navy.

Early Life.—Horatio Nelson, who was educated at Norwich, Downham and North Walsham, was entered in the "Raisonnable" when Captain Suckling was appointed to her in 1770 on an alarm of war with Spain. The dispute was settled and Captain Suckling was transferred to the "Triumph," the guardship at Chatham, taking his nephew with him. In order that the lad might have more practice than could be obtained in a harbour ship, his uncle sent him to the West Indies in a merchant vessel, and on his return gave him constant employment in boat work.

In 1773 Nelson served with Captain Lutwidge in the "Carcass," in an expedition to the arctic under the command of Captain Phipps (later Baron Mulgrave). On his return from the north he was sent to the East Indies in the "Seahorse," in which vessel he met his lifelong friend Thomas Troubridge. At the end of two years he was invalided home. In later times he spoke of the depression under which he laboured during the return voyage, until "after a long and gloomy reverie, in which I almost wished myself overboard, a sudden glow of patriotism was kindled within me, and presented my king and my country as my patron. My mind exulted in the idea. 'Well then,' I exclaimed, 'I will be a hero, and, confiding in Providence, I will brave every danger.'" He spoke to friends of the "radiant orb" which from that hour hung ever before him and "urged him onward to renown."

On his return he served during a short cruise in the "Worcester" frigate, passed his examination as lieutenant on April 9, 1777, and was confirmed in the rank next day. He went to the West Indies with Captain Locker in the "Lowestoff" frigate, was transferred to the flagship of Sir Peter Parker and was then promoted in rapid succession to the command of the "Badger" brig and the "Hinchinbrook" frigate. By the last appointment, which he received in 1779, he was placed at the age of 20 in the rank of post captain (from which promotion to flag rank was by seniority).

Active Service.—In 1780 Nelson saw arduous active service in an expedition to San Juan in Nicaragua; he became very ill with fever, and once more was invalided home. In 1781 he was appointed to the "Albemarle" frigate, and after some convoy service in the North sea and the Baltic, was sent to Newfoundland and then to the North American station. From there he sailed for the West Indies, where he made the acquaintance of Admiral Lord Hood. The admiral presented him to the duke of Clarence (afterward William IV), as an officer well qualified to instruct him in "naval tactics"—a marked compliment to a young officer from one of the greatest exponents of the art. He appeared, said the prince, "to be the merest boy of a captain I ever beheld; and his dress was worthy of attention. He had on a full-laced uniform; his lank unpowdered hair was tied in a stiff Hessian tail of an extraordinary length; the old-fashioned flaps of his waistcoat added to the general quaintness of his figure, and produced an appearance which particularly attracted my notice; for I had never seen anything like it before, nor could I imagine who he was or what he came about. My doubts were, however, removed when Lord Hood introduced me to him. There was something irresistibly pleasing in his address and conversation; and an enthusiasm, when speaking on professional subjects, that showed he was no common being." The slight oddity of appearance, the power to arouse affection, and the glow indicating the fire within, are noted by all who ever looked Nelson in the face.

BY COURTESY OF THE NATIONAL MARITIME MUSEUM, GREENWICH

PORTRAIT OF NELSON AS A CAPTAIN BY J. F. RIGAUD

The peace of Versailles (1783) gave Nelson leisure to visit France, and in 1784, when most naval officers were condemned to idleness on shore, he had the good fortune to be appointed to the command of the "Boreas" frigate, for service in the West Indies. While on that station he insisted on enforcing the navigation laws against the Americans, who by becoming independent had become foreigners. He called the attention of the government to the corruption prevailing in the dockyard of Antigua. His line impressed the admiralty as somewhat assuming, and his strong measures against the interloping trade brought on him lawsuits, which caused him much trouble.

In the West Indies on March 11, 1787, Nelson married Frances Nisbet, the widow of a doctor in Nevis. The union was one of affection and prudence.

Outbreak of War.—When war broke out with revolutionary France, Nelson was appointed captain of the 64-gun "Agamemnon," and joined his ship on Feb. 7, 1793. From this date until June 1800 he was engaged on almost continual active service. This period is the most varied, the busiest, the most glorious and the most debated of a very full career.

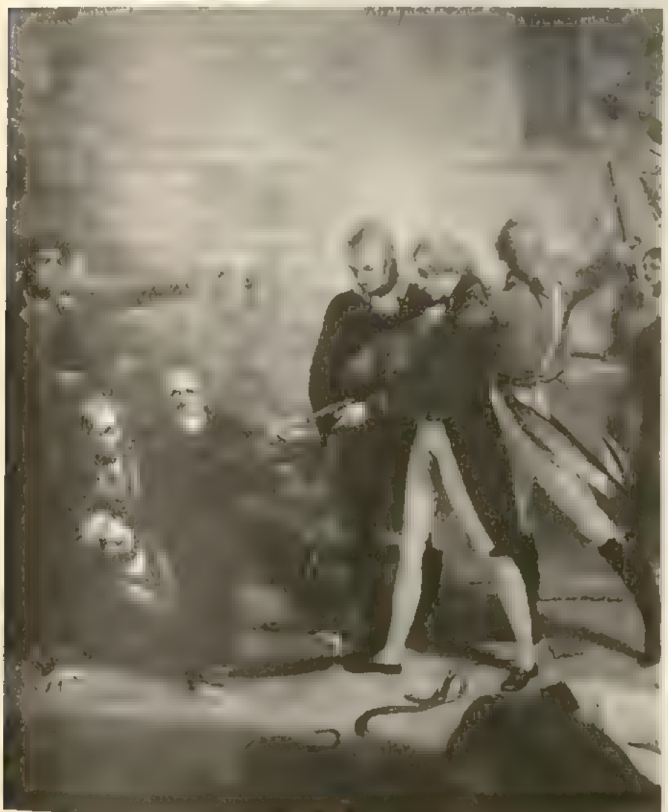
It subdivides naturally into three: (1) From the date of his appointment as captain of the "Agamemnon" until he was disabled by the loss of his arm in the unsuccessful attack on Santa Cruz de Tenerife on July 24, 1797, he served as captain or commodore, under successive commanders in chief in the Mediterranean. (2) After an interval of nine months spent at home in recovering from his wound, he returned to the Mediterranean and was at once sent in pursuit of the great French force which sailed from Toulon under the command of Napoleon for the conquest of Egypt. His victory of the Nile, on Aug. 1, 1798, placed him in the foremost rank among the warriors of a warlike time and made him a national hero. (3) From his return to Naples after the battle of the Nile until his return to England in the summer of 1800, he was immersed in Mediterranean affairs which tended to centre around the shores of Naples and Sicily.

The Mediterranean.—The first of these three passages in his life is full of events, which must, however, be told briefly. In June 1793 he sailed for the Mediterranean with Admiral Hood and was engaged under Hood's orders in the occupation of Toulon by the allied British and Spanish forces. In September he was dispatched to Naples to arrange for troops to contribute toward the garrison of Toulon. It was on this occasion that he made the acquaintance of Emma Hamilton (*q.v.*), the wife of Sir William Hamilton, minister at the court of Naples. References to Lady Hamilton begin to appear in his letters to his wife, but, as might be expected, they indicate little beyond respectful admiration, and he makes a good deal of her kindness to his stepson, Josiah Nisbet, whom he had taken to sea.

After the allies had been driven from Toulon, Nelson was mainly employed in the operations connected with the occupation of Corsica. In April and May 1794 he was engaged in the capture of Bastia; in June, July and part of August in the taking of Calvi. During the operations at Calvi, Nelson received a wound in his right eye which healed without leaving disfigurement, though the sight faded. From the date of the occupation of Corsica until the island was evacuated (1794–96) he was incessantly active. He served under William (later Baron) Hotham, who succeeded Hood in the command, and was engaged in the indecisive actions fought by Hotham in March and July 1795. The complacency of the new admiral fretted the eager spirit of Nelson, who declared that, for his part, he would never think that the British fleet had done well if a single ship of the enemy escaped while there was a possibility of taking her. Happily he was detached to the Riviera of Genoa, where, first as captain and then as commodore, he had scope and opportunity to prove his qualities for independent command by

harassing the communications of the French and co-operating with the Austrians.

In Sir John Jervis, who superseded Hotham, he found a leader after his own heart. When Spain, after first making peace with France, declared war on England, and the fleet under Jervis withdrew from the Mediterranean, Nelson was dispatched to Elba on a hazardous mission to bring off the small garrison and the naval stores. He sailed in the "Minerve" frigate, having another with him. After a smart action with two Spanish frigates and a narrow escape from a squadron of Spanish line-of-battle ships, he fulfilled his task and rejoined the flag of Jervis on the eve of the great battle (Feb. 14, 1797) off Cape St. Vincent. (*See* SAINT VINCENT, BATTLE OF.) The judgment, independence and promptitude he showed in this famous engagement revealed him as one of the heroes of the navy.



BY COURTESY OF THE NATIONAL MARITIME MUSEUM, GREENWICH
NELSON RECEIVING THE SURRENDER OF THE "SAN JOSEF," FEB. 14, 1797. OIL PAINTING BY RICHARD WESTALL

Blockade of Cádiz.—A few days after the victory Nelson became rear admiral by seniority, but continued with Jervis, who was made a peer under the title of earl of St. Vincent. Nelson's own services were recognized by his being made a knight of the Bath. During the trying months in which discontent in the fleet was developing toward the mutinies at Spithead and the Nore, he remained with the flag and in the blockade of Cádiz.

In July 1797 he was sent to Santa Cruz de Tenerife and made a desperate attempt to capture it. The enterprise was, in fact, rash in the last degree, for no troops were available for the service, and a fortified town was to be taken by man-of-war boats alone. The Spaniards were on the alert and the attack, made with the utmost daring on the night of July 24, was repulsed with heavy loss. Some of the boats missed the mole in the dark and were stove in by the surf, others being shattered by the fire of the Spaniards. Nelson's right elbow was shot through and he fell back into the boat from which he was directing the attack. The amputation of his arm was performed in haste and in semi-darkness. He was invalided home and spent months of pain in London and at Bath. In April 1798 he returned to the fleet off Cádiz as rear admiral, with his flag in the 74-gun "Vanguard."

Nelson was then one of the most distinguished officers in the navy. Within the next six months he was to raise himself far above the heads of his contemporaries. A great armament was preparing at Toulon for some unknown destination. To discover its purpose, and to defeat it, the British government resolved to send a naval force into the Mediterranean, and Nelson was chosen for the command.

Command in the Mediterranean.—Having joined the flag of Lord St. Vincent outside the straits of Gibraltar on April 30, Nelson was detached on May 2, with three line-of-battle ships and five frigates, to discover the aim of the Toulon armament. Napoleon had, however, enforced rigid secrecy, and beyond the fact that a powerful combined force was collected in the French port, Nelson could learn nothing. On May 20 the "Vanguard" was dismasted in a gale. "I ought not," wrote Nelson, "to call what has happened by the cold name of accident; but I believe firmly that it was the Almighty's goodness to check my consummate vanity." The "Vanguard" was saved from going on shore by the skill of Captain Ball of the "Alexander," for whom Nelson had henceforth a peculiar regard.

The frigates attached to his command had returned to Gibraltar, in the erroneous belief that the big ships would be taken there to make good the damage suffered in the gale. In June Nelson was off Toulon again, only to find that the French were gone. Deprived of his best means of obtaining information by the disappearance of his frigates, he remained cruising until he was joined by Captain Troubridge with ten sail of the line. He then started on his fierce pursuit of the enemy, seeking him in the dark, for there were no scouts at hand; exasperated at being left without the eyes of his fleet; knowing that St. Vincent would be blamed for choosing so young an admiral; but resolved to follow the enemy to the antipodes if necessary. From Sardinia to Naples, from Naples to Messina, from Messina to Alexandria, from Alexandria, where he found the roadstead empty, back to Sicily and then, when at last a ray of light came to him, back to Alexandria—he swept the central and eastern Mediterranean.

Unlike most admirals of his time, he freely discussed his plans with his captains. He had his reward in their devotion and perfect comprehension of what he wished them to do. At the same time he acquired an absolute confidence in the efficiency of his squadron, the magnificent force which had been formed by years of successful war and by the careful training of his predecessors. The captains were the band of brothers he himself had made them.

The great victory of Aug. 1, 1798 (*see* NILE, BATTLE OF THE), brought Nelson yet another wound. He was struck on the forehead by a shot and had for a time to go below. For this victory he was made a baron.

Blockade of Naples.—After providing for the blockade of what remained of the French in Alexandria, Nelson set sail for Naples and arrived there on Sept. 22. Pitt's second coalition against France was then on the point of completion, and Naples, naturally enough in view of the French behaviour on its borders, was preparing to side with Austria and Russia in the defense of monarchy; indeed Naples was already organizing an army, but no decision as to how the troops should be used had as yet been arrived at. Nelson immediately tried to enliven the proceedings and suggested what should have been a perfectly feasible plan, by which the Neapolitan army was to advance northward against the French front, while the fleet was to capture Leghorn, thus cutting the French communications.

Leghorn was duly taken, but the army showed little aptitude for fighting, soon becoming a disorderly rout, pursued by the French. This had the effect of rousing all the Jacobins in the country, which was soon in such an uproar that the royal family found it necessary to retreat to Palermo—an evacuation carried out by Nelson and his ships. From Palermo, Nelson kept up a double blockade—one squadron under Captain Ball was detached to Malta and another, under Captain Troubridge, was sent to the bay of Naples to operate against the Neapolitan Jacobins.

The king and queen, however, found this method of pressure

too slow, and determined to appeal to the conservative instincts of many of their subjects through the agency of an ecclesiastic, Fabrizio Cardinal Ruffo. Ruffo landed in Italy, and his appeal for an "Army of the Faith" was soon answered by thousands. While these events were taking place, a French fleet of 26 vessels, under Admiral Bruix, set out from Brest and was joined by 17 Spanish warships at Cartagena. Such a force constituted a threat to Nelson, who called up his ships from Malta and Naples and prepared for resistance. He managed, however—and this was important in view of Ruffo's successful beginning—to maintain the blockade of Naples by means of a squadron of small ships placed under Captain Foote.

The Franco-Spanish threat proved an idle one and the allied fleet soon retired, but, in the meanwhile, Ruffo was driving all before him and finally shut up the French in the castle of St. Elmo, in the city of Naples, and the native insurgents in the sea-washed castles of Uovo and Nuovo. From this commanding position he began to parley with the enemy, and the king, hearing of this, and nervous of what the cardinal might do—he had not been empowered to make terms of peace—asked Nelson to proceed to Naples and take matters into his own hands.

Ruffo's Treaty of Peace.—Nelson sailed for Naples, with Sir William and Lady Hamilton on board, on June 21, and arrived on the 24th to find the white flag flying from the castles and from his own flotilla. Supposing this to indicate an armistice, he at once made signal for the resumption of hostilities, only to be informed by Captain Foote that matters had gone further and that a treaty of peace had been signed by which the native insurgents were to be allowed to leave their strongholds with all the honours of war and were to be carried by ship to countries that would be willing to receive them.

In making such a treaty there can be no doubt that Ruffo had exceeded his instructions, though it is probable that he was actuated by motives of humanity, since his control over his bloodthirsty army was incomplete. Nelson refused to listen to Ruffo's arguments or to admit the validity of his undertakings. He agreed to let the armistice run its course, but let it be known that at the end of it he would expect unconditional surrender. This he received, and the rebels were placed in boats. One, Carraciolo, reached the hills, only to be caught at last and brought to Ruffo. He in his turn, because Carraciolo was a naval officer, handed him over to Nelson, who at once convened a court-martial of Neapolitan officers to try the rebel. The court sentenced Carraciolo to death by a majority vote, and this sentence was immediately carried out.

For refusing to carry into effect Ruffo's peace terms and for not interfering to delay the execution of Carraciolo, Nelson has been violently attacked. The whole matter is too involved to be fully discussed here; the conclusions which have been reached by scholars on either side have almost invariably reflected the political prejudice of the writers.

The whole question of Nelson's conduct at Naples is of course bound up with his friendship with Lady Hamilton. No one denies that it was then that Nelson's friendship for this woman ripened into the intimacy that was eventually to separate him from his wife. But that a private attachment seriously warped his judgment in public matters no one has yet shown, nor has anyone explained why it should.

Return to England.—These events were shortly followed by the reduction of the French and by the restoration of the Neapolitan royal family, while in the same month Nelson laid himself open to a sharp rebuke from the admiralty for disobeying the orders of Lord Keith, who had been appointed to succeed Lord St. Vincent in the Mediterranean command. Keith, puzzled as to the objective of a combined Franco-Spanish fleet, decided that Minorca was in danger and ordered Nelson to its defense. Nelson decided that it was not in danger and did not go. His judgment was correct, but his disobedience was inexcusable.

On Jan. 20, 1800, having in the meantime been created duke of Brontë by the king of Naples, Nelson joined Keith at Leghorn, and in February captured "Le Généreux," which had escaped him at the Nile. Shortly afterward he obtained leave to go home and, not being spared a battleship, he traveled overland with Sir William and Lady Hamilton, being fêted on the way. He landed in England in November of the same year.

Battle of Copenhagen.—Nelson's leave, which promoted the final separation between him and his wife, was short. He became vice-admiral on Jan. 1, 1801, and soon after was offered the post of second in command to Sir Hyde Parker in the fleet which was to break up the armed neutrality of the northern powers. It is difficult to see why such a brilliant man was subordinated to one of such ordinary gifts as Parker. Nelson, however, treated Parker with such tact that the admiral's reserve toward him disappeared. Indeed Nelson had his commander in chief to some extent under his thumb by the time they reached Copenhagen, and so was permitted to carry out his famous attack on the city and its defenses that resulted in the battle of Copenhagen (*q.v.*). This battle showed Nelson's ability to hit upon the weak point in a defensive scheme and is famous for his action in putting his telescope to his blind eye when, in the middle of the fight, his attention was directed to Parker's signal ordering his withdrawal. It was an order that could not be obeyed without losing all chance of decision.

In May, Parker was recalled and Nelson given the command, but the armed neutrality was dissolved and this left him little to do. His health, too, was bad and in June he went home, his services having been recognized by the bestowal of the title of viscount. In the months before the peace of Amiens he was in command of a flotilla of small ships that were to combat Napoleon's threat of invasion. More in the hope of satisfying public opinion than for any other reason, an attack was launched on Boulogne with the object of destroying the flat-bottomed boats stationed there. The port, however, was too strongly defended even for a Nelson.

During the short period of the peace of Amiens (1802–03), Nelson, in company with Sir William and Lady Hamilton, lived at the house and estate that he had purchased at Merton in Surrey. This, probably the happiest period of his life, was all too short. War reopened in May 1803, and Nelson was at once appointed to the Mediterranean command.

The Mediterranean Command, 1803.—Nelson arrived off Toulon in July 1803 and instituted a strict blockade of that port. The French under Latouche-Tréville continually tried to lure him into indecisive actions in which, by damaging some of his ships they might force him to withdraw, but Nelson consistently refused such offers and the French admiral, writing to Napoleon, stated that he had offered battle but the English had withdrawn. Nelson declared that if he captured Tréville he would make him eat the letter, but he never had the chance to fulfill his boast, even figuratively, for Tréville died and was succeeded by Villeneuve.

In the spring of 1805 the French eluded the blockade and made for the West Indies. This move was part of a large scheme directed toward the invasion of England. The series of naval movements arising from it are known as the Trafalgar campaign, and the whole matter is dealt with under NAPOLEONIC WARS. Nelson, after searching the Mediterranean, decided that Villeneuve had gone to the West Indies, and thither he followed him. On hearing of his enemy's arrival, Villeneuve returned precipitately to Europe, again pursued by Nelson, and got into El Ferrol and then into Cadíz where he was blockaded by Collingwood.

Nelson meanwhile had gone home on leave to enjoy the delights of Merton. His respite was brief. No sooner had the news reached England that the allied fleet was in Cadíz than, with the approval of Lady Hamilton, he offered his services, "to give M. Villeneuve a drubbing." They were immediately accepted, and he left Merton for the last time on Sept. 13, and on the 28th was off to Cadíz.

Trafalgar.—The victory of Trafalgar (*q.v.*) which followed on Oct. 21 set the seal on Nelson's fame. Tactically it was a masterpiece, and his famous signal "England expects that every man will do his duty," made as the fleet moved into battle, together with his death in the moment of victory, added, and still add, to its lustre.

The "Victory," after passing through the French line, was ex-

gaged with the "Bucentaure" and the "Redoubtable," and Nelson, as he walked up and down his quarterdeck with his flag captain, Thomas Hardy, was struck by a bullet from a sharpshooter firing from the top of the "Redoubtable." His spine was broken and he was carried below to the cockpit, suffering great pain. There, amid the din and racket of battle, he lingered for a few hours. To the last he retained his interest in the battle, and Hardy came to him from time to time to tell him of its progress. As his sight grew dimmer and he felt the end approaching he asked Hardy to kiss him. "Now I am satisfied," he said, "Thank God I have done my duty."

BY COURTESY OF THE VICTORY MUSEUM, PORTSMOUTH, PHOTO, BRITISH TRAVEL AND HOLIDAYS ASSOCIATION

THE "VICTORY," NELSON'S FLAGSHIP, MOORED AT PORTSMOUTH, ENG.

Nelson's body was taken home and buried in St. Paul's.

So died the most famous of English seamen. He was more than merely a tactically brilliant commander; he was a true leader of men—and men of all types, for the common seamen trusted and venerated him as much as did his officers. The seamen were, in their turn, trusted by him and were ever in his confidence. No officer under Nelson could ever complain that he went into action not knowing his commander's plans and intentions—and it is as much to this as to his tactical ability that his successes were due. It has been said that he was vain, liked flattery and was an egotist. In fact, he had faults common in genius.

See also references under "Nelson, Horatio Nelson" in the Index.

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(D. H.; O. M. W. W.)

NELSON, a municipal borough (1890) in the Nelson and Colne parliamentary division of Lancashire, Eng., 28 mi. N. of Manchester by road. Pop. (1961) 32,292. The area of Marsden was entirely agricultural until the 18th century when a small wool factory was established from which developed the present industrial town specializing in silk and cotton weaving. The coming of the railway caused the change of name from Marsden to Nelson (after the Lord Nelson inn) to avoid confusion with Marsden in Yorkshire.

NELSON, a town on the northern coast of the South Island, New Zealand. It is the administrative and commercial centre of the Nelson land district and Tasman Bay lowland. Pop. (1961) 23,971 (urban area 25,321). Its mild climate is the sunniest in New Zealand and it is the centre of an intensive fruit- and vegetable-growing area. Its industries reflect this, and are largely concerned with canning and preserving. Nelson is linked with Wellington, Christchurch and Westland by air services. The settlement was established by the New Zealand company in 1842.

Nelson Land District had a population of 74,281 at the 1961 census. Area 10,870 sq.mi. It occupies the northwest corner of the South Island west of the St. Arnaud and Spenser mountains as far south as Punakaiki and the upper Grey river. It is a rugged and empty portion of the country. Population is largely confined to: (1) the mild and sunny Tasman bay lowland where an intensive crop-growing economy (tobacco, hops, apples, soft fruit, tomatoes) is serviced by Nelson and Motueka (pop. 3,310); (2) the Buller, New Zealand's only bituminous coalfield (Granity, Stockton, Millerton and Denniston). Westport (pop. 5,464) is the chief town of this section. In the southeast corner of the district Nelson Lakes National park (214 sq.mi.) contains the beautiful lakes Rotoiti and Rotoroa, and rises to Mt. Franklyn (7,636 ft.). (K. B. C.)

NELSON RIVER, in Manitoba, Can., drains the waters of Lake Winnipeg and discharges into Hudson bay near Port Nelson, 400 mi. to the northeast, falling 713 ft. in the process. The catchment area of Lake Winnipeg extends from the Rocky mountains to Minnesota, so that the Nelson has a total drainage basin of 444,000 sq.mi. and includes the North and South Saskatchewan rivers, the Assiniboine and the Red River of the North. The total length of the Nelson from its source at the head of the Bow River in the Rockies is 1,600 mi. Its chief tributary is the Burntwood. The Nelson was discovered in 1612 by Sir Thomas Button and named for another member of the expedition. Norway House, at the source of the Nelson, is a Hudson's Bay company trading post and York Factory, near its mouth, operated as a trading post from 1682 to 1957. The Nelson is navigable for about 56 mi. from its mouth. Power development along the river is under the control of the Manitoba Hydro-Electric board. (An. Kr.)

NEMAN (Lithuanian Nemunas; German Memel; Polish Niemen), a river of the western U.S.S.R., is 582 mi. long and drains a basin of about 38,000 sq.mi. It rises 30 mi. S.W. of Minsk, on the southern flank of the Minsk upland (Minskaya Vozvyshennost) in the Belorussian Soviet Socialist Republic. Cutting through the Belorussian ridge (Belorusskaya Gryada) the Neman flows in a general westerly direction, across a broad basin, often extremely swampy. Near Grodno it swings northward into the Lithuanian S.S.R., cutting through another belt of terminal moraines. The valley there is much narrower and highly sinuous. Just above Kaunas the Neman turns west once more and, flowing across another broad, marshy basin, between Lithuania and Kaliningrad *oblast,* past Sovetsk (formerly Tilsit), it enters the Kurski gulf (Kurisches Haff) of the Baltic. Its main tributaries are the Viliya, on which Vilnius stands, the Shchara, Merkis and Nevezis. Navigation for small craft extends to Belitsa village, about 416 mi. upstream. Considerable quantities of timber are rafted along the river. The Oginski canal, built at the end of the 18th century, formerly linked the Neman, by way of the Shchara, to the Pripyat (Pripet) and Dnieper, but it is now completely disused. The Neman has an annual average discharge of 24,367 cu.ft. per second, with a marked spring maximum. The average period of freeze-up is from late November to mid-March. There is a hydroelectric plant near Kaunas. (R. A. F.)

NEMATODA, class or phylum name for the roundworms (*q.v.*), marine, freshwater and soil forms, many of which are parasites of plants and animals, including man.

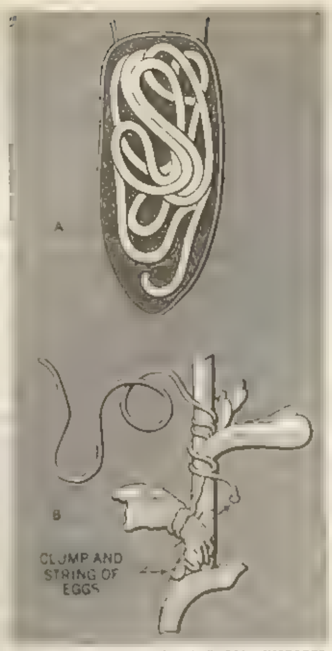
NEMATOMORPHA (Gordiacea), a class of elongate, threadlike, unsegmented worms belonging to the phylum Aschelminthes, which phylum includes also the roundworms (class Nematoda), rotifers (class Rotifera) and other mostly small to microscopic animals. Nematomorphs—called gordian worms, after their tendency to tangle together in loose writhing masses or knots, and horsehair worms, after the myth dating to the 14th century that these hairlike forms are transformed horsehairs—vary in length from a few inches to two or three feet, and in diameter from about $\frac{1}{100}$ inch to about $\frac{1}{16}$ inch. The free-living adults are often seen wriggling in quiet, shallow fresh waters throughout the world—ponds, streams, rain puddles and water troughs (occasionally in wet soil)—where they are indeed suggestive of horsehairs come to life. They vary in colour from buff or yellowish through shades of brown to black; the tip of the head end is almost always whitish bordered by a dark ring. The larvae are parasites of arthropods, chiefly insects.

The body wall consists of: (1) a stout cuticle, with an outer layer (smooth, or rough with minute nipples [areolas] sometimes bearing spines or bristles) and an inner layer of obliquely crossed fibres; (2) a single subcuticular layer of cells; and (3) a layer of longitudinal muscle fibres. Most of the space within the body wall is filled with soft, jellylike connective tissue (parenchyma) in which the internal organs are embedded. The alimentary canal is more or less degenerate in all horsehair worms; in most cases there is no mouth, so that active taking in of food at any time seems improbable. Instead, nutriment is absorbed through the skin and only when the immature nematomorph has become established in a host. What there is of an intestine opens along with the genital ducts into a common posterior chamber (cloaca). No circulatory or excretory organs are known. There is a single ventral

nerve cord, with anterior and posterior ganglia.

The sexes are separate, the males being usually smaller than the females and in some genera distinguishable by having a forked tail. The tail of the female is usually undivided, but in *Paragordius* it has three prongs. The gonads are paired in both sexes, and are continuous with their ducts.

Upon emergence from their insect hosts, usually in spring or early summer, they are sexually mature and copulation and egg-laying occur. In the pregnant female the ovaries give off thin-walled lateral pockets, which ultimately break down and discharge the ova into spaces in the parenchyma. The eggs, held together by a cementlike substance, are laid in strings or masses, usually on plants or stones under water. The first larval stage is a minute creature armed with spines and having a boring organ anteriorly, by means of which it enters the flesh of almost any aquatic animal; it must, however, find an appropriate host before it can fully develop. In species that attack insects such as grasshoppers, the second larval stage may apparently be reached without change of host. In others it may develop in a second host, usually a beetle, which preys upon the first. The second larval stage is elongate and wormlike, and develops directly into the adult form. Pigment is developed, and the larval cuticle shed, just before emergence from the host. This usually takes place on contact with water, the worm bursting its way out through a soft place in the host's body wall.



FROM "THE CAMBRIDGE NATURAL HISTORY"; REPRODUCED BY PERMISSION OF THE MACMILLAN CO.

HORSEHAIR WORMS (MAGNIFIED): (A) ABDOMEN OF A BEETLE WITH BACK COVERING REMOVED, SHOWING WORM WITHIN; (B) FEMALE DEPOSITING ITS EGGS ON A WATER PLANT

The Nematomorpha includes two orders, Gordioidea and Nectonematoidea. The main genera of the former are *Gordius*, *Paragordius*, *Chordodes*, *Parachordodes* and *Gordionus*. Nectonematoidea comprises only one genus *Nectonema*, a form provided with rows of bristles and inhabiting the open ocean (pelagic).

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(H. A. B.; X.)

NEMEA, BATTLE OF. This battle was fought in 394 B.C. in the valley of the Nemea river in the northern Argolid (near the modern town of Nemea) during the Corinthian War, which was waged against Sparta by a coalition of Thebes, Corinth, Athens and Argos, but instigated by Persia (*see* GREECE: *History: The City States, 404–354*). The coalition forces outnumbered those of the Spartans. As the lines advanced, the drift to the right characteristic of hoplite (*q.v.*) warfare occurred so that each right wing overlapped the opponents' left wing, the Spartans encircling the Athenians while their allies were overwhelmed by the Argives and Corinthians. The Spartans then wheeled round from attacking the Athenians and caught in succession the Argives, Corinthians and the Thebans in the flank as they returned from pursuing the Spartan allies.

Their opponents had heavier losses than the Spartans and the Spartan superiority in hoplite warfare displayed on this occasion broke the force of the coalition.

See Xenophon, *Hellenica*, iv, 2, 9–23.

NEMERTINA (NEMERTEA): *see* RIBBON WORM.

NEMESIANUS, MARCUS AURELIUS OLYMPIUS (fl. *c.* A.D. 280), Roman poet, born in Carthage, who wrote pastoral and didactic poetry. There survive four eclogues and an incomplete poem of 325 hexameters on hunting (*Cynegetica*). Two small fragments on bird catching (*De aucupio*) are generally attributed to him. The four eclogues were usually printed along with the seven eclogues of Calpurnius Siculus (*q.v.*); in 1854 M. Haupt established the difference of authorship and date. They are in the Vergilian tradition, influenced also by Calpurnius, purely imitative and of conventional form and imagery, and yet attractive because of their smooth diction and melodious movement. The *Cynegetica* gives instruction about dogs, horses and hunting equipment; it is a gracefully written piece in the literary genre of the *Georgics* and of the *Cynegetica* of Grattius.

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(R. D. Wa.)

NEMESIS, in classical mythology, the name of two divine conceptions. The first is a goddess, worshiped at Rhamnus in Attica, who is very similar to Artemis, of whom she may have been a local form; she may have had to do with fertility. In post-Homeric story she is pursued by Zeus, who, after they have both assumed various animal guises, turns himself into a swan and catches her in the form of a goose. Nemesis then lays an egg which, in many versions of the tale, is brought to Leda (*q.v.*), who hatches Helen from it. There seems also to have been a legend that at some battle, perhaps that of Marathon, Nemesis appeared in person to encourage her worshipers.

The second divine entity of this name is an abstraction—*i.e.*, indignant disapproval of wrongdoing, particularly the disapproval of the gods, with the consequent punishment of a sinful or over-prosperous man; and the eventual personification of that disapproval (first traceable in Hesiod). Pausanias mentions an old cult of "Nemesis" at Smyrna (mod. Izmir), but whether the object of this cult was Nemesis of Rhamnus or Nemesis the abstraction is not clear. That the abstraction was worshiped, at least in later times, is beyond doubt, however; her first altar was said to have been erected in Boeotia by Adrastus, leader of the Seven Against Thebes. In Rome especially her cult was very popular, particularly among soldiers, by whom she was worshiped as patroness of the drill ground (Nemesis *campestris*). In association with Fortune she seems also to have been adored as presiding over races. She had a cult association, the Nemesiaci. (H. J. R.; X.)

NEMESIUS (fl. *c.* A.D. 390), a Christian philosopher, author of a treatise "On Human Nature" (Eng. trans. by W. Telfer, 1955), was, according to the title of his book, bishop of Emesa (in Syria). His book is an attempt to compile a system of anthropology from a Christian standpoint, using as sources various Greek philosophers and men of science. His interest in medicine is marked, the information being in great part derived from Galen, whom, however, he corrects in some details. He first explains the unique position of man as a creature halfway up the scale of beings, who is endowed with a rational soul and shares the nature of the divine and of the perishable; next describes in detail the human frame, the powers of the soul and the emotions; and finally defends in Aristotelian fashion the belief in human responsibility in opposition to fatalism and astrology. (D. J. A.)

NEMI, LAKE, in the Alban hills about 22½ km. (14 mi.) S.E. of Rome, Italy, in the Lazio (Latium) region, is an extinct subsidiary crater in the outer ring of the ancient Alban crater, east of Lake Albano. It is about 3½ mi. in circumference and about 110 ft. deep; the precipitous slopes of its basin are over 300 ft. high and are mainly cultivated. In ancient times it was included in the territory of Aricia and was called Lacus Nemorensis and sometimes the "Mirror of Diana" from a temple and a grove (*nemus*) sacred to that goddess (*see* also DIANA). The worship of Diana there was originally celebrated with human sacrifices; even in imperial times the priest was a man of low condition, a gladiator or fugitive slave, who won his position by slaying his predecessor in fight, having first plucked a mistletoe bough from the sacred grove. The temple itself was one of the richest in Latium; Octavian borrowed money from it in 31 B.C. The remains of its precinct are situated a little above the level of the lake, on the northeast—a large platform, the back of which is

formed by a wall of concrete, with niches, resting against the cliffs. Excavations (now covered in again) led to the discovery of the temple itself, a comparatively small building, 98 by 52 ft., containing objects, none earlier than the 4th century B.C. A road descended to it from the Via Appia from the southwest. The lake is drained by a tunnel about 2 mi. long.

It had long been known that on the west side of Lake Nemi two Roman galleys rested on the lake bottom but attempts to raise them were unsuccessful; they were raided by divers in 1895 and some of the most valuable objects were removed. Finally, in the late 1920s, the water level was lowered and the ships appeared. They were pleasure ships, of the period of the empire, one measuring 210 by 66 ft., the other 233 by 80 ft. Many of the objects found on the ships are in the museums in Rome. The ships themselves were burned by the German army on May 31, 1944.

(G. KH.)

NEMIROVICH-DANCHENKO, VLADIMIR IVANOVICH (1858–1943), Russian novelist, playwright and producer, and a founder of the Moscow Art theatre, was born at Ozurgety, Georgia, on Dec. 23, 1858. In 1890 he took over the drama classes of the Moscow Philharmonic society, and by the end of the 1890s he was already the author of a number of best-selling novels and successful plays. As a writer of the "psychological" school, he laid particular stress on bringing out the psychological undertones in the acting of his pupils, and his first great success in this line was the production at his school of Ibsen's *A Doll's House* in 1896. A year later he had an 18-hour meeting with Konstantin Stanislavski (*q.v.*), at which they laid the foundations of the Moscow Art theatre. It was Nemirovich-Danchenko, too, who was chiefly responsible for introducing Chekhov's plays into the theatre's repertory. In the 1920s he organized the Moscow Art Theatre Musical studio, and he toured the United States in 1925. His work as producer is chiefly remarkable for the adaptation of *The Brothers Karamazov* and *War and Peace* in 1910, and for an operatic version of M. A. Sholokhov's *And Quiet Flows the Don* during the last years of his life. He died in Moscow on April 25, 1943. His autobiography has been translated as *My Life in the Russian Theatre* (1936). (D. MK.)

NEMOPHILA, a genus of North American herbs of the waterleaf family (Hydrophyllaceae), comprising over 15 species found chiefly in the Pacific coast region. They are more or less delicate annuals, with parted, divided or lobed leaves, and small bluish or white flowers, usually blossoming continuously and profusely from early spring to late summer. Several are grown as border plants, especially the baby blue-eyes (*N. menziesi*) and the five-spot (*N. maculata*), which do well in partly shady locations.

Other interesting species are the climbing or purple nemophila or fiesta flower (*N. aurita*), the small white nemophila (*N. heterophylla*) and the small flowered nemophila (*N. parviflora*), the last named ranging from California to Washington.

NEMOURS, DUCS DE. The lordship of Nemours, in Gâtinais (in the modern *département* of Seine-et-Marne), was acquired by the French crown in the 1270s. In 1404 it was granted as a peerage-duchy to Charles III (*q.v.*) of Navarre. After his death in 1425, succession to the duchy was intermittently contested between his daughters' consorts and their heirs till 1462. In that year Louis XI of France confirmed it to JACQUES D'ARMAGNAC, whose father, Bernard, comte de Pardiac (a younger son of the great Bernard VII; *see* ARMAGNAC), had in 1429 married Éléonore de Bourbon-La Marche, daughter of Charles III's daughter Béatrix. The new duc de Nemours subdued Roussillon for France in 1463 but joined the Ligue du Bien Public against Louis XI in 1465. Detached from this by the grant of the governorship of the Île-de-France, he was pardoned for further treason in 1470, but began conspiring again and was taken prisoner at Carlat in 1476. Brought to Paris, he was beheaded on Aug. 4, 1477. The forfeited peerage was restored by acts of 1484 and 1492 to his son JEAN D'ARMAGNAC (d. *c.* 1500), whose brother and successor, LOUIS (d. 1503), viceroy of Naples, was killed in the battle of Cerignola. Their sisters, married into the house of Rohan-Gié, failed to secure the succession.

The title was granted as a peerage-duchy in 1507 to GASTON DE FOIX (1489–1512), who lost his life in his great victory at Ravenna; and as a simple duchy in 1515 to GIULIANO DE' MEDICI (d. 1516; *see* MEDICI). On the death of Giuliano's widow, Philiberta of Savoy (1524), it was assigned to Louise of Savoy, mother of Francis I of France; but in 1528 it was transferred to her half brother PHILIPPE DE SAVOIE, comte de Genevois (1490–1533).

JACQUES DE SAVOIE (1531–1585), Philippe's son by Charlotte d'Orléans-Longueville, became duc de Nemours in 1533. He won a military reputation in the French royal service on the eastern frontier and in Piedmont in the 1550s and against the Huguenots and their German allies in the 1560s. His amorous exploits at the Valois court were also admired: Brantôme characteristically calls him "the paragon of chivalry." After being considered for marriage to Elizabeth I of England in 1559–60, Nemours became interested in Anne d'Este, wife of François de Lorraine, 2nd duc de Guise; and after Guise's death (1563) he repudiated a solemn promise of marriage to Mlle de La Garnache (Françoise de Rohan, who had borne him a son and whose cause was taken up by her Albret and Bourbon relatives) in order to marry Anne in 1566. He later retired to his Savoyard appanage of Genevois and died at Annecy on June 15, 1585.

CHARLES EMMANUEL DE SAVOIE (1567–1595) succeeded his father as duc de Nemours. A supporter of the Holy League, he was appointed governor of Lyonnais just before he was arrested at Blois in King Henry III's coup against the Guises (1588). Escaping to Paris, he quarreled with the duc de Mayenne, withdrew to Lyonnais, took Vienne for the League but was taken prisoner (1593) by the archbishop of Lyon, Pierre d'Épinac. Escaping in 1594, he died in July 1595. His brother and successor, HENRY I DE SAVOIE (1572–1632), who as marquis de Saint-Sorlin had helped the Savoyards to capture Saluzzo (1588) and had fought for the League in Dauphiné, reconciled himself with Henry IV of France in 1596. When the Spaniards went to war against Savoy in 1615, Nemours raised an army to co-operate with them but had to make peace in 1616. Married in 1618 to Anne de Lorraine-Aumale, he died in Paris on July 10, 1632.

Henry's eldest son, LOUIS DE SAVOIE (d. 1641), generally used the title of duc d'Aumale by right of his mother, but was confirmed as duc de Nemours in 1639. His brother and successor, CHARLES AMÉDÉE DE SAVOIE (1624–1652), was married to Élisabeth de Vendôme in 1643 and fought against the Spaniards in Flanders in 1645–46. During the third war of the Fronde (*q.v.*) he took the side of the rebels but caused dissension among them by flirting with the duchesse de Longueville (*q.v.*) and with Mme de Châtillon (Isabelle Angélique de Montmorency) and by quarreling with his brother-in-law, François, duc de Beaufort, who shot him in a duel in Paris on July 30, 1652. He left two daughters: Marie Jeanne Baptiste (1644–1724), married in 1665 to Charles Emmanuel II of Savoy and regent for her son Victor Amadeus II (*q.v.*) from 1675 to 1684; and Marie Françoise Élisabeth (1646–83), whose marriage of 1666 to Afonso VI of Portugal was annulled so that she could marry his brother and supplanter, Pedro II, in 1668.

HENRY II DE SAVOIE (1625–1659), the chess player who had been nominated archbishop of Reims in 1651, succeeded his brother as duc de Nemours in 1652, took a wife in 1657 and died in Paris on Jan. 1, 1659. His widow, Marie d'Orléans-Longueville (1625–1707), was the daughter of Henry, duc de Longueville, by his first wife, Marie de Bourbon-Soissons. This duchesse de Nemours is renowned for her obstinacy in litigation over the Longueville inheritance. Though she finally lost her case as far as the French property was concerned (1698), she established her right to the sovereign principality of Neuchâtel (1699). She died in Paris on June 16, 1707. In her *Mémoires* (first published 1709), which deal with the Fronde, she writes with sympathy toward her father and with particular hatred for her stepmother and other Condés.

Louis XIV in 1672 gave the duchy to his brother Philippe, duc d'Orléans, with whose descendants it remained (*see* BOURBON: Tables III and IV). King Louis Philippe's son Louis Charles Philippe Raphaël d'Orléans, duc de Nemours, is the subject of a separate article.

NEMOURS, LOUIS CHARLES PHILIPPE RAPHAËL D'ORLEANS, Duc de (1814–1896), French prince who after the fall of the July monarchy tried to unite the exiled royalists. He was born in Paris on Oct. 25, 1814, the second son of Louis Philippe (*q.v.*), duc d'Orléans, who became king of the French in 1830. He was made a colonel of cavalry in 1826. In 1831 he was elected king of the Belgians, but Louis Philippe refused that crown in his son's name; even so, Nemours was present at the siege of Antwerp (1832). Later he accompanied three expeditions to Algeria (1836, 1837 and 1841). His conservatism antagonized the liberal opposition in France, and in 1840 the chamber of deputies refused to grant the dowry proposed for his marriage to Princess Victoria of Saxe-Coburg-Gotha. In 1842, however, the death of his eldest brother, Ferdinand, duc d'Orléans, made Nemours the prospective regent of France in the event of Louis Philippe's dying before Ferdinand's son Louis Philippe Albert, comte de Paris, should have come of age. On the outbreak of revolution in 1848 Nemours organized the defense of the Tuileries to cover the king's escape and then tried to accompany the duchesse d'Orléans (Helena of Mecklenburg-Schwerin) to the chamber of deputies to press her son's claims. In exile in England, he sought to effect a reconciliation between the house of Orléans and the comte de Chambord (*q.v.*), as the indispensable preliminary to a restoration of the Bourbon monarchy in France; and he also, in a letter of 1857, urged the comte de Chambord to undertake to maintain the Tricolour flag and the principles of constitutional government. After the Franco-German War and the removal of the legal disabilities of the French princes (1871), Nemours returned to France and was restored to his army rank of divisional general, but the comte de Chambord's insistence on the white Bourbon standard ruined royalist hopes of a restoration. Nemours died at Versailles on June 26, 1896. For his descendants *see* Bourbon: Table IV.

See R. Bazin, *Le Duc de Nemours* (1906). (Je. V.)

NEMOURS, a town of north central France, *département* of Seine-et-Marne, stands on the Loing 15 km. (9 mi.) S. of Fontainebleau and 75 km. (47 mi.) S.E. of Paris by road. Pop. (1962) 6,313. Historic buildings include the Catholic church of St. Jean-Baptiste (13th-16th century), a Protestant meetinghouse and a 12th-century castle housing a museum. The Parc Gréan contains some picturesque rocks. Nemours is on the railway from Paris to Clermont-Ferrand, and on the national route from Paris to Antibes and Italy. The most thriving industry is sand quarrying, a white sand being produced that is 99.92% pure quartz. Nemours is held to derive its name from the fountains dedicated to the Celtic god of springs, Nemausus, and discoveries of Gallo-Roman remains indicate its early origin. The duchy of Nemours was important in the middle ages. The town is the ancestral home of the du Pont family of Delaware, U.S., world-known chemical manufacturers. (L. É. Pe.)

NENAGH (Aonach Urmhumhan), the chief town of northern Tipperary, Republic of Ireland, lies near the river Nenagh, 98 mi. S.W. of Dublin by road. Pop. (1961) 4,317. It is an agricultural centre with some industry, *e.g.*, aluminum ware and chemical products. Of the old castle, Nenagh Round, dating from King John, there exists the circular donjon or keep. There are no remains of the hospital founded in 1200 for Austin canons, and only slight remains of the Franciscan friary, founded in the reign of Henry III. Nenagh was one of the ancient manors of the Butlers, who received for it the grant of a fair from Henry VIII.

NENE (Nen), a river of the east Midlands, Eng., which, from its source on the Jurassic uplands 15 mi. W. of Northampton to its mouth on the southern coast of the Wash, 10 mi. N. of Wisbech, is 90 mi. long. Its upper parts consist of a fan of tributaries draining a broad shallow basin 15 mi. in diameter focusing on Northampton. From there it runs in a broad valley across Jurassic rocks generally northeastward past Wellingborough, Irthlingborough, Thrapston and Oundle to Peterborough, receiving a number of left-bank tributaries, principally the Ise, Harper's brook and Willow brook, and with a gradient gradually decreasing from 20 ft. per mile above Northampton to 3 ft. per mile. At Orton near Peterborough its average discharge is 290 cu.ft. per second, with extremes of 13,500 and 3 cu.ft per second. The last 30 mi. from Peterborough to the Wash via Wisbech is an artificially embanked course across the Fens with a gradient hardly exceeding 8 in. per mile. This is 17 mi. shorter than the old natural course through March. The river has locks as far up as Northampton, which is also reached from the southwest by a branch of the Grand Union canal. Several of its upper tributaries are dammed to form small reservoirs supplying such places as Northampton, Kettering, Higham Ferrers and Rushden. (B. W. S.)

NENETS NATIONAL OKRUG, established in 1929, forms the northern part of Archangel *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., extending as a strip about 150 mi. wide along the northern coast of European Russia, from Mezenskaya Guba (gulf) of the White sea to Baidaratskaya Guba of the Kara sea, together with Kolguyev and Vaigach Islands. Area 64,749 sq.mi.; pop. (1965 est.) 38,000. The surface for the most part is a level marine plain, broken by the northern ends of the Timan hills (Timanski Kryazh) and the Urals (the latter known as Khrebet Pai-Khoi). The whole *okrug* lies within the tundra, with a scanty vegetation of mosses, lichens and dwarf shrubs on poor, waterlogged soil, underlaid by permafrost. In the south are sparse and stunted trees.

The Nenets people, a Finno-Ugrian group formerly known as the Samoyed (*q.v.*), make their living chiefly by reindeer herding, supplemented by a little fur hunting. The formerly nomadic tribes now are settled in permanent villages and only herders move with the animals. Fishing, especially for salmon, is important. The Russian population is concentrated mainly in the one town of Naryan-Mar, on the Pechora river, and the urban district of Amderma. Naryan-Mar, the administrative centre (pop. [1959] 13,200), is an important sawmilling town and processes fish and hides. There are no all-weather land communications within the *okrug*. (R. A. F.)

NENNIUS (fl. *c.* 800), Welsh antiquary who between the years 796 and *c.* 830 compiled or revised the *Historia Britonum*, a miscellaneous collection of historical and topographical information, containing the earliest known reference to Arthur (*q.v.*). He was probably the Nemnius or Nemnivus referred to in an early 8th-century manuscript as the inventor of a Welsh alphabet. In the preface to the *Historia* he describes himself as a disciple of Elvodugus (d. 809), chief bishop in Gwynedd.

The *Historia Britonum* has survived in about 35 manuscripts dating from the early 10th to the 13th centuries. Besides the preface, it contains an account of the six ages of the world, a description of the inhabitants and invaders of Britain, a section on St. Patrick, a list of 12 victories ascribed to Arthur, some Anglian genealogies and accounts of 28 cities and of various "marvels" in Britain. The fullest manuscript (British Museum Manuscript Harleian 3859) also contains two later interpolations, the British annals now known as *Annales Cambriae* and some Welsh genealogies.

The controversy as to whether Nennius himself composed the *Historia* or merely adapted and edited an earlier version is still unresolved. Until Heinrich Zimmer published his *Nennius Vindicatus* (1893), the latter view was universally held, and it remained that of Theodor Mommsen. A. W. Wade-Evans, who ascribed the whole compilation to Nennius, suggested that he attempted to correlate the evidence of his other sources with that of the *De excidio et conquestu Britanniae* of Gildas (*q.v.*). It is Nennius who gives the name Vortigern to Gildas' "proud tyrant" and he is the sole authority for the story of Vortigern's marriage with the daughter of Hengist.

Bibliography.—The *Historia* was ed. by T. Mommsen in *Monumenta Germaniae historica, auctores antiquissimi*, vol. iii (1898), and by F. Lot, *Nennius et l'historia Brittonum* (1934); for Eng. trans. *see* A. W. Wade-Evans, *Nennius's History of the Britons* (1938). *See also* F. Liebermann, "Nennius the Author of the Historia Brittonum," in *Essays in Mediaeval History Presented to T. F. Tout* (1925); Ifor Williams, "Notes on Nennius," *Bulletin of the Board of Celtic Studies*, vol. vii, part 4 (1935); *English Historical Documents*, vol. i, ed. by D. Whitelock (1955).

NEOCLASSICAL ARCHITECTURE: *see* Baroque and Post-Baroque Architecture.

NEOCLASSICAL ART refers to the dominant style of the late 18th and early 19th centuries. Various phases of its course can be distinguished. In France, there are the rococo neoclassicism of the reigns of Louis XV and XVI, the developments of the revolutionary transition including the Directory, consulate and first empire and that of the Bourbon restoration until the July Revolution of 1830. In England, the style is found in the late Georgian phase of the Adam school beginning in the 1760s, in the United States, in the federal style (about 1785–1820), and internationally, in the romantic neoclassicism of the Roman and Greek revivals. Thereafter its waning influence is felt throughout the 19th century in the academic neoclassicism in painting and sculpture, and as a component of the eclectic style in architecture.

The beginnings of neoclassicism are found in the decline of the rococo in France and the Georgian style in England. J. G. Soufflot's Panthéon (1754–1790) in Paris, with its chaste Corinthian portico and Roman detail, reflects the shift in taste, as does Jacques Ange Gabriel's design for the Petit Trianon (1762–66) at Versailles, with its neat geometrical balance of horizontal lines and vertical pilasters surmounted by a classical entablature. Under Louis XVI the Pompeiian influence further curbed rococo decorative extravagances and purified the sense of design. In the work of Robert Adam, who returned to England in 1760 after studying the excavations of Diocletian's palace at Spalato, the Palladian influence gave way to a more authentic neoclassicism. His interiors for private houses show his enthusiasm for the discoveries about Roman domestic architecture at Pompeii. His preferences ran to Roman stucco decoration with such classical motives as scrolls, vases, festoons and candelabra.

In the pictorial arts the reaction to the rococo was evidenced by the unparalleled popularity of Piranesi' prints of ancient Roman ruins and in the paintings of J. M. Vien in France, A. R. Mengs in Germany, and B. West in England. With the great success of J. L. David's "Oath of the Horatii" (1785) neoclassicism was in full swing. David's archaeological enthusiasm led him to model the faces and figures in his pictures after antique busts; and his announced intention was to make the backgrounds and details of his pictures so faithful to the ancient world that if an old Roman should suddenly come to life, he would find himself completely at home.

Neoclassical art reflected an important aspect of the life and thought of the pre- and post-revolutionary generation, especially in France and British-colonial America; and the brave new revolutionary world figuratively dressed itself in the ancient toga.

At this time of swift and violent social and political change, the rising middle class began to assume a more active leadership in public and private affairs, and the straightforward simplicity and uncomplicated forms of neoclassicism made a strong appeal to the stoic and austere taste of the revolutionists. After the chaos and confusion of these years, American and French citizens felt the need for the disciplined orderliness, economy of means and logical predictability inherent in neoclassical forms. As monarchical rule was overthrown in the United States and France, the citizenry discovered an emotional identification with the forms and images of the ancient republics. To them Greece and Rome were not dead civilizations, but the living birthplaces of freedom and democracy. Their affinity with the ancient world not only gave them a sense of heroism and glory, but it also furnished convenient precedents for the new governments in America and France, and to a certain extent the British constitutional monarchy. The ancient Athenian commonwealth and Roman republic became the symbols of liberty and the new order. The senior legislative houses in the United States, France and later in the Latin American republics, were named senates after the old Roman prototype.

George Washington was acclaimed as the father of his country, in emulation of the ancient Roman honorific *pater patriae*. The new U.S. capital was destined to be built on classical, rather than baroque, colonial or Georgian, models; and the new legislature was to be housed on Capitol hill, a site named after one of the seven hills of Rome.

This was a generation that built new government buildings, municipal offices, public libraries, art museums, national repertory theatres, concert halls, hospitals, hotels, banks and railroad stations. The Roman revival was perhaps strongest in Paris, which Napoleon envisaged as a new Rome replete with temples of glory, triumphal arches, and monumental commemorative columns. In the United States the federal style also followed Roman models; Thomas Jefferson designed the Virginia state capitol after the Maison Carrée at Nîmes, and his residence at Monticello and the Rotunda of the University of Virginia after the Roman Pantheon. The Greek revival generally found a foothold in the countries least sympathetic to Napoleon's new Roman empire. More chaste and correct than its Roman counterpart, the style is seen in the following: the Brandenburg gate at Berlin (1788–91), modeled after an archaeological reconstruction of the Athenian Propylaea; the semicircular Corinthian colonnade of the Hall of Representatives (1803–17) at Washington, D.C., inspired by the Monument of Lysicrates in Athens; St. Pancras' church (1818–22) and the Ionic façade of the British museum (1823–47) in London, after the Erechtheum; and the Valhalla (1830–42) at Regensburg, Bavaria, after the Parthenon.

In spite of their deeper penetration into the classical spirit, the neoclassicists still suffered from a lack of detailed knowledge about antiquity. Winckelmann's ideal statues were the Apollo Belvedere and the Laocoön, both late Hellenistic examples rather than those of the earlier and superior Hellenic style. Sculptors left the irises and pupils of eyes uncarved because they did not know that the ancients painted in such details. A. Canova and B. Thorvaldsen both turned the human body into the cold marble of antique statuary instead of molding marble into a semblance of living flesh, as the great Greek sculptors had done. Josiah Wedgwood imitated the Greek vases of the fifth century B.C., which he mistakenly took to be Etruscan.

After David and his successor J. A. D. Ingres, French neoclassical painting degenerated into the sterile academicism of the later 19th century as exemplified by Thomas Couture's once-popular "Romans of the Decadence" (1847), Adolphe Bouguereau's "Birth of Venus," and the stereotyped pictures of Puvis de Chavannes, Alexandre Cabanel and Marcus Collin. Neoclassical architecture nevertheless continued in various modified forms until it was supplanted by the new materials, building methods and aesthetic viewpoints of the machine age.

The popularity of neoclassicism can be traced to several sources. A series of publications stimulated a shift in taste toward a new and more authentic interpretation of antiquity. Among the early histories was Montesquieu's *Considerations on the Causes of the Greatness of the Romans and of their Decadence* (1734), an important precursor of Gibbon's monumental *Decline and Fall of the Roman Empire* (1776–1788), which reached a wide public and focused attention on ancient Rome. Winckelmann's *Thoughts on the Imitation of Greek Works in Painting and Sculpture* (1755) and his epoch-making *History of Ancient Art* (1764) made a clear distinction between Roman and Greek styles and brought forth cogent arguments to prove that Greek art was superior to Roman. Besides being the founder of modern systematic classical archaeology and the one who divided Greek art into logical periods, Winckelmann formulated the neoclassical aesthetic with its professed ideals of pure beauty, noble simplicity, and quiet grandeur. Winckelmann's ideas and conclusions were further expanded and applied to drama and the other arts by G. E. Lessing in his brilliant critical study, *Laocoön*.

Some important archaeological discoveries were made. After the discovery of Herculaneum in 1719 and Pompeii in 1748, the subsequent excavations attracted wide attention. Other expeditions followed; R. Wood published his findings about the Roman ruins at Palmyra and Baalbek (1737–57), and in 1769 his *Essay on the Original Genius and Writings of Homer, with a Comparative View of the Ancient and Present State of the Troade*. J. Stuart and N. Revett visited Athens and published their drawings and comments on the acropolis buildings in *Antiquities of Athens Measured and Delineated* (1762). The London Society of Dilletanti continued their archaeological work and later expeditions were published in *Ionian Antiquities* (1769) and *Unedited Antiquities of Attica* (1817).

C. L. Clérisseau in turn brought out his study of the Roman remains at Nîmes, and thereafter the archaeological work gained momentum with such major events as Lord Elgin's shipment of the Parthenon sculptures to London, H. Schliemann's excavation of Troy and Mycenae in the 1870's, and the discovery of the Mausoleum at Halicarnassus and the great Altar of Zeus at Pergamum (Bergama). All these books were concerned not only with the existing ruins but also with restorations of the ancient structures based on detailed measurements and as much knowledge as they could muster. Thereafter throughout the 19th century, all the scattered information and isolated discoveries were collated by scholars, documented and made available.

The romantic movement became increasingly popular. The idealization of the Greco-Roman world was as much a form of romantic escapism as that of the middle ages. The noble Greek and virtuous Roman embodied the romantic longing for a past golden age quite as much as the image of the pious medieval knight in armour. Later, when the romantic spirit became identified with the various struggles for national independence, the cause of Greek liberation from the tyranny of the "terrible Turks" symbolized the struggle of classical ideals against the ugliness of the contemporary world.

The emotional espousal of Greek independence that was prevalent all over Europe and the U.S. was actively expressed in letters and the arts. Both classical countries—Greece and Italy—were under the yoke of foreign tyrants, and intellectuals and poets passionately championed their cause. Byron's *Isles of Greece*, Shelley's *Hellas* and *Prometheus Unbound*, Friedrich Hölderlin's *Hyperion*, Victor Hugo's *Les Orientales*, and Vittorio Alfieri's tragedies, all upheld these liberation movements. Beethoven's ballets, *Ruins of Athens* and *Prometheus*, and Delacroix' painting, *Massacre at Chios* were based on incidents describing the oppression of the Greek people. Finally the whole movement was dramatized by Byron's quixotic death in one of the Greek skirmishes against the Turks.

Education, based on the study of classical languages and literatures, spread to an ever-widening circle. From the Renaissance through the 19th century, education was constantly closing the gulf between scholars and the public as a vast new reading public was brought into being. The heart of education was the study of the classics, which were considered indispensable for a gentleman. So also was the grand tour to Italy to view the ruins of antiquity. A classical orientation in the arts followed quite naturally, and a common set of symbols drawn from ancient literature, mythology and art brought about an intellectual unity that transcended the barriers of language, creeds and national frontiers and brought all the nations of western civilization together in the last completely international style—neoclassicism.

See also references under "Neoclassical Art" in the Index.

See Fiske Kimball, "Romantic Classicism," *Gazette des Beaux-Arts*, xxiv:313 (1944); Louis Hautecouer, *L'art Classique* (1957).

(Wm. F.)

NEODYMIUM, the second most abundant element of the rare-earth group, is a silver-white metal. The symbol for neodymium is Nd, the atomic number is 60 and the atomic weight is 144.24. It is slowly oxidized by air, burns easily to give the sesquioxide (Nd_2O_3) and reacts gradually with cold water, or rapidly with hot water, to liberate hydrogen. The metal is used in the electronics industry, in the manufacture of steel and as a component of a number of alloys, among them the misch metal (*see* Cerium) used for lighter flints. Its compounds are used in the ceramics industry for glazes and to colour glass. The crude oxide is employed for counteracting the colour of iron in glass and the more pure compound is used in the production of the only known glass that is bright purple in colour. A mixture of neodymium and praseodymium absorbs light in the region of the harmful sodium D lines and therefore is used in the glass of welders' and glass blowers' goggles. The oxide and chloride are effective catalysts in certain organic reactions.

Neodymium was discovered by C. A. von Welsbach in 1885 when he separated salts of didymium, a metal he thought was a simple element, into two chemically distinct fractions, neodymium (*neo*, "new") and praseodymium. Neodymium occurs along with other rare earths in many minerals but is produced commercially almost exclusively from monazite; it is also found in the products of atomic fission. The naturally occurring element consists of isotopes with mass numbers 142, 143, 144, 145, 146, 148 and a long-lived radioactive isotope, 150.

Until World War II the element was separated by fractional crystallization procedures; however, an ion-exchange technique is now used for commercial production. The metal is prepared by electrolysis of the fused halides or by thermoreduction of its salts by alkali or alkaline earth metals. The melting point of the metal is 1,024° C.; its density is 7.004 g. per cubic centimetre for the hexagonal close-packed structure; other forms are known to exist.

Neodymium behaves as a typical rare earth and forms a series of blue-coloured salts in which it is trivalent. The ionic radius is 0.995 Å. The reddish-violet solutions have a series of sharp absorption lines in the visible and ultraviolet region of the spectrum that may be used for quantitative analysis. Because of unpaired electrons, the trivalent neodymium ion is paramagnetic. The thermal neutron absorption cross section is 52 barns. *See* Rare Earths. (Ld. B. A.)

NEOGRAMMARIAN is the name of a school of linguistics flourishing in, and spreading from Germany (*Junggrammatiker*) after 1875. The founders and leaders, August Leskien, Hermann Osthoff, Karl Brugmann and Berthold Delbrück, had numerous disciples in all countries. They proposed that the living languages (as opposed to the dead languages, *i.e.*, those not spoken any longer by native speakers) should be given stronger emphasis than hitherto accorded them by philologists, and that greater attention should be paid to the psychological forces in language. And they stated that every historic sound change occurs according to rules, so-called sound laws, which "suffer no exceptions." This means that every occurrence of the phoneme /x/, at a certain moment in the history of a language, under certain phonetic conditions, is represented by the phoneme /y/ in a later stage and that every apparent deviation from this law is to be explained, not as fortuitous "exception," but as a consequence of some overriding interference. Viewed thus, the often voiced objection against the "exceptionlessness" of the sound laws appears groundless. One of the chief causes cited by Neogrammarians as capable of neutralizing a sound law is analogy, which they considered a psychological force causing speakers to adhere to patterns, especially paradigmatic, whereby the expected regular development seems canceled. For example, Latin *amo* "I love" regularly becomes French *(j')aime;* but although the infinitive *amare,* with the stress not on the first but the second *a,* should regularly give *amer*, the word is in fact *aimer*, with the *ai-* extended by analogy to all forms of this verb regardless of the place of the stress. Apart from analogy, the programmatic statement concerning the importance of psychology scarcely bears fruit in neogrammarian practice. Also the theoretically required emphasis on living languages has little practical consequence in the Neogrammarian works (except insofar as some were also dialectologists): they deal mainly, and masterfully, with dead languages and the reconstruction of unattested proto-languages.

Despite often bitter attacks on neogrammarian theory (justifiably addressed to some incomprehending malpractitioners), all historical linguists implicitly accept and operate with the principle of regular change.

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NEO-HEGELIANISM, a term applied, generally by unsympathetic critics, to the doctrines of the idealist school of philosophers which was prominent in Great Britain and in the United States between 1870 and 1920; its use is sometimes extended to cover other philosophies of the period which were Hegelian in inspiration, for instance those of Benedetto Croce and of Giovanni Gentile (*qq.v.*). Neo-Hegelianism in Great Britain developed originally as a natural sequel to the semipopular work of S. T. Coleridge and Thomas Carlyle. Its exponents sought to give

philosophical expression to a widely felt antipathy to the prevailing materialism and utilitarianism and turned to the writings of the German school as containing penetrating, if oracular, statements of an alternative view.

The ideas of Kant, Fichte, Schelling and Hegel were at first all used for this purpose, but closer knowledge led to a more reserved attitude to Kant and to an increasing tendency to look to Hegel for the elements of a really sound philosophy. There was, however, always a certain reluctance among the best-known members of the school to let themselves be described as "Hegelians": T. H. Green and F. H. Bradley both issued disclaimers on this point and both in fact were influenced by British ways of thinking which they shared with the opponents whom they criticized. It remains true, nevertheless, that the outlook of each was determined by Hegel more than by any other writer and that their work can be regarded as an attempt to tackle the philosophical problems of their time from a standpoint which was broadly Hegelian.

What Green described as "the vital truth which Hegel had to teach" was put by him in 1880 in the following terms: "That there is one spiritual self-conscious being, of which all that is real is the activity or expression; that we are related to this spiritual being, not merely as parts of the world which is its expression, but as partakers in some inchoate measure of the self-consciousness through which it at once constitutes and distinguishes itself from the world; that this participation is the source of morality and religion" (reprinted in *Works*, vol. iii, p. 146 [1888]). These words might well be taken as expressing Green's own personal philosophical creed and as indicating the central tenets of the Neo-Hegelian school as a whole. The Neo-Hegelians were opposed to materialism and to naturalism in metaphysics; to analyses of consciousness in terms of sensation and of the association of ideas in theory of knowledge; to psychologism (*q.v.*) and to formalism in logic; and to the "greatest happiness" principle as well as to the doctrine of duty for duty's sake in ethics. In politics they dissociated themselves from the prevailing individualism and tended to look on the state as a living community rather than a mutual benefit society. Their attitude to religion was ambiguous, for though they were in general sympathetic to religious claims, they made no secret of the fact that they could not accept them at their face value. Much of the popular attraction of their philosophy, indeed, sprang from its seeming to provide a rational alternative to the religious beliefs which, with the spread of scientific knowledge and the shock of Darwin, men found it increasingly difficult to hold; and one reason for its decline may have been that, as religious difficulties ceased to be a central preoccupation, less need was felt of such a substitute for religion as this philosophy offered.

The earliest representative of this way of thinking in Great Britain was J. F. Ferrier (1808–64), a professor at St. Andrews, who was, however, influenced as much by George Berkeley as by German writers. Ferrier's *Institutes of Metaphysics* appeared in 1854, but it was not until somewhat later that the ideas it expressed gained general currency. The creation of an idealist "school" was due to two men in particular: T. H. Green (1836–82), who taught at Oxford from 1860 onward, and Edward Caird (1835–1908), professor of moral philosophy in Glasgow from 1866 to 1893. Green was notable for his moral earnestness, personal integrity and intense interest in contemporary life, Caird for the breadth and thoroughness of his scholarship; and both were highly effective teachers. Neither had the philosophical insight and originality of their younger contemporary, F. H. Bradley (1846–1924), in whose works Neo-Hegelianism reached its intellectual high-water mark. The skeptical cast of Bradley's mind was, however, uncongenial to many who shared his general outlook; much misgiving was caused by the ruthless dialectic and apparently negative conclusion (which Caird described as "a manifest self-contradiction") of his *Appearance and Reality* (1893).

The fierce logical criticism to which Neo-Hegelian doctrines were subjected, notably by G. E. Moore and Bertrand Russell, in the opening years of the 20th century, may be said paradoxically to spring directly from Bradley's own work, with its insistence on subjecting all ideas, however seemingly sacrosanct, to remorseless scrutiny. Though Bradley himself and his polished but less gifted colleague Bernard Bosanquet (1848–1923) did their best to meet the attack, their efforts in the end were of no avail.

Neo-Hegelianism in the United States sprang from the work of the Boston Transcendentalists, whose knowledge of German philosophy was, however, mostly secondhand; it owed much of its advance to the efforts of W. T. Harris (1835–1909) and to the *Journal of Speculative Philosophy* which he founded in 1867. Its most distinguished and determined proponent was Josiah Royce (1855–1916), professor at Harvard from 1882, though Royce's idealism, with the special place that it assigned to the will, was closer to the ideas of Fichte than to those of Hegel himself. Royce's distinguished contemporaries C. S. Peirce and William James both repudiated his metaphysics; yet Peirce had described himself as an "idealist" in his early life, and even James had experienced the Hegelian influence to some extent. The same was true of James's successor John Dewey, who began life as a Hegelian and, despite his antipathy to absolutes, retained certain Hegelian features in his thought, notably a tendency to denounce abstractions and a reserved attitude toward the claims of formal logicians. *See* also the individual articles on the several philosophers mentioned.

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(W. H. W.)

NEO-KANTIANISM is a term used in a rather arbitrary way to cover a wide variety of philosophical movements that not only show the influence of Kant's thought but also explicitly claim to go back to Kant, to free his system from inconsistencies and other errors, or to develop it further in the light of new mathematical and scientific discoveries (*see* KANT, IMMANUEL). All these movements agree to some extent with the Kantian intention of a synthesis of empiricism and rationalism and hold that theoretical and practical thought involves empirical and nonempirical concepts. They all claim to use the Kantian so-called critical method of philosophy. They differ from each other chiefly in the emphasis that they lay on different parts of Kant's work. Neo-Kantianism as a deliberate revival of Kant's thought starts about the middle of the 19th century. It has become usual to distinguish schools of Neo-Kantianism, as follows:

The Physiological School.—Represented mainly by Hermann von Helmholtz (1821–94; *Handbuch der physiologischen Optik*, 1856) and Friedrich Albert Lange (1828–75; *Geschichte des Materialismus*, 1866), the physiological school interprets the creative and modifying functions of the mind in terms of the organization of external stimuli by the nervous system. These give rise to signs (not pictures) of external objects, and their coherence is physiologically explained. The post-Kantian physiology is regarded as confirming the main Kantian doctrines. But the philosophy of space, time and mathematics must be modified in accordance with the discovery of non-Euclidean geometry. The "synthetic a priori principles," in other words the presuppositions of all science, have their basis in the structure of the human brain and nervous system and are not capable of being justified as necessary a priori.

The Realist School.—The chief exponent of realist Neo-Kantianism is Alois Riehl (1844–1924; *Der philosophische Kritizismus und seine Bedeutung für die positive Wissenschaft*, 1876–87), who not only emphasizes the Kantian rejection of speculative metaphysics but also denies the possibility of any scientific or absolute, as opposed to a merely persuasive ethics. To speak generally, the school can be regarded as a compromise between Kant's philosophy and positivism. Its main contributions are in the field of the philosophy of the natural sciences.

The Marburg School.—Founded by Hermann Cohen (1842–1918; *Logik der reinen Erkenntnis*, 1902), this school is also mainly concerned with philosophy of science, in particular with an inquiry into its necessary presuppositions after the fashion of the Kantian "Transcendental Logic." It differs from Kant in regard-

ing sense-perception as ultimately analyzable into relations between concepts. Cohen assigns an overwhelming importance to the "infinitesimal" calculus for the understanding not only of physics but of all science. Some of his speculations about the infinitely small and the nature of mathematics are incompatible with later developments in the foundations of mathematics. Another prominent member of the Marburg school was Paul Natorp (1854–1924; *Die logischen Grundlagen der exakten Wissenschaft*, 1910).

The Baden School.—Most deeply influenced by Kant's *Critique of Practical Reason,* this school interprets every kind of judgment as normative. Its main representative, Wilhelm Windelband (1848–1915; *Einleitung in die Philosophie*, 1914), is also important as a historian of philosophy. His classification of the sciences into nomothetic sciences, which discover general laws, and ideographic sciences, such as history, which describe particular events, has been accepted by many historians and sociologists. Even the ideographic sciences presuppose normative propositions, namely those that distinguish what in a description is to count as an important feature. Philosophy itself is conceived as the general critique of thought, which in turn is always normative. Heinrich Rickert (1863–1936; *Die Grenzen der naturwissenschaftlichen Begriffsbildung*, 1896–1902) also belongs to the Baden school.

The Relativistic School.—This school derives its general point of view from the "Transcendental Dialectic," in particular from Kant's doctrine that it is sometimes useful to treat the empirically empty ideas of reason as if they were true of experience. Its theory of knowledge is pragmatist, truth being conceived as utility for survival. Its ethics is positivistic. Normative ethics proposes ideals, descriptive ethics describes socially accepted moral standards; neither admits of an a priori justification, as attempted by Kant. Representative of this school is Georg Simmel (1858–1918; *Hauptprobleme der Philosophie*, 1910).

The School of Fries and Nelson.—This school considers the "Transcendental Aesthetic" as the model of philosophical method. Both Jakob Friedrich Fries (1773–1843; *Neue Kritik der reinen Vernunft*, 1807) and Leonard Nelson (1882–1927; *Über das sogennante Erkenntnisproblem*, 1904, and *Vorlesungen über die Grundlagen der Ethik*, vol. i, 1917) distinguish sharply between the system of synthetic a priori principles and their justification, a distinction which reminds one, as Nelson emphasizes, of the distinction which formalist mathematicians make between mathematics and metamathematics (*see* MATHEMATICS, FOUNDATIONS OF). The justification of the principles of mathematics consists in showing that they merely reiterate in propositional form an immediate, intuitive (nonpropositional) knowledge of the structure of space and time. The justification of nonmathematical synthetic a priori principles consists in establishing that they too reiterate immediate, though nonintuitive and originally obscure, knowledge. This procedure of justification is psychological and results in empirical propositions *about* the a priori principles, namely empirical propositions to the effect that the principles correspond to nonpropositional immediate knowledge.

According to Nelson the so-called theory of knowledge, because it tries to justify propositions by deriving them from other propositions and not by establishing their relation to immediate knowledge, is involved in a vicious circle, a defect from which Kant's philosophy of natural science and morals also suffers. Nelson's philosophy of mathematics agrees with Kant's in holding that Euclidean geometry, and no other, describes the structure of perceptual space. In the light of their methodology, the school of Fries and Nelson made contributions to almost all branches of philosophy. (S. Ko.)

NEOLINGUIST: *see* NEOGRAMMARIAN.

NEOLITHIC. In 1865 Sir John Lubbock, in describing cultural evolution, termed Neolithic all those remains of prehistoric man that included stone tools shaped by polishing and that appeared in the archaeological record before the emergence of metal, or the Bronze Age. He thus distinguished the Neolithic from the Paleolithic (*q.v.*) or age of chipped stone that preceded. Since Lubbock's definition, the term Neolithic has taken on many additional meanings and there is no consensus in the use of the word. Three criteria are most often included in definitions. Neolithic archaeological assemblages are those having (1) polished stone tools; (2) pottery; and (3) horticulture and/or domestication of animals.

These criteria and combinations of them are used in specific ways by specialists who work in certain restricted areas. Thus in Europe, Neolithic usually means that the prehistoric people had polished stone hoes and axes and had an economy based on agriculture supplemented by hunting and sometimes fishing. Some groups had permanent villages whereas others regularly moved to new farm land. Extensive trade in luxury items such as amber and sea shells was prevalent. By contrast, workers in western U.S.S.R. call assemblages Neolithic when they contain no metal but do have pottery. The people lived by hunting and fishing very much as people had done in the Paleolithic. Again, by contrast, in the Americas the term Neolithic is rarely used when referring to the indigenous cultures even though they may satisfy all three criteria.

One can assign no specific time to all archaeological assemblages that might be called Neolithic. To use one criterion, for example, agriculture had begun bv 7000 B.C. in the near east while Europe stayed Mesolithic (*q.v.*), and agriculture did not reach Europe in force until 3000 B.C. In the near east by 3000 B.C. urban civilizations had begun and these archaeological assemblages are no longer referred to as Neolithic. In many parts of the world agriculture replaced a hunting economy only in the last few centuries.

Without careful definition the use of the term Neolithic is misleading. Since Lubbock's time archaeologists have discovered that man's prehistory is too complicated to be described by single terms describing unilinear evolution.

See also references under "Neolithic" in the Index.

(F. A. HE.)

NEON, a gaseous element found in the atmosphere and represented by the symbol Ne. It belongs to the family of noble gases, composed of helium, neon, argon, krypton, xenon, and radon, which comprise the zero group of the periodic system.

Neon is used in a variety of lamps and other electrical devices which take advantage of its unusually high electrical conductivity and light-emissive power. The brilliant orange-red light emitted from "neon tubes" in which an electrical discharge passes through the gas under a pressure of a few millimetres of mercury first became a familiar sight in the 1920s. Most gaseous conduction lamps and fluorescent lamps contain neon as a component of the gaseous mixture which carries the electricity. Other neon-tube devices include lightning arresters, high-voltage testers and negative glow lamps. The latter can be built with electrodes in the form of figures or letters suitable for display purposes.

Neon has the atomic number of 10 and an atomic weight of 20.183. Its stable isotopes, listed in order of decreasing abundance, have mass numbers of 20, 22 and 21. Short-lived radioactive isotopes of mass numbers 18, 19, 23 and 24 have been reported. Electrons of the atom occupy and fill the K and L ($2s^2$ $2p^6$) shells.

The element was discovered in 1898 by Sir William Ramsay and M. W. Travers as a component of the most volatile fraction of liquefied crude argon obtained from air and was given a name meaning "the new one."

Neon is widely distributed in nature and occurs in traces not only in the atmosphere but also in gases trapped within the earth. The content in dry air is close to 0.0018% by volume. Industrial production of the element is accomplished by fractional distillation of air. The most volatile fraction is composed of helium neon and nitrogen. The latter gas is removed by chemical absorption and the neon is then separated from helium by selective adsorption on activated charcoal at low temperature.

The following physical constants have been selected from technical literature, most of the values being taken from a table critically compiled by F. P. Gross: density of the gas at 1 atm. pressure and 0° C., 0.8999 g. per litre; density of the liquid at its boiling point, 1.204 g. per millilitre; normal boiling point, −246.09° C.; freezing point, −248.61° C.; critical temperature, −228.75° C.; critical pressure, 26.86 atm.; heat of vaporization at the normal boiling point, 20.8 cal. per gram; heat of fusion, per gram, 3.9

cal.; ionization potential for first electron, 21.5 v.; solubility in water (neon at 1 atm. pressure) at 25° C., 0.0101 ml. (measured at 1 atm. pressure and 0° C.) per millilitre of water; at 15° C., 0.0108 ml. of neon per millilitre of water. Since the ratio of the specific heat of the gas at constant pressure to that at constant volume is 1.642, it may be concluded that a single atom of the element comprises a molecule.

Neon appears to form no stable chemical compounds and apparently attracts other atoms only by the relatively weak interatomic action known as van der Waals forces. Procedures for the analytical determination of neon provide for measuring the gas after it has been isolated by chemical absorption of reactive gases on hot calcium or other reagent and separation of helium, argon, krypton and xenon by physical means. Such a physical separation is usually accomplished by fractional desorption from cold activated charcoal or by diffusion (of helium) through hot quartz. The element is recognized by its characteristic spectrum which contains many beautiful red lines.

See also references under "Neon" in the Index.

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NEO-ORTHODOXY is the American name for a theological movement known in Europe as CRISIS THEOLOGY and as DIALECTICAL THEOLOGY. Of these three names, perhaps Crisis Theology is the most appropriate, because the movement began as and remains a Protestant response to the crisis of Christendom after World War I. Two world wars in the 20th century, the rise of totalitarian regimes, the decline of Christian humanism in western culture, together with a premonition of disasters yet to come, led to the view that Christendom is under divine judgment and at the parting of ways; that is, in a state of crisis. The phrase Dialectical Theology refers to the preference of the theologians under consideration for stating their insights in terms of paradox; for instance, that the Bible is the Word of God to man and man's words about God, or that man is at once creature and sinner, good as creature and evil as sinner. Apparently contradictory statements are made in the interests of "truth" so as to suggest both the mystery of human life and the limits of human thought. According to this theology, this is the only proper way to speak about God and man. The meaning of Neo-orthodoxy will appear in the rest of this article.

The origins of Neo-orthodoxy, as of existentialism in philosophy, are usually traced to Sören Kierkegaard (1813–55), who saw the western culture of his day, including its religious institutions, as destructive of humanity. He wrote against objectivity as lacking in seriousness and declared, especially against Hegel and orthodoxy, that "truth is subjectivity." Friedrich Nietzsche, who attacked Christendom as having lost its soul and cried out "God is dead," and Fëdor Dostoevski, who in his novels celebrated the freedom of man as well as uncovering his bondage, both came to make a prophetic impression upon European thought. The anti-idealistic and antiscientific writings of existentialist writers such as Karl Jaspers and Martin Heidegger must also be kept in mind. Further, the Marxist criticism of capitalism exerted considerable influence upon Neo-orthodoxy, and so did depth psychology. In short, Neo-orthodoxy was occasioned by the spiritual shock experienced by the European mind under the impact of the 20th-century age of anxiety and commotion.

Neo-orthodoxy first responded to the age with a negative judgment upon it. In *The Theology of Crisis*, a series of lectures given in the U.S. in 1928, Emil Brunner repudiated modern European culture by attacking idealism, scientism, rationalism, evolutionism, romanticism, immanentism and liberalism. What he saw in all this was man's pride and self-deification which he regarded as at the root of all evil in the modern world. Man had repudiated his finitude and responsibility before the God of the Bible. He had thus put himself in a fundamentally false position, and lived and acted on the basis of a lie which could not but be, as it was, his undoing.

In the same year a series of essays by Karl Barth appeared in English under the title *The Word of God and the Word of Man*. These essays, written between 1916 and 1923, are built upon the contrasts between the righteousness of God and the righteousness of man, the Bible and western culture, the preaching of the gospel and the preaching of religion. At every turn the discontinuity between God and man is set forth and it is made clear that unless Christendom once again listens to the biblical word of God addressed to it from beyond its religion, philosophy and ethics, it is lost.

The same theme was worked out by Barth in *The Epistle to the Romans* (1918, 1921 *et seq.*, trans. from the 6th ed. by Edwyn C. Hoskyns, 1933), which made a profound impression upon Protestant thought in Europe. Here Barth took up Kierkegaard's theme of "the infinite qualitative difference" between God and man, and declared that there is no way from man to God. He wrote of God's self-revelation in judgment and mercy, and called the church to repentance. However, this early writing of Barth was inspired in the main by a vision of the collapse of European culture.

The Epistle to the Romans led Christian thinkers, above all Barth himself, to re-examine the Bible and the faith of the Christian church. Men's eyes were opened to the "strange new world within the Bible" and to the hardly less strange theologies of the Protestant Reformation with their doctrines of justification by faith alone and God's sovereignty over his creation. They began to speak and write seriously of God who is not man and of the word of God to man, of Jesus Christ the Lord, of revelation and faith. The outcome of the process was the rediscovery of theology itself as an intellectual activity growing out of the church's concern with its faith and obedience in Jesus Christ.

In 1932 Reinhold Niebuhr published his *Moral Man and Immoral Society*. This book marks the beginning of Neo-orthodoxy in the United States. It administered a telling blow at a Christianity whose "gospel of love" had made it inept in dealing with the realities of political life in which coercion is a constant and operative factor. Niebuhr struck at idealism, rationalism, optimism and the like, and argued that the amoral and immoral character of nations and classes requires justice through the use of force as well as through religion and enlightenment. He began to speak forcefully about sin and repentance, and insisted that Christianity is above all a critical principle which brings western culture under the judgment of God. Gradually Niebuhr turned to the Bible and to Augustinian theology for insight into "human nature and destiny," and elaborated his views in a number of books as well as innumerable articles which constitute the chief body of Neo-orthodox writing in America. Niebuhr's competence as a political observer gave unusual authority to his theology which he elaborated in constant debate with secular culture.

Other important Neo-orthodox theologians include Friedrich Gogarten, who collaborated with Karl Barth in the early years of the movement; Rudolf Bultmann, who combined Crisis Theology with the existentialism of Heidegger; H. Richard Niebuhr, who made important contributions to the study of Christianity and culture; Nikolai Berdyaev, who was at once a radical critic of western culture and the author of numerous works in which he elaborated a personalism of his own as against "objectivity" in western philosophy; and Paul Tillich, who criticized the dominance of "technical reason" in modern society and elaborated a "philosophical theology" in which "depth of reason" and faith entered into a much debated alliance.

These theologians are called Neo-orthodox because they speak the traditional language of the Christian church as found in the Bible, the creeds and the main line of orthodox theology. They have written of the Trinity, the Creator, the fall of man and original sin, Jesus Christ the Lord and Saviour, justification, reconciliation and the Kingdom of God. The language is the language of orthodoxy but, as the orthodox were quick to see, the meaning of the language has undergone radical changes. The new theologians repudiated the literalism of later orthodoxy. According to them the world was not created in six days. There was no man by the name of Adam who listened to a wife who listened to a serpent and thus sinned and plunged mankind into ruin. Jesus

was not born of a virgin and he did not walk on water. The Bible itself was not written under the dictation of the Holy Spirit and it contains much that is not literally true. In short, the new theologians, assuming modern man's aversion to "physical miracles," refuse to go back to supernaturalism. In this they are modernists. The miracle of the Christian faith to them is Jesus Christ and his gospel proclaimed in the church for the salvation of the world.

To Neo-orthodoxy the controversy between science and religion, which occupied a prominent place in the 18th and 19th centuries, resulted from failure, on the part of both defenders and opponents of Christianity, to understand the nature of the Christian faith. It presents this nature as having to do with faithfulness to God and man in this world and not with opinion about the world in itself as envisioned by scientists.

Neo-orthodoxy in the main is concerned with the problems raised by modern culture and not by the modern sciences. On the other hand, scientism as an aspect of culture itself is subjected to radical criticism. Neo-orthodoxy does not deny the evolution of the species but it rejects evolutionism as an optimistic view of history having a dubious logical basis in biology. It does not repudiate the scientist's self-forgetfulness as a person when occupied with observation and experiment, but it rejects objectivity in human relations. It does not deny logic as integral to scientific explanation, but it rejects the kind of determinism that makes freedom in any sense illusory. Scientism is understood by the Neo-orthodox as incompatible with their fundamental thesis that man is a responsible being and that unless he is understood as such, he is not properly understood as a human being. Neo-orthodox polemics against science, reason, autonomy, with repeated charges of pride and self-idolatry against modern man, are directly or indirectly related to the conviction that modern culture, as largely dominated by science and "technical reason," has become blind to humanity itself as response to persons. In this way, as in others, Neo-orthodoxy is itself related to existentialism. It is also related to liberalism in its aversion to orthodox literalism and authoritarianism and in its humanistic concern for the dignity of persons in the machine age.

Neo-orthodox theology may well be regarded as a set of variations on the theme of man's existence as a responsible being.

1. God as the sovereign Other is the Person who places man under an inviolable responsibility. God transcends man as Creator and Redeemer, and therefore as the Source of responsibility which is neither in man nor in his world. God speaks his Word to man, and in this peculiarly personal act he lays his claim upon man and obligates him to respond to him and thus to exist as a human being. He addresses man in his freedom and love as God, through the freedom and love of Jesus the man which constitute his humanity and illumine our own existence as fellow men.

2. Neo-orthodox preoccupation with Jesus Christ as the Son of God in whom the Father reveals himself to man is understood most readily in the light of Christian humanism. It includes a polemic against natural theology, which argued from nature to God, and in doing this not only obscured God who speaks but also man who is contradistinguished from nature in that he exists in his response to God and to his fellow men. In singling out Jesus Christ as the self-revelation of God, Neo-orthodoxy also singled out man and his responsiveness and recognized a unique dignity in him.

This in part explains also the emphasis upon the humanity of Jesus which is characteristic of Neo-orthodoxy. In the responsibility of the man Jesus, man comes into his own as a person and a fellow man. Thus Jesus acts as the Word of God to man and as man who exists in hearing God's Word.

3. Jesus Christ is, according to this theology, the Word become flesh for our salvation. Therefore, it places a new and searching emphasis upon man the sinner. God reveals himself in the freedom and love of Jesus, and in his forgiveness. But forgiveness reveals man's sin. Therefore, man knows God and himself as a sinner; without such knowledge he knows neither God nor himself. Man knows himself as a person only as he knows himself as a sinner under God's forgiveness. Thus, the knowledge of sin is an occasion for acknowledging at once "the misery and the grandeur of man," and it is integral to personal existence. It is the antidote both to despair and to pride, and to the degradation of human culture that follows upon these twin evils.

Sin for Neo-orthodoxy is the violation of persons as seen in contrast to the love of God in Jesus for sinners. It is man's rebellion against his limited life and powers which comes both before and after his repudiation of responsibility, which in turn is the sign of death both for the individual and for the community. From it come dehumanization and the consequent evils of egotism, stupidity and guilt, as well as the loneliness, the loss of the meaning, anxiety, enmity and cruelty which plague human life. The Neo-orthodox defend such a view of sin as biblical and in line with a realistic knowledge of the condition of man.

4. Neo-orthodox criticism of modern culture led its theologians to examine political and economic institutions with a new awareness of their significance for responsible human existence. In this they have been influenced both by Marxist criticism of western capitalism and by new insights into the influence of social institutions upon personal life and relations. These theologians argue that religion, ethics, economics and politics are aspects of a larger whole which is the culture of a society, and that they cannot be understood and dealt with separately. Therefore, they assume a peculiar responsibility to concern themselves with social institutions and problems and to take a "Christian" attitude toward the controversial issues of the day, such as Communism, race relations and nuclear weapons. There is no unanimity among them as to answers to these perplexing public problems, but they are one in seeing the Word as addressed to the total present human situation.

Neo-orthodoxy is a political theology. It is illumined by politics and is a response to it. But it seeks to interpret politics in terms of biblical and Reformation theology: in terms of creation, sin and reconciliation, of God's self-revelation in Jesus Christ.

5. Neo-orthodoxy, especially in its European form, lays new emphasis upon the doctrine of the church as the community of believers. The church is spoken of as the Household of God, the Realm of Redemption, the Body of Christ. This phase of Neo-orthodoxy has been especially evident in the World Council of Churches where the several non-Roman churches have debated the nature and the responsibility of the church. Much has been written to the effect that the church is the place where God realizes in the world His saving work of restoring man to his true nature as person in community. These discussions have been once again biblical and according to traditional theology, but their empirical validity is apparently in doubt. Much has also been written which is strongly critical of the churches and presents them as dim lights in the world. There is no certain method by which the churches might become a more palpable influence toward the recovery of humanity. Thus a link is missing between theology and politics, and this, on the presuppositions of Neo-orthodoxy, is a great problem.

See also **Existentialism**; **Liberalism, Theological**.

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NEOPHYTE (Greek for "newly planted"), a word used exclusively by early Christians in the figurative sense (probably suggested by Rom. vi, 5, translated in the Authorized version "For if we have been planted together in the likeness of his death") of "one recently baptized." The term occurs once in the New Testament (I Tim. iii, 6, variously given in English Bibles as "neophyte," "novice," "convert newly baptized" and "recent convert") —an injunction against ordaining neophytes often cited by church writers and councils. The word is also common in epitaphs, notably on the sculptured sarcophagus, dated A.D. 359, of the Roman prefect Junius Bassus preserved in the Vatican grotto. By extension it came to be used to describe a newly ordained priest or a

novice in a convent, and, eventually, simply "beginner."
(M. H. Sh.)

NEOPLATONISM is the name given by historians of ideas to the last school of Greek philosophy (the ancient philosophers who are generally classified as Neoplatonists called themselves simply "Platonists," as did the philosophers of the Renaissance and the 17th century whose ideas derive from ancient Neoplatonism). After a long preparatory development it was given definitive shape in the 3rd century A.D. by the one great philosophical and religious genius of the school, Plotinus. From that time onward Neoplatonism dominated the thought of that dying ancient world within which the Byzantine and western Christian cultures were already coming to birth. Pagan Greek philosophy was Neoplatonist till it faded out in the 6th century A.D. Many of the greatest Christian thinkers of this period, the great formative period of Christian theology, were deeply influenced by Neoplatonism, as were later the great Muslim philosophers. The influence of Neoplatonism medieval thought was very great and has continued to influence men's minds. In modern times Neoplatonism was long despised and little understood; yet without some knowledge of this philosophy it is impossible to understand a great deal in the cultural tradition of Europe.

General Characteristics of Neoplatonism.—Neoplatonism began as an extremely complex philosophy and took varied forms in the course of its history, and it is therefore not altogether easy to generalize about it. But the leading ideas in the thought of philosophers who can properly be described as Neoplatonists seem always to include the following:

1. There is a hierarchy of reality, a plurality of spheres of being arranged in descending order, the last, lowest and least comprising that which exists in time and space, the being perceptible to the senses.

2. Each sphere of being is derived from its superior; this derivation is not a process in time or space.

3. Each derived being is established in its own reality by turning back toward its superior in a movement of contemplative desire, which is implicit in the original creative impulse of outgoing that it receives from its superior; so that the Neoplatonic universe is characterized by a double rhythm of outgoing to return. The movement of return is the most important, that which constitutes each level of reality.

4. Each sphere of being is an image or expression on a lower level of the sphere above it, and each individual reality an image or expression of a corresponding reality in the higher sphere. The relation of archetype and image runs through the whole of the Neoplatonic universe.

5. Degrees of being are also degrees of unity; in each subsequent sphere of being there is greater multiplicity, more separateness, increasing limitation of each reality till we arrive at the atomic individualization of the spatio-temporal world.

6. The supreme sphere of being, and so the whole of reality, is derived from a principle which as the source of all being cannot be described as being. "Being" to the Neoplatonist always means "being *x*," being this or that. Thus the inexhaustible source of being, which has no limitations, as it is not confined to being this or that but is in the fullest sense infinite, cannot be said to "be"; it is "beyond being." As it has no limitations, so it has no divisions, attributes or qualifications; it cannot really be named but may be called "the one" to designate its complete simplicity or lack of determination. It may also be called "the good" as the source of all perfections and the ultimate goal of return. For the impulse of outgoing to return that constitutes the hierarchy of derived reality is an impulse that comes from and leads back to the good.

7. The knowledge of this supreme principle is radically different from any other kind of knowledge because the supreme principle is absolutely simple and undetermined; it is not an object (a separate, determined, limited thing) and no predicates can be applied to it. It can be known only if it raises the mind to an immediate contact or union with itself, which cannot be imagined, described or defined.

Origins.—Whether the beginnings of Neoplatonism can be traced back to Plato himself is a question vigorously discussed by modern scholars. As always in the study of Plato, it is difficult to arrive at any sort of certainty. What does seem to be certain is that ideas which can be found in passages of Plato's dialogues (whether interpreted or not as Plato meant them) or in the scanty and obscure accounts of his later oral teaching are the root ideas of Neoplatonism. The most important are: (1) the basic Platonic doctrine of the two worlds, (*a*) the eternal and intelligible world and (*b*) the sense-world of time and change; (2) the idea that appears in one passage of Plato's *Republic* (509 B) that the principle of the eternal world, of the "forms" or "ideas" (*see* UNIVERSAL), is "the good . . . beyond being, surpassing it in dignity and power"; (3) the attempt made by Plato in his later teaching (about which very little is known) to derive the ideas by a logical-mathematical process from ultimate principles, namely "the one" (perhaps identical with "the good") and "the indeterminate dyad"; (4) the doctrine of a supreme divine intelligence, the relation of which to the ideas is not clear, but which forms and rules the sense-world according to their eternal order; and (5) the position of soul, human and cosmic, as intermediary between the two worlds, eternal and temporal, belonging to and able to operate in both. It seems to be becoming fairly certain, too, that Plato's immediate pupils and successors, Speusippus and Xenocrates, took some steps farther on the road that leads to Neoplatonism. This is particularly true of Speusippus; in the scanty fragments that survive of his teaching we find a "one beyond being."

Yet the beginnings of the continuous development that led immediately to the philosophy of Plotinus cannot be traced back beyond about the 1st century B.C. At that time certain philosophers—notably the stoicizing Platonist Antiochus of Ascalon, who revived dogmatic teaching after a period of skepticism in the Platonic school (*see* ACADEMY, GREEK), and the great Stoic Poseidonius, who was deeply influenced by Plato—inaugurated a type of thought that is found embedded in the vast confused works of Philo, an Alexandrian Jew of the 1st century A.D., and that was continued and developed into the 2nd century by the philosophers sometimes known as Middle Platonists and Neo-Pythagoreans, for instance Albinus, Atticus (*c.* 150–200), Plutarch of Chaeronea and Numenius of Apamea. The general characteristics of this revived Platonic or Pythagorean philosophy are the recognition of a hierarchy of divine principles and the stressing of the remoteness and transcendence of the supreme principle, which is sometimes called "the one"; the placing of the Platonic ideas in the divine mind; a strongly other-worldly attitude and a stressing of the necessity of the "flight from the body," the ascent of the mind to the divine and eternal; and a preoccupation with the problem of the origin of evil in this lower world, which is sometimes attributed to an evil world-soul (*e.g.*, by Plutarch) and sometimes to matter (by Numenius). Thus it obviously approaches very closely to the fully developed Neoplatonism of Plotinus, who worked out his own in some ways profoundly original philosophy on the basis of this already existing tradition.

Plotinus.—The history of Neoplatonism must be held to begin with Ammonius Saccas, the master of Plotinus, who was teaching in Alexandria in 232, when Plotinus came to him. But Ammonius wrote nothing and we know next to nothing of his teaching. So it is to the *Enneads* of his great pupil Plotinus that we must turn for our first evidence of authentic Neoplatonism. The *Enneads* are the primary document of the school, the foundation on which all later developments are built, and at the same time represent the summit of Neoplatonism's philosophical and religious achievement. In them may be seen the great leading ideas mentioned above in their strongest and simplest form.

The hierarchy of reality, in Plotinus, consists of only two great principles below the ineffable source (the One or the Good). The first of these two principles is intellect (*nous*), the divine mind which is identical with the totality of Platonic forms or ideas; it is the level of purely intuitive thought, immediate grasp of reality, which on the principles of Aristotelian psychology is identical with its object and so at once perfect intelligence and true reality, the cause of all less real derived beings. The individual realities in it (and there are forms of individuals as well as universals, and each one of us has his archetype in the world of

intellect) are at once forms and living minds which think and so, each in their own way, are the whole as well as parts. The second great principle is soul, which extends from the frontiers of the world of intellect to the last and lowest realities, the forms of material bodies. The characteristic of the life of soul is discursive reasoning, which proceeds from premisses to conclusions and does not immediately possess its object but strives to attain it. This restless rational movement of soul is the origin of time; intellect is beyond time in changeless eternity. Yet soul seems able to pass beyond rational-discursive thinking in both directions. On the one hand it can reach up into intellect, be fully illuminated and perfectly conformed to it and then ascend to the One; on the other hand the whole material universe is within the sphere of soul and is not only ruled but formed and animated by it, so that soul has a lower, immanent, unthinking activity that extends beyond even the limits of the organic, down to the forms of the lowest material things, as far as it is possible to go into the darkness of matter. No material thing can exist without a share in soul.

Thus Plotinus' view of reality, though hierarchic, is not complicated. The great realities, intellect and soul, have different aspects and many (though not infinitely many) members—and different levels on which those members can live. But Plotinus always maintains their essential unity, so as to keep close to the Platonic tradition as he received it and to his own philosophical experience. Moreover, the whole of his universe is open to and filled with the power of its first principle, the One or the Good beyond being. None of the realities that derive from it is cut off or separated from the One; it is immediately present to all of them according to the capacity of each to receive it.

The sole object of the good and wise man, the supreme goal of human endeavour, is to return to the Good and be united to it in the union of love which is beyond and above the contemplation of intellect, by the power coming from the Good, the impulse of return which is constitutive of his very being. First he must detach himself from the worldly desires and concerns of his lower self, the composite being of body and soul, by rigorous intellectual and moral discipline, inspired always by love and helped on his way at first by contemplation of the beauty of the world of the senses—which, rightly contemplated, will lead him back to the intelligible beauty of which it is a reflection. As he becomes perfect in intelligence and virtue (for Plotinus the two kinds of perfection are inseparable), the philosopher will rediscover his true and eternal self, which is intellect, or rather soul perfectly conformed to intellect, and wake to its life. Then he is ready to go on to the One when the One manifests itself and brings him to union.

Plotinus' philosophy, then, is not only theory but practice (a practice admirably exemplified in his own life). It is the union of theory and practice, of powerful metaphysical thinking with the continual stimulation to remember our true nature and return to our source. This accounts for its perennial power and attractiveness.

Porphyry and Iamblichus.—Plotinus' pupils were not of the same intellectual stature as their master, and in them can be seen the beginnings of the tendencies that were to become dominant with Iamblichus and that produced a considerable alteration for the worse in Neoplatonism. Very little is known about Amelius, the senior member of the school. External religious practice, the observation of feasts and sacrifices, was important to him as it was not to Plotinus, whose religion was entirely interior. In this Amelius points the way to later Neoplatonism; and he seems also to have begun the process of splitting up the levels of reality that was to lead to such fantastic complications later, by dividing the intellect of Plotinus into three. Of Porphyry, the biographer and editor of Plotinus, a good deal more is known; a number of his writings survive. He kept in most ways very close to the teachings of his master, but he was more interested in the details of practical asceticism, notably vegetarianism, on which he wrote a treatise. He was also a good deal more interested than Plotinus in the *daemones*, spirits intermediate between gods and men in whom Plotinus, as well as all ancient Platonists, believed, but who play no important part in his thought. Porphyry made evil *daemones* responsible for everything that was most repulsive and immoral in the practices of popular paganism, of which he strongly disapproved. He carried on the tradition inaugurated by Plotinus of polemic against the non-Hellenic religions that were steadily gaining influence, Gnosticism and orthodox Christianity. Plotinus himself, and his pupils in his lifetime, had written against Gnosticism, and Porphyry wrote 15 books *Against the Christians*. The work was destroyed by the Christian authorities in the 5th century, but quotations from it in Christian polemical writings allow us to suppose that it was the most powerful and intelligent of all pagan attacks on Christianity. Porphyry's hostility to popular paganism and non-Hellenic religion apparently did not extend, however, to pagan theosophy. He seems to have been the first philosopher to take seriously a theosophical farrago called the *Chaldaean Oracles*, composed late in the 2nd century A.D. by one Julian the Theurgist, which enjoyed unbounded authority among the later Neoplatonists, with most unfortunate results. But on the whole Porphyry remained reasonably close to the teaching of Plotinus, and his chief importance is as the disseminator and popularizer of Plotinian philosophy.

It was Porphyry's pupil Iamblichus who more than anyone else was responsible for the type of later Neoplatonism found in the schools of Athens and of Pergamum. Iamblichus, who died *c.* A.D. 330, moved back in later life from Rome, where Plotinus had established his school, to his native Syria; and from his time onward the chief centres of Neoplatonism were in the eastern half of the Roman empire—in Syria and at Athens, at Alexandria and at Pergamum. On the purely philosophical side, a distinctive characteristic of this Neoplatonism of Iamblichus (which continued to mark its later developments in the Athenian and Pergamene schools) was the tendency to multiply entities and to split up the levels of reality so that the hierarchic chain of being became continually longer and more complicated. Plotinus' hierarchic universe, as we have seen, was relatively simple and close to his own philosophic experience. He was content to allow ideas that might seem, on a superficial or too narrowly logical view, to be inconsistent to coexist in his reticent statements pointing us toward the ineffable source of being, the One or Good; and his great derived realities, intellect and soul, are rich, complex and many-sided. Plotinus, in short, though by no means a muddled thinker, would not seek clarity at the expense of truth. Iamblichus and his successors, while they were certainly anxious not to leave out any of the truth, also pursued perfect clarity and verbal coherence, at the price of no matter how many distinctions, with a fanatical unbalance characteristic of closed philosophical schools engaged in minute comment upon the works of established authorities. The basic assumption underlying their elaborations seems to be that the structure of reality corresponds so exactly to the way in which a late Greek philosopher's mind works that there is a separate real entity corresponding to every distinction that the mind can make.

Another characteristic of Iamblichean Neoplatonism adds considerably to its complications; viz., the apologetic motive, the desire to defend what Neoplatonists regarded as the true Hellenic tradition against its great (and now politically victorious) adversary Christianity. This motive, which had not been absent, as we have seen, from the school of Plotinus, soon became so strong that Iamblichus and his successors set out to construct a complete pagan theology. This means that they had to find a place in their system for every supernatural being in whom the pagans of the later Roman empire believed and, in particular, for all those mentioned by that very dubious authority for which Porphyry had opened a way into the school, the *Chaldaean Oracles*. This work indeed, now became a sort of inspired scripture, along with the dialogues of Plato (into which a remarkable amount of late pagan theology was read by vigorous allegorical interpretation). With this complicated theologizing and under the influence of the *Chaldaean Oracles*, there came into Neoplatonism the practice of theurgy, to which Iamblichus and most of his Athenian and Pergamene successors were enthusiastically addicted. Theurgy was a sort of higher magic aimed at producing an external communion with the gods. This was done sometimes by animating images, filling them with divine power by well-established Greco-Egyptian magical procedures; and sometimes by inducing the gods to possess a medium

and even to give visible manifestations of their presence, in ways strikingly reminiscent of modern spiritualism. This kind of thing was utterly alien to the spirit of Plotinus, who was certainly not a magician or a theurgist, though he was once persuaded to attend a theurgic séance (*see* Porphyry's *Life of Plotinus*, ch. 10); and Porphyry likewise, though he was persuaded by the *Chaldaean Oracles* to admit to some extent the real efficacy of theurgy, yet regarded it as a dangerous and dubious practice, useful at best to purify the lower part of the soul but quite unable to bring the true self to that union with God which he, as a true follower of Plotinus, regarded as the ultimate goal. From Iamblichus onward, however, most of the leading Neoplatonists were practising theurgists.

The Pergamene School.—The Pergamene school of Neoplatonism was founded by Aedesius, a pupil of Iamblichus; and the Pergamenes in general were, if anything, more wholeheartedly devoted to religious magic than the Athenians (though we hear of a strong protest against theurgy from Aedesius' pupil Eusebius of Myndus). Their most spectacular theurgist, Maximus of Smyrna, was the chosen master of the emperor Julian, who was converted from Christianity to Neoplatonism in its most superstitious and fantastic form and in whose short-lived pagan revival theurgists, Maximus himself and Chrysanthius, played an important part. The conversion of Julian, in fact, was the great achievement of the Pergamene school; his surviving writings are not of much importance philosophically, but they give a vivid idea of the religious spirit and outlook of Iamblichean Neoplatonism and its devotion to what it believed to be the ancient Hellenic tradition. Julian's death in 363 (after a reign of less than two years) and the restoration of Christianity as the state religion brought the Pergamene school to an end.

The Athenian School.—By the beginning of the 5th century the ancient school of Plato in Athens, the Academy, had become Neoplatonist; and there pagan Neoplatonism after the manner of Iamblichus survived nearly two centuries more under the Christian empire. The first outstanding teachers of this Neoplatonist Academy of whom we know were Plutarch of Athens and Syrianus; but far more important, at least for later generations, is Proclus (410–485), the great "scholastic" of Neoplatonism, who gathered and preserved in his voluminous works for such of posterity as might have the strength to read them every detail of Iamblichean philosophy as elaborated by his predecessors and by himself. The influence of his writings on Byzantine, Arabic and medieval Latin thinkers was considerable. After him a dim line of Platonic successors leads finally to Damascius and to the closing of the school by Justinian I in 529.

The School of Alexandria.—Later Neoplatonism, however, was not all Iamblichean elaboration and theurgy. Its exponents did not quite forget the authentic mystical doctrine of Plotinus, and the ideal of union with the One remained at least as a remote aspiration. In Athens, Proclus expounded the "negative theology" very adequately; and Damascius comes, at the beginning at least of his monstrous theological treatise, very close to the spirit of Plotinus. In Alexandria, moreover, a school developed in which little trace can be found of the influence of Iamblichus. The Alexandrian Neoplatonists were not given to metaphysical elaboration or addicted to theurgy. They were, first and foremost, scholars, learned commentators on the great philosophers of the past, and it is interesting to observe that they studied the works of Aristotle quite as much as those of Plato. In this they were following a tendency present in Neoplatonism from the beginning. There was already a very large Aristotelian element in the thought of Plotinus, though his own attitude toward Aristotle was generally critical; he had a low opinion of the philosophical importance of Aristotelian logic, though he admitted that it might have some usefulness as a preliminary study for the philosopher. Porphyry, however, was a good deal more Aristotelian (in this he was following a tradition already well established in the school—just as Plotinus' critical attitude shows the influence of an anti-Aristotelian tendency which appears in some Middle Platonists, notably Atticus) and, in particular, took Aristotle's logic very seriously. The great series of Neoplatonist commentaries on the *Organon* that was continued by the Alexandrian school was inaugurated by Porphyry's commentaries on the logical works and *Introduction to the Categories*—which furthermore were to play an important part in the development of medieval logic. It should be noted here that the greatest of the Neoplatonist Aristotelian commentators, Simplicius, though he was a member of the Athenian school, had been a pupil of the Alexandrian Ammonius Hermiae and is closer in spirit to his Alexandrian master than to his Athenian master Damascius.

The scholarly outlook of the Alexandrians and their lack of enthusiasm for the elaborate pagan theology and theurgy of the followers of Iamblichus made them much less hostile to Christianity than the Athenians (in spite of the murder of Hypatia by the Christian mob in 415). In the 6th century the commentator John Philoponus was converted to Christianity; and several of his contemporaries in the last generation of Alexandrian commentators, the pupils, like Simplicius, of Ammonius Hermiae, were Christians. Finally, in the 7th century, the last-known Alexandrian scholar, Stephanus, who was a Christian, was called to teach in the University of Constantinople under Heraclius. Stephanus forms one of the most important links in the chain of transmission of Platonism to the Byzantine middle ages.

Neoplatonism and the Christian Tradition.—In the Latin west there was no organized school of philosophy after Porphyry, but such philosophy as there was was Neoplatonist, and Neoplatonist in the manner of Plotinus and Porphyry rather than of Iamblichus. The Latin Neoplatonists included several people who, though not very original or important thinkers, had a considerable influence on western medieval thought. Some were pagans of a mild, scholarly and antiquarian sort; for instance, Macrobius (fl. *c.* 400) and Martianus Capella (early in the 5th century). Others were Christians; for instance, Chalcidius, the 4th-century commentator on Plato's *Timaeus* (he was really more a belated Middle Platonist than a Neoplatonist), and his contemporary the great convert rhetorician, translator and Christian Plotinian theologian Gaius Marius Victorinus, whose works and example influenced St. Augustine. More important than these was noble Boëthius, scholar, statesman, philosopher and theologian, who was executed by Theodoric in 524. His logical commentaries on Aristotle and Porphyry transmitted much of the learning of the Alexandrians in this field to the medieval west, and the influence of the book he wrote in prison, *On the Consolation of Philosophy*, was still deeper and wider. It was one of the books most read in the middle ages. King Alfred translated it into Old English.

But the most important achievement of Latin Neoplatonism was to bring the works of Plotinus and Porphyry to the notice of St. Augustine. He has told us himself in his *Confessions* how deeply they influenced him. Augustine had too great and original a mind simply to be labeled a "Christian Neoplatonist"; but it was through his writings more than through any other intermediary that something of the spirit and outlook of Plotinus was transmitted to the Latin middle ages.

In the east the great Cappadocian theologians, St. Basil and St. Gregory of Nyssa, read Plotinus and show some signs of his influence as well as of that of his great Christian contemporary Origen, whose thought sometimes shows striking parallels with that of Plotinus, perhaps due to the teaching of their common master Ammonius Saccas (if it really was the same Ammonius). Like St. Augustine, the Cappadocians are original thinkers and not merely servile copyists, and like him, too, they are Christians first and Platonists very much second; but through them also something of Plotinus passed into the theological tradition of the eastern and eventually of the western church.

Neoplatonic ideas also came into the Christian theological tradition through that most successful of pseudonymous writers "Dionysius the Areopagite," who expounded Christian mystical theology in the terminology and using some of the ideas of Proclus *c.* A.D. 500 and whose writings, with all the authority of their supposed author, St. Paul's Athenian convert, behind them, had an extraordinary influence both in the east and in the west. It was this influence of a diffused, diluted and transformed Neoplatonism in traditional Christian theology that was the most historically important part of the Neoplatonic contribution to European thought and culture.

This Neoplatonic influence can be detected in many places, not only in theology, in metaphysics, in logic and in moral philosophy but also in the early history of European science and of medieval and Renaissance art. From the 12th century onward it was reinforced in the west by the medieval Latin translations of Proclus and of the great Arabic philosophers who owed much to Neoplatonism; and from the 16th century onward the Greek texts of the writings of the Neoplatonist philosophers themselves became available in the west again (they had never been quite forgotten in Byzantium). But though the influence of these, and especially of the works of Plotinus, on those who read them has always been deep and lasting, the number of those who read them, even in translation, has been and probably always will be few; post-Renaissance Neoplatonism based on the original texts has been confined to select individuals and groups, of which one of the most important and attractive was that of the English Neoplatonists of the Cambridge school in the 17th century (*see* CAMBRIDGE PLATONISTS).

See also articles on many of the philosophers mentioned and references under "Neoplatonism" in the Index.

BIBLIOGRAPHY.—For the Middle Platonists, the Neopythagoreans and the Neoplatonists of the ancient world *see* F. Ueberweg and K. Praechter, *Die Philosophie des Altertums,* 12th ed., pp. 513–556 and 590–655 (1926); also T. Whittaker, *The Neo-Platonists,* 2nd ed. (1918). On Middle Platonism and the remoter origins of Neoplatonism *see* R. E. Witt, *Albinus* (1937); and P. Merlan, *From Platonism to Neoplatonism* (1953). On theurgy *see* E. R. Dodds, *The Greeks and the Irrational* (1951), appendix ii, pp. 283–311. On the development of Platonism and its influence on early Christian and Islamic thought *see* the *Entretiens sur l'antiquité classique,* ed. by the Fondation Hardt, vol. iii (1958). For the influence of Neoplatonism on later European thought, *see,* in addition to general histories of medieval and Renaissance thought and culture, R. Klibansky, *The Continuity of the Platonic Tradition During the Middle Ages* (1939). For the Cambridge Platonists, their antecedents and influence, *see* E. Cassirer, *The Platonic Renaissance in England* (1954). (A. H. Ar.)

NEOPTOLEMUS, in Greek legend the son of Achilles and of Deidameia, daughter of King Lycomedes of Scyros; sometimes called PYRRHUS, "the fair." He was brought up by Lycomedes on the island of Scyros. In the last year of the Trojan War, Odysseus brought him to Troy, because the seer Helenus had declared that the city could not be captured without the aid of a descendant of Aeacus, who had helped to build its walls; Neoptolemus was Aeacus' grandson. He fought bravely and took part in the capture of Troy, but committed the sacrilege of slaying the aged king Priam at an altar. By Andromache, Hector's widow, he was father of Molossus, ancestor of the Molossian kings. He eventually married Hermione, daughter of Helen and Menelaus, and was shortly thereafter murdered at Delphi—by Orestes according to some versions of his story. He was buried there, and later worshiped on the spot as a hero.

NEOPYTHAGOREANISM is the name given by modern scholars to the revival of Pythagoreanism (*see* PYTHAGORAS AND PYTHAGOREANISM) which began in the 1st century B.C. and formed part of the development of Greek thought which led up to Neoplatonism (*q.v.*).

One of the principal forms which the literary activity of the Neopythagoreans took was the production of a large number of pseudonymous works attributed to Pythagoras himself or to early Pythagoreans, a method of procedure which did a good deal to obscure their own philosophical personalities. It is also impossible to draw a clear line of demarcation between Neopythagoreanism and the revived Platonism of the period, which is generally known as Middle Platonism. There had already been, of course, a strong Pythagorean element in Plato's own thought, and Pythagorean influence had become still more marked in that of his immediate successors in the Greek Academy, Speusippus and Xenocrates; and the systems of the Neopythagoreans often show clear traces of the influence of the latest, most Pythagorean phase of Plato's thought—his speculations about the ideal numbers and the ultimate mathematical principles of reality, the One and the indefinite dyad—and also of doctrines which developed later in the history of Platonism, notably the placing of the ideas or forms in the mind of God.

Neopythagoreans can be distinguished, as far as distinction is possible, from Middle Platonists in the following ways. They think of the eternal realities and cosmic principles as numbers rather than as forms or ideas (though ideas are often identified with numbers) and speculate extensively on the nature and properties of numbers and their origin from the One: in these speculations something like the Neoplatonic hierarchy of being begins to appear. Some of them lay great stress on an ascetic morality and way of living according to precise, allegedly ancient Pythagorean precepts, among which vegetarianism, based on the old Orphic-Pythagorean doctrine of the kinship of all living things, holds an important place. Some, too, show a strongly marked tendency to magic and occultism; *e.g.,* Publius Nigidius Figulus (Cicero's learned friend and the first Neopythagorean whose name we know) and Apollonius (*q.v.*) of Tyana.

Neopythagoreans who are philosophically interesting because they contributed to the developments leading up to Neoplatonism include the unnamed authors whose works were read by Alexander Polyhistor in the 1st century B.C. (according to Diogenes Laërtius viii, 25–35); Moderatus of Gades in the 1st century A.D. and Nicomachus (*q.v.*) of Gerasa in the 2nd, who developed Platonic-Pythagorean number-theory; and Numenius (*q.v.*) of Apamea also in the 2nd century A.D., whose system in some ways anticipates that of Plotinus. There are also two curious Neopythagorean political treatises by authors writing under the names of Diotogenes and Ecphantus, of which excerpts are preserved by Stobaeus (their date is uncertain, but probably about the 2nd century A.D.). These take a very exalted view of kingship, representing the king as cause of harmony and order in the state as God is in the world, and as a kind of mediator between God and men. Ecphantus, the more inflated of the two, who develops a kind of royalist quasi-mysticism, influenced Eusebius of Caesarea, so that his ideas passed into the thought of the Christian Roman empire.

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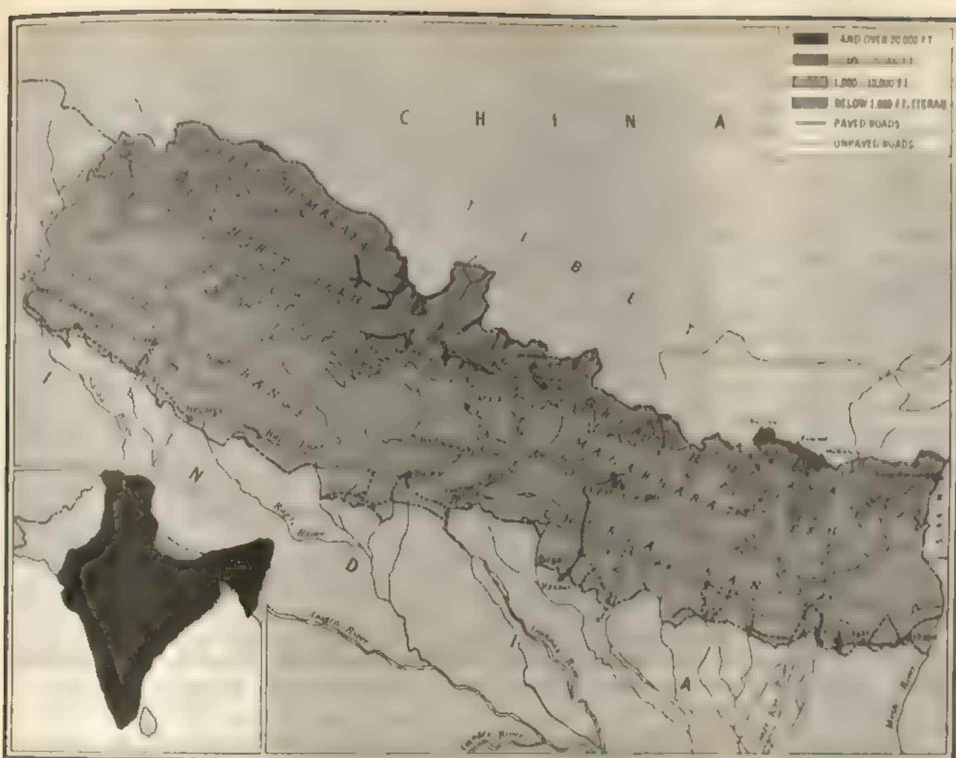
NEOSHO, a river of Kansas and Oklahoma, where it is also known as the Grand. The river rises about 20 mi. N. of Council Grove, Kan. This was Kaw Indian country and Neosho is a Kaw word meaning "wet bottom land." The crossing at Council Grove was the jumping-off point for the Santa Fe trail. There provisions were supplied for the long haul across the treeless plains. Flowing southward, the Neosho enters the Arkansas river near Ft. Gibson in Oklahoma. Erratic flow has limited development of the river. With a drainage area of 12,660 sq.mi., flow at its mouth varies from 133,000 cu.ft. per second to as little as 35 cu.ft. per second. Grand lake (Lake o' the Cherokees; 1,492,000 ac.ft. capacity) behind Pensacola dam is on the east edge of the Cherokee plain in Oklahoma and Ft. Gibson reservoir is near the junction of the Neosho with the Arkansas river. (C. N. C.)

NEPAL, an independent kingdom situated on the northeastern frontier of India, lying between longitude 80° 15′ and 88° 10′ E. and between latitude 26° 20′ and 30° 10′ N. Its extreme length is about 525 mi., and its breadth varies from 90 to 140 mi. It is bounded on the north by Tibet, on the east by Sikkim and West Bengal, and on the south and west by the Indian states of Bihar and Uttar Pradesh. Pop. (1961) 9,387,661. Area 54,362 sq.mi. The name Nepal is said to have been derived from the name of a saint Ne-Muni (Ne-pal, "the cherished of Ne"), who took up his abode near the confluence of the Bagmati and Vishnumati rivers. Originally applying only to the valley of Katmandu, it came to mean, with the Gurkha conquest, the whole of the territories at present incorporated in the state of Nepal. The capital is Katmandu.

Physical Geography.—Except for a narrow strip along the southern border, Nepal lies entirely within the great mass of the Himalayas. It is divided by altitude into three distinct zones: (1) The Terai, a strip of comparatively level country at the foot of the mountains, formerly consisting almost entirely of jungle and swamp, but of which large areas have now been brought under cultivation, and the low-lying valleys or Duns situated between the low Siwalik or Churia range of hills and the



TOPOGRAPHY AND MAJOR CITIES OF NEPAL

habharat Lekh of the Himalayas, which may be included with the Terai; (2) the central mountainous belt, varying in altitude from 1,000 to 8,000 ft.; and (3) the alpine zone, comprising the higher slopes and valleys of the main Himalayan range and the trans-Himalayan districts of Manangbhot, Mustangbhot and Charkhabhot. The backbone of the Nepalese Himalayas contains many of the highest mountains in the world; from east to west there are: Kangchenjunga (*q.v.*; 28,168 ft.); Makalu (27,790 ft.); Everest (*q.v.*; 29,028 ft.); Cho Oyu (26,750 ft.); Manaslu (26,-658 ft.); Himal Chuli (25,801 ft.); the Annapurna (*q.v.*) massif, which extends for more than 30 mi. and terminates in the east in Annapurna II (26,041 ft.) and in the west in Annapurna I (26,-391 ft.); Dhaulagiri (26,790 ft.); and, in the extreme west, Api (23,399 ft.). From this great range, which runs roughly from northwest to southeast, two lesser but still formidable ranges run roughly southward from Dhaulagiri and Gosainthan.

These ranges divide the country into four distinct regions. The western region extends from the Sarda, or Mahakali, river, which forms the frontier with Kumaon in the west, to the Dhaulagiri range and comprises the basins of the Karnali and Bheri, or Surju, and the greater Rapti, all of which combine to form the Gogra, which eventually flows into the Ganges. The central region comprises the basin of the Gandak and its tributaries the Narayani, or Kali Gandaki, the Seti, the Marsyandi, the Darondi, the Burhi Gandak and the Trisuli—the Sapt Gandaki (Seven Gandaks) of the Nepalese, which unite and flow out of Nepal near Tribeni Ghat and also join the Ganges. The great southern offshoot from Gosainthan bifurcates to form the third region, the elevated valley about 12 by 15 mi., the true Nepal, or valley of Katmandu, lying at an elevation of slightly more than 4,000 ft. and surrounded by mountains, which rise in places to 9,000 ft. and through which there is but one outlet, the gorge through which the holy Bagmati flows. To the east lies the fourth region, which is formed by the basin of the Sapt Kosi draining the mountains from Gosainthan to Kangchenjunga and including the Indrawati, the Sun Kosi, the Dudh Kosi, which flows down from Everest and Namche Bazar, the Arun and the Tamur. These rivers combine and flow into India not far from the Nepalese town of Biratnagar, where, as they debouch into the level plains, the almost annual floods used to cause havoc. To prevent this, the building of a barrage has been undertaken partly in India and partly in Nepal. The eastern frontier with the Darjeeling district of India is formed by the Singelala range running south from Kangchenjunga and the small Mechi river, which, although insignificant in itself, gives rise to the expression "from the Mechi to the Mahakali" denoting the whole of Nepal. Before consolidation of Nepal under the Gurkha power, the central region consisted of a number of independent principalities known to the Gurkhas as the Chaubisia, or Twenty-four Kingdoms; likewise the western region consisted of another 22 principalities known as the Baiisi Raj.

Climate.—The whole of Nepal is subject to the monsoon, but the climate varies greatly with altitude. The low-lying Terai has a subtropical climate and a heavy rainfall, hot in the summer, very humid during the monsoon but pleasantly cool in the winter. The central hills and the alpine zone have a pleasant summer, a cold winter with heavy snowfalls above 8,000 ft., and a monsoon in which the rainfall varies greatly from one valley to the next.

Vegetation and Animal Life.—The vegetation and animal life also vary considerably with altitude. In the Terai the most important tree is the sal (*Shorea robusta*), which provides a hard and durable timber. Other trees are the silk-cotton tree (*Bombax*) and dhak (*Butea frondosa*), which make the jungles beautiful in the spring with their red and flame-coloured flowers. The lower slopes of the central mountainous zone are for the most part heavily cultivated, but the chir pine (*Pinus roxburghii*) grows in places. Above the cultivation, from about 7,000 to 10,000 ft., are forests of oaks, including *Quercus lanuginosa*, *Q. semecarpifolia* and *Q. lammelosa*, while the rhododendrons, which grow from 5,000 to 12,000 ft., sometimes in dense forests and in many varieties, provide a magnificent show of flowers in the spring. Scattered through the forests are magnolias and wild cherry, wild pear, barberry (*Berberis*) and *Daphne*. There are many orchids, ferns and other wild flowers. In the alpine zone exist varieties of conifers, the silver fir, blue pine, juniper, yew, hemlock and also birch, dwarf rhododendron and other alpine flora, including primulas of many varieties, while in the higher and drier regions grows the blue poppy.

In the uncultivated parts of the Terai are vast jungles, the home of tiger and leopard, gaur or wild ox, occasional elephants and buffalo, and many deer: chital or axis deer, sambar and swamp deer. In the valley of the Lesser Rapti in the district of Chitawan is one of the last homes of the great Indian rhinoceros (*Rhinoceros unicornis*), of which only about 700 are believed to exist, 300 of these being in Nepal. Much poaching has gone on as the horn of the rhinoceros is reputed to be valuable as an aphrodisiac, but the Nepal government was, in the 1960s, organizing protective measures.

There are few wild animals in the central zone because of cultivation, extensive woodcutting and grazing in the forests. Occasional leopards, bear and the smaller carnivores inhabit the forests and ravines, and muntjac are found in the woods. In the alpine zone are musk deer, much persecuted for the musk pods it carries, the tahr and goral wild goats, and wild sheep, which are preyed upon by wolves and snow leopards. Pheasants are common, the kalij in the central hills and the magnificent monal, tragopan and blood pheasant in the alpine zone. The Yeti (bear-

man or Abominable Snowman, *q.v.*) is said by the Sherpas to inhabit the high snow mountains but has eluded discovery by several expeditions that have set out to solve the mystery of this fable. Strange tracks are often found in the snow, but opinion inclines to the belief that they were probably made by bears searching for new foraging grounds. River fauna includes the mahseer.

History.—In the early history of Nepal it is difficult to distinguish fact from legend, and dynasty succeeds dynasty with little apparent reference to historical time. According to legend, the valley of Nepal was once a lake that was drained by the saint Manjushri (Manjusri), who came on a religious pilgrimage from China and, striking the earth with his sword, opened the gorge of Chobar ("sword-cut"), through which the river Bagmati now flows. Having drained the valley, he returned to China, leaving his disciple Dharmarkar as the first king of the country. Many succeeding dynasties followed until Dharma Dutta is reported to have come with a conquering army from Conjeeveram (Kancheepuram), in south India. Gautama Buddha reputedly was born at Lumbini (*q.v.;* Rummindei, or Rupindei), which, although not in the valley of Nepal proper, is now in the Nepalese Terai. About 250 B.C. Asoka is said to have visited Nepal, where his daughter settled and founded Deopatan near the present shrine of Pashupati (*q.v.*). In the 5th century A.D., under King Mana Deva, commerce flourished, and trade with India and Tibet enriched the country. The pillar at the shrine of Changu Narayan, dated 496, records the successes of this reign. In about 606 began the reign of Amshuvarman, who founded the Thakur dynasty. He gave his daughter in marriage to the powerful Tibetan king Songtsen Gampo (Srong Btsan Sgampo), who also took a wife from China, and the two Buddhist queens converted their husband and are thus credited with introducing Buddhism into Tibet; they are famous to the Nepalese as the two Taras. Narendra Deva, the seventh king of this dynasty, is said to have brought the saint Machendra, deeply revered until the present day, into the valley. It was during his reign also that the first Chinese mission came to Nepal, and many pilgrims are said to have visited the valley, attracted by its reputation for piety and its connections with Buddha. Yaksha Malla, who is thought to have reigned from 1429 to 1460, annexed Morang, Tirhut, Gaya and Shekar Dzong in Tibet. He divided the country into four kingdoms: Bhadgaon, Katmandu, Banepa and Patan, giving one each to his three sons and daughter.

Little is known of the ancient kingdom of Gurkha (*q.v.*), but tradition and legends say that the ruling family was descended from the Rajput princes of Udaipur, who had been driven out of their own country by the Muslims and who moved into the Himalayas and settled down to set up their own principalities. In 1742 the able and ambitious Prithvi Narayan Shah (*q.v.*) came to the throne and took up arms against the Nepalese kingdoms. After many failures he was able, through the internal dissensions of the Malla kings of Katmandu, Bhadgaon and Patan, to subjugate the valley and brought it finally under his rule in 1768. He moved his capital to Katmandu, and for the first time the term "Nepal" began to denote more than the mere valley and the three towns. The Gurkha armies then turned east and west, extending their territories to Sikkim and subduing many of the principalities of the Chaubisia Raj. Prithvi Narayan died in 1775, but his successors continued to expand, conquering Sikkim and advancing in the west as far as the Kangra valley in Punjab, where they were brought to a stop by the power of Ranjit Singh of the Sikhs. An invasion of Tibet, which took the Gurkha armies to Shekar Dzong, brought on a war with China in which the Gurkhas were driven back to Nepal, and in 1793 a peace was concluded by which Sikkim and the conquests in Tibet were relinquished. Since 1787 there had been increasing friction with the British, culminating in the seizure of some of the territories administered by the East India company, which led to the Gurkha War of 1814–16. After some initial reverses British forces led by Gen. Sir David Ochterlony conducted a successful campaign, and a treaty of peace was signed by which the Gurkhas withdrew into approximately the present bounds of Nepal and agreed to accept a British envoy in Katmandu. The war was fought with gallantry and chivalry on both sides, and the two countries have remained close friends ever since.

After the Gurkha War, there followed a period of intrigue and internal dissensions in the court, which led to the rise of an able prime minister, Bhimsen Thapa, who virtually ruled the country through the minority of the king. He himself eventually fell victim to intrigue, and the court relapsed into a further period of dissension, which culminated in 1846 in the massacre of the Kot (the royal court of assembly) in which many of the leading noblemen were killed. A young but able soldier, Jung Bahadur, the grandnephew of Bhimsen, then became prime minister. Intrigues against his life led Jung Bahadur to banish the king and queen and to place the minor heir on the throne. Later he was appointed hereditary prime minister, an office which was to remain in his family until 1951. Jung Bahadur visited England in 1850–51 and remained a firm friend of the British, sending his troops to help them during the Indian mutiny. He died in 1877. Gurkha troops continued to serve as part of the Indian army until India's independence in 1947, and the existing regiments were then divided between Britain and India. In 1923 the treaty of Sagauli (1815, ratified 1816) between Nepal and Britain was replaced by a treaty of friendship by which Britain recognized the complete independence of Nepal.

By the end of World War II the Rana family had been ruling in Nepal for more than 100 years, and the time for change had come. Nepalese students in India had come in contact with democratic ideas, and in 1946 the Nepali Congress party was formed by the brothers Koirala. Not only were the people stirring against the autocratic rule of the Ranas but King Tribhuban (Tribhuvan), who had received a liberal education from tutors, determined to take his place as a constitutional monarch and in Nov. 1950 left his palace to take refuge in the Indian embassy, from where he was allowed to proceed to India. A revolution headed by the Nepali Congress broke out, and early in 1951 terms were agreed on between Maharaja Mohan and the Congress leaders by which a ten-man cabinet, composed half of Ranas and half of the Nepali Congress, assumed the government. King Tribhuban returned to Katmandu as a constitutional monarch on Feb. 18, and democracy had come to Nepal. In November 1951, finding that the mixed cabinet did not work, Maharaja Mohan, the last of the hereditary Rana prime ministers, resigned, and M. P. Koirala formed a government entirely from the Nepali Congress party. It had not yet been possible to hold an election, and during the next eight years there was a succession of more or less ineffective governments. King Tribhuban died in 1955 and was succeeded by his eldest son, the crown prince Mahendra Bir Bikram Shah Deva. The new king was determined to press on with preparations for an election and assembled a committee to draw up a constitution. The first election was held in 1959 and the new constitution brought into force. The Nepali Congress won a clear majority with 74 out of the 109 seats, the Gurkha Parishad with 19 forming the official opposition. Parliament was assembled for the first time in the autumn, with B. P. Koirala as prime minister.

In Dec. 1960, King Mahendra dissolved parliament, suspended part of the constitution and took over the administration himself. The reason given was dissatisfaction with the inefficiency and corruption of the government, which had created restlessness among the people. Later the king formed a council of ministers with himself as chairman, and all political parties were banned in Jan. 1961 by a proclamation, which also outlined the king's proposals for building "basic democracy" from the bottom, starting with village councils (*panchayats*). Relations with India, at first strained, improved, and, in April 1961, agreements were signed providing for continued Indian aid on a substantial scale for a wide range of development plans. The king visited Pakistan in Sept. 1961 and, later, Peking, where, in October, he signed an agreement with the Chinese People's Republic defining the boundaries between Nepal and China. A renewal of unrest occurred from Dec. 1961, and in Jan. 1962 a bomb was thrown at the king's car while he was on tour. In Feb. 1962 elections to village *panchayats* were held. In April 1962 the king paid an official visit to India, and the establishment was announced of an Indian-Nepalese committee to investigate Nepalese charges that India was supporting Nepalese rebels. In Dec. 1962 a revised constitution was an-

The Tamang village of Khangjung, located high in the Nepal Himalayas between Katmandu and the valley of Langtang

A scene in the Katmandu valley near the village of Gokarnabhan which is dominated by the temple of Gokarneshwar Mahadev

Nepalese men crossing a shallow section of the Bagmati river near Katmandu

Hindu pilgrims crossing a suspension bridge over the Kali Gandaki river in central Nepal. Dhaulagiri mountain is in the background

A view of Katmandu, capital of Nepal, noted for its pagoda-shaped temples, with the Himalayas in the distance

SCENES IN NEPAL

NEPAL

Buddhist stupa or shrine surrounded by prayer flags attached to ba[illegible] poles in a Katm[illegible]
[illegible]

Vendors displaying fruit in sidewalk market in Katmandu

CITIES OF NEPAL

Pilgrim women gather for the Shivrati festival by the ancient temple [illegible]
Pashupatinath, located on the Bagmati river

Pagoda-style Hindu temple in Bhadgaon, one of the three ancient cities in the Nepal valley

nounced, based on an indirectly elected single-chamber legislature known as the National *panchayat* (inaugurated April 1963).

The People.—The origin of the present peoples of Nepal is obscure, but it seems that a movement of Mongoloid peoples from the north met a movement of Aryan peoples from the south and west and that the resulting intermingling produced the present tribes. At a considerably later period there was a further influx of people of Rajput stock, who, driven out of their homes in India by the Muslims, drifted up into the hills, where they settled and to some extent intermarried with the local tribes. In the central mountainous zone the mixture of the tribes is most apparent. Throughout the length of Nepal in the lower valleys will be found the Brahmans and Chhetris (Chetris), who are perhaps a more recent mixture of the later Rajput invasion and the local tribes. Both Brahmans and Chhetris are strict adherents of the Hindu religion. The Chhetris belong to the warrior or Kshattriya caste and freely enlist in the army. Higher up the mountain slopes are Magars and Gurungs, two tribes of distinct Mongoloid origin and of famous fighting stock. In the hills surrounding the valley of Katmandu and extending east and west are the Tamangs, or Lamas, and farther east are the Rais, the Sunwars and the Limbus, also with great martial traditions. The religion of these Mongoloid tribes varies. The Magars incline toward the Hindu faith, and the Tamangs to the Buddhist. The Gurungs, Rais and Limbus have their own priests, and rites and ceremonies, at any rate within Nepal, incline more toward Buddhism than to Hinduism; away from home they tend to follow the predominant Hindu rites. In the alpine zone, tribes of more recent Tibetan derivation are found, the Sherpas in the east with their centre around Namche Bazar, and to the west the Bhotias, closely akin to the Sherpas and Tibetans. The chief population centres are Katmandu, Bhadgaon (*qq.v.*) and Patan. (RI. R. P.)

Newar Culture.—Until the end of the 18th century Nepal was all but limited to the central Nepal valley with its main cities of Katmandu, Patan, Bhadgaon and Kirtipur. The inhabitants were the Newars (who speak Newari), and in this enclosed area a remarkable Hindu-Buddhist culture began to develop, probably in the 4th century. The earliest historical records are stone pillars dating from the 5th century onward. Sanskrit was introduced as the literary and religious language, and the Nepal valley rapidly developed into a strong outpost of medieval Indian culture. Buddhism disappeared from India about the year 1200, but its elaborate forms have continued in Nepal up to the present time. In Katmandu are preserved the largest collections in the world of ancient Indian manuscripts. The remarkable pagoda temples so typical of Nepal are in fact descended from earlier Indian models; similar survivals exist in Kulu and the Sutlej valley and in Kerala. Newar craftsmen became famous for their wood carving, sculpture, metalwork and religious painting, and many of their crafts still survive. The Tibetans have been much indebted to Newar craftsmen in the past, and up till the Communist Chinese military occupation (1959) there was still an active Newar community of merchants and craftsmen in Lhasa. (D. L. SN.)

Languages.—Nepali (sometimes called Khaskura, Gurkhali or Parbatiya), the language of the Brahmans and Chhetris, is of Sanskrit derivation and has become the *lingua franca* of Nepal, but the Mongoloid tribes and the Newars have their own languages, which belong to the Tibeto-Burman group.

Administration and Social Conditions.—The constitution, promulgated in Dec. 1962, introduced a *panchayat* (council) system in four tiers, which was designed to enable the people at all levels to take part in the improvement of the country. At the lowest level is the village assembly (*gaun sabha*), representing a village or group of villages, of which all the villagers above 21 years of age are members; this assembly elects a nine-member executive, the village *panchayat*, whose function is to prepare and carry out plans for village improvement, and which can levy certain taxes. There are more than 3,500 village *panchayats* in the country. Urban areas have an elected council (*nagar panchayat*); there are 14 of these. The second level is the district assembly (*zilla sabha*), composed of representatives of the village and town *panchayats*, with its 11-member executive, the *zilla panchayat*, of which there are 75 in the country. This body can also levy taxes. It is also responsible for implementing government plans at district level, with the assistance of technical officials. The third level is the zonal assembly (*anchal sabha*), of which there are 14, and consists of the members of the district *panchayats* in the zone. It selects its own executive of 11, and also members of the national (*Rashtrija*) *panchayat*, which is the highest level and is in fact the national legislature. The national *panchayat* has a single chamber and consists of 125 members who are elected for four years, except for those elected by *anchal* assemblies, who serve for six years. One-third of the members retire every two years.

The council of ministers and its chairman are appointed by the king from the members of the national *panchayat*, and the council is responsible both to the king and to the *panchayat*. Fundamental rights conferred on the people include personal liberty, equality before the law and religious freedom.

The local *panchayats*, with their planning functions, are intended eventually to replace the administrative system also. For purposes of local government the country is divided into 38 districts, each under a Bada Hakim, who is responsible for all local administration. At each district headquarters is the district court and also an appeal court. There are three high courts, one in the east at Biratnagar, one in the centre at Katmandu and one in the west at Nepalganj, to which further appeals may be taken. There is also a supreme court in Katmandu to which certain appeals may be taken, and which is empowered to declare invalid any law not consistent with the provisions of the constitution.

Taxation is light, and there is no income tax. Revenue is raised chiefly from a land tax and from customs duties. A house tax for larger houses has been introduced, and the tax-free land tenure has been abolished.

The standard of living on the whole is low, but stark poverty is rare, the people generally being well fed, clothed and housed though there is little surplus. In the countryside little money passes, most families being more or less self sufficient. Houses are well built, usually of mud brick, coloured with red or white earth, and have two stories and generally a thatched roof.

Health and social services are in a rudimentary state, but in the early 1960s a mission from the World Health organization was assisting the government to improve health services and was running a school for medical assistants to work in the districts. There are state hospitals in Katmandu, Biratnagar and Nepalganj, but medical services were lacking outside the main centres. In Aug. 1963 a law code that abolished polygamy and child marriage and made all castes equal came into force.

The standard of education is low and illiteracy is widespread, but great efforts are being made to establish primary schools throughout the country. Katmandu and some other main centres have high schools, and in Katmandu, Tri-Chandra college prepares students for the external degrees of Patna university. Tribhubana university was established in 1958 and gives its own degrees. English is the principal medium of instruction.

The army consists of one division of infantry with a few supporting and ancillary units. There are, however, considerable reserves of trained men in the country, and expansion could be rapid. An armed police force is maintained for use in case of civil disturbance, and the normal civil police are organized throughout the districts.

The Economy.—Nepal is an agricultural country with few industries. The mountainous nature of most of the territory makes agriculture difficult, while the lack of communications hampers the development of industries and trade. In the greater part of the country the people live by subsistence agriculture, producing their own food and most of their requirements. Cloth and a few simple consumer goods are imported through India. A five-year plan (1956–60) was implemented to develop agriculture and industry. Aid for this plan was received from a number of more developed countries. A four-year plan (1962–65) followed with emphasis on communications, electrification and industry.

Agriculture.—In the Terai the main crop is rice. Most of the surplus rice is sent to the valley of Katmandu, where there is a deficit, but some of it is exported to India. Jute is grown in the

eastern districts of Morang and Jhapa, and there would appear to be possibilities of increasing this crop considerably. In the densely populated valley of Katmandu every available piece of ground is heavily cropped with rice in the monsoon season and with wheat or vegetables in the winter and dry months. The main crops in the hills are maize (corn), millet and pulses, which are grown on the carefully terraced hillsides; rice is grown in the valleys wherever it is possible to bring an irrigation channel. Comparatively few animals are kept as there is little cultivable land that can be spared for them, and they must graze on the rough hillsides. Buffalo and cows reared for milk are largely stall fed, but the Gurungs in the western hills keep flocks of sheep that feed on the high mountain slopes in summer and move down in winter to the rough and uncultivable areas in the lower hills. For the most part Nepal receives a sufficient rainfall, but in a few districts in the hills and in the central Terai the monsoon is sometimes scanty or untimely, and acute hardship, if not actual famine, results. In the alpine zone the Sherpas keep chaunries, a cross between the yak and hill cattle, for the production of butter. Surplus butter has been exported to Tibet, but efforts have been made to encourage the making of cheese that can be exported to India.

Forestry.—The main forest product is sal timber from the forests of the Terai, which is much in demand in India. In the past, forests have been mismanaged and severely damaged by indiscriminate cutting, but in the 1960s steps were taken to conserve them and to develop this industry, which brings in an appreciable revenue to the state.

Mining.—In various places in the hills small deposits of ochre, copper and iron are found, some of which are worked by primitive methods to produce simple utensils and agricultural tools, but these meet only a small part of the demand. A geological survey under the auspices of the United Nations Technical Aid administration was being carried out in the early 1960s. Deposits of hematite iron ore have been found on Phul Chowk, a 9,000-ft. mountain near Katmandu, but difficulties of extraction and the provision of fuel for smelting make it doubtful if these could be worked economically. A few deposits of soft coal exist, but their exploitation has so far not been found worthwhile. The main impediment to the development of mineral products is the difficulty of the terrain and the lack of communications.

Power.—Nepal has a vast potential for the production of hydroelectric power, which up to the early 1960s had hardly been tapped. Small hydroelectric plants exist near Katmandu for the production of electricity for the capital, and these are being further developed. The Kosi project, a joint project between Nepal and India for the control of the waters of the Kosi river by building a barrage on the river at the point where it crosses the Indian frontier, was planned to produce about 20,000 kw., half of which will be available to Nepal; and India, under the Colombo plan, is planning the construction of a hydroelectric power station at Trisuli, about 35 mi. from Katmandu, which when built will produce 18,000 kw. But this has hardly scratched the surface, ample water power being available in almost every district of the country.

Industries.—There has been very little industrial development beyond a few rice, jute and sugar mills at Biratnagar and rice mills at Birganj. Cement production near Hitaura, a tobacco factory, paper mills to deal with an indigenous grass that forms a suitable raw material and the modernization of the Biratnagar jute mills were planned.

Trade and Finance.—Internal trade is mostly concerned with the supply of the few consumer goods that the population can afford and is carried on by small shopkeepers rather than by large trading organizations. Practically all imports and exports pass through India. Imports consist of manufactured consumer goods, while exports are timber, rice and a small quantity of jute and wool. A small barter trade in rice and salt is carried on with Tibet.

There are two banks in Nepal, the Rashtriya (National) bank, concerned in government business, and the Nepal bank, which deals with ordinary banking business. The currency is the Nepali rupee, which had fluctuated in value but in the 1960s was maintained at a rate of 160 Nepalese to 100 Indian rupees.

The country is poor, and taxes are necessarily low. The budget is divided into two parts, that of ordinary expenditure and that for development. The main items of revenue are customs duties, land revenue, and forests. The development budget was supported by grants-in-aid from countries assisting in the development of Nepal.

Transport and Communications.—Good roads are few. A motor road runs from Raxaul on the Indian frontier to Katmandu, about 130 mi., and another from Jogbani to Dharan, about 30 mi. Under the tripartite road agreement between Nepal, the United States and India, a road was begun from Katmandu to Trisuli Bazar, and other roads were planned. A narrow-gauge railway about 30 mi. long runs from Raxaul to Amlekhganj and another from Jaynagar to Janakpur. The railhead at Amlekhganj was linked by truck road with Dhursing, thence by ropeway (electrically operated aerial cableway) to Matatirtha in the Nepal valley and thence by trolley line to Katmandu. A larger ropeway from nearer Amlekhganj to Katmandu was constructed in the 1960s. Katmandu has an all-weather landing ground, but low clouds can prevent the approach of aircraft to the valley. Other landing grounds are at Biratnagar, Rajbiraj, Simra, Narayangarh, Dang, Nepalganj and Pokhara, all of these being fair-weather grounds and all except Pokhara being in the Terai.

Radio Nepal at Katmandu broadcasts in Nepali, Hindi, Newari and English. Nepal has joined the International Postal union, and postal and telegraphic services are maintained with the rest of the world. (Ri. R. P.)

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NEPALI LITERATURE. Before the Gurkha (*q.v.*) conquest in 1768, Nepalese writings were in the Sanskrit, Newari and Nepali (also called Khas-kurā, Parbatiyā and Gurkhali) languages. They consisted of religious texts, chronicles, gift-deeds, etc. Extant material in Nepali, with the possible exception of the memoirs of the Gurkha king, Pṛthvī Nārāyaṇ Shāh (*c.* 1770), has historical but not literary interest. Literary writing in the language only began in the 19th century.

About 1830 a school of poets appeared which included Vasanta Sharma, Vidyāranya Keshari and Indiras. They wrote on themes from the *Rāmāyaṇa* (*q.v.*) and the *Bhāgavatapurāṇa*, in a language that is more Sanskrit than Nepali. They were followed by Bhānubhakta (1814–69), whose version of the *Rāmāyaṇa* achieved great popularity for the colloquial flavour of its language, its religious sincerity, its patriotic fervour and its realistic natural descriptions; and, later, by Lekhnāth Pauḍyāl (b. 1884) who also tended to the colloquial and used the rhythms of popular songs in some of his poems.

Printing in Katmandu, the capital of Nepal, dates from the 1860s, and there were presses also in Varanasi (Benares) and Darjeeling. The *Gorkhā Patra*, Nepal's first newspaper, began in 1901; educational books appeared, and *Candrikā*, the first indigenous Nepali grammar, was published in 1912. The age of modern literature, however, really began in the 1920s with the institution of the *Gorkhā Bhāsāprakāśinī Samiti*, and owes much to two brothers, Bālkṛṣṇa (b. 1903) and Puṣkar Shamsher (1902–60). The former wrote plays based on Sanskrit and English models, lyric poetry and some short stories; the latter, a teacher, lexicographer and grammarian, was a short-story writer and translator from English. Their contemporaries were the poets Lakṣmīprasād Devkoṭā (1908–60) and Siddhi Caran (1912–) and the prose writer Bhīmnidhi Tivārī (1911–). Modern poets have discarded the earlier Sanskrit-dominated tradition in favour of themes more suited to the ideologies of their new democracy, and have imitated 20th-century European and American verse, though Devkoṭā also used the popular *jhyāure* metre. Their diction, however, is often artificial and their thoughts ob-

scure. By the 1960s modern Nepali literature had produced only minor poets, but in the short story some authors had achieved a measure of success.

Newari, the mother tongue of more than half the population of the Katmandu valley (*see* PAHARI LANGUAGE), and the court language until 1769, was denied literary expression until censorship began to relax in the 1940s. Since then many Newars have written and published, and in the 1950s one, Cittadhar "Hrday" (1906–), achieved considerable local reputation.

In the past many scripts were used in Nepal, including *devanāgārī*; the various scripts of Newari; and Tibetan. The modern press uses only the *devanāgārī*, for Newari and Nepali alike.

See Bāburām Ācārya, *Purānā Kavi Ra Kavitā* (1946).

(T. W. CL.)

NEPHELINITE is a basic lava, usually completely crystallized, in which the essential minerals are nephelite and pyroxene.

Known only from Tertiary strata, nephelinites are abundant in the Canary Islands, the Azores, the Cape Verde Islands and Fernando De Noronha Island off the coast of Brazil. Specimens from the Eifel and Kaiserstuhl regions in Germany are staples in petrographic collections, as are those from central Bohemia and the Odenwald (Katzenbuckel). They are on the whole not common in the Mediterranean area, but leucite-bearing representatives are known from Monte Vulture in Italy and Tripoli in north Africa. Nephelite-rich basic lavas are perhaps most extensively developed in east Africa, especially in the Somali Republic and Masai-land (in Kenya) and also in Nigeria. In the United States they are best known from the Big Bend region of west Texas, the Bearpaw mountains, Mont., and Cripple Creek, Colo.

The pyroxene in nephelinites may be either titan-augite or aegirine; plagioclase, if present, is commonly labradorite. Varieties rich in leucite and haüyne are well known. Biotite is characteristic in some types; amphibole is scarce. Accessories may include sanidine, melilite, melanite, sodalite, perofskite, pseudobrookite, apatite and chromite.

The nomenclature of these nephelite-rich basalts is confusing but firmly established. The plagioclase-free varieties are called nephelinite if they also lack olivine, nephelite-basalt if olivine is an essential constituent. The plagioclase-bearing varieties are called nephelite-tephrite if they lack olivine and nephelite-basanite if olivine is an essential constituent. They are otherwise similar in mineralogy, appearance, structure and occurrence. The relative abundance of the plagioclase-free and plagioclase-bearing members of the group is a matter of conjecture, as is the quantitative importance of the group as a whole vis-à-vis more normal (*e.g.*, nonfeldspathoidal) basalts. About all that can be said is that, despite their wide geographic distribution and occasional extensive local development, they are very rare rocks.

(F. Cs.)

NEPHELITE, or NEPHELINE, a rock-forming mineral consisting of sodium, potassium and aluminum silicate, is an essential constituent of certain older alkaline plutonic rocks, such as the nephelite-syenite of southern Norway. Commercial quantities of nephelite-syenite occur in Ontario, Can., and the nephelite, because of its high alumina content, is used in the manufacture of glass and ceramic products as a substitute for feldspar.

Nephelite is commonly associated with feldspar, sodalite, cancrinite, biotite, corundum and zircon; never with primary quartz. Two varieties are distinguished. Nephelite proper is glassy, light coloured and frequently in crystals. It is common in recent eruptive rocks rich in alkalies, such as phonolite, nephelite-basalt, leucite basalt, etc., and also certain dike rocks such as tinguaite. The best crystals occur with mica, sanidine and garnet in the crystal-lined cavities, or vugs, of the ejected blocks of Monte Somma, Vesuvius. The other variety, eleolite, occurs as rough crystals or irregular masses, which have a greasy lustre, and are translucent or nearly opaque, with a red, green, blue or brown colour.

Nephelite has the approximate formula $Na_6K_2Al_8Si_9O_{34}$. Artificial crystals can be made with the composition $NaAlSiO_4$, but the natural material always contains some potassium and an excess of silica. Nephelite crystals are hexagonal, usually in the form of short six-sided prisms terminated by a basal pinacoid. The specific gravity (2.6), the low index of refraction and the feeble double refraction are nearly the same as in quartz, but it is optically negative, while quartz is positive, and the hardness is only 5.5, in contrast to 7 for quartz. Nephelite is easily decomposed by hydrochloric acid, with separation of gelatinous silica and formation of cubes of salt upon evaporation. A clear crystal of nephelite when immersed in acid becomes cloudy for this reason; hence the name, from the Greek meaning "a cloud." Nephelite alters easily to natrolite, sodalite, cancrinite, kaolin or muscovite. It occurs as a pseudomorph after leucite.

(L. S. RL.)

NEPHELITE-SYENITE or ELEOLITE-SYENITE, a medium- to coarse-grained rock consisting largely of feldspar and nephelite; always considerably poorer in silica and richer in alkalies than granite. Nephelite-syenite from Canada is used in the place of feldspar in ceramic and glass products (*see* NEPHELITE).

Composition.—The feldspar in nephelite-syenite may be cryptoperthite (*see* FELDSPAR: *Unmixing at Low Temperature*) or a mixture of albite and microcline, the latter combination being on the whole rather rare. The place of nephelite is sometimes wholly or partly taken by sodalite or cancrinite. Quartz and calcic plagioclase feldspar are absent. The amount of dark silicates is generally somewhat greater than in granite, but rarely exceeds 30% by volume. The content of nephelite is also usually less than 30%; perhaps it would be more correct to say that rocks containing more than 30% either of dark silicates or of nephelite usually are not called nephelite-syenite.

The commonest dark silicate is green pyroxene, usually zoned from diopside cores to aegirine mantles. Alkaline amphibole (green, brown or blue) is also abundant, and in some areas pyroxene is virtually absent, its place being taken by a mixture of hornblende and biotite.

The accessory minerals include most of those found in granite, as well as a host of uncommon species, such as melanite, scapolite, pectolite, enigmatite, eudialyte, eucolite, mosandrite, lamprophyllite, perovskite, vesuvianite. Calcite is almost never absent and may be abundant. Minerals rich in zirconium, titanium and rare earths occur frequently and sometimes in great abundance. The extraordinarily varied mineralogy of the nephelite-syenites and their remarkable variation in habit, fabric, appearance and modal composition have attracted much attention; more petrographic research has been devoted to them than to any other plutonic rock.

Occurrence.—The amount of nephelite-syenite and related volcanic or plutonic rocks in the lithosphere is proportionately very small; the known or reasonably inferred volume of these rocks is probably less, for instance, than the volume of a single large gabbro complex. Yet they occur in great variety on every major land mass, and volcanic representatives are known from a considerable number of oceanic islands. Plutonic nephelite rocks ordinarily occur in small complexes, some quite isolated, but most in close association with effusive rocks of similar composition. The largest known masses are those on the Kola peninsula (U.S.S.R.), in Pilansberg (western Transvaal, S.Af.) and near Julianehaab (Ilimausak-Igaliko, Greenland). It is estimated that nephelite rocks underlie about 750 sq.mi. in Kola, about 200 sq.mi. in Pilansberg and about 100 sq.mi. near Julianehaab. No other dominantly plutonic complexes of comparable size are known, and most, including some of the most closely studied, are very much smaller.

Mode of Origin.—The magmas which give rise to nephelite rocks must in some way be derivative, either from other, more abundant magmas, or from reaction between one (or more) of these magmas and previously solidified rocks. Lime-rich accessory minerals abound in nephelite-syenite, and many nephelite-syenites are closely associated with limestone. Desilication of basaltic magma by assimilation of limestone was long ago proposed, and has been found to occur. It is extremely limited, however, and where nephelite rocks are genetically associated with other magmatic rocks, the latter are much more often granitic than basaltic. A granite-limestone syntexis, that is, chemical modification by fusion and incorporation of rocks in contact (*see* METASOMATISM), is accordingly favoured by some petrographers, and the field evidence for it is sometimes persuasive. Limestone, how-

ever, is a common sediment and is often intruded by granite, the commonest of all plutonic rocks. Why should the products of a reaction between the two be so rare?

The strongest alternative to syntectic explanations is the ingenious pseudoleucite hypothesis of N. L. Bowen, a generalization based on the observed or reasonably imagined consequences of the incongruent melting of orthoclase (*see* GEOCHEMISTRY: *The Reaction Series*). It is sometimes argued that the hypothesis requires an extraordinarily delicate co-ordination between crystallization and fractionation, but in view of the scarcity of undersaturated rocks this is not a critical objection. Far more important is the unconformable circumstance that leucite is not known to occur in plutonic rocks. One must thus assume either that the transformation of leucite to a mixture of nephelite and orthoclase always proceeds to completion at depth or that nephelite-syenites form in some other fashion.

In sum, despite the great interest that attaches to the nephelite-syenites and the immense amount of work that has been done upon them, there is little agreement about the way(s) in which these rare rocks have been formed.

For discussion of theories of rock formation *see* MINERALOGY; PETROLOGY. (F. Cs.)

NEPHRITIS: *see* URINARY SYSTEM: *Diseases and Their Medical Treatment.*

NEPHROSIS: *see* URINARY SYSTEM: *Diseases and Their Medical Treatment.*

NEPHTHYS, Greek form of the name of the Egyptian goddess Nebtho. She seems to have been artificially created in apposition to Isis to be a second sister to the god Osiris and wife to his brother Set (Setekh). She plays practically no part outside the myth of Osiris, in which her only function is to bewail with Isis the death of Osiris. The meaning of her name ("Mistress of the Castle") suggests that she is a mere personification of Osiris' residence, while Isis (Egyptian Ese, "Seat") personifies his throne. (J. CY.)

NEPOS, CORNELIUS (b. probably between 100 and 90 B.C., d. probably shortly after 31 B.C.), Roman historian, correspondent of Cicero, biographer of Atticus (also a friend of Cicero), and the friend to whom Catullus dedicated his poems. He came, like Catullus, from north Italy. His principal writings were *De Viris Illustribus*, brief biographies of distinguished Romans and foreigners; *Chronica*, introducing to the Roman reader a Greek invention, universal comparative chronology; *Exempla*, anecdotes, perhaps a model for the biographer Valerius Maximus; possibly a universal geography to match the *Chronica;* and lives of the elder Cato and Cicero. There survive one book from the *De Viris Illustribus* (containing the following lives: Miltiades, Themistocles, Aristides, Pausanias, Cimon, Lysander, Alcibiades, Thrasybulus, Conon, Dion, Iphicrates, Chabrias, Timotheus, Datames, Epaminondas, Pelopidas, Agesilaus, Eumenes of Cardia, Phocion, Timoleon, certain kings, Hamilcar and Hannibal) and part of another book from the same work (containing lives of the younger Cato and Atticus). These lives are mostly very brief, being a few characteristic anecdotes uncritically strung together to illustrate trite moral principles; that of Atticus is longer, but absurdly eulogistic. Nepos is not notable as a literary stylist; he writes simply, but without elegance or purity.

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NEPOS, JULIUS, Western Roman emperor 474–480, born of a distinguished family, was sent by Leo I to govern Italy as patrician. He at once took Glycerius (*q.v.*) prisoner and deposed him, and was himself proclaimed emperor in June 474. In 475 he was obliged to recognize the independence of the Visigothic kingdom centred on Toulouse. But the patrician Orestes, father of Romulus Augustulus, rose against him, and Nepos fled from Italy to Dalmatia in Aug. 475. He lived at Salona (modern Split in Yugoslavia) for five years, recognized in Gaul and in the east as emperor, though Romulus had usurped his position in Italy. He was eventually murdered by dependents of Glycerius on May 9, 480. (E. A. T.)

NEPTUNE (Latin NEPTUNUS; Etruscan NETHUNS), an Italian god of fresh water and hence not originally a sea-god. In cult he had a female counterpart, Salacia, who was perhaps a goddess of leaping spring water. He is early (at least by 399 B.C.) identified with the Greek Poseidon (*q.v.*) and hence becomes a deity of the sea. Subsequently his cult partner, in literature at least, was equated with the Greek Amphitrite.

Neptune's festival (Neptunalia) is listed in the oldest calendars and took place in the heat of the summer (July 23) when water was most wanting. Thus it may be conjectured that its purpose was the propitiation of the fresh-water deity. About the festival little is known save that the intense heat of the season necessitated the construction of shelters from the leaves of trees to keep the sun off the worshipers.

Neptune had a temple in the Circus Flaminius at Rome which was either built or extensively restored by Gnaeus Domitius Ahenobarbus, who was consul in 32 B.C. A coin of Domitius shows it to have been a tetrastyle temple. One of the features of the temple was a sculptured group of marine deities headed by Poseidon and Thetis, executed by Scopas and probably obtained by Domitius in Bithynia.

In art Neptune appears as the Greek Poseidon, whose attributes are the trident and the dolphin.

See W. W. Fowler, *Roman Festivals of the Period of the Republic* (1899); G. Wissowa, *Religion und Kultus der Römer* (1912); Platner-Ashby, *Topographical Dictionary,* s.v. (R. B. LO.)

NEPTUNE, astronomical symbol the trident ♆, is the eighth planet in order of increasing distance from the sun. The mean distance of Neptune from the sun is 2,796,700,000 mi. or 30.07 times that of the earth. Its period of revolution around the sun is 164.8 years.

Neptune receives so little light from the sun and is so far from the earth that it is invisible to the unaided eye. However, it is easily visible in a small telescope as a star of about the eighth magnitude. In a large telescope under favourable observing conditions the planet shows a greenish disk 2.5 seconds of arc in diameter. No surface markings have ever been detected upon the disk. From spectrographic observations the period of rotation was found to be 15.8 hours. The direction of rotation is the same as that of the earth.

The mass of Neptune, accurately known from the motion of its larger satellite, is 17.2 times that of the earth. The diameter of the planet is 27,600 mi. (44,516 km.), according to measurements made by G. P. Kuiper in 1949. This makes the mean density of Neptune 2.47 times that of water or 0.45 times the density of the earth. The albedo of Neptune, or ratio of the light reflected from the planet to that falling on it, is 0.62, indicating a cloud-covered surface of high reflecting power.

Although Neptune shines by light reflected from the sun, the greenish hue of the disk is due to the absorption of the red, orange and yellow solar rays by the planet's atmosphere. In the infrared region the absorption bands are so strong as nearly to obliterate the spectrum. The origin of the bands remained unknown until 1932 when R. Wildt identified them with methane (CH_4). The amount of methane in the atmosphere has been found to correspond to a thickness of 25 mi. of the gas under normal atmospheric pressure. The most abundant gases present are believed to be hydrogen and helium, derived originally from the sun and retained by the high velocity of escape from the planet's atmosphere. Unfortunately hydrogen and helium give no observable absorption markings in the spectrum so that their presence can only be inferred. There is a group of bands at λ 7500 found by Kuiper in 1949 in the spectra of Uranus and Neptune which has not been identified.

The temperature at the visible surface of Neptune is low, about −337° F. (−205° C.).

The Satellites of Neptune.—Neptune has two known satellites. The larger was discovered on Oct. 10, 1846 by William Lassell, only 17 days after the discovery of the planet itself. The

name of Triton was suggested for the moon by N. C. Flammarion and is often used. Triton revolves around Neptune at a mean distance of 220,000 mi. in a period of 5.876833 days. The direction of revolution is retrograde or opposite to the direction that Neptune rotates on its axis. The mass of Triton found by H. L. Alden (1943) is 0.022 times the mass of the earth or 1.8 times the mass of the earth's moon, in good agreement with earlier determinations. Its diameter has been estimated at 3,000 mi.

From the motion of the plane of the satellite's orbit and the period of Neptune's rotation, the oblateness, or deviation from spherical form, of the planet and the nature of its internal constitution can be inferred. From such deductions it is concluded that internally Neptune closely resembles Jupiter.

In 1948 a second satellite was discovered by Kuiper, who gave it the name of Nereid. According to G. Van Biesbroeck (1951), Nereid revolves around Neptune in the same direction the planet rotates in a period of 359.4 days. The mean distance or length of the semimajor axis of the satellite's orbit is 3,465,000 mi. But the eccentricity of the orbit is so high (0.76), that Nereid may approach as close as 832,000 mi. to Neptune, and recede as far as 6,100,000 mi. Kuiper estimated that Nereid is 180 mi. in diameter and 1/4,000 as massive as Triton.

The Discovery of Neptune.—By far the most interesting thing about Neptune is the story of its discovery. The account which follows was written by Simon Newcomb.

The detection of Neptune through its action upon Uranus before its existence had been made known by observation is a striking example of the precision reached by the theory of the celestial motions. So many agencies were concerned in the final discovery that the whole forms one of the most interesting chapters in the history of astronomy.

The planet Uranus, before its actual discovery by Sir William Herschel in the year 1781, had been observed as a fixed star on at least 17 other occasions, beginning with John Flamsteed in 1690. In 1820 Alexis Bouvard of Paris constructed tables of the motion of Jupiter, Saturn and Uranus, based upon a discussion of observations up to that year. Using the mutual perturbations of these planets as developed by Pierre Laplace in the *Mécanique céléste*, he was enabled satisfactorily to represent the observed positions of Jupiter and Saturn; but the case was entirely different with Uranus. It was found impossible to represent all the observations within admissible limits of error, the outstanding differences between theory and observation exceeding 1′. In these circumstances one of two courses had to be adopted; either to obtain the best general representation of all the observations, which would result in the tables being certainly erroneous, or to reject the older observations which might be affected with errors, and base the tables only on those made since the discovery by Herschel. A few years of observation showed that Uranus was deviating from the new tables to an extent greater than could be attributed to legitimate errors of theory of observation, and the question of the cause thus became of growing interest. Among the investigators of the question was F. W. Bessel, who tried to reconcile the difficulty by an increase of the mass of Saturn, but found that he could do so only by assigning a mass not otherwise admissible. Although the idea that the deviations were probably due to the action of an ultra-Uranian planet was entertained by Bouvard, Bessel and doubtless others, it would seem that the first clear statement of a conviction that such was the case, and that it was advisable to reach some conclusion as to the position of the disturbing body, was expressed by the Rev. T. J. Hussey, an English amateur astronomer. In a letter to Sir George B. Airy in 1834 he asked Airy's views of the subject, and offered to search for the planet with his own equatorial if the required estimate of its position could be supplied. Airy expressed himself as not fully satisfied that the deviation might not arise from errors in the perturbations. He therefore was not certain of any extraneous action; but even if there were such action, he doubted the possibility of determining the place of a planet which might produce it. In 1837 Bouvard, in conjunction with his nephew Eugène, was again working on the problem; but they appear not to have done more than to collect observations and to compare the results with Bouvard's tables.

In 1835 F. B. G. Nicolai, director of the observatory at Mannheim, Ger., in discussing the motion of Halley's comet, considered the possibility that it was acted upon by an ultra-Uranian planet, the existence of which was made probable by the disagreement between the older and more recent observations.

In 1838 Airy showed in a letter to the *Astronomische Nachrichten* that not only the heliocentric longitude but the tabulated radius vector of Uranus was largely in error, but made no suggestions as to the cause. In 1843 the Royal Society of Sciences of Göttingen, Ger., offered a prize of 50 ducats for a satisfactory working up of the whole theory of the motions of Uranus, assigning Sept. 1846 as the time within which competing papers should be presented. It is also recorded that Bessel, during a visit to England in 1842, in a conversation with Sir John Herschel, expressed the conviction that Uranus was disturbed by an unknown planet. He went so far as to set his assistant Fleming at the work of reducing the observations, but died before more was done.

The question had now reached a stage when it needed only a vigorous effort by an able mathematician to solve the problem. Such a man was found in John Couch Adams, then a student of St. John's college, Cambridge, who seriously attacked the problem in 1843, the year in which he took his bachelor's degree. He soon found that the observations of Uranus could be fairly well represented by the action of a planet moving in a radius of twice the mean distance of Uranus, which would closely correspond to Bode's law. During the two following years he investigated the possible eccentricity of the orbit, and in Sept. 1845 communicated his results to James Challis. About Nov. 1, 1845, Adams also sent his completed elements to Airy, stating that according to his calculations the observed irregularities in the motion of Uranus could be accounted for by the action of an exterior planet, of which the motions and orbital elements were given. It is worthy of note that the heliocentric longitude of the unknown body as derived from these elements is only between one and two degrees in error, while the planet was within half a degree of the ecliptic. Two or three evenings devoted to the search could not therefore have failed to make the planet known. Adams' paper was accompanied by a comparison of his theory with the observations of Uranus from 1780, showing an excellent agreement. Airy in replying to this letter inquired whether the assumed perturbation would also explain the error of the radius vector of Uranus, which he seemed to consider the crucial test of correctness.

The Elements.—At D. F. Arago's suggestion the investigation had been taken up by U. J. J. Leverrier, who had published some excellent work in theoretical astronomy. Leverrier's first published communication on the subject was made to the French Academy on Nov. 10, 1845, a few days after Adams' results were in the hands of Airy and Challis. A second memoir was presented by Leverrier on June 1, 1846. His investigation was more thorough than that of Adams. He first showed that the observations of Uranus could not be accounted for by the attraction of known bodies. Considering in succession various explanations, he found none admissible except that of a planet exterior to Uranus. Considering the distances to be double that of Uranus he then investigated the other elements of the orbit.

The following are the elements found by Adams and Leverrier:

	Leverrier	Adams	
		Hypothesis I	Hypothesis II
Semimajor axis	36.154	38.38	37.27
Eccentricity	0.1076	0.16103	0.12062
Long. of perihelion	284° 45′	315° 57′	299° 11′
Mean longitude	318° 47′	325° 8′	323° 2′
Epoch	1847, Jan. 1	1846, Oct. 1	1846, Oct. 1
True longitude	326° 32′	328°	329°

The longitude of the planet was 327° 57′ on Oct. 1, 1846.

The close agreement of these elements led Airy to suggest to Challis, on July 9, 1846, a search for the planet with the Northumberland telescope. He proposed an examination of a part of the heavens 30° long in the direction of the ecliptic and 10° broad,

and estimated the number of hours' work likely to be employed in this sweep. The proposed sweeps were commenced by Challis on July 29. The plan required each region to be swept through twice, and the positions of all the known stars found to be compared, in order that the position of the planet might be detected by its motion. On Aug. 31 Leverrier's concluding paper was presented to the French academy, and on Sept. 18 he wrote to John G. Galle (1812–1910), then chief assistant at the Berlin observatory, suggesting that he should search for the computed planet, with the hope of detecting it by its disk, which was probably more than 3″ in diameter. J. F. Encke, the director of the observatory, approved of the search, and with the aid of H. L. d'Arrest, a student, the search was commenced, but it was not found possible to detect any planet by its disk.

Star charts were at the time being prepared at the observatory under the auspices of the Berlin Academy of Sciences. It was suggested by d'Arrest that this region might be covered by one of the charts. It was found that such was the case. Comparing the stars on the chart one by one with the heavens it was found that an eighth-magnitude star now visible was not on the chart. On the following evening the object was again looked for, and found to have moved. The existence of the planet was thus established. It was afterward found that Challis had observed the planet on Aug. 4, but had failed to detect it.

In the debate whether Leverrier should receive the sole credit of the discovery, Arago argued that actual publication alone should be considered, rejecting Adams' communications to Airy and Challis as quite unworthy of consideration. He also suggested that the name of Leverrier should be given to the planet, but this proposal was received with so little favour outside of France that he withdrew it, proposing that of Neptune instead.

The observations at the first opposition showed that the planet was moving in a nearly circular orbit, and was at a mean distance from the sun much less than that set by Leverrier as the smallest possible. The latter had in fact committed the error of determining the limits by considering the variations of the elements one at a time, assuming in the case of each that while it varied the others remained constant. But a simultaneous variation of all the elements would have shown that the representation of the observations of Uranus would be improved by a simultaneous diminution of both the eccentricity and the mean distance, the orbit becoming more nearly circular and the planet being brought nearer to the sun. But this was not at first clearly seen, and Benjamin Peirce of Harvard university went so far as to maintain that there was a discontinuity between the solution of Adams and Leverrier and the solution offered by the planet itself, and that the coincidence in direction of the actual and computed planet was an accident. But this view was not well founded, and the only explanation needed was to be found in Leverrier's faulty method of determining the limits within which the planet must be situated. The actual motion of the planet during the century preceding, as derived from Leverrier's elements, was much nearer the truth than the elements themselves were. This arose from the fact that his very elliptic orbit brought the planet near to the sun, and therefore near to its true position, during the period from 1780 to 1845, when the action on Uranus was at its greatest.

The observations of the first opposition enabled Sears Cook Walker of the National observatory, Washington, D.C., in Feb. 1847 to compute the past positions of the planet, and identify it with a star observed by J. J. Lalande at Paris in May 1795. Lalande's manuscript showed that he had made two observations of the planet and finding them discordant had rejected one as probably in error and marked the other as questionable.

A mere re-examination of the region to see which observation was in error would have led him to the discovery of the planet more than half a century before it was actually recognized.

See also references under "Neptune" in the Index.

(S. N.; T. E. R. P.; S. B. N.; R. S. Rn.)

NEPTUNIUM, a synthetic chemical element, has the symbol Np and atomic number 93. In the periodic system of the elements it is the fourth member of the actinide series (*see* Periodic Law; Transuranium Elements). The long-lived isotope Np^{237} can be considered the parent of the missing $4n + 1$ radioactive series, and it has been suggested that this radioactive family be called the neptunium radioactive series by analogy with the names for the uranium and thorium radioactive series. The atomic weight of neptunium can be taken as that of its only long-lived isotope available in quantity, Np^{237}, whose atomic weight is 237.0480.

Discovery.—Among the many experiments stimulated by news of the discovery of atomic fission in uranium was a very simple one designed by E. M. McMillan at the University of California at Berkeley in 1940, with the object of testing the penetrating power of fission fragments. As a target at the cyclotron he used a piece of paper thinly coated with uranium oxide, backed by a stack of cigarette papers. After bombarding the uranium atoms with neutrons, he measured the radioactivity of each of the pieces of cigarette paper. He found in the uranium sample a radioactivity that evinced a different half-life and different properties from those of the fission products with which the other sheets were impregnated. He realized that this radioactivity might be caused by a previously undiscovered element. In the task of identifying the new substance, McMillan was joined by P. H. Abelson. They succeeded in chemically separating the first transuranium element, atomic number 93, which they named neptunium after the planet Neptune, the first planet beyond Uranus (after which the element uranium had been named). The neptunium isotope found by McMillan and Abelson has the mass number 239 and undergoes a 50% disintegration by radioactivity in 2.33 days (its half-life). The element was first isolated (using the long-lived isotope Np^{237}) in weighable quantity, as 10 μg. of the oxide, by L. B. Magnusson and T. J. LaChapelle in 1944 at the wartime Metallurgical Laboratory (now the Argonne National Laboratory) of the University of Chicago.

Occurrence and Production.—Traces of Np^{239} are to be expected in uranium minerals as a result of continual formation by capture in U^{238} of neutrons from various sources, according to G. T. Seaborg and M. L. Perlman. D. F. Peppard and co-workers established the presence of Np^{237} in Belgian Congo pitchblende in a concentration corresponding to a ratio of Np^{237} to U^{238} of 1.8×10^{-12}, the result of the action of fast neutrons.

In the late 1960s the only practical source of neptunium in weighable amounts was through the production of Np^{237} as a byproduct in nuclear chain reactors. In reactors utilizing U^{238} as fertile material, it results as the decay product of the short-lived, beta-particle-active U^{237}, which is formed by the action of neutrons on U^{238}. In such reactors fueled with natural uranium Np^{237} is produced at a rate of about 0.1% of that of the concur-

Table I.—*Isotopes of Neptunium*

Isotope*	Half-life	Type† and energy of radiation (Mev)
Np^{231}	~50 min.	α6.28
Np^{232}	~13 min.	EC
Np^{233}	35 min.	EC $\alpha(\sim 10^{-3}\%)$ 5.53
Np^{234}	4.40 days	EC (99%) $\alpha(<10^{-3}\%)$ $\beta^{+}(4.6 \times 10^{-3}\%)$ 0.8
Np^{235}	410 days	EC $\alpha(1.6 \times 10^{-3}\%)$ 5.095, 5015, 4.925, 4.864
Np^{236m}	≥5,000 yr.	
Np^{236}	22 hr.	EC (51%) β^{-}(49%) 0.52, 0.48
Np^{237}	2.14×10^{6} yr.	α4.872 (3.1%) 4.816 (3.5%) 4.787 (53%) 4.767 (29%) 4.713 (1.7%) 4.674 (3.3%) 4.644 (6.0%) 4.589 (0.5%) 4.52 (0.02%)
Np^{238}	2.10 days	β^{-}1.25 (45%) 0.27 (55%)
Np^{239}	2.33 days	β^{-}0.715, 0.654, 0.44, 0.33
Np^{240m}	7.3 min.	β^{-}2.16 (52%) 1.59 (31%) 1.26 (11%) 0.76 (6%)
Np^{240}	63 min.	β^{-}0.89
Np^{241m}	~3 4 hr	β^{-}
Np^{241}	16 min	β^{-}1.4

*The symbol m placed after the mass number refers to an isomeric form of isotope.
†EC = electron capture; α = alpha particle;
β^{-} = negative beta particle; β^{+} = positive beta particle.

rent Pu^{239} production. In high neutron flux reactors with enriched U^{235} as fuel, Np^{237} results from the successive absorption by U^{235} of two neutrons to form U^{236} and then U^{237}, which decays to form Np^{237}. The neptunium can be isolated by carrying on appropriate precipitates, by solvent extraction procedures, or by ion-exchange methods. The future may see the production of ton quantities of Np^{237} for use in the preparation of the useful isotope Pu^{238} (*see* PLUTONIUM).

Chemical Properties.—Metallic neptunium is highly electropositive, much like uranium and other actinide metals; it can be prepared by reducing the trifluoride or tetrafluoride with an active metal such as calcium or barium. The metal has a silvery appearance and melts at 640 ± 1° C. The room-temperature form of neptunium metal (α-neptunium) is orthorhombic (calculated density = 20.45 ± 0.03 g. per cubic centimetre). This form has been found to be stable up to 278° C, where it transforms into a tetragonal form (β-neptunium) with a density at 313° C of 19.36 g. per cubic centimetre. Above 570° C the metal seems to be cubic body-centred (γ-neptunium), and its density at 600° C is 18.0 g. per cubic centimetre. This phase is presumably stable up to the melting point. The metal is about as malleable as uranium made under the same conditions. Although the metal is chemically reactive, in common with other metals of the actinide elements, it does not tarnish rapidly when exposed to air at room temperature.

Using the isotope Np^{237}, it has been possible to establish the oxidation states and the properties of a large number of the compounds of neptunium. These investigations have shown that neptunium has the oxidation states VI, V, IV, and III with a general shift in stability toward the lower oxidation states as compared to uranium. The compounds which are formed are very similar to the corresponding compounds of uranium.

The ionic species corresponding to the oxidation states vary with the acidity of the solution; in acid solution and of moderate strength the species are Np^{3+}, Np^{4+}, NpO_2^+, and NpO_2^{2+}, similar to the ions of uranium and plutonium. The potential scheme (units of volts relative to hydrogen-hydrogen ion couple as zero) in one molar perchloric acid is as follows:

$$Np^0 \xrightarrow{+1.83} Np^{3+} \xrightarrow{-0.155} Np^{4+} \xrightarrow{-0.739} NpO_2^+ \xrightarrow{-1.137} NpO_2^{2+}$$

$$Np^{3+} \xrightarrow{-0.677} NpO_2^{2+} \qquad Np^{3+} \xrightarrow{-0.447} NpO_2^{+} \qquad Np^{4+} \xrightarrow{-0.938} NpO_2^{2+}$$

The metal is highly electropositive, in common with the other actinide elements. The $Np^{3+} \rightarrow Np^{4+}$ couple is reversible and this oxidation can be accomplished by the oxygen of the air. The IV state is stable, not oxidized by air, and only slowly oxidized to NpO_2^+ by nitric acid. The $Np^{4+} \rightarrow NpO_2^+$ couple is not readily reversible while the $NpO_2^+ \rightarrow NpO_2^{2+}$ couple is reversible; this is reasonable on the basis that the former involves breaking the neptunium-oxygen bonds while the latter does not. The oxidation of NpO_2^+ to NpO_2^{2+} requires moderately strong oxidizing agents.

Neptunium ions in aqueous solution possess characteristic colours: pale purple for Np^{3+}, pale yellow-green for Np^{4+}, green-blue for NpO_2^+, while NpO_2^{2+} varies from colourless to pink or yellow-green depending on the acid present. The sharp absorption bands are useful for quantitative and qualitative analysis for neptunium with the following the most useful: 5520, 6020, 6610, and 7875 Å for Np^{3+}; 5040, 7430, and 8250 Å for Np^{4+}; 4280 and 6170 Å for NpO_2^+; and 4760 and 5570 Å for NpO_2^{2+}.

The neptunium V ion NpO_2^+ is in many respects a unique ion, there being few if any elements forming a stable 5^+ oxidation state in solution that at the same time form a simple unpolymerized ion. The NpO_2^+ ion resembles other singly-charged cations such as K^+ in many respects. NpO_2^+, however, is complexed by oxalate ion in aqueous solution; this appeared to be the only complex ion of this oxidation state known in the late 1960s. In addition to the well-characterized neptunium V oxalate, a solid incompletely characterized potassium neptunium V carbonate is also known. The neptunium VI ion, NpO_2^{2+}, separates as the beautifully crystalline salt, $NaNpO_2(CH_3COO)_3$, sodium neptunylacetate, from solutions containing high concentrations of sodium ions and acetate ions.

TABLE II.—*The Halides of Neptunium*

Compound	Colour	Crystal structure	Density* (g./cc.)	Melting point (° C)	Boiling point (° C)
NpF_3	purple	hexagonal	9.12	—	2500†
NpF_4	light green	monoclinic	6.8	—	1750†
NpF_6	white(?)	orthorhombic	—	53	decomposes
$NpCl_3$	white	hexagonal	5.58	800†	1800†
$NpCl_4$	red brown	tetragonal	4.92	—	—
$NpBr_3$	green	hexagonal	7.11	—	1800†
$NpBr_4$	red brown	UBr_4 type	—	740	decomposes(?)
NpI_3	brown(?)	orthorhombic	6.82	—	—

*Calculated from X-ray diffraction data.
†Estimated values.

The neptunium-oxide system exhibits complexity similar to but perhaps less than that found in the uranium-oxide system. Thus the important oxide is NpO_2 and there exists a range of compositions, depending upon the conditions, up to Np_3O_8. The oxide of composition NpO_3 has also been prepared. The important halides of neptunium are summarized in the accompanying table.

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NERBUDDA: *see* NARMADA.

NEREIDS, in Greek mythology the daughters (numbering 50 or 100) of a sea-god, Nereus (eldest son of Pontus, a personification of the sea, and Gaea, the earth goddess), and of Doris, daughter of Oceanus. They were imagined as young girls, inhabiting any water, salt or fresh, and as benign toward mankind. They were not worshiped as much as some nymphs, but were popular and literary figures. The best known of the Nereids are Amphitrite, consort of Poseidon; Thetis, wife of Peleus and mother of Achilles; and Galatea, a Sicilian figure loved by the Cyclops Polyphemus.

See also NYMPH. (H. W. PA.)

NERETVA, a river of Yugoslavia in Hercegovina and Dalmatia, rises in the Cemerno Mountains and flows for 135 mi. in a northwesterly direction past Konjic through Jablanica Lake and then southwest via Mostar and Gabela (its head of navigation) to the Adriatic Sea. Much of the course of the river is flanked by cliffs. With the building of the Jablanica Dam, Neretva formed an artificial lake of crystal green-blue waters, abounding in fish and provided water for an important hydroelectric station. During World War II Yugoslav partisans fought one of the most decisive battles against the Germans and Italians in the Neretva gorges. (V. DE.)

NERGAL, a secondary god of the Sumero-Akkadian pantheon. He was identified with IRRA, the god of pestilence, and with MESLAMTAEA, "he who comes forth from Meslam" (*i.e.*, from Hades). A text of King Shulgi of the 3rd dynasty of Ur (*c.* 2000 B.C.) gives the name Emeslam to Nergal's temple at Cuthah (modern Tell Ibrahim), the chief centre of his cult. A text saying that "Shamash and Nergal are one" may indicate that Nergal was originally a solar deity. In later thought he also was "a destroying flame" and has the epithet "burner," *sharrapu*.

His name is Sumerian, meaning "Lord of the Great Abode." It does not occur on the earliest Sumerian texts nor on Semitic texts of the dynasty of Akkad (*c.* 24th century B.C.). A later tradition makes King Naramsin of that dynasty attribute to Nergal his victories. The few references to Nergal on texts of the 3rd dynasty of Ur reveal nothing of his nature or genealogy. A little later Kudurmabuk, king of Larsa, describes him as "the first in rank of the sons of the god Enlil," "full of mighty force and terrifying splendour." Kudurmabuk's son Rim-Sin adds that Nergal causes not only fear and death but also life and vegeta-

tion. Hammurabi (*c.* 18th century B.C.) beseeches him, as "the fighter without a rival who brought him victory," to destroy any who contemn his laws. Assyrian documents of the 1st millennium B.C. describe him as a benefactor of men, who hears prayers, restores the dead to life and protects agriculture and flocks. Hymns depict Nergal as a god of pestilence, hunger and devastation. The names of the 14 demons who accompany him are, for the most part, names of diseases. He works destruction, especially at night.

The other sphere of Nergal's power is the underworld, of which he became "king" and "great in Arallu." From the two fragments of an Akkadian text found at Tell el Amarna it appears that Nergal, escorted by demons, descends to the underworld where the goddess Ereshkigal (*q.v.*) is queen. He threatens to cut off her head. She saves herself by becoming his wife, and Nergal obtains "kingship over the wide underworld" and the "tablets of wisdom" (probably the tablets on which were written the names of persons whose date of death had been decided).

Nergal does not figure prominently in epics and myths. In the Epic of Gilgamesh, however, it is he who opens a hole in the ground from which the spirit of Enkidu, the dead friend of Gilgamesh, comes forth. In the deluge story, "Irragal" (*i.e.*, Nergal) takes a hand in bringing devastation to the earth by tearing out its posts.

The cult of Nergal was very widespread beyond the borders of Sumer-Akkad, where it first appears. He had a sanctuary at Mari (modern Tell el Hariri), on the Euphrates. Inscriptions of Assyrian kings name him. To Sargon II (722–705 B.C.) he is one of the "gods who dwell in Kalakh" (modern Nimrud). There was a gate of Nergal at Nineveh by Sargon's son Sennacherib and a temple to him at Tarbisi, to the north (by Sennacherib and Ashurbanipal). Inhabitants of Cuthah, transported to Samaria, brought their god with them (II Kings xvii, 24–31). The name of "Atanahili, slave of Nergal," occurs on a Babylonian cylinder found at Taanach in Canaan. There were priests of Nergal at Piraeus, the port of Athens. A letter found on the island of Elephantine in the Nile includes Nergal in a list of gods. *See* also BABYLONIA AND ASSYRIA: *Religion: Sumerian Pantheon.*

See A. Deimel, *Pantheon Babylonicum* (1914); E. (Paul) Dhorme, *Les Religions de Babylonie et d'Assyrie* (1949). (T. FH.)

NERI, SAINT PHILIP (FILIPPO NERI) (1515–1595), one of the outstanding figures of the Counter-Reformation, known as the second "apostle of Rome," was the founder of the Institute of the Oratory (*see* ORATORIANS). St. Ignatius of Loyola and St. Charles Borromeo were his friends, the church historian Caesar Baronius was his disciple, and Palestrina came within his circle. Born in Florence on July 21, 1515, Philip left the city at about the age of 18 for the home of a relative near Monte Cassino. After what might be termed a conversion (though his life was innocent), he went to Rome where he spent his remaining 60 years. He tutored the sons of a Florentine in return for an attic and a pittance. He attended lectures on philosophy and theology, though not intending to receive holy orders but rather to pursue a lay apostolate. Cheerful and open by temperament, he conversed with the young men of the city in order to lead to some serious question: "Well, and when shall we begin to do good?" He served in the hospitals and frequently spent whole nights in prayer in the catacombs of St. Sebastian.

In 1548 he founded the confraternity of the Holy Trinity to give hospitality to poor pilgrims and convalescents discharged from hospitals.

In 1551, prevailed on by his spiritual adviser, he was ordained priest and went to reside with the chaplains at San Girolamo della Carità, in the via di Monserrato. There he gathered in his room the young men he had already grouped around him and others whom he won by an assiduous ministry in the confessional. These meetings had some resemblance to modern discussion groups with the addition of prayers and hymns. When numbers increased he transferred these meetings to the church attics. They called this locality "the Oratory," a name that came to be applied also to those who met there and to the devotional, charitable and recreational activities that Philip devised for them (among these music, whence ultimately "oratorio"). For a time (1564–75) Philip was rector of the Florentines' church of San Giovanni; in this period Baronius and other disciples were ordained, thus forming the germ of a new community.

In 1575, a bull of Gregory XIII granted Philip the ancient church of Sta. Maria in Vallicella and established there in perpetuity "a Congregation of secular priests and clerics known as the Oratory." The old church was pulled down and a new one built—still called the Chiesa Nuova—and a house for the priests, though it was not until 1583 that Philip went there to reside. In 1577 he was formally elected provost of the congregation.

Apart from the pressure he exerted on Pope Clement VIII to obtain the absolution from excommunication of King Henry IV of France, Philip played no part in the political events of the time. His work was essentially one of personal influence; he attracted men not merely by his joyfulness and humour but, even more, by the spiritual gifts he manifested. His fervour of spirit was accompanied by a sensation of physical heat and a violent palpitation of the heart; distrustful of all ecstatics he was frequently carried away by ecstasies himself. Many miracles were attributed to him, notably the raising to life of Paolo dei Massimi. Up until the end of his life he continued to hear confessions and receive all who sought his help.

Philip died on May 26, 1595, and was buried in the church he had built. He was canonized in 1622; his feast day is May 26.

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NERNST, WALTHER HERMANN (1864–1941), German chemist, winner of the 1920 Nobel prize in chemistry for his thermochemical work, was one of the founders of modern physical chemistry, making fundamental contributions in the fields of electrochemistry, theory of solutions, thermodynamics, the solid state and photochemistry. He was born June 25, 1864, in Briesen, West Prussia, and was educated at the universities of Zürich, Graz and Wurzburg. In 1887 he became assistant to Wilhelm Ostwald (*q.v.*) at Leipzig university. Ostwald, along with J. van't Hoff and Svante Arrhenius, was then establishing physical chemistry as an independent branch of chemistry, and Nernst, in the midst of such a stimulating group, at once began his own important researches.

His academic career commenced with his appointment to the physics department of the University of Göttingen in 1890. In 1905 he moved to the Physicochemical laboratory of the University of Berlin and in 1924 he became director of the Institute for Experimental Physics there. He remained in this position until his retirement in 1933. His electrochemical studies were begun under the inspiration of the then new dissociation theory of Arrhenius which first recognized the importance of ions in solution.

In 1889 Nernst worked out the theory of galvanic cells by assuming a solution pressure which forced ions from the electrode into solution and which was opposed by an osmotic pressure of the dissolved ions. In the same year, still thinking in terms of ions, Nernst derived the equations for the solubility product which defined the conditions under which solids precipitate from saturated solutions. In 1906 he announced his heat theorem, or third law of thermodynamics, which showed that the maximum work obtainable from a process could be calculated from the heat evolved at temperatures near absolute zero. This made precise the older ideas which had neglected the effects of temperature and permitted calculation of conditions of equilibrium in many chemical reactions. Besides its great theoretical importance, the theorem had many industrial applications, including calculations for the synthesis of ammonia. Nernst received the Nobel prize for his formulation of the heat theorem. Nernst and his students made many important physicochemical measurements, especially the determination of vapour densities at high temperatures and of the

specific heats of solids at very low temperatures. These he considered from the point of view of the quantum theory. In 1918 his photochemical studies led him to the atom chain reaction theory. This assumed that once the energy of a quantum has initiated a reaction in which free atoms are formed, these atoms can in turn decompose other molecules with the liberation of more free atoms, and so the reaction can continue for long periods without further illumination. This mechanism explained many reactions which had puzzled photochemists.

Nernst was mechanically minded and was much interested in the application of science to industry. Besides his theoretical contributions he invented an improved electric light and a piano with electronic amplification of its sounds. His inventions never received wide acceptance, however. His textbook on theoretical chemistry, first published in 1893, was influential for many years. He also published a number of monographs in his special fields. In his later years he concerned himself chiefly with astrophysical theories, a field in which the heat theorem also had important applications. He died Nov. 18, 1941, in Muskau. (H. M. L.)

NERO (NERO CLAUDIUS CAESAR) (A.D. 37–68), Roman emperor from A.D. 54 to 68, born on Dec. 15, 37, was an Ahenobarbus (*q.v.*) by birth, his original name being Lucius Domitius Ahenobarbus. His father died about 40, and his mother, Agrippina (*q.v.*) the younger, a great-granddaughter of Augustus, became in 49, on Messallina's death, the wife of her uncle, the emperor Claudius I. Claudius' son Britannicus was only three years younger than Nero; but Agrippina persuaded Claudius in 50 to adopt Nero and later to give Nero his daughter Octavia in marriage and mark him out for the succession by various honours. On Oct. 13, 54, Claudius died, poisoned, it was said, by Agrippina; she at once had her son proclaimed by the praetorian guard, whose prefect Burrus (*q.v.*) was her partisan; the senate had to accept a *fait accompli*. For the first time absolute power in the empire was vested in a mere boy, not yet 17.

Agrippina immediately eliminated the powerful freedman Narcissus, who had always opposed her aims, and Marcus Junius Silanus, a descendant of Augustus and a potential pretender. She hoped to control the government, and in 55 her dominance is symbolized in coins which bear her name and bust. But Burrus and Nero's old tutor, the philosopher Seneca (*q.v.*), though they owed their influence to her, were not content to remain her tools. They encouraged Nero in an amour with the freedwoman Acte, of which Agrippina disapproved; this led to a growing coolness in her relations with Nero. She even showed favour to Britannicus, and Nero retaliated by poisoning him. In 56 she was forced into retirement. From that time, if not earlier, till 62 Burrus and Seneca were the effective rulers of the empire.

On his accession Nero had promised in a speech written by Seneca to put an end to the most odious features of the Claudian regime, secret trials before the emperor and dominance of corrupt freedmen, and to accord more independence to the senate. For some time these promises were largely fulfilled. Secret trials were few. Narcissus was dead; his rival, the financial secretary Pallas, retired in 55. Not till 66, when Nero left Helius in charge of Italy, did any freedman openly enjoy such power as they had done. The senate had more liberty in debate. The law of treason was dormant; Claudius had put 40 senators to death, but between Marcus Silanus' murder and 62 there were no like incidents in Nero's reign.

The great question of the day was that of Armenia. Since Augustus it had been Roman policy to appoint vassal kings and so make it a buffer against Parthia. But the Armenians could rarely tolerate Roman nominees and the Parthians regarded Roman control of Armenia as a threat to their own security. In Claudius' last years a Parthian prince, Tiridates, had possessed himself of the country with the good will of most of its people. Claudius had done nothing; the new government took vigorous action, appointing an able general, Corbulo (*q.v.*), to the command. Prolonged and desultory operations led in 66 to a new settlement; Tiridates was recognized as king, but had to come to Rome to do homage to Nero. This settlement had probably been the consistent aim of Nero's government (*see* Tacitus, *Annals*, xiii, 9, 34, 37; xv, 5, 25), though Parthian intransigence forced it *c.* 59 to revert temporarily to the Augustan pattern. It is generally held that this arrangement, which most of Nero's successors adopted, made for more harmony with Parthia; yet with Armenia no longer dependent the Romans had to post two more legions on the Euphrates to guard against Parthian attacks. Whatever the merits of the new policy, they must be credited to Nero's early advisers, even though it was only in his last years that it could be put into effect.

While directing the government themselves, Burrus and Seneca left Nero to pursue his own tastes and pleasure uncontrolled. In his essay *De clementia*, Seneca urged him to use his autocratic power conscientiously, but he failed, if indeed he tried, to harness the boy's more generous impulses to his responsibilities. At first Nero hated signing death sentences, and the extortions of the tax-farmers led him to suggest in 58 that the customs dues should be abolished; this was of course impracticable and only abortive reforms resulted. Even later Nero was capable of grandiose plans —for rebuilding Rome, for cutting a canal through the Isthmus of Corinth, or for eastern conquest. But for the most part he used his position simply to gratify his own personal pleasures. As early as 56 his nocturnal rioting in the streets was a grave scandal. In 58 he became attached to the wife of Otho (*q.v.*), Poppaea Sabina. Agrippina objected and in 59 he had her murdered. Seneca himself was employed to justify her death as that of a traitor. No one believed this, but all accepted it. Nero concluded that he was free to behave as he chose. He fancied himself not only as a poet but as a charioteer and lyre player, and in 59–60 he began to give public performances; later he also appeared on the stage. To the Roman mind these were infamous breaches of decorum. Seneca felt that he had lost all influence and, after Burrus' death in 62, retired. Nero at once divorced Octavia on a trumped-up charge of adultery and soon put her to death; he then married Poppaea (62); she died in 65 and Nero subsequently married Statilia Messallina.

The great fire at Rome illustrates how low his reputation had sunk by 64. He did what he could to relieve the homeless and initiated rebuilding on a much better plan. Yet it was believed, without warrant, that he had fired the city himself in order to indulge his aesthetic tastes in its reconstruction. Nero tried to shift the charge on to the Christians, who were commonly thought to practise all kinds of wickedness. Hitherto the government had not clearly distinguished Christians from Jews; almost by accident, Nero initiated the later policy of intermittent and half-hearted persecution and earned himself the reputation of Antichrist in the Christian tradition.

Hated and therefore suspicious, Nero began in 62 to remove men whose lineage made them seem dangerous. In 65 a plot to make Gaius Calpurnius Piso emperor was quenched in a blood-bath; Lucan (*q.v.*) perished, as did Seneca, who may have been guiltless. It was ominous that the conspirators included military officers, one of whom spoke for all respectable people in denouncing Nero as "murderer of his mother and wife, a charioteer, an actor and an incendiary" (*Annals*, xv, 67). A reign of terror ensued among the high classes; among the victims was the upright Thrasea Paetus, who had retired from public life in protest against Nero's conduct (A.D. 66).

In 67 Nero went to Greece to display his artistic prowess. Perhaps while he was there, a new plot was revealed; its author was a son-in-law of Corbulo, and Nero thought it prudent to recall both Corbulo and the generals of the Rhine armies and order their death. But the situation remained so tense that Helius (*see* above) urgently recalled him to Rome.

The provinces too were oppressed. Misgovernment in Britain had provoked Boudicca's revolt in 60 (*see* BOADICEA), and in Palestine Jewish patience was exhausted in 66; the great insurrection lasted till 70. Exactions are most fully documented from Egypt, but the scanty allusions in extant literary sources suggest that if similar papyrological evidence survived from elsewhere it would tell much the same story. They resulted from Nero's extravagance in court expenditure, buildings and gifts to his favourites; the last are said to have amounted to 2,200,000,000 sesterces, a sum

probably over five times the annual cost of the army. At Nero's death the treasury was empty and the soldiers' pay had fallen into arrears. Nero had thus earned the hatred and contempt of the old ruling class at Rome; the Italian middle class, which had old-fashioned moral views and from which many or most army officers were drawn; the provincials; and even the troops.

In March 68 Julius Vindex, a Gallic senator who was governing Gallia Lugdunensis, raised a revolt; he had no army, but he could appeal not only to his oppressed fellow Gauls but also to Romans and provincials everywhere. Galba (*q.v.*), the governor of Nearer Spain, lent the revolt the authority of his high birth and reputation, and even the Rhine legions, though they destroyed Vindex at Besançon, threw off their allegiance. At Rome the praetorians followed suit; proscribed by the senate, Nero cut his throat on June 9. The Roman populace and later the praetorians regretted a liberal patron. To his subjects in general he had been a tyrant, and the revolt his misrule provoked sparked off a series of civil wars which threatened the survival of the empire and caused widespread misery. For portrait *see* article ROMAN HISTORY. *See* also references under "Nero" in the Index.

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NERTHUS (HERTHA), in Germanic mythology, the goddess of fertility, "Mother Earth," stated by Tacitus to be worshiped with orgies and mysterious rites at night by Teutonic tribes. Her veiled statue was moved from place to place by sacred cows. After the rites the image, vestments and vehicle were bathed in a lake.

NERVA, MARCUS COCCEIUS (A.D. 30 [probably]–98), Roman emperor from Sept. 18, 96, to Jan. 27 or 28, 98, was a member of a distinguished senatorial family distantly related by marriage to the Julio-Claudian house. He had been twice consul (A.D. 71 and 90) when, on the assassination of Domitian, he was invited to be emperor by the conspirators and gladly accepted by the senate. A number of elder statesmen emerged from retirement to help him in the task of government, and the keynote of the regime was a skilfully propagandized return to public and private freedom after the tyranny of Domitian. Sound, though uninspired, measures were taken, concentrating on the welfare of Rome, Italy and the *cives Romani;* they included the last *lex populi* in Roman history, an agrarian law on the Gracchan model. The one imaginative innovation commonly attributed to Nerva's government, the system of *alimenta*, which combined a farming subsidy with the establishment of trusts for the maintenance of poor children in Italy, was more probably the work of Trajan.

In 97 the praetorian guard, instigated by one of its commanders, forced Nerva to hand over the men who had given him the principate, Domitian's murderers, to be murdered in their turn. His helplessness convinced him that he must secure the succession, and in the second half of 97 he adopted and took as colleague M. Ulpius Traianus, governor of one of the German provinces. Trajan had no need to return to Rome; the government went quietly on, and Nerva died in his bed in Jan. 98. He was the last emperor to be buried in the mausoleum of Augustus.

Nerva is usually described as benevolent but feeble; historians echo Pliny in saying that only by the adoption of Trajan was a total collapse of government prevented. Some believe that the choice of Trajan was forced upon Nerva by a "Spanish party" at court and in the army. This is an exaggerated view, not proved by the evidence. Nerva was old and childless; he had therefore to choose a successor sooner or later, and his death early in 98 shows that he chose none too soon. It does not follow that the choice was forced on him; he should be given the credit for statesmanlike rule and wisdom in deciding who was best fitted to succeed him.

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NERVAL, GÉRARD DE (pseudonym of GÉRARD LABRUNIE) (1808–1855), French poet, whose talent, long undervalued as that of a minor writer, was rediscovered in the 20th century, when it was recognized that, especially in his last works, he had symbolized the aspirations of romanticism by his power to transmit the drama of his own inner life with brilliant intensity.

He was born in Paris on May 22, 1808, and, in the same year his father, a doctor, was sent to serve with Napoleon's Rhine army. His mother left him in the care of a nurse in the country, and joined her husband in Hanover. She died in 1810, and Gérard was placed in charge of a great-uncle at Mortefontaine in the Valois. The memory of his childhood there was to haunt him with its poignant sweetness all his life. In 1820 he went to live with his father in Paris, in order to attend the Collège Charlemagne, where he formed a lasting friendship with Théophile Gautier (*q.v.*), a fellow student. For a few years he led a carefree existence, shared with Gautier and other friends, in which dances and suppers counted more than the demands of literature. A legacy from his grandparents gave him the means to travel in Italy. These years, a time which Gérard later called his "*bohème galante*," reached their climax in 1835, when the young painters and poets used to meet in an old house in the Impasse du Doyenné. This lighthearted time soon ended, however. The *Monde dramatique*, a periodical into which Gérard had poured the remains of his legacy, failed. And in 1836 he fell passionately in love with Jenny Colon, an actress; two years later she married and in 1842 she died. This shattering experience changed his life. Later in the same year he was able to set out on his travels to Egypt and the Levant, and in the years that followed he both wrote and published; but from then on his life was ridden by such violent obsessions that his reason was constantly endangered and on eight occasions he had to be sent to mental hospitals for care. These years of anguish and destitution ended in the dawn of Jan. 26, 1855, when he was discovered hanging from a lamppost in the Rue de la Vieille-Lanterne, Paris.

Until 1836 Nerval's gifts as a writer were dissipated in work which failed to reflect his particular genius; neither the poems of patriotism, the stories in the manner of E. T. W. Hoffmann, the intimate verse, nor even the adaptation of Goethe's *Faust* would have been enough to ensure his fame. He began to write from his deepest self in the *Voyage en Orient* (1843–51). At the foot of the pyramids, in Syria and in Lebanon he pursues the phantom of his beloved or seeks analogies between his personal obsessions and oriental folktales. The goddess Iris appears to him as the image of the Eternal Feminine of which Jenny herself had been a fugitive incarnation.

Finally he wrote his masterpieces. "Sylvie," written in 1853 and included in *Les Filles du feu* (1854), is a short story in which the countryside where he had been happy as a child and the women he had loved are recreated in musical, lucid prose. His playmate Sylvie, with all her peasant simplicity, is a foil both to the high-born grace of Adrienne, glimpsed long ago in the gardens of a château, and to the magical enchantment of Aurélia who is none other than Jenny Colon herself. The memory of Jenny Colon also dominates *Aurélia* (1853–54), a longer story written during the intervals of his last mental crises: here he describes his obsessions and hallucinations, as well as his trust and hope, and in the final visions the image of Aurélia merges with that of the Virgin who assures him of salvation. Finally, *Les Chimères* (1854) is a sonnet sequence of extraordinary complexity in which the images derived from his reading coalesce with those that echo his personal life; a literal commentary is often difficult to achieve, but the splendid music of the language in the most perfect of the sonnets ("El Desdichado," "Artémis") has an overwhelming power. As a poet and writer of prose Gérard de Nerval attained the summit of his art whenever he combined his exquisite taste with his infallible intuition for the appropriate image to transcribe the dreams of his sensitive spirit, forever in quest of an unattainable paradise.

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(P.-G. CA.)

NERVE, in anatomy, is a glistening white cordlike bundle of fibres, surrounded by a sheath, that connects the nervous system with other parts of the body (*see* NERVOUS SYSTEM). The nerves conduct impulses toward or away from the central nervous mechanism. In man 12 pairs, the cranial nerves, are attached to the brain and 31 pairs, as a rule, of spinal nerves attach to the spinal cord. The fibres constituting the individual nerves are very numerous, and all, save those arising in the sympathetic ganglia, extend from the brain or cord to the peripheral structures which they innervate.

With respect to function, nerve fibres are divided into two categories, namely, sensory or afferent and motor or efferent. The fibres of these categories and their subdivisions constitute the functional components of the nerves. The combinations of such components vary in the individual cranial nerves; in the spinal nerves they are more uniform.

The afferent (sensory) fibres are subdivided into somatic and visceral groups. The somatic afferents conduct impulses received from outside the body or produced by movements of the muscles and joints, those from the muscles and joints also being known as proprioceptive fibres. The visceral afferents conduct messages from the organs serving the internal economy of the body; such impulses result in reflex control of these organs (*e.g.*, the rate of the heart beat, activities of the digestive system and others).

The motor fibres also are divided into somatic and visceral motor or efferent groups. Somatic efferent fibres innervate voluntary muscles that derive from the myotomes of the embryo (*see* MUSCLE AND MUSCULAR SYSTEM). Visceral motor fibres are subdivided into special visceral efferents, which innervate striped muscles of branchial origin, and general visceral efferents, which innervate involuntary muscle and secreting glands. The general visceral efferent fibres constitute the autonomic system, of which there is a sympathetic division and a parasympathetic division, based on differences in anatomical arrangement and physiological characteristics. The term sympathetic also is frequently used to include both divisions as well as the ganglia and afferent fibres associated with them.

The autonomic pathway involves a chain of two fibres, one arising in the brain or spinal cord and ending in a sympathetic ganglion (hence called the preganglionic fibre), the second (the postganglionic fibre) arising in the ganglion and passing to the organ innervated.

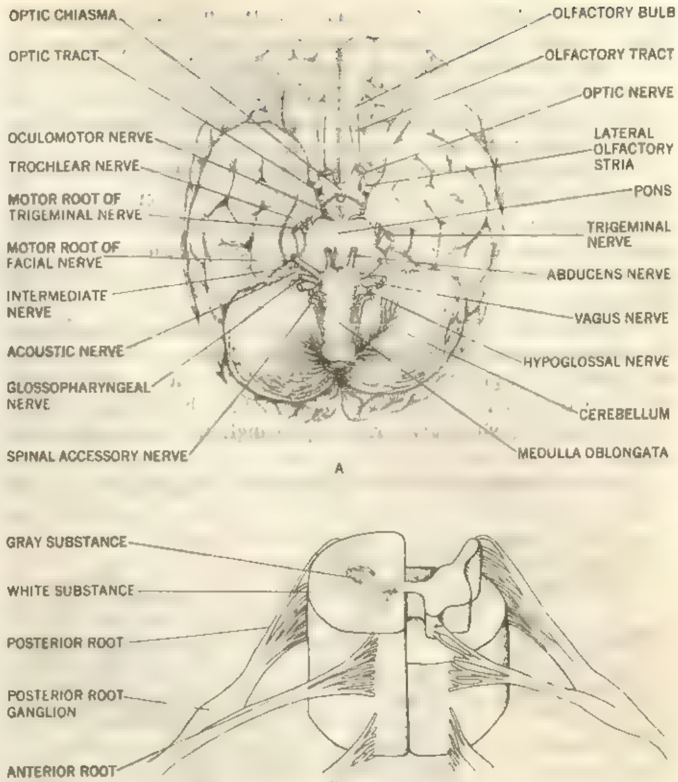
CRANIAL NERVES

The cranial nerves (fig. 1[A]) are designated by name and also by number, Roman numerals being conventionally used as a rule. They emerge through openings (foramina) of the skull (*see* SKULL). Some of the cranial nerves are purely sensory, some entirely motor and others are mixed. The afferent fibres, save those of the olfactory and optic nerves, arise in the cranial sensory ganglia, situated in the course of sensory nerves near the brain. Central processes (in this context the word process means a projecting part, an extension) terminate in sensory nuclei of the brain. The motor fibres arise within the brain from motor nuclei. In some instances the central nuclei, sensory or motor, are distinct for each nerve; in others the functional components of the same category from several nerves may enter or arise from a nucleus shared in common.

In addition to the 12 pairs described below, a small pair, the nervus terminalis, whose significance is obscure, is found in close relation with the olfactory nerve.

Olfactory Nerve.—The first cranial nerve is entirely afferent, serving the sense of smell. It comprises about 20 small filaments formed by convergence of numerous fibres that arise from cells in the olfactory mucous membrane. These cells also are the olfactory receptors and are unique since, besides being percipient, they give rise to long nerve fibres. The filaments enter the brain cavity through small openings in the anterior part of its floor and terminate in the olfactory bulb of the forebrain (fig. 1[A]). (*See also* OLFACTORY SYSTEM.)

Optic Nerve.—The second cranial nerve serves the sense of sight and is entirely afferent. Its cells of origin lie in the retina of the eye. The nerve fibres emerge from the back of each eyeball



(TOP) MODIFIED FROM O. LARSELL, IN MORRIS' "HUMAN ANATOMY," 11TH ED. (1953); REPRODUCED BY PERMISSION OF BLAKISTON DIVISION, MCGRAW-HILL BOOK COMPANY, INC. (BOTTOM) FROM O. LARSELL, "ANATOMY OF THE NERVOUS SYSTEM," 2ND ED. (1951); REPRODUCED BY PERMISSION OF APPLETON-CENTURY-CROFTS, INC.

FIG. 1.—(A) INFERIOR SURFACE OF THE BRAIN SHOWING ROOTS OF THE CRANIAL NERVES; (B) SEGMENT OF THE SPINAL CORD SHOWING ONE PAIR OF SPINAL NERVE ROOTS

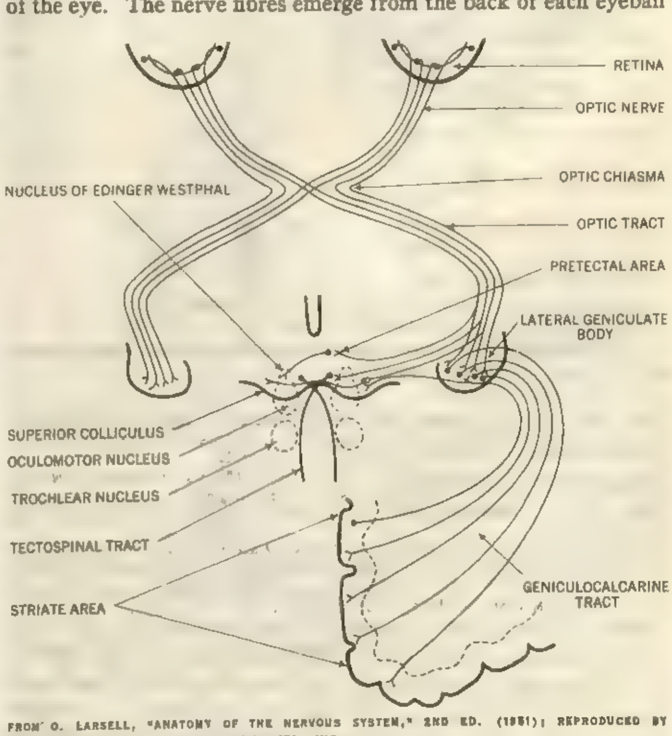


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FIG. 2.—DIAGRAM OF THE OPTIC NERVE, OPTIC TRACT AND CENTRAL CONNECTIONS

as a bundle called the optic nerve. The two nerves converge and form the optic chiasma, from which the optic tract continues to the lateral geniculate body of the thalamus and the superior colliculus and pretectal area of the midbrain (fig. 1[A] and 2). The nerve fibres, however, pass without interruption from the retina to the centres named.

Those from the medial (toward the nose) half of each retina cross in the chiasma and enter the opposite optic tract; those from the lateral (toward the temples) side of the retina enter the optic tract of the same side. The optic centres of either half of the brain, accordingly, receive fibres from both eyes. (*See* also EYE, HUMAN.)

Oculomotor Nerve.—The third cranial nerve has its origin in the oculomotor nucleus of the midbrain (fig. 3). This nucleus comprises (1) a group of cells, the principal nucleus, which sends fibres to the extrinsic eye muscles; and (2) the nucleus of Edinger-Westphal, which gives rise to preganglionic parasympathetic fibres.

The nerve emerges from the underside of the midbrain and divides into a superior branch and an inferior branch. The superior branch supplies one of the muscles of the eyeball and the muscle of the upper eyelid. The inferior branch supplies three of the muscles of the eyeball; from the branch to one of these muscles the preganglionic parasympathetic fibres pass by a short connection to the ciliary ganglion. This ganglion gives rise to postganglionic fibres that enter the eyeball and end in the constrictor muscle of the iris and the ciliary muscle. The oculomotor nerve also includes proprioceptive fibres to the extrinsic eye muscles.

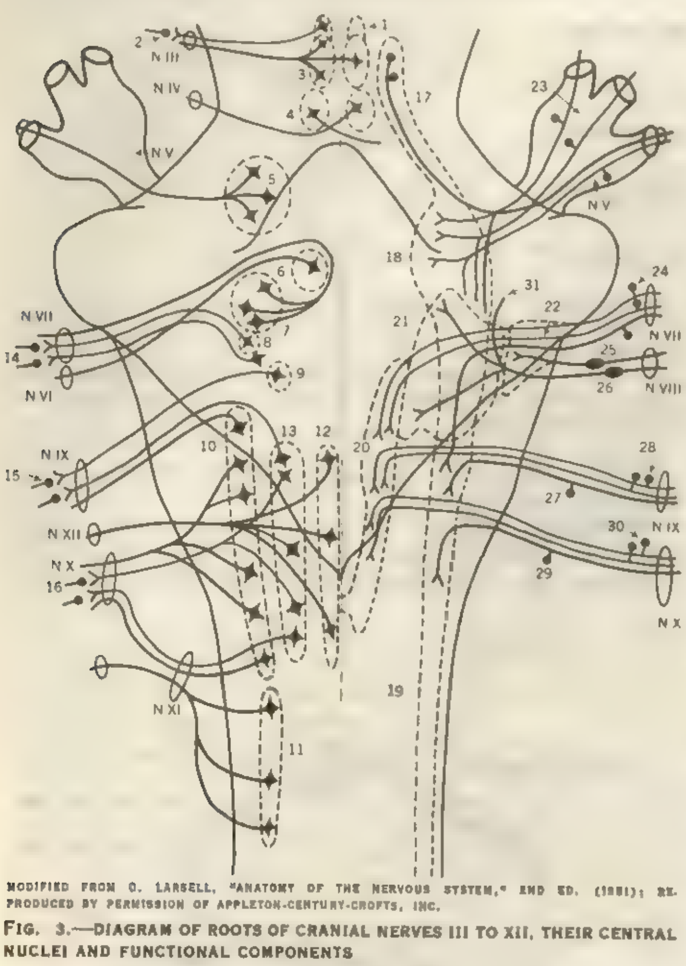

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FIG. 3.—DIAGRAM OF ROOTS OF CRANIAL NERVES III TO XII, THEIR CENTRAL NUCLEI AND FUNCTIONAL COMPONENTS

Right side: Sensory components and nuclei; *left side:* motor components and nuclei. Cranial autonomic ganglia, situated at a distance from the brain, are indicated in connection with the appropriate nerve roots
Nerves: (N. III) oculomotor; (N. IV) trochlear; (N. V) trigeminal; (N. VI) abducens; (N. VII) facial; (N. VIII) acoustic, including cochlear and vestibular divisions; (N. IX) glossopharyngeal; (N. X) vagus; (N. XI) spinal accessory; (N. XII) hypoglossal
Nuclei and Ganglia: (1) nucleus of Edinger-Westphal; (2) ciliary ganglion; (3) oculomotor nucleus; (4) trochlear nucleus; (5) motor trigeminal nucleus; (6) abducens nucleus; (7) motor facial nucleus; (8) superior salivatory nucleus; (9) inferior salivatory nucleus; (10) vagus and glossopharyngeal dorsal motor nucleus; (11) spinal accessory nucleus; (12) hypoglossal nucleus; (13) nucleus ambiguus; (14) submaxillary and sphenopalatine ganglia; (15) otic ganglion; (16) vagus visceral ganglia; (17) mesencephalic trigeminal nucleus; (18) superior sensory trigeminal nucleus; (19) spinal trigeminal nucleus; (20) solitary tract nucleus; (21) vestibular nuclei; (22) cochlear nuclei; (23) semilunar ganglion; (24) geniculate ganglion; (25) spiral ganglion; (26) vestibular ganglion; (27) superior glossopharyngeal ganglion; (28) glossopharyngeal petrous ganglion; (29) vagus jugular ganglion; (30) vagus nodose ganglion; (31) direct vestibular fibres to cerebellum

Trochlear Nerve.—The fourth cranial nerve has its origin in the trochlear nucleus (fig. 1[A] and 3). The fibres cross to the opposite side and emerge dorsally, continuing as a long slender strand to the superior oblique muscle of the eyeball. Proprioceptive fibres probably are included with the predominant motor component.

Trigeminal Nerve.—The fifth cranial nerve (fig. 1[A] and 3) is the largest of this group. It has sensory and motor roots, both attached at the anterior lateral surface of the pons. The sensory fibres arise from the semilunar ganglion, their central processes terminating in the superior and spinal trigeminal nuclei. The peripheral fibres are gathered into three divisions, (1) the first or ophthalmic, (2) the second or maxillary and (3) the third or mandibular.

Ophthalmic Nerve.—This supplies a branch to the dura mater of the brain and then divides into lacrimal, nasociliary and frontal nerves, the last subdividing into supraorbital and supratrochlear branches. The latter two nerves supply the skin of the upper part of the face and the front of the scalp (fig. 4). The lacrimal nerve also sends twigs to the conjunctiva of the eye, and the supratrochlear nerve supplies part of the conjunctiva of the upper eyelid.

Maxillary Nerve.—Numerous branches are given off by the maxillary. These are (1) a small meningeal nerve; (2) two connections with the sphenopalatine ganglion that continue as pharyngeal, palatine and nasopalatine nerves to the mucous membrane of the pharynx, palate and nasal cavity; (3) the posterior superior alveolar nerve to the upper teeth; (4) the zygomatic nerve to the skin of the prominence of the cheek and the temple; (5) the infraorbital nerve to the upper gums and teeth, mucosa of the nasal floor, the skin below the eye, on part of the nose and the upper lip.

Mandibular Nerve.—The mandibular includes motor and proprioceptive fibres, in addition to sensory fibres. The latter are distributed (1) to the skin and inner mucous lining of the cheek by the buccinator nerve; (2) to the mucous membrane of the tongue by the lingual nerve; (3) to the lower teeth, lower lip and chin by the inferior alveolar nerve; and (4) to the skin of the auditory canal, eardrum and much of the external ear by the auriculotemporal nerve.

The motor fibres of the mandibular nerve arise in the motor trigeminal nucleus and emerge as the motor root, passing beneath the semilunar ganglion. They are distributed by branches of the

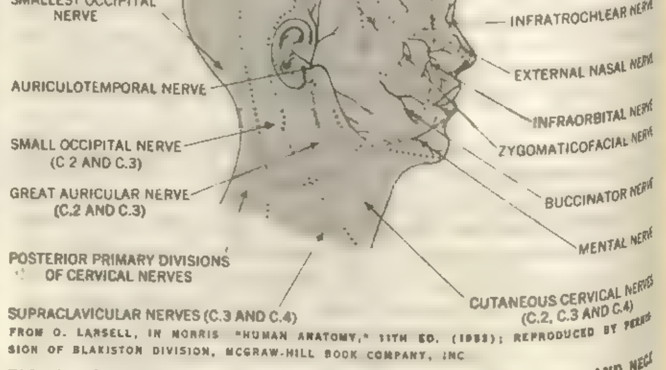

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FIG. 4.—CUTANEOUS NERVES AND THEIR REGIONS IN THE HEAD AND NECK

nerve to the muscles of mastication, the temporal muscle and the tensors of the palate and eardrum.

The proprioceptive fibres arise from cells of the mesencephalic trigeminal nucleus, in the midbrain, and are distributed to the muscles of mastication with the motor root and its branches. Components related to proprioceptive fibres reach the teeth and gums through the alveolar branches of the mandibular and maxillary nerves.

Abducens Nerve.—The sixth cranial nerve takes origin from the abducens nucleus (fig. 1[A] and 3) and emerges from the forward surface of the medulla oblongata. Passing into the orbit it ends on the lateral rectus muscle. Save for possible proprioceptive fibres the abducens nerve is entirely motor.

Facial Nerve.—The seventh cranial nerve leaves the medulla oblongata by the principal or motor root and the smaller root called the intermediate nerve of Wrisberg (fig. 1[A] and 3). The two roots unite to form a common nerve trunk which enters the facial canal of the petrous bone. Within the canal it gives off a small branch to the stapedius muscle of the ear and one that joins the auricular branch of the vagus nerve, described below. On leaving the canal the facial nerve gives off branches to two muscles beneath the angle of the jaw and also branches to the muscles of facial expression.

The motor fibres derive from the facial nucleus. The intermediate nerve includes both motor and sensory fibres. The motor component consists of parasympathetic fibres from the superior salivatory nucleus and adjacent region. Those from the nucleus are preganglionic fibres that unite with the sensory fibres to form the chorda tympani. This nerve leaves the trunk of the facial nerve before the latter emerges from the facial canal, loops upward into the tympanic cavity and then downward and forward, joining the lingual branch of the trigeminus. The sensory fibres reach the taste buds on the anterior two-thirds of the tongue. The preganglionic fibres turn to the submaxillary and sublingual ganglia, from which postganglionic fibres lead to the glands similarly named.

Another contingent of preganglionic parasympathetic fibres leaves the trunk of the facial nerve just before it enters the facial canal and passes to the sphenopalatine ganglion by way of the great superficial petrosal nerve; postganglionic fibres distribute to the lacrimal gland and the mucous glands of the posterior nasal cavity. Sensory fibres of the intermediate nerve have their origin in the geniculate ganglion; their central processes form part of the solitary tract and end in the nucleus of this tract.

Acoustic Nerve.—The eighth cranial nerve includes two divisions, (1) the vestibular, serving equilibrium; and (2) the cochlear, which serves hearing (fig. 1[A] and 3). They are closely related in much of their course, but have separate central connections and peripheral distribution.

The fibres of the vestibular nerve arise in the vestibular ganglion, the central processes terminating in the vestibular nuclei. The peripheral branches of the nerve pass to the utricle, saccule and ampullae of the semicircular canals, the nerve fibres ending in relation to sensory hair cells.

The cochlear fibres arise in the spiral ganglion of the cochlea. The centrally directed processes terminate in the cochlear nuclei and the peripheral processes end in relation to hair cells of the organ of Corti, which are stimulated by sound waves.

Glossopharyngeal Nerve.—The ninth cranial nerve is attached to the side of the medulla oblongata by five to six linear rootlets (fig. 1[A]). It includes both motor and sensory fibres, the latter having their origin in the superior and inferior ganglia of the nerve. The central processes of those of the inferior ganglion pass into the solitary tract and end in its nucleus (fig. 3). The peripheral branches of the nerve distribute to the mucous membranes of the pharynx and middle ear and the posterior third of the tongue and to taste buds on this part of the tongue. The motor fibres include special visceral efferents from the nucleus ambiguus to muscles of the pharynx, soft palate and the stylopharyngeus muscle. Preganglionic parasympathetic fibres arise in the inferior salivatory nucleus and relay in the otic ganglion to the parotid gland.

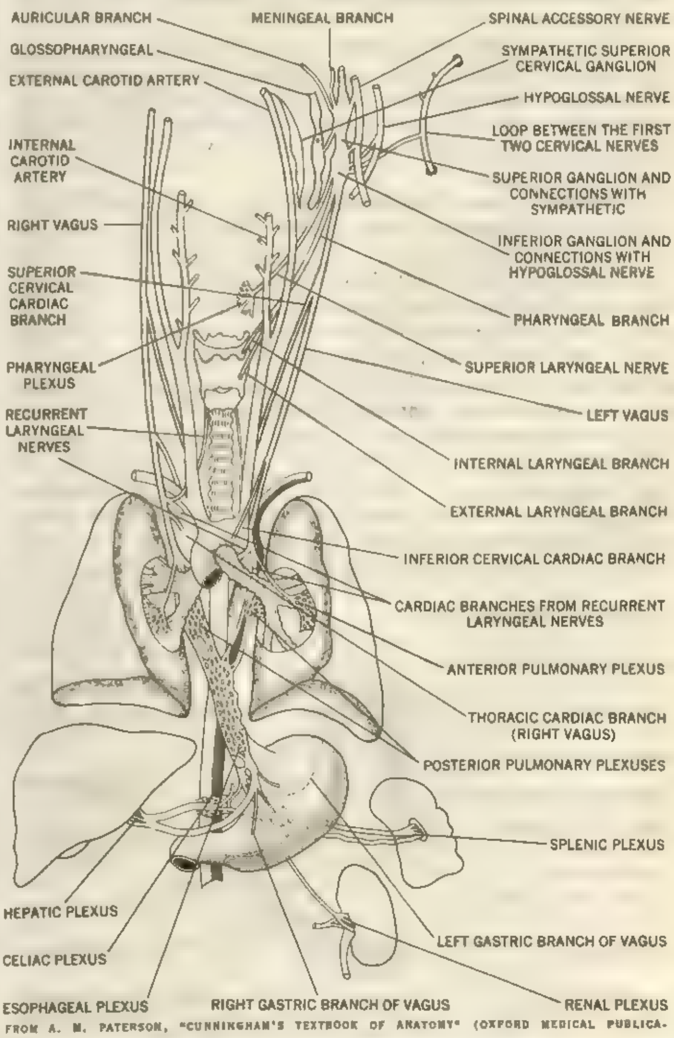
Vagus Nerve.—The tenth cranial nerve is attached to the side of the medulla oblongata by eight to ten linear rootlets that converge to form the nerve trunk (fig. 1[A], 3 and 5). It has two ganglia, the superior and the inferior of the vagus. The superior ganglion gives off meningeal and auricular branches; the auricular distributes to the skin of part of the ear and external auditory canal. The inferior ganglion gives rise to the pharyngeal and superior laryngeal nerves. The former joins the pharyngeal branch of the glossopharyngeus as sensory supply to the mucous membrane of the pharynx. The superior laryngeal nerve is sensory to the mucous membrane of the larynx and base of the tongue; it includes motor fibres to one muscle of the larynx and one of the pharynx.

The recurrent laryngeal nerve branches from the vagus in the neck and supplies the remaining muscles of the larynx and the inferior constrictor of the pharynx; it also provides sensory fibres to the mucous membrane of the larynx below the vocal cords.

Parasympathetic fibres from the dorsal motor nucleus of the vagus pass through cardiac branches of the nerve, through the cardiac plexus in the chest, to the heart, in which their ganglia are situated. Branches also contribute to the esophageal and pulmonary plexuses, relaying in ganglionic clusters in the plexuses and in the esophagus, trachea, bronchi and lungs to reach the involuntary muscle and glands of these organs.

The vagus continues into the abdomen, supplying the parasympathetic innervation of the greater part of the digestive tract and other abdominal viscera through the gastric, celiac and other plexuses, which also include sympathetic fibres.

The right and left vagus nerves differ somewhat in course and specific distribution. Visceral afferent fibres from the thoracic



FROM A. M. PATERSON, "CUNNINGHAM'S TEXTBOOK OF ANATOMY" (OXFORD MEDICAL PUBLICATIONS)

FIG. 5.—DISTRIBUTION OF THE VAGUS NERVE

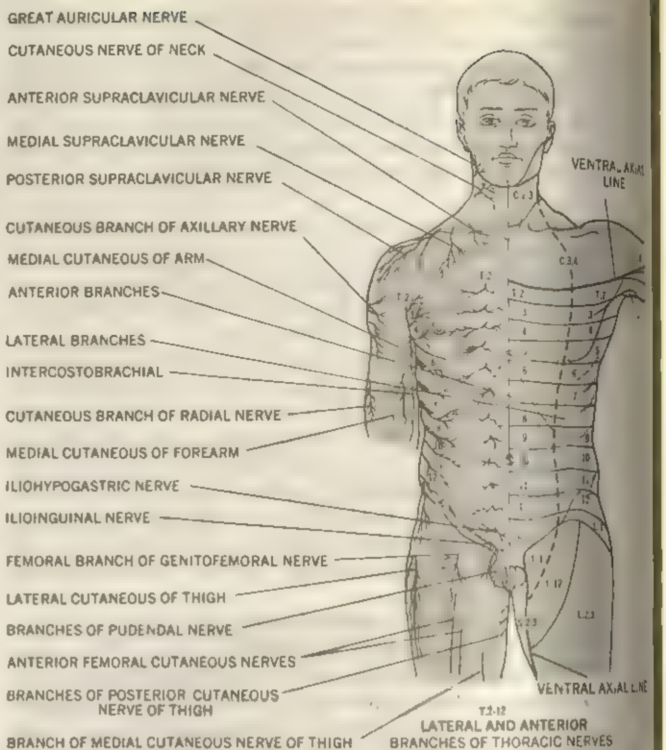


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FIG. 7.—DISTRIBUTION OF CUTANEOUS NERVES ON ANTERIOR SURFACE OF THE TRUNK. THE POSITION AND COURSE OF THE NERVES ARE SHOWN ON THE LEFT; THE DISTRIBUTION OF EACH AS NUMBERED, ON THE RIGHT

and abdominal organs, with cells in the inferior ganglion, enter the solitary tract and its nucleus. The somatic afferents from the skin end in the spinal trigeminal nucleus.

Spinal Accessory Nerve.—The 11th cranial nerve comprises a spinal part and an accessory part (fig. 1[A] and 3), both motor. The accessory part arises chiefly from the nucleus ambiguus and the spinal part from the motor column of the upper five or six segments of the spinal cord. The accessory part joins the vagus and accompanies its branches to the pharynx. The spinal part contributes to the innervation of two muscles of the neck which are of branchial origin.

Hypoglossal Nerve.—The 12th cranial nerve arises from the hypoglossal nucleus, its fibres emerging by numerous rootlets that converge into one trunk (fig. 1[A] and 3). This gives off branches to the musculature of the tongue, which in origin is related to myotomic muscles. Proprioceptive fibres have been described in the hypoglossal nerve. (*See* also TONGUE.)

SPINAL NERVES

The spinal nerves are named and numbered according to the region of the spinal cord to which they attach. (*See* SPINAL CORD.) There are 8 cervical (abbreviated C.), 12 thoracic (T.), 5 lumbar (L.), 5 sacral (S.) and usually 1 coccygeal (Co.).

Each spinal nerve has two roots, a dorsal or posterior (meaning "toward the back") and a ventral or anterior (meaning "toward the front") (fig. 1[B]). The dorsal root is sensory and the ventral root motor ("the law of the roots"); the first cervical nerve may lack the dorsal root. Oval swellings, the spinal ganglia, characterize the dorsal roots; they are formed of nerve cells that give rise to the sensory nerve fibres. The fibres of the ventral roots derive from cells in the anterior gray column (ventral horn) of the cord.

Central processes of the dorsal root fibres end in the posterior gray column (dorsal horn) of the cord or ascend to nuclei in the lower part of the brain. Immediately lateral to the spinal ganglia the two roots unite into a common nerve trunk which includes both sensory and motor fibres; the branches of this trunk distribute both types of fibres.

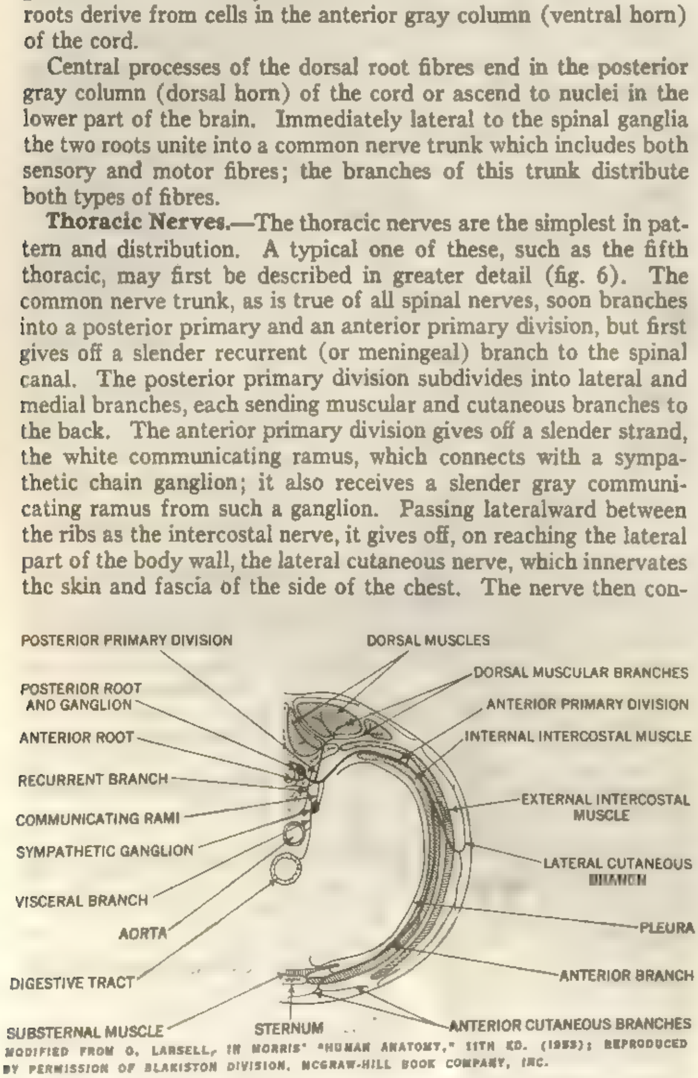
Thoracic Nerves.—The thoracic nerves are the simplest in pattern and distribution. A typical one of these, such as the fifth thoracic, may first be described in greater detail (fig. 6). The common nerve trunk, as is true of all spinal nerves, soon branches into a posterior primary and an anterior primary division, but first gives off a slender recurrent (or meningeal) branch to the spinal canal. The posterior primary division subdivides into lateral and medial branches, each sending muscular and cutaneous branches to the back. The anterior primary division gives off a slender strand, the white communicating ramus, which connects with a sympathetic chain ganglion; it also receives a slender gray communicating ramus from such a ganglion. Passing lateralward between the ribs as the intercostal nerve, it gives off, on reaching the lateral part of the body wall, the lateral cutaneous nerve, which innervates the skin and fascia of the side of the chest. The nerve then continues forward, as the anterior branch, to the border of the breastbone where it turns outward and forms the anterior cutaneous branch to the front of the chest. Throughout its course the intercostal nerve sends twigs to the intercostal muscles.

The functional types of fibres in the fifth and other thoracic nerves include (1) somatic afferents and efferents to the body wall, (2) autonomic fibres of the sympathetic division; and (3) visceral afferents from the internal organs.

The preganglionic sympathetic fibres take origin in the lateral part of the ventral horn of the cord; all pass through the anterior roots, common nerve trunk and white communicating rami to the sympathetic chain ganglia. Some end in these ganglia, while others continue through splanchnic nerves to the celiac and mesenteric ganglia of the abdomen. Postganglionic fibres from the chain ganglia pass through the gray rami to the common nerve trunk and are distributed by its branches to sweat glands, erector muscles of the hairs and blood vessels. Those arising in the celiac and mesenteric ganglia pass through the celiac, mesenteric and subsidiary plexuses to the internal organs.

The visceral afferent fibres from the internal organs reach the spinal cord without interruption by way of the splanchnic nerves, sympathetic ganglia, white rami, common nerve trunk and the dorsal roots.

Other thoracic nerves show various departures from the pattern of the fifth. The first thoracic nerve enters also into the formation of the brachial plexus, described below. The second thoracic nerve gives off the intercostobrachial nerve to the skin of the armpit and medial side of the arm (fig. 7). The third thoracic nerve sends a lateral cutaneous branch to the skin of the medial side of the base of the arm, which usually joins the intercostobrachial nerve. The 7th to 12th thoracic nerves continue obliquely into the wall of the abdomen, providing branches to its muscles and to the skin and fascia as far down as the crest of the hipbone and onto the buttock. The 12th nerve frequently sends a connection to the lumbar plexus, described below. The cutaneous branches of a given thoracic nerve supply not only its own body segment but overlap onto adjacent segments above and below it. Each segment, accordingly, is innervated by cutaneous branches of three spinal nerves (fig. 7). The intercostal nerves also send



MODIFIED FROM O. LARSELL, IN MORRIS' "HUMAN ANATOMY," 11TH ED. (1953); REPRODUCED BY PERMISSION OF BLAKISTON DIVISION, MCGRAW-HILL BOOK COMPANY, INC.

FIG. 6.—DIAGRAM SHOWING DISTRIBUTION OF A TYPICAL SPINAL NERVE

numerous twigs to the linings of the thorax and abdomen.

The innervation of the skin of the shoulder, upper extremity, lower part of the body and lower extremity overlaps as in the trunk but in a less regular pattern. Tests after injury to individual sensory nerve roots have revealed longitudinal zones of reduced sensibility, some extending from the lower neck or upper trunk to the hand, or from the lower back or the buttock to the foot. These indicate the areas primarily supplied by individual spinal nerves.

Spinal Nerve Plexuses.—The cervical, lumbar, sacral and coccygeal nerves all receive gray rami from the sympathetic chain ganglia, but only the upper lumbar, in addition to the thoracics, have white communicating rami. The posterior primary divisions of all, according to their regions of origin, pass to the muscles of the back that are associated with the axial skeleton, and to the skin and fascia of the back of the head and neck, the back, medial part of the buttock, and that overlying the coccyx or tail bone.

The anterior primary divisions of all these nerves are arranged in a series of plexuses, namely, the cervical, brachial, lumbar, sacral and coccygeal, in which fibres from the individual spinal nerves are regrouped before entering the nerves of distribution.

Cervical Plexus.—The cervical plexus is formed from the first four cervical nerves as a series of loops whose branches include fibres of two or more upper cervical nerves. These branches supply the skin of the head, neck and shoulder and the muscles of the neck and diaphragm, with the result that the skin areas, especially, have multiple innervation. The nerves to the muscles, as a rule, do not form loops but are arranged as medial and lateral groups.

Brachial Plexus.—This plexus (fig. 8) is derived from the fifth to the eighth cervical nerves and the greater part of the first thoracic. These first form three trunks—the superior, medial and inferior—and then recombine through anterior and posterior divisions of each trunk into three cords.

The plexus is divided into supraclavicular and infraclavicular parts. Before the cords are reached the supraclavicular part gives off the long thoracic (C. 5, 6, 7), dorsal scapular (C. 5), subclavian (C. 4, 5, 6) and suprascapular (C. 4, 5, 6) nerves. These supply muscles of the shoulder girdle, the suprascapular also innervating the joint between the collar bone and the acromion process.

The infraclavicular part comprises the three cords—lateral, medial and posterior—from which are derived the nerves of distribution to the shoulder and upper extremity. Each cord is composed of fibres from several of the lower cervical nerves. Some include both sensory and motor fibres, while others have only cutaneous or muscular fibres. The segmental source of the muscular supply does not necessarily correspond to that of the overlying skin.

The lateral cord gives off (1) the lateral anterior thoracic nerve (C. 5, 6, 7), to the breast muscles; (2) the musculocutaneous nerve (C. 4, 5, 6), to the muscles of the front of the arm and to the skin of the side of the forearm; and (3) the median nerve (C. 5, 6, 7, 8; T. 1), to certain muscles of the forearm, thumb and fingers, to the skin of the palm, hand and fingers and to the elbow, wrist and hand joints.

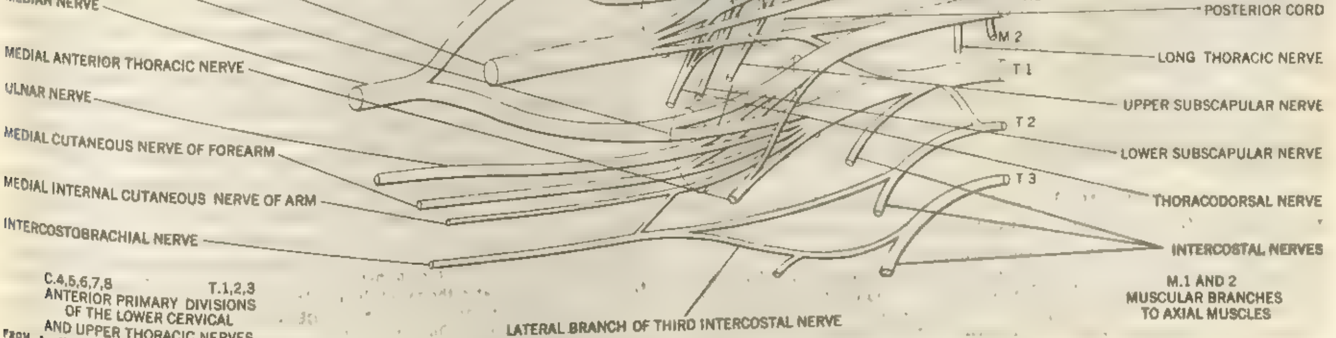
The medial cord branches into (1) the ulnar nerve (C. 8; T. 1), to flexor muscles of the wrist and fingers, most of the muscles of the hand, to the skin of the medial part of the hand and to the joints of the elbow, wrist and long bones of the hand; (2) the medial brachial cutaneous nerve (C. 8; T. 1), to the skin of the medial side of the arm and forearm; and (3) the medial anterior thoracic nerve (C. 8; T. 1), to the breast muscles.

The posterior cord divides into (1) the axillary nerve (C. 5, 6), to shoulder muscles and joint and to the skin of the lateral part of the shoulder and arm; and (2) the radial nerve (C. 5, 6, 7, 8), to muscles of the arm and forearm and to the skin of the back of the arm and hand, also to elbow, wrist and hand joints and, through its (a) subscapular (C. 5, 6) and (b) thoracodorsal (C. 6, 7, 8) branches, to muscles related with the humerus and shoulder girdle.

Lumbosacral Plexus.—The lumbar, sacral and coccygeal nerves form the lumbosacral plexus, subdivided into lumbar and sacral plexuses.

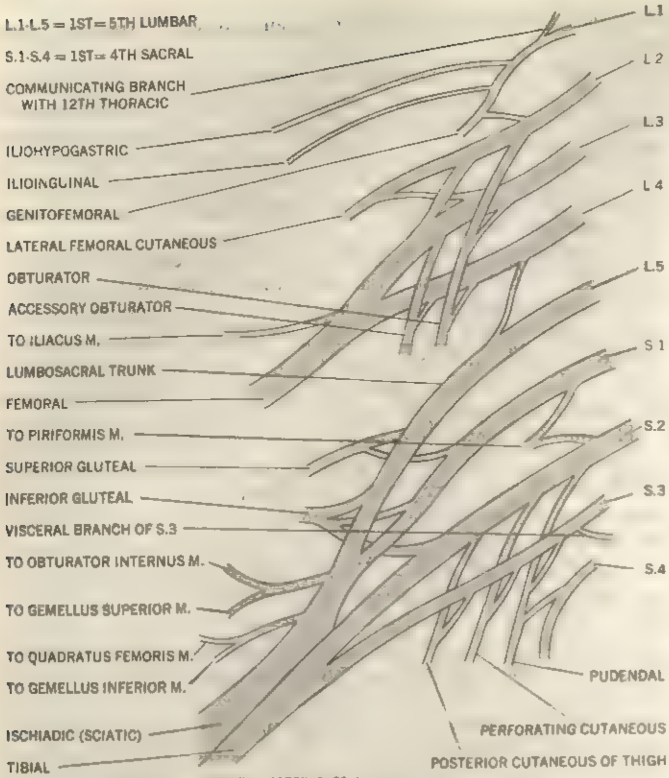
The lumbar plexus (fig. 9) usually involves the first three and part of the fourth lumbar nerves. Most of the first lumbar, however, is distributed much like a thoracic nerve. The plexus first gives off the iliohypogastric (L. 1) and ilioinguinal (L. 1) nerves, which pass around the abdominal wall in its muscles, into which they send twigs. The iliohypogastric also supplies the skin and fascia of the upper and lateral parts of the buttock and above the pubis. The ilioinguinal supplies the skin of the upper part of the thigh and part of the external genitals. The remaining branches of the plexus are: (1) the obturator nerve (L. 2, 3, 4), to the muscles and skin of the inner side of the thigh and to the hip and knee joints; (2) the genitofemoral nerve (L. 1, 2), to the skin of the upper part of the thigh and of the scrotum or major labium; (3) the lateral femoral cutaneous nerve (L. 2, 3), to the skin of the lateral part of the thigh; (4) the femoral nerve (L. 2, 3, 4) to the iliac muscle and muscles on the front of the thigh, to the hip and knee joints, to the skin on the front and inner side of the thigh and, through the saphenous nerve, to the leg and foot.

The sacral plexus (fig. 9) is formed from the fourth and fifth lumbar and the first four sacral nerves, the lumbosacral trunk con-



FROM A. M. PATERSON, "CUNNINGHAM'S TEXTBOOK OF ANATOMY" (OXFORD MEDICAL PUBLICATIONS)

FIG. 8.—THE BRACHIAL PLEXUS AND ITS NERVES



FROM "GRAY'S ANATOMY" (LONGMANS, GREEN & CO.)

FIG. 9.—PLAN OF THE LUMBAR AND SACRAL PLEXUSES AND NERVES

necting the first two with the first sacral. The divisions of the fourth and fifth lumbar and the first three sacral nerves are gathered into the sciatic or ischiadic nerve, which runs down the back of the thigh. The sciatic nerve divides in the space behind the knee joint to form the common peroneal and tibial nerves. The common peroneal nerve (L. 4, 5; S. 1, 2) supplies a muscle that flexes the knee joint and fibres to this joint. After passing a short distance down the posterior portion of the lower leg, the common peroneal nerve bifurcates into deep and superficial portions. The deep peroneal nerve passes to muscles of the lower leg and the foot, to toe muscles, to skin between the first and second toes and to the joints of the ankle and foot. The superficial peroneal nerve supplies muscles of the foot, the skin of the lower lateral part of the leg and upper surface of the foot. The tibial nerve (L. 4, 5; S. 1, 2, 3) innervates muscles of the back of the leg and the foot, the skin of the back of the leg and the knee and ankle joints.

Branches from the sacral plexus pass to the muscles of the hip and buttock and to the skin of the buttock. The pudendal nerve (S. 2, 3, 4) contributes to supply the skin and muscles of the perineum (the region of the outlet of the pelvis) and the genital organs. The posterior cutaneous nerve of the thigh (S. 2, 3, 4) innervates the skin of the posterior part of the buttock, thigh and perineum. Variable perforating cutaneous branches (S. 2, 3) pass to the skin of the buttock. Sacral parasympathetic fibres emerge with the second and third or third and fourth sacral nerves, pass through the pelvic plexus and terminate in ganglionic clusters in the plexus or in the walls of the organs supplied. Postganglionic fibres reach the lower part of the colon, the rectum, bladder and lower ureter and the genital organs.

Coccygeal Plexus.—The coccygeal plexus is formed from the fourth and fifth sacral and the coccygeal nerves. It sends small branches to muscles of the floor of the pelvis and to the skin over the coccyx.

See also EQUILIBRIUM, ANIMAL; MUSCLE AND MUSCULAR SYSTEM; NERVE CONDUCTION; NERVOUS SYSTEM; SPINAL CORD; and references under "Nerve" in the Index.

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(O. LL.)

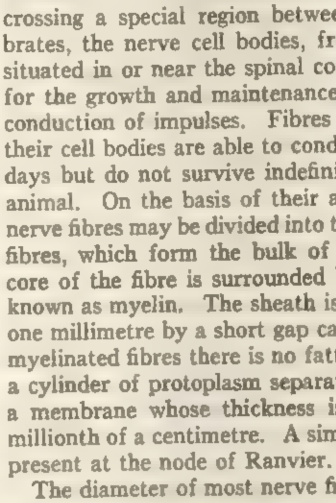
NERVE CONDUCTION, the process by which the nerve fibres carry messages throughout the bodies of multicellular animals. In the higher animals, information about the outside world or the state of the animal's body is conveyed along sensory nerves to the central nervous system, which sorts out the information and issues appropriate orders to the muscles or glands. The outgoing information travels in motor nerves and reaches the muscles after crossing a special region between nerve and muscle. In vertebrates, the nerve cell bodies, from which nerve fibres arise, are situated in or near the spinal cord. The cell bodies are essential for the growth and maintenance of nerve fibres, but not for the conduction of impulses. Fibres which have been separated from their cell bodies are able to conduct impulses for several hours or days but do not survive indefinitely, either inside or outside the animal. On the basis of their appearance under the microscope, nerve fibres may be divided into two distinct classes. In myelinated fibres, which form the bulk of human nerves, the protoplasmic core of the fibre is surrounded by a sheath of a fatty substance known as myelin. The sheath is interrupted at intervals of about one millimetre by a short gap called the node of Ranvier. In unmyelinated fibres there is no fatty sheath and the fibre consists of a cylinder of protoplasm separated from the external medium by a membrane whose thickness is probably of the order of one-millionth of a centimetre. A similar membrane is almost certainly present at the node of Ranvier.

The diameter of most nerve fibres is usually 0.001 to 0.02 mm. but certain invertebrates possess very large unmyelinated fibres and in the extreme case of the squid these may be as much as one millimetre in diameter. The length of nerve fibres varies from a fraction of a millimetre in a small insect to many metres in the largest mammals.

The protoplasmic core of the fibre is an aqueous solution and a reasonably good conductor of electricity. It contains a high concentration of potassium ions and a low concentration of sodium and chloride ions. This is the reverse of the animal's blood, in which sodium and chloride are the dominant ions and potassium ions are relatively dilute.

In contrast to the protoplasm, the membrane at the surface of the fibre is a moderately good insulator, and this helps to prevent the contents of the fibre from mixing rapidly with the external solution. In addition, much of the cells' metabolism is probably directed toward maintaining a state of unequal ionic concentration across the surface membrane.

Nervous messages are invariably accompanied by brief electrical changes, known as action potentials. When a sense organ is stimulated, or when the central nervous system issues an order to a muscle, electrical impulses can be recorded from the nerve which would be expected to be carrying information. Fig. 1 illustrates trains of action potentials traveling to and from the central nervous system in two nerves that control the respiration of a cat.



(A–C) FROM E. D. ADRIAN IN "THE JOURNAL OF PHYSIOLOGY" (1933); (D–G) FROM BARRON IN J. F. FULTON, "TEXTBOOK OF PHYSIOLOGY," 17TH ED., W. B. SAUNDERS COMPANY, PHILADELPHIA (1955)

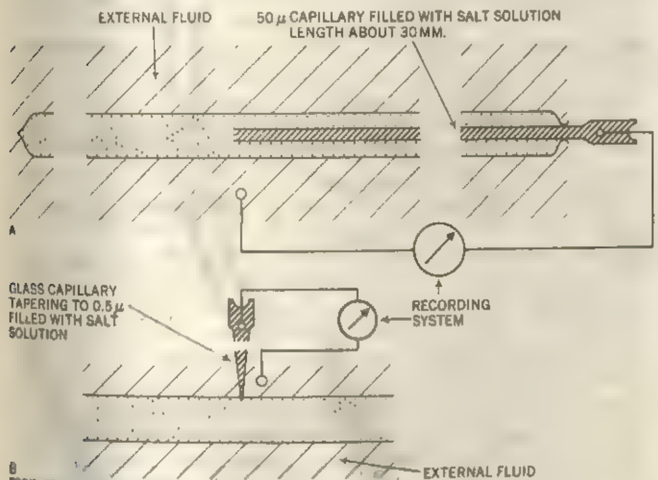
FIG. 1.—ELECTRICAL IMPULSES IN THE RESPIRATORY NERVES OF A CAT

(A–C) Sensory impulses traveling from the lungs to the brain in the vagus nerve. White lines indicate the degree of inflation of the lungs. The impulses, recorded with external electrodes from a strand of the nerve trunk, appear as black vertical lines. The deflections produced by the impulses are shown downward and the frequency of the impulses rises as the distension of the lungs is increased

(D–G) Motor impulses traveling to the diaphragm in the phrenic nerve. Upper tracing indicates the respiratory movement; impulses are shown below as upward deflections. One fibre carries the impulses in (D), two in (E) and (F), and three in (G)

The action potentials which carry information along the nerve fibres last about $\frac{1}{1,000}$ sec. and travel at speeds of 1–100 m. per second (100 m. per second is equal to 224 m.p.h.). The velocity of conduction is greater in large fibres than in small, and myelinated nerve fibres conduct faster than unmyelinated fibres of comparable size. However, in any one fibre, the size and velocity of the action potential is constant and cannot be altered by changing the strength or quality of the stimulus. In other words, provided that a stimulus is strong enough to evoke an impulse, the size of the action potential in a single fibre is independent of the strength of the stimulus. This invariance of the action potential arises because the energy used in propagation does not come from the stimulus but is released by the nerve along its length. In this respect, nervous conduction resembles the burning of a fuse of gunpowder and is unlike the propagation of an electric signal along a cable or telephone wire. (*See* also ALL-OR-NONE LAW.)

For many years physiologists suspected that the electrical changes in nerve arose at the surface membrane. This idea was verified by experiments in which the electrical potential difference across the surface of the fibre was measured directly with an internal electrode (figs. 2 and 3). In such experiments it is found that the inside of the fibre is usually about 0.07 v. negative to the external solution; this difference in electrical potential is known as the resting potential. When an impulse travels along



FROM "BIOLOGICAL REVIEWS," VOL. 26 (1951)

FIG. 2.—METHODS OF RECORDING ELECTRICAL CHANGES ACROSS THE SURFACE MEMBRANE OF A NERVE FIBRE

(A) Longitudinal insertion of internal electrode, used with giant nerve fibre. (B) Transverse insertion of internal electrode used with nerve or muscle fibres and other cells. The electrical recording system consists of a vacuum tube amplifier and cathode ray oscillograph. (1 $\mu = \frac{1}{1,000}$ mm.)

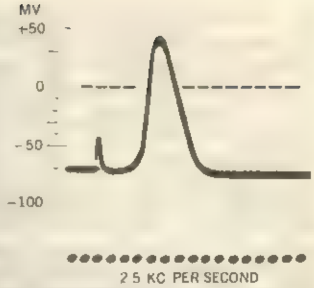
the fibre, the inside swings momentarily positive, giving a transient action potential of amplitude 0.1–0.12 v. At the crest of the action potential the inside of the fibre is about 0.04 v. positive to the outside.

When a brief electric current is applied to a nerve it is found that the impulse always arises at the cathode. This means that the event which starts the impulse is a decrease of the electrical potential difference across the membrane. The amount by which the potential difference must be reduced is naturally somewhat variable but under most conditions is about 0.02 v.

Shortly after a stimulus has evoked a response, the nerve enters an absolute refractory period, during which no stimulus, however strong, can evoke a second response. The absolute refractory period lasts for about $\frac{1}{1,000}$ sec. and is followed by the relative refractory period during which a second impulse can be evoked, but only by a stimulus which is stronger than normal.

Although nerve fibres normally conduct impulses in one particular direction (toward the central nervous system in sensory fibres, away from it in motor fibres), all nerves can conduct impulses in both directions, and the velocity at which the impulse propagates is independent of the direction in which it is traveling.

The conductivity of the surface membrane increases greatly during an impulse, and sodium and potassium ions cross the membrane more easily than in the resting state. The net effect of an impulse is that a small quantity of sodium ions enters the fibre and a corresponding amount of potassium ions leaves it. These movements, which are both down concentration gradients, are thought to provide the immediate source of energy for propagation and must be reversed by a metabolic process operating during the period of recovery which follows a burst of electrical activity.



FROM "PROCEEDINGS OF THE ROYAL SOCIETY" B., 140, 1

FIG. 3.—ACTION POTENTIAL, TRAVELING TOWARD MUSCLES, IN THE GIANT NERVE FIBRE OF THE SQUID, RECORDED FROM A NERVE FIBRE IN ITS NATURAL POSITION IN THE WHOLE ANIMAL

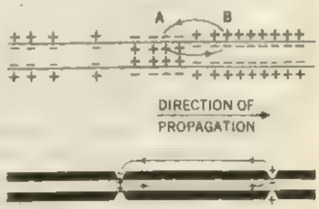
The record shows the electrical potential difference between the inside of the fibre and the external fluid (1 mv. = $\frac{1}{1,000}$ volt). Dots below the record correspond to a frequency of 2,500 per second. The brief excursion at the beginning of the record occurred at the moment when the electric shock, which started the action potential, was applied to the nerve. The temperature was 8.5° C.

Mechanism of Nervous Conduction.—Many of the facts described in this article are explained by a hypothesis which is essentially a modification of the membrane theory, proposed early in this century by Bernstein, Overton and Lillie. According to this hypothesis, the resting membrane is impermeable to sodium ions but is moderately permeable to potassium ions. Since potassium ions are more concentrated inside the fibre, they tend to move outward, and this makes the inside of the fibre negative with respect to the external solution. Evidence for this idea is provided by the observation that the resting potential disappears if the concentration of potassium in the external solution is made equal to that inside the fibre.

When the potential difference across the resting membrane is reduced by an external electric current, or by the approach of the active region, the properties of the membrane change in a remarkable way. The molecular nature of this change is entirely unknown, but it always involves an increase in the conductivity of the membrane and its effect appears to be that the membrane undergoes a large but transient increase in the permeability to sodium ions. Since sodium ions are more concentrated outside the fibre, they enter it and make the inside of the membrane positive. The change in permeability generates the action potential and the movement of sodium ions provides the inward current on which conduction of impulses depends.

The way in which the impulse propagates in an unmyelinated fibre is illustrated in the upper part of fig. 4. Suppose that point A is active and that B is resting. A is sodium permeable so the inside of the fibre is positive; B is potassium permeable so the inside is negative. Electric current therefore flows in a local circuit between resting and active nerve and this reduces the potential difference just ahead of the active region. When the potential difference at B is reduced by about 0.02 v. the permeability to sodium rises and the inside of the fibre becomes positive. Point B is now active and can stimulate the next region in precisely the same manner. In this way a wave of increased sodium permeability spreads along the fibre.

Since the increase in sodium permeability is transient, the membrane does not remain in the active state but returns to its original condition after about $\frac{1}{1,000}$ sec. The restoration of the normal potential difference is brought about by an outward movement of potassium ions and is accelerated by a rise in potassium permeability, which takes place later than the initial rise in sodium permeability.



FROM "PROCEEDINGS OF THE ROYAL SOCIETY" B., 140, 1

FIG. 4.—DIAGRAMS ILLUSTRATING PROPAGATION OF THE NERVE IMPULSE IN (TOP) AN UNMYELINATED FIBRE AND (BOTTOM) A MYELINATED FIBRE. THE ARROWS SHOW THE DIRECTION OF THE ELECTRIC CURRENT

Like most other theories of nervous conduction, the one just

outlined assumes that the causal agent in propagation is the electric current which flows between resting and active nerve. This assumption is supported by extremely strong evidence and is accepted by those who have reservations about the part played by the sodium and potassium ions in generating the action potentials.

Unmyelinated fibres are continuous structures and the impulse propagates smoothly from one point to the next. In myelinated nerve fibres, which are present in all vertebrates and in shrimps and prawns, a different type of conduction has been evolved. Here most of the fibre is covered with an insulating layer and the excitable membrane is exposed only at the nodes of Ranvier. When one node becomes active, current flows through the next node in the manner shown in fig. 4.

In this system only the nodes generate the action potential, and the function of the myelin is to make the local electric current act at some distance ahead of the active point. The effect of this type of propagation, which is known as saltatory conduction, is that the impulse is conducted at a higher velocity and with greater economy than in an unmyelinated fibre of comparable size.

See also NERVE; NERVOUS SYSTEM; SYNAPSE; SPINAL CORD; COMPARATIVE NEUROLOGY. (A. L. HN.)

NERVI, PIER LUIGI (1891–), internationally known Italian structural engineer, was born in Sondrio, Italy, June 21, 1891, and graduated from the University of Bologna in 1913. He later joined the staff of the School of Architecture of Rome, teaching technology and construction technique. His most important works are several large-span structures built in Italy—the municipal stadium in Florence (1929); aircraft hangars with geodesic structure at Orvieto, Orbetello and Torre del Lago (1936–41), all destroyed during World War II; a complex for the Turin exhibition (1948–50); the permanent headquarters of the United Nations Educational, Scientific and Cultural organization at Paris, in collaboration with Marcel Breuer and B. Zehrfuss, architects; and the Olympic sport palace and the Flaminio stadium, both built in Rome, and the stadium of Taormina, in Sicily.

In 1956 Nervi went to the United States to lecture on his work at the invitation of several universities. He is an honorary member of the American Academy Institute of Arts and Letters (1957) and of the American Institute of Architects, and a member of the National Association of Italian Engineers and Architects and of the International Congress of Contemporary Architecture.

(E. F. C.)

NERVO, AMADO (1870–1919), recognized as Mexico's best modernist poet, was born in Tepic, Mex., on Aug. 27, 1870, and was originally named Amado Ruiz de Nervo. He studied at the Colegio de Jacona and at the seminary of Zamora from 1886 to 1888. Nervo's literary career was begun in Mazatlán as a newspaperman. From there he went to Mexico City in 1894, where he published his short novel *El Bachiller* (1895), his first volume of poems *Perlas Negras* (1898) and also wrote for the *Revista azul*. With J. E. Valenzuela he founded the modernist periodical *Revista moderna* (1898–1903). From 1905 to 1918 he lived in Madrid, Spain, as secretary to the Mexican legation; and there he wrote most of his innumerable poems, essays and short stories. After a short visit to Mexico in 1918 he was appointed minister to Argentina and Uruguay. He died in Montevideo on May 24, 1919. His best poems, found in the volumes *Elevación* (1914–16) and *Plenitud* (1917) are characterized by a deep religious feeling and a simple but perfect form.

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(L. LL.)

NERVOUS SYSTEM. The nervous system may be divided into (1) the central nervous system, consisting of the brain and spinal cord and (2) the peripheral nervous system, consisting of the cranial, spinal and peripheral nerves with their motor and sensory endings.

The anatomy and physiology of many parts of the nervous system are treated in separate articles (*see* BRAIN; CIRCULATION OF BLOOD; DIGESTION; EAR, ANATOMY OF; EYE, HUMAN; MUSCLE AND MUSCULAR SYSTEM; NERVE; NERVE CONDUCTION; NEUROLOGY, COMPARATIVE; OLFACTORY SYSTEM; SMELL AND TASTE; SPINAL CORD; TOUCH).

HISTOLOGY

The organs and organ systems of the body are composed of tissues, and these in turn are composed of microscopic units termed cells. Cells are specialized to perform a particular function, such as secretion (gland cell), contraction (muscle cell) or conduction (nerve cell). The nervous system is composed of billions of individual cells. The most noted investigator of the histology (microscopic anatomy) of these cells was the Spanish scientist Santiago Ramón y Cajal.

Nerve Cells.—Nerve cells or neurons are distinguished by processes (projections) that conduct nerve impulses to and from the body of the cell. Nerve impulses are physicochemical reactions that sweep along the surfaces of neurons and their processes (*see* NERVE CONDUCTION). Similar reactions occur in many other types of cells, but are most notable in neurons, the structural features of which are designed to transmit impulses over long distances to many parts of the body.

The bodies of neurons vary in diameter from 4–5μ (microns)

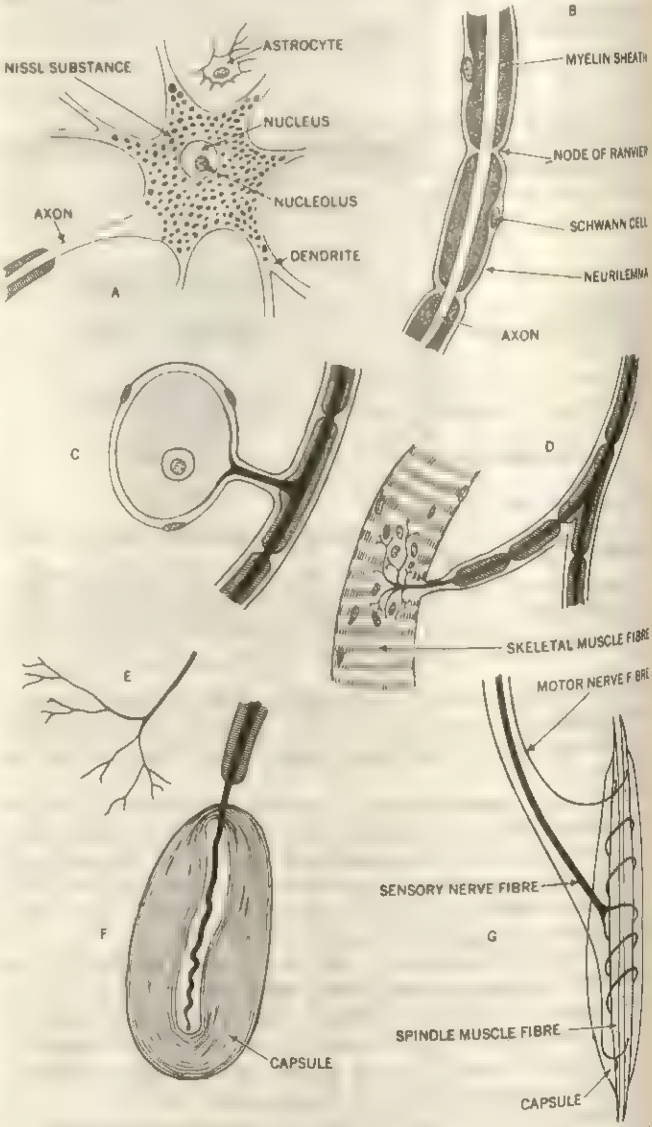

FIG. 1.—DIAGRAMS OF NERVE CELLS AND ENDINGS AT HIGH MAGNIFICATIONS

(A) Multipolar cell of spinal cord; (B) part of a myelinated nerve fibre; (C) unipolar cell; (D) motor end plate; (E) nonmyelinated fibre forming a free ending; (F) Pacinian corpuscle; (G) neuromuscular spindle, present in muscles near the junction of muscle and tendon

up to 50–100μ (a micron is about $\frac{1}{25,000}$ in.). The largest neurons are almost visible to the naked eye. The nuclei of cells contain a material called chromatin; chromatin in the nuclei of neurons is sparse in amount, although the nucleolus is very prominent. The cytoplasm of neurons contains a chromatinlike material called Nissl substance (named after Franz Nissl) (fig. 1[A]). The cytoplasm also contains special particles called mitochondria, and a complex, lipoid structure, the Golgi apparatus (after Camillo Golgi). Both are important in metabolic processes and both are present in other types of cells. Thin fibrils termed neurofibrils are also present in the cytoplasm and processes of nerve cells; their significance is unknown.

The processes of neurons may be only a few microns in length, or they may extend several feet. Processes that conduct impulses away from the cell body are termed axons. A neuron generally has only one axon. Processes that conduct toward the cell body are called dendrites. Most neurons have many dendrites and are classified as multipolar cells (fig. 1[A]). The neurons of the brain, spinal cord and autonomic ganglia are multipolar. The neurons of spinal ganglia and of the ganglia of certain cranial nerves are unipolar; that is, they have only one process (fig. 1[C]). This process divides into two branches, one of which conveys impulses from sensory endings toward the cell body, while the other conveys these impulses to the brain or spinal cord. Certain neurons in ganglia of the inner ear, in one of the layers of the retina of the eye and in the olfactory mucous membrane have two processes and are classified as bipolar. One process conducts toward, and the other away from, the cell body. The processes of unipolar and bipolar cells are structurally similar to the axons of multipolar cells.

The dendrites of multipolar cells are short branching processes that contain Nissl substance and mitochondria. The branching increases the surface area of the cell. Axons (and the processes of unipolar and bipolar cells) lack Nissl substance but contain mitochondria. They often extend for long distances, and have few branches until near their terminations. If an axon is more than about one micron in diameter, it is surrounded by a whitish, lipoid sheath, the myelin or medullary sheath (fig. 1[B]). This sheath is interrupted at regular intervals to form nodes of Ranvier (after Louis Ranvier), which are of fundamental importance in nerve conduction. The largest axons, with their myelin sheaths, are no more than about 20μ in diameter. All axons of the peripheral nervous system, whether they have a myelin sheath or not, are surrounded by a thin, protoplasmic sheath, the neurilemma. This sheath is a cellular tube formed by cells of Schwann (after Theodor Schwann). It is of fundamental importance in the formation of myelin and in nerve regeneration. There are no neurilemmal cells in the central nervous system.

The term nerve fibre is often used to specify an axon and its various sheaths; hence the terms myelinated fibre and nonmyelinated fibre. The gray matter of the central nervous system is composed mainly of cell bodies and fibres that, for the most part, are nonmyelinated. By contrast, white matter contains large numbers of myelinated fibres and relatively few cells. A nerve is a collection of nerve fibres that is visible to the naked eye; the constituent fibres are bound together by connective tissue. Each fibre is microscopic in size, hence hundreds or thousands of fibres are present in each nerve. Thus, according to the number of constituent fibres, a nerve may be barely visible or it may be quite thick.

Nerve Endings.—Nerve fibres carry impulses to and from nonnervous structures (such as muscle), and they end in a special way in relation to these structures. They also transmit impulses to other nerve cells and have special endings at the points of transmission.

Sensory Endings (Receptors).—When skin is stimulated so that the sensation of touch is aroused, the stimulus activates certain special structures in the skin. These structures are receptors, composed of nerve fibres and nonnervous tissue, so arranged that when mechanically deformed by the stimulus, they discharge nerve impulses to the brain or to the spinal cord. Receptors are further specialized according to the type of stimulus to which they are most sensitive; *e.g.*, the retina of the eye is activated by radiant energy, taste buds of the tongue by chemical reactions.

Receptors for the special senses (vision, hearing, balance, taste and smell) are described in other articles. Receptors for the general senses (touch, pain, temperature, pressure, position and movement) are of several varieties that differ mainly in the way in which the nonnervous tissue is arranged. The simplest are those in which a nerve fibre breaks up into fine branches that end in connective tissue or in epithelium; these are free nerve endings (fig. 1[E]).

In other receptors, the nerve fibres end in a complicated branching, surrounded by a specialized connective tissue capsule. Such endings are often called corpuscles; they are most sensitive to mechanical deformation. The nerve fibres to corpuscles are usually myelinated, but the myelin is lost before the fibre enters the corpuscle.

The sensations of touch, pain and temperature can be aroused from skin. The only receptors in hairy skin are free endings and complicated plexuses around hair follicles. In skin without hair, such as on the finger tips, there are also oval, encapsulated endings known as Meissner's corpuscles (after George Meissner) and believed to be touch receptors. Other types of corpuscles may also be present. Some receptors in skin are sensitive to mechanical deformation (pressure), others to injury (pain) and others to radiant energy (temperature). Further correlation between structure and function is quite speculative.

The Pacinian corpuscle (after Filippo Pacini) has a capsule arranged in layers like an onion (fig. 1[F]). This corpuscle is often large enough to be visible to the naked eye. It is present in the deeper parts of skin and in the subcutaneous tissues, and in these locations is believed to be concerned with the sensation of pressure (deep touch). Pacinian corpuscles are present in and around muscles, joints, ligaments and tendons. Other complex receptors are also found in these structures. One is the neuromuscular spindle (fig. 1[G]), which is so constructed that it is deformed if the muscle is stretched. Hence it is sensitive to a change in muscle length and on that account is often called a stretch receptor. Neurotendinous spindles are stretch receptors in tendons. A Ruffini ending (after Angelo Ruffini) is a stretch receptor in ligaments and joints; it lacks a definite capsule. The various receptors in muscles, joints, ligaments and tendons are concerned with the sensations of position and movement. Free endings are also present in these structures and are believed to be associated with pain.

Viscera also contain receptors. Some are concerned with pain and others with sensations, but most are involved in the reflex control of visceral activity. For example, some viscera contain Pacinian corpuscles, the positions of which near blood vessels suggest that they are sensitive to changes in vessel diameter due to pulsation. Many viscera and blood vessels contain endings that resemble stretch receptors. Those in blood vessels are activated when the vessel walls are stretched during dilatation of the vessels, and the resulting impulses are transmitted to neurons in the brain that are concerned with the reflex control of blood pressure.

Motor Endings.—Motor impulses to the heart, glands and smooth muscle are carried by small nerve fibres of the autonomic system. The way in which they end is still obscure. Presumably they form simple, free endings in these structures.

Skeletal muscle fibres are supplied by large motor nerve fibres that are axons of cells in the brain and the spinal cord. When such an axon enters a muscle (hundreds or thousands usually enter each muscle) it divides into many smaller branches. Each branch ends on a muscle fibre as a ramification that is surrounded by muscle fibre nuclei and is termed a motor end plate or myoneural junction (fig. 1[D]). The myelin sheath ends before the muscle fibre is reached, and the neurilemma becomes continuous with the cell membrane of the muscle fibre. The arrival of a nerve impulse at a motor ending is followed by the contraction of the muscle fibre.

Neuronal Junctions (Synapses).—When an axon approaches a neuron to which it is conveying an impulse, it decreases in diameter and divides repeatedly. Each branch ends by making contact with

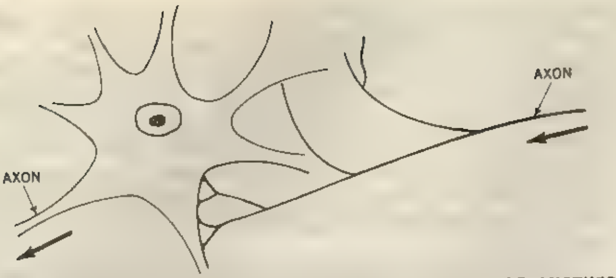

FIG. 2.—DIAGRAM OF A MULTIPOLAR CELL SHOWING AXON OF ANOTHER CELL SYNAPSING ON ITS SURFACE. HEAVY ARROWS INDICATE DIRECTION OF CONDUCTION

the surface of a dendrite or of the cell body (fig. 2), generally as a small swelling that may have a ringlike appearance. The branch may make several contacts before it ends. These contacts or junctional regions are called synapses. The axon and the cell with which it is synapsing are not fused. This "contiguity without continuity" has been demonstrated by electron microscopy. It is the basis of the neuron theory; *i.e.*, that neurons are cellular units.

Some of the terminal branches of an axon may synapse with one neuron, others with another, so that one axon may make contact with hundreds of neurons. Conversely, any one neuron may have hundreds or thousands of synaptic contacts on its surface, derived from many axons. Nerve impulses usually cross synaptic junctions in only one direction, namely from the axon of one neuron to a dendrite or the cell body of the next neuron.

Neuroglia.—The central nervous system contains blood vessels and a small amount of connective tissue around the vessels. Otherwise the nonnervous elements consist of cells known collectively as neuroglia. Glial cells differ in size and shape; nearly all have processes that weave around cells and fibres, and are frequently attached to the walls of blood vessels. Some glial cells have many processes and, because of their shape, are known as astrocytes (fig. 1[A]). Others, with fewer and shorter processes, are termed oligodendroglia. Both types develop embryologically from cells of the neural tube. Another type of glial cell is derived embryologically from connective tissue cells carried in with blood vessels. These cells are small and have few processes; they are called microglia. The lining of the cavities of the brain and the spinal cord is called ependyma; its cells constitute a special type of neuroglia.

Most glial cells can act as phagocytes; that is, they can ingest and remove dead or injured nervous tissue. There is evidence that glial cells are also concerned with the formation of myelin. Glial cells are clinically important because all tumours that begin in the brain and spinal cord are composed of glial cells.

Degeneration and Regeneration.—Adult neurons cannot divide and form new cells. Hence, a neuron that is lost cannot be replaced. If an axon is destroyed, however, the cell body may survive, although it undergoes certain changes. For example, if the axon of a spinal cord neuron is severed by cutting a peripheral nerve, the Nissl substance in that cell disappears (chromatolysis), but may reappear after several weeks or months; however, neurons confined entirely to the central nervous system generally do not survive axonal section. That part of the axon separated from the cell body degenerates; the myelin sheath and the axon swell and disintegrate. The fragments are removed by scavenger cells, most of which are proliferating neurilemmal cells. These cells remain as a cellular cord. The tip of that part of the axon still connected with the cell body begins to grow through the neurilemmal cord (at the rate of about one to two millimetres a day in man) and eventually reestablishes contact with whatever structure it had previously innervated. Function is often restored more or less completely. The myelin sheath is reformed, probably by neurilemmal cells.

There is no significant regeneration in the brain and spinal cord of warm-blooded animals; it may occur to a striking degree in many cold-blooded animals, however.

EMBRYOLOGY

Early in embryonic development, a neural tube is formed in the manner illustrated in fig. 3. This figure also shows that the head end of the neural tube early in development has three and then five enlargements from which the adult brain is derived. The rest of the tube forms the spinal cord. In spite of complex changes during growth and maturation, the central nervous system retains the cavity of the neural tube. The ventricles of the adult brain develop from this cavity.

Some cells in the neural tube are called spongioblasts; glial cells develop from these. Others, known as neuroblasts, give rise to adult neurons. Some cells in the neural crest develop into the unipolar cells of the spinal ganglia, others into neurilemmal cells, and still others, together with neuroblasts from the basal plate, migrate to positions alongside the vertebral column and to viscera. Most of these migrating cells develop into multipolar neurons of the autonomic ganglia. Some, however, give rise to the medullary cells of the adrenal glands. Cell division in the nervous system stops at or shortly after birth. Individual cells and processes, how-

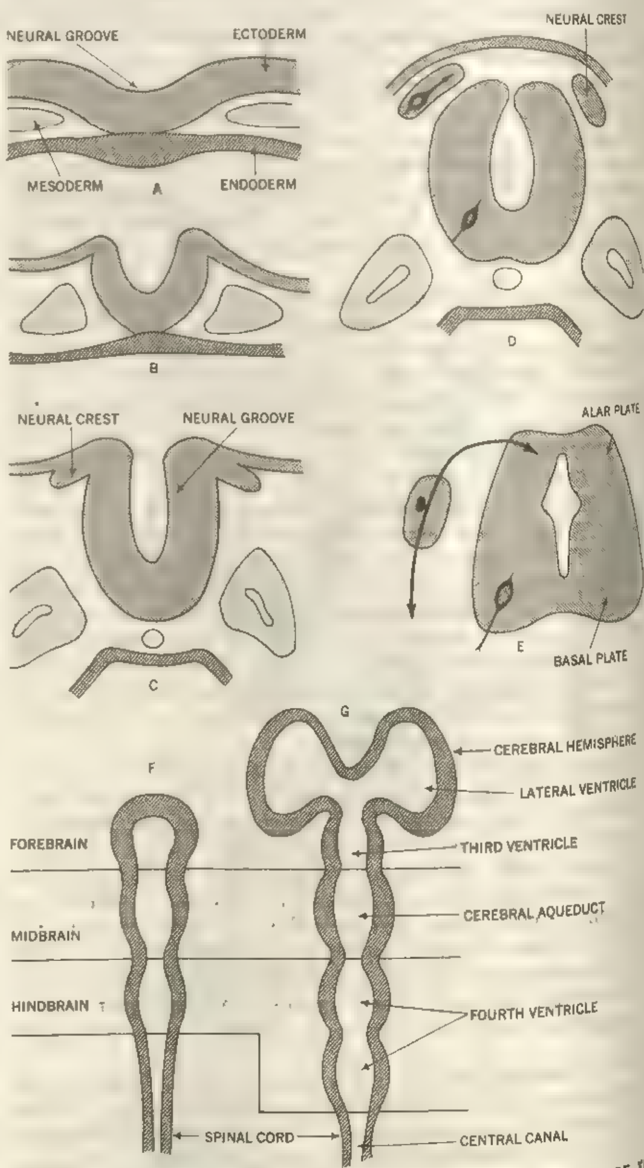

FIG. 3.—DIAGRAMMATIC REPRESENTATION OF CERTAIN FEATURES OF THE EMBRYOLOGY OF THE NERVOUS SYSTEM

(A–E) Cross-sections of parts of embryos. The ectoderm is a sheet of cells (individual cells not shown) that grows to form a longitudinal groove. The groove deepens and closes off to form a neural tube, from which the neural crest detaches. A single neuroblast is shown in the neural crest of D, and in E this has become a unipolar cell with processes growing centrally and peripherally. A neuroblast of the basal plate in D develops an axon that in E is growing out of the spinal cord. (F–G) Longitudinal views of the front end of the neural tube showing enlargements and cavities from which the adult brain develops

ever, continue to grow and enlarge until after adolescence.

COMPARATIVE ANATOMY

The nervous systems of vertebrates have certain features in common and show certain evolutionary changes that are summarized very briefly here.

The vertebrates include fishes, amphibians, reptiles, birds and mammals and are the largest subdivision (subphylum) of the phylum Chordata. All chordates have a single nerve trunk situated along the back, above the notochord or the vertebrae. This cord is a hollow, nonganglionated structure with a central, fluid-filled cavity. Its embryonic development is similar in all chordates. The anterior (front) end of this tube has evolved, in vertebrates, into a hollow brain with characteristic subdivisions. There are also characteristic sense organs (eyes, ears, etc.) that develop in the head region of vertebrates. The rest of the tube becomes the spinal cord.

The spinal cord has nerve roots attached to it. In *Amphioxus* (the lancelet; not a vertebrate, but a primitive chordate) the dorsal and ventral roots alternate; a dorsal root on one side is opposite a ventral root on the other. The dorsal roots are both sensory and motor; the ventral roots are purely motor. In fishes and higher vertebrates, dorsal and ventral roots unite to form spinal nerves, and there is an increasing tendency for dorsal roots to be entirely sensory. Ventral roots are motor in all chordates.

The cranial nerves of chordates are special nerves associated with the brain. They are named from studies in man, but the human arrangement of 12 pairs does not hold throughout the phylum Chordata. In *Amphioxus*, for example, there are two pairs of cranial nerves. The 12th pair of cranial nerves (hypoglossal) is absent in fishes. The 11th pair (accessory) is not separate in lower vertebrates, but is part of the 10th pair (vagus). The first pair in most vertebrates is the "terminal nerve"; it is absent or rudimentary in man.

The fibres in cranial nerves are of several types. Some cranial nerves are composed of but one type, others of several. There are fibres for the special senses, general sensory fibres from the head and face, special sensory and motor fibres for the branchial or gill region (primarily pharynx, larynx, facial muscles, muscles of mastication), parasympathetic fibres and motor fibres to eye muscles and tongue.

The major evolutionary changes of the nervous system are found in the brain. The hind end of the brain stem (the brain stem connects the cerebral hemispheres with the spinal cord) contains motor and sensory nerve cells like those of the spinal cord. It also contains groups of nerve cells concerned with certain special sensations, such as hearing, balance and taste, and with certain vital functions, such as respiration and circulation. This part of the brain stem changes relatively little in ascending the vertebrate scale.

The cerebellum is a part of the brain that is concerned with automatic regulation of posture and movement. Certain groups of cerebellar neurons regulate trunk muscles, others limb muscles, and still others are connected with the cerebral cortex. Hence the anatomical arrangement of the cerebellum varies greatly from species to species, depending on mode of locomotion. The cerebellum is relatively best developed in primates, especially in man.

In lower vertebrates, the main nervous centres are in the front end of the brain stem, which receives impulses of the special and general sensations. It acts as a co-ordinating centre. Parts of it are highly developed in birds, in which those portions devoted to vision are relatively large.

The primitive cerebral hemispheres are centres for smell, but in higher vertebrates they carry out many of the functions of the brain stem. Furthermore, by virtue of a complex surface layer of nerve cells, the cerebral cortex, the hemispheres in higher vertebrates are important association centres. The increasing importance and complexity of the cerebral hemispheres are associated with two main evolutionary trends. One involves the cerebral cortex, which is first present in reptiles and is most highly developed in man (important regions of the human cerebral cortex are concerned with speech mechanisms). The other trend involves the basal ganglia.

Basal ganglia are masses of nerve cells in the interior of the cerebral hemispheres and are concerned with many stereotyped or automatic aspects of movement, sensation, visceral activity and emotional behaviour. Basal ganglia are first present in amphibians and are most specialized and advanced in birds, in which they are the highest level of nervous function. Basal ganglia are present and important in mammals, but are overshadowed by the increasing development and complexity of the cerebral cortex.

AUTONOMIC NERVOUS SYSTEM

The term autonomic nervous system refers to those parts of the central and peripheral nervous systems that regulate the activity of the viscera. By a very broad definition the term viscera means the heart with its special type of muscle, and any organ or structure, such as stomach or skin, that contains smooth (involuntary) muscle and glands. The term autonomic implies an autonomy that does not actually exist. For example, skin exposed to cold air becomes blanched or pale because of a reflex constriction of blood vessels in the skin. The cold air stimulates temperature receptors in the skin, and the spinal reflex, by way of autonomic fibres to blood vessels, acts to conserve heat. At the same time impulses are sent to the brain for the sensation of cold. This is an example of co-ordination of somatic and autonomic activities.

The autonomic nervous system can be considered as a series of levels that differ in function in that the higher the level the more widespread and general its functions; the lower the level the more restricted and specific the functions. The highest level is the cerebral cortex, certain areas of which control or regulate all visceral functions. These areas send nerve fibres to the next level, the hypothalamus, at the base of the brain. The hypothalamus is a co-ordinating centre for the motor control of visceral activity. One of its many functions, for example, is regulation of body temperature. The hypothalamus has nervous and vascular connections with the pituitary gland, by virtue of which it influences the pituitary and through it the entire endocrine system. The hypothalamus also sends nerve fibres to lower centres in the brain stem that are concerned with still more specific functions; *e.g.*, the reflex regulation of respiration, heart rate and circulation. These centres function by virtue of their connections with still lower centres, which are collections of nerve cells that send their axons into certain cranial and spinal nerves. It is characteristic of these axons that, unlike motor fibres to skeletal muscle, they synapse with multipolar cells outside the central nervous system before they reach the viscus to be supplied. These cells are collected into ganglia; hence the ganglionic level is the lowest one. The axons from the central nervous system to ganglion cells are termed preganglionic fibres. The axons of ganglion cells are called postganglionic fibres, and all such fibres from a particular ganglion supply a specific organ or region of the body.

The preganglionic fibres that issue from the thoracic and upper lumbar levels of the spinal cord comprise the sympathetic or thoracolumbar part of the autonomic system. These fibres reach spinal nerves by way of ventral roots, then leave the spinal nerves to enter adjacent ganglia (fig. 4). These ganglia are contained in long nerve trunks (sympathetic trunks), one on each side of the vertebral column, extending from the base of the skull to the coccyx. Some preganglionic fibres continue to medullary cells of the suprarenal glands, but most synapse in the ganglia. The postganglionic fibres either go directly to adjacent viscera and blood vessels, or else return to spinal nerves and thus reach blood vessels, smooth muscle and glands of the limbs and body wall.

The preganglionic fibres that issue from the brain stem and sacral part of the spinal cord comprise the parasympathetic or craniosacral part of the autonomic system. The ganglion cells with which these fibres synapse are in or near the organs innervated. The postganglionic fibres are very short; apparently none go to the blood vessels, smooth muscle and glands of the limbs and body wall. Most viscera have a double motor supply, sympathetic and parasympathetic, generally with opposing functions.

There is also a physiological classification. Certain chemicals

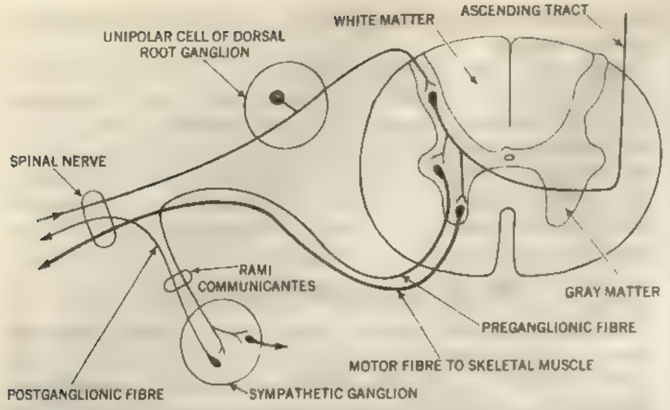

FIG. 4.—DIAGRAM OF REFLEX PATHS IN THORACIC (SYMPATHETIC) PORTION OF AUTONOMIC SYSTEM

A sensory fibre enters the spinal cord (shown in cross section) over a dorsal root and synapses with a cell, the axon of which synapses with motor cells, then ascends to the brain. Motor fibres leave by way of a ventral root. Preganglionic sympathetic fibre leaves the spinal nerve to synapse in a ganglion of the sympathetic trunk. Postganglionic fibres go to adjacent viscera or back to the spinal nerve

that are liberated at the terminals of postganglionic autonomic fibres act as transmitters; *i.e.*, they are released when nerve impulses arrive, and in turn they initiate activity in the viscus or alter its existing activity. Acetylcholine is liberated at postganglionic parasympathetic terminals; such fibres are called cholinergic. Noradrenaline is released at most postganglionic sympathetic terminals, and such fibres are called adrenergic. The sympathetic fibres to smooth muscle and sweat glands of the skin, however, are cholinergic. Adrenaline, formed by the medullary cells of the adrenal glands and released into the blood stream, has actions similar to those of noradrenaline. Hence the sympathetic system, by virtue of stimulating the release of adrenaline, can enhance its own actions.

The autonomic system is an important part of the mechanism by which the body keeps its internal environment constant; *i.e.*, maintains temperature, fluid balance, ionic composition of the blood, etc. This maintenance is generally known as homeostasis. The parasympathetic system regulates many specific functions, such as digestion, intermediary metabolism and excretion. The sympathetic system is an important part of the mechanism by which a person reacts to stress. This system tends to act as a whole, especially when stress is of sudden onset. For example, a situation that results in fear or rage may also result in increased blood pressure, pulse rate, cardiac output and blood sugar, measures designed for "fight or flight." These acute responses to stress are widespread because the sympathetic system has many connections and also because adrenaline is secondarily released into the blood stream.

Stress may also be followed by more slowly developing changes in metabolic activities and defense mechanisms, brought about by activation of the hypothalamic–pituitary system, leading to changes in the functions of the endocrine organs.

See also references under "Nervous System" in the Index.

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(E. D. G.)

NERVOUS SYSTEM, DISEASES OF. It is convenient to consider diseases of the nervous system according to their effects on three parts of that system—the brain, the spinal cord and the peripheral (sensory and motor) nerves. (For information on the anatomy and physiology of the nervous system the reader should consult BRAIN; MENINGES AND CEREBROSPINAL FLUID; NERVE; NERVE CONDUCTION; NERVOUS SYSTEM; PARALYSIS; SPINAL CORD; TIC. Other articles relating to diseases of the nervous system, in addition to those cited as cross references later in this article, include CEREBRAL PALSY; DEMENTIA; DRUG ADDICTION; HEADACHE; HYDROCEPHALUS; METABOLISM, DISEASES OF; NERVOUS SYSTEM, SURGERY OF; NEURALGIA; NEUROPHARMACOLOGY AND PSYCHOPHARMACOLOGY; NEUROSES; PSYCHIATRY; PSYCHOSES; SPINE, DISEASES AND DISABILITIES OF; STROKE; VERTIGO AND DIZZINESS.)

The disease processes affecting the brain, spinal cord and peripheral nerves are in general similar, but the resulting symptoms and signs may be distinctive in each part. Diseases may attack each part separately, or two or all three together. These three parts subserve sensation and voluntary movement. There is, in addition, a partly segregated autonomic or vegetative nervous system that controls the viscera, blood vessels and the secretion of certain glands. This system is connected with the brain and spinal cord centrally and its fibres also join in the distribution of peripheral nerves, but part of it is anatomically separated and is disposed as a series of nerves and ganglia along each side of the spinal canal; here local disease may attack the autonomic system alone or part of it. In diagnosis, both the nature of the disease process and where it attacks must be considered.

The main categories of diseases affecting the nervous system are: congenital disease, when the individual is born with some inherent defect; inflammatory and infective, when bacteria, viruses or other germs infect the nervous system; toxic and metabolic, when a poison, either from outside or as a result of some abnormal metabolism of the body, acts on the nervous system; deficiency, when some essential food factor is absent from the diet; traumatic, when injury causes defect; neoplastic, when a new growth or tumour damages the system; vascular, when the blood vessels supplying essential nutriment to the system are diseased; and degenerative, when the cells or nerve fibres of the nervous system show intrinsic degeneration. Congenital diseases usually show themselves in infancy. Inflammatory, infective, toxic and metabolic troubles may occur in any age group. This also applies to trauma, though exposure to this may be greater during the physically active years of early adult life. Neoplasms are commoner in middle and late life. Vascular and degenerative diseases are more frequent in the elderly.

Peripheral Nerve Disease.—If peripheral nerves are diseased, those parts of the body that they supply suffer a loss of power and sensation. There may also be local changes in blood supply and sweating because the autonomic nerve fibres are carried by peripheral nerves.

Individual peripheral nerves are commonly affected by injury causing a localized traumatic neuropathy. As pressure is a ready source of injury, the nerves most susceptible to this type of injury are those that at some part of their course lie near the surface of the body and in relation to bone, so that compression can easily occur. Nerves often affected by traumatic neuropathy are the ulnar nerve at the elbow, the median nerve as it passes under the firm carpal ligament to enter the palm of the hand, the radial nerve as it winds round the shaft of the humerus, and the lateral popliteal nerve as it winds round the head of the fibula.

Generalized affections of peripheral nerves (*polyneuritis*), when weakness, numbness and tingling at the periphery of limbs occur, are usually toxic or metabolic in origin. External poisons that may cause polyneuritis include arsenic, lead and mercury and a number of organic compounds, some of which may be used as drugs. There is individual variation in the response to these agents and some people develop neuropathy more easily than others. Alcohol can produce a polyneuritis by interfering with the nervous normal supply of thiamine (vitamin B_1). Supplying extra thiamine will sometimes dramatically reverse this type of polyneuritis. Nutritional deficiency, both of thiamine and of another vitamin (B_{12}, also called cyanocobalamin, or cobalamine), may, of itself, also produce a polyneuritis. So may the endogenous toxic metabolic upset associated with diabetes (*see* DIABETES MELLITUS

LITUS: *Signs and Symptoms*); less often it may cause a localized neuropathy of one or more nerves (*mononeuritis multiplex*). In the 1950s it was discovered that carcinoma, especially of the lung, may sometimes cause a generalized polyneuritis. When the small arteries supplying blood to nerves are diseased, as in the condition of *polyarteritis nodosa*, polyneuritis may also result, usually producing both motor and sensory symptoms, though one or the other may occasionally predominate or appear alone.

Peripheral nerves originate as sensory and motor nerve roots from the spinal cord, several roots or parts of them combining to form a given nerve. Disease may attack the nerve roots and cause pain in the distribution of the root, as well as sensory and motor loss. Such lesions are usually traumatic from pressure by nearby structures, since the roots run for a short distance inside the bony spinal canal where pressure occurs from diseased vertebrae or intervertebral cartilaginous discs. In the upper limb a form of arthritis of the neck (*cervical spondylosis*), in which disc and bony changes occur, may cause cervical nerve root lesions leading to brachial neuropathy and sometimes pressure on the spinal cord as well. In the lower limbs, a similar pathology of intervertebral discs causes *sciatica* (*see* NEURITIS) and *lumbago*.

Spinal Cord Disease.—The spinal cord consists mainly of nerve tracts carrying impulses for sensation up to the brain and for movement down to peripheral nerves and muscles. If it is diseased there is loss of power, sensation, visceral control and autonomic function below the level of the disease. This is usually a generalized change but may sometimes be mainly on one side of the body in unilateral cord disease. In such cases motor function may be largely affected on one side and sensory on the opposite, since sensory nerve fibres conducting pain and heat sensation cross immediately after entering the spinal cord, while motor fibres travel up on the side they enter until they reach the brain stem. Occasionally disease may be limited to a small part of the cord so that only certain functions, motor or sensory, are altered and the spinal cord tracts as a whole are not interrupted. In this case, motor or sensory function will be affected only in the body areas supplied by the diseased segment of cord and there may be no general loss of function below the lesion. Sometimes, also, tracts serving one function (motor, sensory or connected with the cerebellum and co-ordination) seem to be selectively diseased, producing disability limited to a function rather than to an anatomical area. As with peripheral nerves, autonomic function may also be affected in cord disease.

As the spinal cord is contained in a rigid bony canal, it is readily compressed by anything that causes enlargement of the surrounding vertebrae or of the contents of the canal. Thus inflammation or tumour of the spinal bones may cause pressure on the cord with consequent interruption of sensory and motor function below the level of the compression. This not only produces weakness, numbness and possibly paresthesia in limbs and trunk below the lesion but also interferes with control of bladder and bowel function. *Spinal caries* (tuberculosis of the vertebrae) used to be a common cause of this but has decreased with the lessened frequency of tuberculous infection. If an intervertebral disc becomes displaced it may sometimes press backward on the cord and produce compression, though it more usually causes pressure on nerve roots because the displacement is more commonly at the lateral edges rather than the central part of the disc.

The meninges, or membranes, that ensheath the spinal cord may also be the seat of disease that causes secondary defects of the cord. A tumour (*meningioma*) may cause pressure on the cord and inflammation (*meningitis*; *q.v.*) may pass directly to the cord or cause constriction and interference with its blood supply. It is probable that anything that causes constriction of the cord, whether by enlargement from within or pressure from without, causes some degree of vascular insufficiency, which of itself may result in damage or even total destruction of part of the cord. This is occasionally seen as a result of acute trauma when the anterior spinal artery is suddenly occluded and severe permanent damage to a segment of the cord results. Similar secondary vascular effects may occur when the cord is much swollen from inflammation, in virus infection for instance; these vascular disturbances may cause a necrotizing myelitis that is far more severe than the original inflammation. Intrinsic tumours of the cord (*gliomas*) are less common. They usually produce insidious signs of cord dysfunction at and below their site of origin. (*See* also TUMOUR.)

Virus diseases may attack the cord, a common one being *anterior poliomyelitis* (*see* POLIOMYELITIS), which affects mainly the motor nerve cells of the cord—the so-called anterior horn cells. The result is local weakness or loss of power, usually of segmental distribution of muscles to correspond with the cord segments most severely affected. There is no sensory change. *Herpes zoster* virus, on the other hand (*see* SKIN, DISEASES OF), is mainly sensory in incidence and attacks the posterior horn cells. Both these cause limited damage but other viruses seem to produce a general myelitis with inflammation affecting the whole thickness of the cord and its sensory and motor tracts.

Subacute combined degeneration affects both motor and sensory tracts in the cord and also causes a peripheral neuritis. It is associated with pernicious anemia (*see* ANEMIA: *Anatomical Derangements of Bone Marrow*) and is now known to be due specifically to vitamin B_{12} deficiency. If diagnosed early enough, it can be rapidly cured by treatment with vitamin B_{12}.

Multiple sclerosis (*q.v.*) is a disease in which a number of limited areas or plaques of nerve fibre degeneration occur with consequent local scarring. Its exact etiology is unknown, but one view considers it a primary virus disease with secondary effects of an allergic nature in the nervous system. The disease attacks both brain and spinal cord, but there is a form that presents clinically as a purely spinal disease, causing mainly stiffness, weakness and in-co-ordination of limbs and trunk. The condition is then often benign and slowly progressive.

Motor neuron disease (*see* AMYOTROPHIC LATERAL SCLEROSIS) is essentially a degenerative condition, again of unknown cause, that affects the motor nerve cells or neurons, upper and lower, selectively. It may be present as cord disease because motor tracts in the cord, as well as the motor cells, are affected. The result is weakness and wasting of muscles, but with no sensory change. As the lower motor cells in the cord become diseased, a characteristic flickering (fasciculation) occurs in the muscles innervated by them.

Another degenerative disease, *syringomyelia*, causes cavitation in the centre of the cord. As this cavity enlarges, first the sensory fibres for pain and temperature are involved, then motor tracts and finally other sensory tracts. This sequence gives a characteristic picture at first of loss of pain and temperature sense dissociated from loss of other sensation.

Syphilis (*see* VENEREAL DISEASES: *Syphilis*) of the nervous system usually affects both brain and spinal cord. However, it may produce a mainly cord disease in which sensory tracts (posterior columns) are especially affected. The condition—*tabes dorsalis* (*q.v.*)—is characterized by widespread loss of proprioceptive sensation, with consequent interruption of the reflex arc subserving tendon jerks, which are abolished, and by variable areas of pain loss. A particular change in pupillary reactions by which the pupil is small and constricts to accommodation but not to light (the Argyll Robertson pupil) and some degree of optic atrophy usually accompany tabes dorsalis and aid the diagnosis. This, however, is most firmly established as in all forms of neurosyphilis by the serological reactions (Wassermann reaction, etc.) in blood and cerebrospinal fluid.

Finally a number of degenerative and often familial diseases occur in which various tracts in the cord are selectively diseased. Thus, differing combinations of losses of motor, reflex and sensory function and co-ordination causing ataxia result. The group is referred to as *Friedreich's ataxia* and its variants.

Brain Disease.—The brain may be generally diseased by such factors as inflammation, toxins or degeneration, or it may be locally affected, *e.g.*, by injury or tumour. In the first case there will always be some change in psychological function such as memory, concentration or emotional reactions. This is because the brain is the organ of adaptive behaviour; whatever the ultimate substrate of thought and emotion may be, in man they are not experienced in the absence of the brain. In local brain disease there may be little or no mental change, but local loss of neurologi-

cal function in some part of the body occurs and may indicate the exact site of the brain disease.

Acute *encephalitis* (*q.v.*)—inflammation of the brain—is usually caused by virus infections, less often by bacteria. It may be abrupt in onset or slowly ingravescent and results in delirium, stupor and coma. It involves most parts of the brain and there are rarely any local neurological abnormalities. As recovery occurs, however, and general changes in consciousness subside, local abnormalities may be revealed.

At the other end of the scale, a slow, generalized degeneration of brain cells may occur, causing increasing dementia and restriction of the normal range of behaviour. This so-called *presenile* dementia is probably genetically determined though its exact cause is unknown (*see* also DEMENTIA). A similar generalized loss of cerebral function may occur with arterial disease of the brain, with cerebral syphilis or with advanced and widespread disseminated sclerosis. When the brain is repeatedly injured, as by blows on the head, even though each individual injury is slight, a cumulative effect may again produce a general mental slowing and loss of cerebral function exemplified in the "punch-drunk" condition. Sometimes, in cerebral tumour, although the disease is quite localized, it produces a general rise in intracranial pressure, since the skull and brain membranes (meninges) form a relatively inexpansible container. Inflammation of the meninges may cause adhesions and loss of normal circulation of the cerebrospinal fluid filling the cerebral ventricles and bathing the surface of the brain, with consequent rise in pressure. Such adhesions may be a prominent feature of *tuberculous meningitis* (*see* MENINGITIS: *Nonsuppurative Meningitis*). In these cases again, symptoms of general cerebral dysfunction occur. When disease is strictly limited to certain regions in the brain stem, it may sometimes produce quite general symptoms by interfering with some alerting mechanism necessary for proper cerebral and especially mental function.

When local brain disease occurs, its exact site determines local symptoms. The cerebral cortex on each side of the brain contains areas representing motor and sensory function on the opposite side of the body, since sensory and motor fibres cross, some in the cord but most in the medulla oblongata. The most posterior, or occipital, part of the cortex is concerned with vision. More anteriorly, but still posterior to the great fissure of Rolando (central sulcus) of the cortex, various forms of common sensation are represented, while farther forward the pre-Rolandic area governs motor function. The two lateral halves of the cortex are not quite equipotential, for one half (the left half in right-handed people), often called the dominant hemisphere, is involved in understanding and execution of speech and writing. Lesions in limited areas of the frontal and posterior temporal regions of this hemisphere cause a variety of losses of organized speech called dysphasias, or aphasias (*see* also SPEECH DISORDERS: *Aphasia* [*Dysphasia*]). There are also areas of the cortex that control important but less clear-cut functions. Areas in the parietal lobes are linked with recognition of the significance and meaning of objects, orientation of the body in space and recognition of the constituent parts and positions of outside space. These functions are shared by the two hemispheres. The anterior or frontal poles of the cortex seem associated with general manifestations of emotion and personality, as do the medial parts of the temporal lobes. Local lesions in these areas will cause localized changes in the functions represented. The commonest cause for such local lesions is cerebral tumour. Injury, local vascular disease and abscess may also be responsible.

Apart from loss of function, however, the cortex may react to disease by producing sudden abnormal discharge of nerve cells, resulting in an *epileptic fit*. Focal fits take the form of a sudden involuntary sensory or motor change in part of the body or in the special senses—smell, taste, vision and hearing. In generalized fits consciousness is abruptly lost and the whole body is seized by *convulsions* (*q.v.*). Focal fits are a valuable indication of which part of the brain is diseased. Besides appearing as a local disease, epilepsy may occur (sometimes focal but more often generalized) as a special disease (*see* EPILEPSY). In this condition (idiopathic epilepsy) there is usually a genetic factor and a family history reveals other cases.

In disease of subcortical or basal parts of the brain, various abnormalities of movement occur: there may be slowing and loss of fine movement with tremor and rigidity as in *Parkinson's disease* (*see* PARKINSONISM); sudden involuntary jerks may interrupt normal smooth movement as in *chorea* (*q.v.*); or movement may become writhing or flail-like as in *athetosis* (*q.v.*). Such diseases are most commonly degenerative in origin, though a form of encephalitis (*encephalitis lethargica*), of which there was a pandemic in 1918, gave rise to a number of cases and *rheumatic encephalitis* may also be responsible for some.

Diseases of the cerebellum result in ataxia of movement—walking, limb movements, speech and eye movement may all be affected. This may be degenerative as in disseminated sclerosis but tumours of the cerebellum or of nearby structures causing cerebellar compression are also common.

In the brain stem, pons and medulla oblongata, where the various tracts to and from the brain are passing down to join the spinal cord, lesions tend to produce interruptions of these tracts with consequent loss of sensory and motor function below, together with loss of function of cranial nerves, which supply the special senses and sensation and movement to the face, head and neck. When such lesions are tumours, they are also liable to produce a general rise in intracranial pressure.

Diagnosis of Nervous System Disease.—Apart from the symptoms and signs shown by clinical examination and the history of how they developed, there are some special tests that are widely useful in neurological diagnosis. The electroencephalograph records the electrical activity of the brain through the intact skull and can detect localized or lateralized abnormalities from tumours, local atrophies, vascular changes, etc., as well as certain generalized changes from metabolic upsets, raised intracranial pressure or intrinsic abnormalities due to idiopathic epilepsy (*see* ELECTROENCEPHALOGRAPHY). X-rays of the skull and spine may reveal bony changes that are affecting underlying nervous tissue in brain, spinal cord or nerve roots. The cerebrospinal fluid may be withdrawn at lumbar puncture; changes in the pressure, constitution and cell content of the fluid may indicate the nature of the disease process. The fluid may also be withdrawn and replaced by a small amount of air, which will pass into the ventricles and parts of the space on the surface of the brain that are usually filled by the fluid. X-rays will then show an outline of the air-filled portions, since air is much less opaque to X-rays than is brain tissue or the fluid. The resulting picture (an air encephalogram) will reveal local distortions or general changes in ventricular and brain surface shape and size. Equally, lumbar fluid may be replaced by a few millilitres of an X-ray-opaque iodized oil and a series of X-ray pictures (myelograms) may be taken that will outline the shape and size of the spinal cord and reveal any obstruction to the fluid flow (*see* also RADIOLOGY: *Skull, Brain and Spinal Cord*). The rate of conduction of impulses in certain peripheral nerves can also be measured electrically (electromyography); local loss or reduction of conduction can determine the exact site of the lesion. Finally, the electromyogram can sample the electrical activity of muscles and sometimes determine whether weakness and wasting are due to disease of the nerves supplying them or to intrinsic muscle disease. *See* also DIAGNOSIS and references under "Nervous System, Disease of" in the Index.

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NERVOUS SYSTEM, SURGERY OF. This article discusses the surgery of the human nervous system, taking up the major subdivisions of the subject in the following order: brain, spinal cord and sympathetic and peripheral nerves. For information about the anatomy of these structures, *see* BRAIN; SPINAL CORD; NERVE.

Brain.—Evidences of surgical operations on the skull have been found in the skeletons of prehistoric man and of peoples of many later eras. Such procedures cannot be considered brain surgery

since they rarely, if ever, were carried deeper than the cranial bones, for experience taught the ancient physicians that penetration of the tough sheath (dura mater) covering the brain was usually fatal because of infection by bacteria—a phenomenon not understood until a century ago. Only when operations were carried out under conditions that minimized the likelihood of bacterial invasion could brain surgery develop.

The early success of this type of surgery was hampered by a lack of knowledge of the localization of function within the brain and spinal cord. In order to know where to make an opening through the skull to expose diseased tissue, the surgeon had to be able to interpret properly the symptoms and signs of disease of the nervous system. In the first place, the fact that one side of the brain controlled the movements and sensation of the opposite side of the body had to be firmly established. Then, the principle that certain parts of the brain had to do with movement, others with common cutaneous sensation and still others with vision and audition had to be proved. Later the location of these areas in the cortex of the big brain, or cerebrum, was demonstrated. When the neurologist knew that a blindness in the right half of the visual field in both eyes was associated with derangement of the left occipital (back part of the brain) lobe, he could then decide if the condition might be relieved by an operation and could indicate precisely where the surgeon should make a hole in the skull to find the trouble.

Techniques for Detecting Abnormalities.—Other means soon became available, however, for detecting abnormal conditions in the brain. With these techniques the surgeon is able to locate the diseased places within the head and to plan his operation accurately.

Soon after the discovery of X-rays, photographs were made of the head with those rays. In these pictures the structure of the skull bones is seen and brain conditions that involve the cranium can be recognized. But since this technique shows changes in bone only, methods by which the brain itself could be visualized had to be devised. Within the cerebrum are cavities, or ventricles, containing a watery fluid (ventricular fluid); this fluid passes about the base of the brain and is absorbed by the veins on the surface of the hemispheres. Normally these cavities are symmetrical on the two sides and have a fairly constant shape. But in the presence of a tumour or other disease of the brain they may be distorted. If the fluid is removed from the cavities with a needle and is replaced by air, an X-ray photograph of the head will show the ventricles, for the X-rays pass more readily through air than brain and hence more rays reach the film through the ventricles and therefore fog their outline. This technique is termed ventriculography (or if the air is injected through the spinal canal, pneumoencephalography).

Another method of showing the contour of the brain utilizes an injection of a radiopaque dye (one that stops X-rays) in the neck (carotid) artery at the time that an X-ray photograph is made of the head. This outlines the arteries of the brain, which usually have a constant position, and will show any displacement of the vessels or any collection of abnormal blood channels within the brain. This technique is called cerebral angiography.

When it was found that normal brain activity is accompanied by changes of electrical potential that can be detected by leading wires from different places on the scalp, another means of demonstrating the location of brain disease became available. The changes in potential normally occur at constant and identical frequencies (8 to 11 per second) on the two sides of the head. Unusually slow, fast or sharp waves often indicate abnormalities in the brain; a disturbance in electrical activity localized in one area usually means that that part of the brain is diseased. This technique, called electroencephalography (*q.v.*), is particularly useful in studying the epilepsies. (*See* EPILEPSY.)

When radioactive isotopes were produced for use in medicine, another tool for determining the location of disease within the brain became available. Diagnostic use of the isotopes is based on the fact that tumours of the brain take up or accumulate greater amounts of certain radioactive substances than does normal brain tissue. Several hours after the irradiating isotopes of these substances (*e.g.*, iodine) are given to the patient, a detecting tube is passed over the head to determine the areas of maximum discharge of gamma rays from the isotope. The findings from this process, known as brain scanning, can be recorded on paper or photographic film over an outline of the head.

Exposing the Brain.—The purely mechanical procedure of uncovering the brain taxed the ingenuity of the first brain surgeons, for the control of bleeding from scalp arteries, which retracted when cut, and from skull bones was a serious matter. The early surgeons attempted to stop the bleeding from the scalp vessels by tying a tight band around the head just above the ears. Later, clamps were applied to the layer of fibrous tissue just beneath the blood vessels and turned back over the scalp to choke off the bleeding vessels, or clips were applied to squeeze the vessels between the scalp and fibrous layer. This fibrous layer is loosely attached to the underlying outer covering of the skull bone; it was in this plane that the American Indians scalped their victims.

To expose the hard coverings of the brain, the skull was perforated by a trephine—a tool similar to a carpenter's brace and bit—and the hole enlarged by rongeurs, an instrument similar to a pair of pliers but with cutting edges on the jaws so that the bone can be bitten away. However, this left a hole in the skull after recovery that sometimes caused headache and alarmed the patient for fear a fall or blow might damage the brain.

The hole technique has been replaced in recent years by a trap door in the skull (technically called a bone flap) that is made by boring holes about 4 cm. apart around the area to be exposed (fig. 1). Usually the base of the flap is at the margin of one of the muscles attached to the lower part of the skull. The bone between

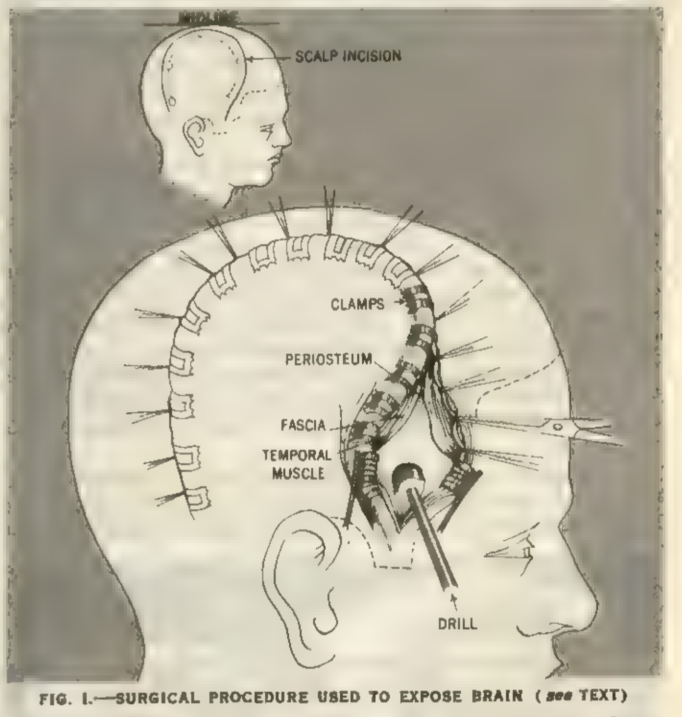

FIG. 1.—SURGICAL PROCEDURE USED TO EXPOSE BRAIN (*see* TEXT)

the holes away from this base is cut with a wire saw so that a horseshoe-shaped piece of bone is free except beneath the muscle. By prying up on the bone, the base of the flap is broken and the entire piece attached to muscle is then lifted up and turned away from the dura mater of the brain, using the muscle as a hinge. The edges of the cut bones are plugged with wax to stop their bleeding. Thus a large area of dura mater is uncovered, and the underlying brain can be easily exposed by cutting the dura mater with a scissors around most of the margin of the bony opening. The cortex, which is covered by the transparent pia arachnoid, or soft membrane, is thus brought into view (fig. 2).

After the operative procedures on the brain have been completed, the dura mater is usually sewed together to cover the brain (fig. 3). The bone flap is replaced and held by a wire suture that is passed through the adjacent outer and inner margins of skull bone. The cut margins of the muscle at the base of the flap are

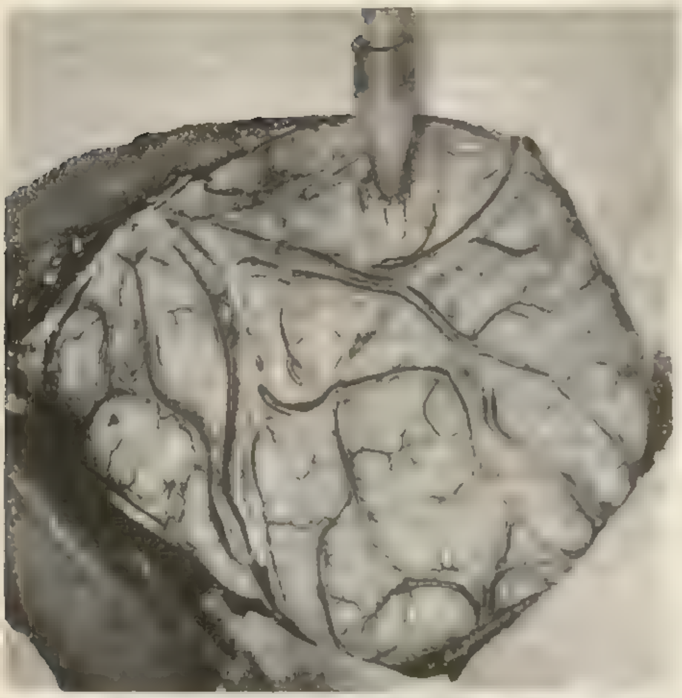

FIG. 2.—BRAIN AFTER OPENING OF DURA MATER

sewed together. Then the deep layer of fibrous tissue of the flap is stitched to the same layer of the scalp, usually with silk thread. Finally the superficial margins of the incision are brought together by sutures tied on the surface. Thus the scalp edges are held together in apposition so that they can heal. The cutaneous stitches may be removed in three to seven days.

Occasionally if a tumour cannot be taken out completely, pressure inside the head is relieved by (1) removing the lower portion of the bone flap under the muscle and the temple bone adjacent to the flap, and (2) incising the hard coverings of the brain in a radiating manner so as to leave a defect through which the brain can protrude and press against the temporal muscle. The remainder of the bone flap is then replaced and wired in place, and the muscles and scalp are closed as described above. The decompression left beneath the muscle will prevent too great an increase in pressure inside the head, and yet the muscle will tend to keep the protrusion on the side of the head from becoming too large and unsightly.

In certain operations when only a small hole in the skull is necessary and when the proposed opening is covered by muscle, the bone is perforated by a trephine and the opening enlarged to the

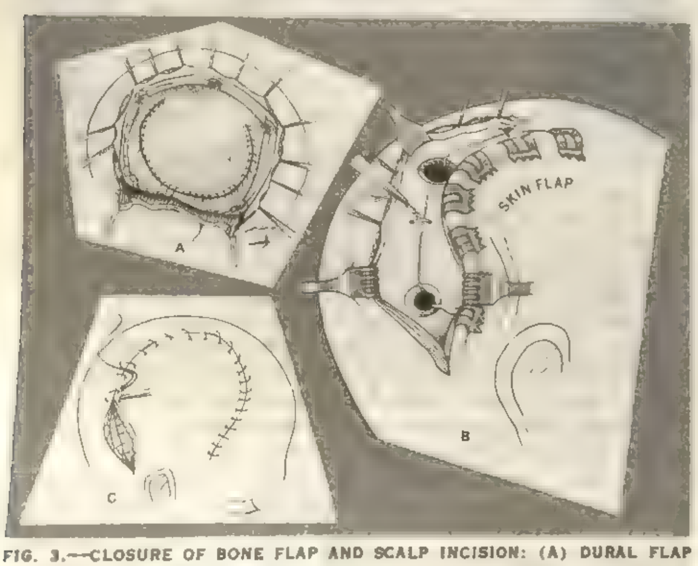

FIG. 3.—CLOSURE OF BONE FLAP AND SCALP INCISION: (A) DURAL FLAP SUTURED; (B) BONE FLAP IN PLACE AND FASTENED WITH STAINLESS STEEL WIRE; (C) SUTURING OF SKIN FLAP

desired size by a rongeur. Such holes are usually made beneath the temporal muscle or the heavy neck muscles; consequently when the muscles are sewed together they cover (and protect) the defect so that it is barely, if at all, visible.

Excision Procedure.—The surgical procedures thus far discussed allow the surgeon to expose and inspect the brain. Depending upon the disease condition—a tumour, abscess, scar or other abnormal state—the surgeon then proceeds to explore the brain or excise the diseased area. First, the many extremely small vessels in the soft covering of the brain are usually shrunken and cut with a high-frequency electric current. The underlying brain tissue, which has the consistency of a soft cheese, may be cut through with a blunt instrument and a large piece of diseased tissue removed.

Usually it is not desirable to cut into the motor cortex, the area of the cortex that controls movements, because doing so may leave the patient paralyzed on one side and speechless.

The extent and type of the surgical procedure depends on the abnormality present in the brain. Some tumours do not invade the brain and may be removed completely. Some are invasive and only a portion of them can be excised to relieve the pressure within the skull. Abscesses usually may be removed without difficulty. Scars that cause epilepsy can often be removed completely; the abnormal tissue at the scar margins, which is responsible for the convulsions, can be mapped accurately by applying electrodes to the surface of the cortex and making a record of the brain activity during the operation (fig. 2).

Many other types of brain operations may be done; for example, the outpouchings (aneurysms) of blood vessels that sometimes rupture and cause serious hemorrhages into the brain may be clipped at their base, leaving the flow of blood in the parent vessel intact. Nerves at the base of the brain may be cut to relieve excruciating pain or bouts of dizziness. Needles can be inserted under X-ray control to destroy the deeper nuclei of the brain and thereby abolish the tremor or relieve the stiffness of a shaking palsy. Finally, the normal contour of the head may be restored by filling holes in the skull bones with pieces of bone from the patient's hip or rib or with sheets of tantalum or plates of molded plastic.

Spinal Cord.—As soon as aseptic techniques and anesthesia were developed, the surgeon cut through the bony coverings of the spinal cord—the spinous processes and laminae of the vertebrae—and removed them with the rongeurs to expose the hard membrane. A longitudinal incision in the spinal dura mater brings into view the transparent soft coverings and the cord. Tumours that do not invade the spinal cord usually are removed easily. Invasive tumours may be partially removed and the dura mater left unsutured to relieve pressure on the nerve tracts in the cord. At times, the surgeon cuts a part of the spinal cord (cordotomy) to relieve pain in the lower parts of the body. At other times the nerve roots entering or leaving the cord are cut to eliminate pain or muscle spasms. Spinal injuries that fracture the vertebrae may or may not damage the spinal cord and may cause varying degrees of paralysis. In most instances conservative measures such as a cast and the posturing extension of the spine are the only forms of treatment required. A decompressive laminectomy (excision of a lamina) is occasionally indicated if the spinal cord is compressed by blood clots or by bone fragments. Paraplegia that results from severe injuries requires a long period of rehabilitation and training but some patients make a remarkable adjustment to their disability and become economically self-supporting.

An important phase of neurosurgery is the treatment of sciatic and arm pain by the removal of the protruding cartilaginous material (disc) that normally acts as a cushion between each vertebral bone. When this disc is broken as result of injury or degeneration from chronic wear and tear, it may stick out at the side of the vertebra and press against a nerve root, causing pain in the leg if the protrusion is of a disc of the lower back or in the arm if it is of the neck. Such protrusions are easily exposed surgically by separating the muscles from one side of the spinous processes and laminae at the involved site. The removal of a small portion of the adjacent laminae allows the surgeon to see the com

pressed and displaced nerve root so that it may be retracted to one side and the protruding disc material underneath may then be removed.

At times the disc material degenerates and leaves the back unstable, that is, with unnatural and painful mobility. To relieve this condition the loose joint is fused by plugging it with pieces of bone or by firmly fastening strips of bone along the spinous processes and laminae of the vertebrae on either side of the diseased disc. When new bone forms between these vertebrae the joint becomes solid.

Improper or incomplete development of the spinal cord and its coverings occurs occasionally and produces a mass on the back that contains a watery fluid surrounding incompletely developed nerve roots or spinal cord. If the failure of growth has not been too severe the surgeon may make a new covering for the cord and nerve roots. Often, unfortunately, the defect is so great that the patient is paralyzed in the legs and has no control over the bladder or bowel. In such cases operation is futile.

Sympathetic and Peripheral Nerves.—A further part of the surgery of the nervous system concerns the sympathetic and peripheral nerves. The former control many of the activities of the abdominal organs, the blood vessels and skin—activities that are automatically modified by the brain in response to changes in the internal or external environment of the individual. Thus in a cold environment the blood vessels of the skin constrict and the hairs stand up to form "goose pimples"; both actions decrease the loss of heat from the skin and conserve it for the body. At times the sympathetic nerves may become excessively active so that the surgeon must remove a portion of them to increase the blood supply of an arm or leg or to prevent spasms of the blood vessels.

The peripheral nerves—those that supply muscles and skin—are subject to the same injuries and diseases as are other tissues of the arms and legs. They must be sutured together after being cut so that their nerve fibres can regenerate and innervate the muscles and skin.

Such operations are relatively simple compared with those of the brain and spinal cord but require a technical skill to obtain apposition of the nerve ends. Even with perfect suturing, severed nerve fibres rarely regenerate so completely that normal muscle function and skin sensation are regained.

See also MENINGES AND CEREBROSPINAL FLUID; NERVOUS SYSTEM; SPINE, DISEASES AND DISABILITIES OF.

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NESBIT, EDITH (1858–1924), English writer of books about children whose characters are as clearly defined and true-to-life as is their middle-class home background, with its secure moral values, and whose adventures, whether brought about by family misfortunes or through the workings of magic, are described with a blend of imagination and practicality which carries immediate conviction. She was born in London on Aug. 15, 1858, and educated spasmodically in France, Germany and England. In 1880 she married the Fabian journalist Hubert Bland, and, as they had to live entirely by writing, she poured out novels, stories, poems and articles, including numerous verses and short tales for children, before she found her vocation in depicting the Bastables, one of the most memorable families in juvenile fiction, in the stories collected as *The Story of the Treasure Seekers* (1899), *The Would-be-Goods* (1901) and *New Treasure Seekers* (1904). She attained an even higher level with unconventional fairy tales and magical adventures in matter-of-fact, everyday settings. Collections such as *The Book of Dragons* (1900), *Nine Unlikely Tales* (1901) and *The Magic World* (1912) were surpassed by the trilogy of adventures with the wonder-working "Psammead"—a fat, furry sand-fairy: *Five Children—and It* (1902), *The Phoenix and the Carpet* (1904) and *The Story of the Amulet* (1906). Her most successful tale of magic is *The Enchanted Castle* (1907) and there is little falling-off in *The House of Arden* (1908), *Harding's Luck* (1909) and *The Magic City* (1910). Widowed in 1914, in 1917 she married Thomas Tucker. She died at New Romney, Kent, on May 4, 1924.

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NESS, LOCH, Inverness-shire, Scot., the largest mass of fresh water in the United Kingdom (Loch Lomond has the largest area, 27½ sq.mi.), is 754 ft. deep and 22½ mi. long. It is only 52 ft. above sea level, lying in the Great Glen Fault, and is free of ice. The watershed extends to over 700 sq.mi., the loch being fed by several considerable rivers, all known for their salmon fishing. The sharp rise and fall of the level of the loch is one reason for the scanty flora of the waters, the other being the great depths reached near the shore line. The abyssal fauna is also sparse. In common with several other very deep lochs in Scotland and Scandinavia, Loch Ness is said to be inhabited by an aquatic monster, accounts of which have been much publicized. Loch Ness forms part of the system of waterways linked by Thomas Telford in 1824. The village of Fort Augustus lies at the head of the loch and the town of Inverness is within a few miles of its foot. (F. F. DG.)

NESSELRODE, KARL ROBERT, COUNT (1780–1862), Russian statesman, sole foreign minister for 34 years, was born on Dec. 13 (new style; 2, old style), 1780, in Lisbon, where his father, a member of a German family of counts of the Holy Roman empire (with their seat at Nesselrode, near Solingen, in the duchy of Berg) was serving as Russian ambassador to Portugal. Educated in Germany and a Protestant by religion, Nesselrode never quite mastered the Russian language, but at the age of 16 he entered the Russian navy, for which his father had signed him up at his birth. He became naval aide-de-camp to the emperor Paul I, but distinguished himself neither in the navy nor, later, in the army. Early renouncing military life, he entered the diplomatic service, in which he was to make his name.

Between 1801 and 1806 Nesselrode served at the embassies in Berlin and at The Hague; and in 1806 he traveled in southern Germany to report on French troops to the Russian emperor Alexander I. In Germany, meanwhile, he had become acquainted with Friedrich Gentz and with Metternich (*qq.v.*), whose influence made him a strong advocate of Russo-Austrian co-operation. He served as diplomatic secretary to generals M. F. Kamenski, F. W. von Buxhöwden and L. A. Bennigsen in the war of 1806–07 against Napoleonic France, was present at the battle of Eylau (Feb. 1807) and assisted at the peace of Tilsit. He then went to the embassy at Paris, where he acted as intermediary between Talleyrand and Alexander and renewed his association with Metternich. Disagreeing with Count N. P. Rumyantsev, the Russian foreign minister, who wanted to incite the Slavs within the Austrian empire to rebellion, Nesselrode was generally pro-Austrian and anti-French in outlook; but he sought to preserve balance and peace in Europe and, after the breach of diplomatic relations in 1811, tried to persuade Alexander to open negotiations with Napoleon. In the war that followed he served at Alexander's headquarters at Vilna (Vilnius) and was present at the battle of Leipzig. Accompanying the invading army to Paris, he signed the treaty of Chaumont in 1814. (*See* NAPOLEONIC WARS.)

At the congress of Vienna, Nesselrode influenced Alexander to favour the Bourbon restoration and to oppose a ruinous war indemnity on France. Though his prestige was shaken somewhat by the discovery of a secret agreement between France and Austria against Russia, he was appointed director of the college of foreign affairs (1816). On the other hand the actual conduct of foreign affairs was entrusted to Count I. A. Kapodistrias (*q.v.*). Conflicts between Nesselrode and Kapodistrias were reconciled by the emperor himself and Nesselrode accompanied Alexander to the congresses of Aix-la-Chapelle, Troppau, Laibach and Verona. Finally, in 1822, when Kapodistrias in the aftermath of the War of Greek Independence received indefinite leave, Nesselrode became sole minister of foreign affairs, a position in which he remained until 1856.

Under Nicholas I, who succeeded Alexander in 1825, Nesselrode was responsible for the change in policy after 1829 by which the traditional goal of conquering Constantinople was abandoned in favour of keeping Turkey a weak power dependent on Russia (*see* Eastern Question). The treaty of Unkiar Skelessi (1833) realized this change, but it aroused great alarm in Great Britain; and Nesselrode himself negotiated the shelving of that treaty and substituted the alliance between Russia and Great Britain which resulted in the Straits convention of 1841. In 1849 it was he who suggested the decisive Russian intervention in Hungary on Austria's behalf, though he had restrained Nicholas from making an active intervention in France after the revolution of 1848 (as he had likewise restrained him after that of 1830). During the international crisis of 1853, Nesselrode prolonged negotiations as long as he could in the hope of avoiding the Crimean War (*q.v.*). The last of his important political acts, the signing of the treaty of Paris in 1856, at the end of that war, undid the results of his patient efforts to establish Russian preponderance in the Balkan peninsula. Retiring from the foreign office, he retained the imperial chancellorship, which he had held since 1845.

Nesselrode died in St. Petersburg on March 23 (new style; 11, old style), 1862. A German translation of his autobiography (the original manuscript is in French) appeared in 1866; and 11 volumes of selections from his letters and papers (also in French) were published in 1904–12. (G. A. Ln.)

NEST. The practice of nest building (nidification), as the term is used in zoology, includes all preparations for the reception of eggs or newborn young and for their care. Common conceptions of nest making are derived from observations of birds; but mammals, reptiles, amphibians and fishes, as well as invertebrates, include species that make more or less elaborate preparation in advance for the reception of their young. The first stage in this sequence is the selection of a definite site for the nest, in or on which the eggs or young are to be deposited. Two chief factors governing this preparation are the conditions of the environment and the state of the young on emergence.

BIRDS

Not all birds make nests; some waterfowl and a few land birds lay eggs on bare rock or ground. For example, auks and murres deposit single eggs on bare ledges of rock projecting from the face of a cliff rising steeply from the sea. Species that haunt sandy wastes make little or no preparation by way of a nest. This receptacle seems originally to have been an adaptation for the purpose of keeping the incubating bird and the eggs from contact with cold, damp earth.

Much more elaborate are the nests of the smaller species. These, placed in hedgerows or bushes or even on the ground, are bowl-shaped structures made of fine grass interwoven with horsehair and cunningly masked by moss or lichen, as in the case of the European long-tailed titmouse. Some, like the thrush, use a foundation of clay and line the interior of the nest with a mixture of decayed wood and cow dung. Certain African weaverbirds and American Baltimore orioles or hangnests, suspend the nest (made of long grass stems and vegetable fibres) by a long fibrous strand or rope attached to the bough of a tree. Toward the end this rope is enlarged to form a spherical chamber, with an entrance at the top or side in the hangnests; and at the end of a further extension of the rope beneath the nest in the weavers. Some of the flowerpeckers of Australia build a nest of felted cotton down. A few species make a more or less extensive use of saliva as a cement for mud-built nests, as the swallow tribe, the South American ovenbird and the flamingo. The use of salivary glands in nest building reaches its maximum with the swifts which glue small twigs to the inside of a chimney to form a tiny basket or, as in the case of the Asiatic edible swifts, use saliva alone. Such nests are harvested early in the nest-building season and used by the Chinese in making bird's nest soup.

Hollows in trees are used by many birds, such as the parrots and the woodpeckers, the eggs being deposited on the rotten wood at the bottom of the hole. Others, like the bank swallow (sand martin) and the kingfisher, drive long tunnels into the face of a sandbank, enlarging the end of the tunnel to form a nest chamber. The greatness of this achievement is commonly overlooked, for it would be difficult to find birds so unsuited for such a task. The sand martin has very feeble feet and an extremely short beak, while the short legs, partly united toes and long pointed beak of the kingfisher seem less fitted for burrowing.

While there is general conformity of type characteristic of the nests of the different groups of birds, there are striking exceptions to the rule. The stork tribe, generally, is content with a simple platform of sticks; but the hammerhead stork (*Scopus umbretta*) builds a huge nest of mud and sticks, covered over by a roof that may be as much as six feet across and so substantial as to bear easily the weight of a man. The flamingos build a steep pedestal of mud, the top of which is scooped out to receive the eggs. Parrots nest in hollow trees, but the quaker-parrot (*Myopsittacus*) of South America builds a large domed nest of sticks.

The chickenlike or gallinaceous birds make little more than a shallow depression in the ground. The fowllike megapodes of Celebes, New Guinea and Australia, however, build a huge mound of decaying vegetable matter, lay their eggs deep down in the fermenting mass and leave them to hatch by the heat generated by decay.

One of the most remarkable cases of nest building among birds is furnished by the hornbills, whose eggs are laid at the bottom of a cavity in a tree. As soon as the female has started incubation the male closes the entrance hole with clay; he leaves open a space only wide enough for his mate to push her beak through to receive food from him. *See* also Bird.

OTHER NEST BUILDERS

Mammals.—Few other animals are as skilful as birds in weaving nests. The harvest mouse among the mammals is, however, the rival of most birds, and many squirrels build bulky structures in treetops or vines. The rabbit builds a nest in her burrow and lines it with the underfur plucked from her body in the same manner as ducks, geese and swans line the nest with down plucked from the breast. The only nest-building mammals that produce eggs are the echidna or spiny anteater *Tachyglossus* and the duck-billed platypus *Ornithorhynchus*. The nest is of the simplest character, a chamber lined with leaves and grass at the end of a long tunnel dug by the animal.

Reptiles.—Among the reptiles nest building, if practised, goes little further than digging a hole in the ground and depositing the eggs within it, leaving them to their fate. The European pond tortoise, however, takes a little more trouble. She prepares the ground by watering it from the bladder and from special anal water sacs. Then, boring a hole with the tail, as one would use a stick, the tortoise enlarges it with her feet. When the hole is about 5 in. deep the eggs are laid at the bottom, the soil is replaced and beaten down flat. The crocodile digs a hole in the sand about 2 ft. deep, lays her eggs in it and covers them. She returns periodically to sleep above the incubating eggs and is thus at hand to assist the young to escape at the time of hatching. She is warned of this by the noise they make in endeavouring to break through the shell, just as young birds announce their advent by cheeping before the shell is actually broken. When the baby crocodiles have all emerged the mother escorts them to the water. The alligator, on the other hand, builds a great mound of decaying vegetation in a marsh to a height of about 3 ft. and as much as 8 ft. in diameter. The white and hard-shelled eggs, 20 to 30 of them, are laid about 8 in. from the surface.

The python, among the snakes, like *Ichthyophis* among the Amphibia, coils her body around the eggs until they hatch and guards her young for some time after.

Amphibians.—Among amphibians, frogs of the genus *Phyllomedusa* build nests resembling those of the tailorbird. *Phyllomedusa hypochondria*, the *Wollenkukk* of the Paraguayan Chaco is a good example. The female carries the male upon her back while searching for a suitable leaf, which must be on a tree overhanging the water. This found, both seize it and hold the edges together with their hindfeet; the female pours her eggs into the

Chestnut bittern (*Ixobrychus cinnamomeus*) nest among the reeds overgrowing a rice field. Indonesia

Nest and eggs of a robin (*Turdus migratorius*). North America

Nest of a chimney swift (*Chaetura pelagica*) in a well. Mucus is used to hold sticks together. North America

Common sparrow hawk (*Accipiter nisus*) guarding its young in a nest of twigs and branches. Europe

Gentoo penguin (*Pygoscelis papua*) on her nest, a hollow among the rocks. Islands south of Australia

Nest of a paradise flycatcher (*Tchitrea paradisi lencogaster*) on the side of a sapling. India

Ground nest of the red-wattled lapwing (*Lobivanellus pluvius*). India

Bank swallow (*Riparia riparia riparia*) nests in a sandy bank. North America

Rookery of nests of the great blue heron (*Ardea herodias*). North America

BIRDS' NESTS

PHOTOGRAPHS, (TOP LEFT, THIRD ROW LEFT, THIRD ROW CENTRE) CAMERA PRESS—PIX FROM PUBLIX, (TOP CENTRE) JACK E. SHADE FROM BLACK STAR, (TOP RIGHT, BOTTOM LEFT, BOTTOM RIGHT) JOHN H. GERARD, (SECOND ROW LEFT) JOHN MARKHAM, (SECOND ROW RIGHT) E. AUBERT DE LA RUE

NEST

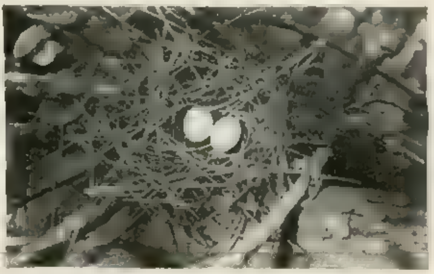
American flamingo (*Phoenicopterus ruber*) nests made of mud and clay. Bahama Islands

Nest of the tailor bird (*Orthotomus sutorius*), an Asian thrush, constructed by sewing leaves together using the bill as a needle. Malaya

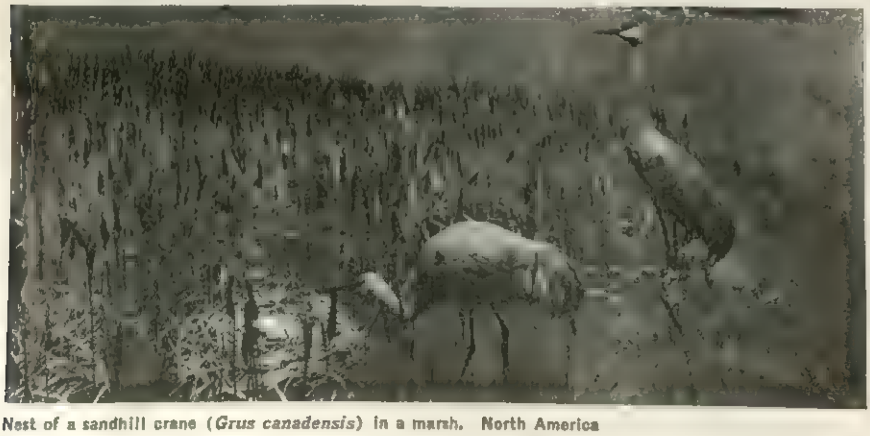
Ibis nests of sticks and leaves in a marsh. Australia

A depression in the sand serves as a nest for the little tern (*Sterna albifrons*). Europe

Nest made of reeds by the Florida gallinule (*Gallinula chloropus cachinnans*)



Platform nest of the mourning dove (*Zenaidura macroura*) on the branch of a tree. North America

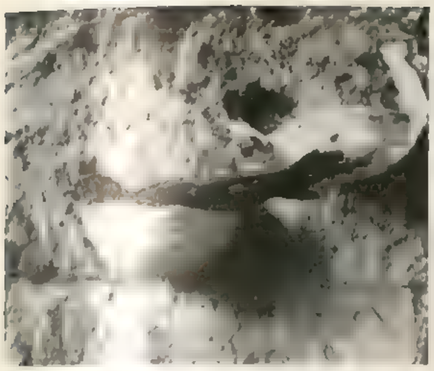


Nest of a sandhill crane (*Grus canadensis*) in a marsh. North America

Treetop nest of the northern bald eagle (*Haliaeetus leucocephalus washingtoniensis*). North America

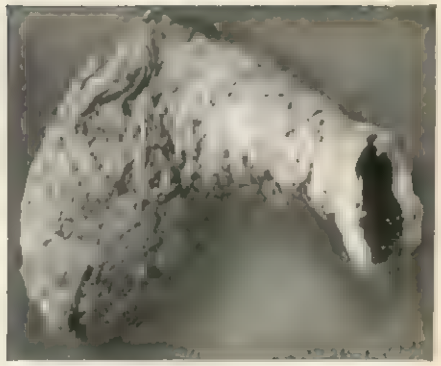
BIRDS' NESTS

BY COURTESY OF (TOP LEFT, BOTTOM LEFT) THE AMERICAN MUSEUM OF NATURAL HISTORY; PHOTOGRAPHS, (TOP RIGHT, CENTRE LEFT) CAMERA PRESS—PIX FROM PUBLIX, (CENTRE ABOVE) MARKHAM, (CENTRE BELOW, CENTRE RIGHT, BOTTOM RIGHT) JOHN H. GERARD



Shelflike nests made of saliva by the East Indian cave swiftlets (*Collocalia*). The edible nest is used by the Chinese in making bird's nest soup

Tree trunk sectioned to show the hollowed-out nest of a downy woodpecker (*Dendrocopus pubescens*)



Hanging nest of the Turkistan Remara (*Remiza caspia*) formed of dried grasses and feathers

Nest of a golden eagle (*Aquila chrysaëtos canadensis*) on a mountain ledge

Large nest of the Carolina wren (*Thryothorus ludovicianus*) in a barn

Stork nest of sticks and reeds on a chimney top in France. A permanent nest, it is enlarged annually

Grass nest of the social weaver bird (*Philetaerus socius*), Africa. Interior contains feather-lined cavities

Clay nest of the ovenbird (*Seiurus aurocapillus*), opened to show interior and protected entrance passage

Suspended nest woven of grass by Amazonian caciques (*Cacicus cela*)

BIRDS' NESTS

BY COURTESY OF (TOP LEFT, TOP RIGHT, BOTTOM RIGHT) THE TRUSTEES OF THE BRITISH MUSEUM, (CENTRE LEFT, BOTTOM CENTRE ABOVE) THE AMERICAN MUSEUM OF NATURAL HISTORY; PHOTOGRAPHS, (TOP CENTRE, CENTRE RIGHT) JOHN H. GERARD, (BOTTOM LEFT) EWING GALLOWAY, (BOTTOM CENTRE BELOW) KURT SEVERIN FROM BLACK STAR


Nest of tent caterpillars in the branches of a tree


Nest of the red-eared turtle. The hole is plugged with soil after the eggs are laid

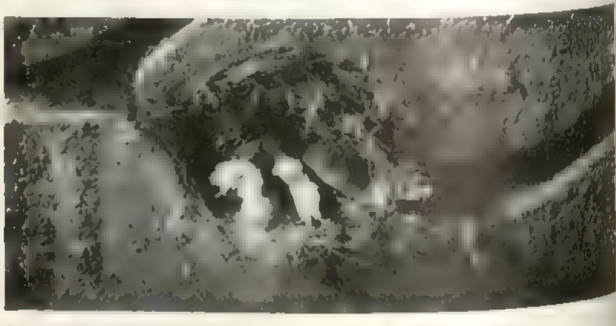

Nest of the funnel-web or grass spider in a thistle branch


Entrance to a nest of Florida harvesting ants


Bald-faced hornets' nest cut away to show arrangement of brood cells


Red-backed salamander guarding its eggs in a cave nest


Prairie meadow mouse nursing its young in nest made of grass


Cutaway view of the underground grass-lined nest of a mole


Muskrat house in a shallow marsh

EXAMPLES OF NON-AVIAN NEST BUILDING

BY COURTESY OF (TOP RIGHT, BOTTOM RIGHT ABOVE) THE TRUSTEES OF THE BRITISH MUSEUM, (CENTRE RIGHT) THE AMERICAN MUSEUM OF NATURAL HISTORY; PHOTOGRAPHS, (TOP LEFT, TOP CENTRE, CENTRE LEFT, BOTTOM LEFT, BOTTOM RIGHT BELOW) JOHN H. GERARD, (CENTRE) A. C. PARSONS FROM BLACK STAR

funnel thus formed while the male fertilizes them as they pass in. The gelatinous envelope of the eggs suffices to hold the leaf edges in position as they are brought together in the filling process, which goes on until about 100 eggs are laid.

Fishes.—Among the fishes the freshwater sticklebacks (*Gasterosteus*) and the marine 15-spine stickleback (*Spinachia*) build nests of weeds, the task being undertaken by the male, who uses a secretion produced by the kidneys as a binding material. He has sole charge of the eggs and young. The gourami (*Osphronemus*) of the Malay archipelago fashions a nest of air bubbles toughened by a kind of saliva, and mounts guard over both eggs and young. The perchlike fishes of the family Cichlidae, both of America and the old world, as well as some of the catfishes and their relatives (siluroid fishes), carry the young in the mouth; in some species both sexes do this, in others the male alone. The male pipefish and seahorse carries the eggs and young either in a pouch running along the belly or attached to his body. The aspredo, a catfish of the Guianas, carries her eggs attached to the under surface of the head, belly and paired fins. The skin assumes a spongy condition for their accommodation so that each lies within a depression, recalling the egg pits of the Surinam toad; in the case of aspredo, however, the pits are shallower and the larvae are not retained there.

Invertebrates.—Among the insects the elaborate care for the eggs and young displayed by the ants, bees and wasps is well known (*see* SOCIAL INSECTS). The scorpions and the wolf spiders carry their young on their backs until they can fend for themselves; some of the scorpions, again, like the wolf spiders, carry their eggs closely packed within a spherical silken bag.

Among the marine invertebrates an antarctic sea slug (*Cucumaria crocea*) carries the young on its back. One of the sea urchins (*Hemiaster philippi*) and a starfish (*Asterias spirabilis*) carry the young in brood pouches—on the back in the case of the sea urchin and around the mouth in the starfish. It would seem that only arctic and antarctic species behave in this manner. In all other cases the young leave the parent as minute, free-swimming larvae and undergo a complicated metamorphosis before they become fully grown.

In the invertebrates the care of the young must be regarded as an entirely impersonal, unconscious act, determined by the physical peculiarities of the external environment. This should be borne in mind in considering the origin and evolution of nest building in animals of all levels.

See also references under "Nest" in the Index.

See B. R. Headstrom, *The New and Revised Birds' Nests* (1961). (W. P. P.; X.)

NESTOR (11th–12th century), Russian hagiographer and chronicler, was a monk of the Monastery of the Caves in Kiev. He was received into the monastery in or soon after 1074, and is thought to have been still alive in 1113. He wrote the lives of SS. Boris and Gleb, the sons of St. Vladimir of Russia, who were murdered in 1015, and the life of St. Theodosius, abbot of the Monastery of the Caves (d. 1074). A tradition first recorded in the 13th century ascribes to him the authorship of the *Povest Vremennykh Let* (*Russian Primary Chronicle*), the most important historical work of early medieval Russia. Modern scholarship, which regards the *Chronicle* as a composite work, written and revised in several stages, inclines to the view that Nestor, about 1113, compiled the basic, though not the final, version of this document. The *Chronicle*, extant in several medieval manuscripts, the earliest dated 1377, was compiled in Kiev. It relates in detail the earliest history of the Russian people down to the second decade of the 12th century. Emphasis is laid on the foundation of the Kievan state, ascribed to the advent of Varangians from Scandinavia in the second half of the 9th century, the subsequent wars and treaties between the Russians and Byzantium, the conversion of Russia to Christianity *c.* 988, the cultural achievements of the reign of Yaroslav of Kiev (1019–54) and the wars against the Turkic nomads of the steppe.

Written partly in Old Church Slavonic, partly in the Old Russian language based on the spoken vernacular, the *Chronicle* includes material from translated Byzantine chronicles, west and south Slavonic literary sources, official documents and oral sagas. This borrowed material is woven with considerable skill into the historical narrative, which is enlivened by the powers of vivid description, the humour and the sense of the dramatic displayed by the different compilers and is given added depth of perspective by their appreciation of the position occupied by the land of Russia within the Christian community of nations.

See edition of *Povest Vremennykh Let* with Russian trans. and notes by V. P. Adrianova-Peretts, 2 vol. (1950); Eng. trans. with notes by S. H. Cross and O. P. Sherbowitz-Wetzor (1953). (D. OB.)

NESTOR, in Greek legend, son of Neleus and Chloris, king of Pylos (Navarino) in Elis. When all his brothers were slain by Heracles, in consequence of the refusal of Neleus to purify him for the murder of Iphitus, Nestor alone escaped. In the *Iliad* he is about 70 years old, having seen two generations of men flower and die. Sage and pious, his role is largely to incite the warriors to battle and to tell stories of his early exploits, by contrast with which his auditors' warlike experiences are shown to be soft and easy. After the war Nestor returned easily to Greece, avoiding the troubles and wanderings which afflicted Agamemnon, Menelaus and Odysseus (*qq.v.*). In the *Odyssey*, whose dramatic date is ten years later than that of the *Iliad*, Nestor is still ruling in Pylos, where he is visited by Telemachus. Ovid parodied his antique garrulity, making him 200 years old and putting into his mouth a long and gruesome account of the famous battle between the Lapithae and the Centaurs (*Metamorphoses*, 12). (T. V. B.)

NESTORIANS, historically, were those Christians of Asia Minor and Syria who refused to accept the condemnation of Nestorius and his teachings by the Council of Ephesus (431). In modern times they are represented by the CHURCH OF THE EAST, usually referred to in the west as the Assyrian or Nestorian Church. Most of its members—numbering perhaps 100,000—live in Iraq, Syria and Iran. There are about 3,000 in the United States. The catholicos-patriarch, Mar Eshai Shimun XXI (b. 1909), who was exiled from Iraq in 1940, resides in San Francisco.

The liturgical language of the church is Syriac. There is a variety of rites. In the communion service three different anaphorae are used: of Addai and Mari, of Theodore of Mopsuestia, and of Nestorius.

Origins and Early History.—The condemnation of Nestorius (*q.v.*) and his teaching by the ecumenical Council of Ephesus was strongly resented in the churches of Asia Minor and Syria. Though these churches finally accepted the decision of the council, there remained a considerable minority unwilling to conform. The centre of resistance was the renowned theological school of Edessa (*q.v.*) in eastern Syria (modern Urfa, Turk.), a school rigorously adhering to the Antiochene tradition as represented by Nestorius. Theodore of Mopsuestia, "the Interpreter," was regarded there as the main authority in all matters of faith. As early as 457 some teachers were compelled to leave the school, moving across the border into Persia. The Edessa school was closed by imperial order in 489, and a small but vigorous Nestorian remnant migrated to Persia.

The Christian church in Persia was by that time a comparatively large body, but its connection with the churches in the west, within the limits of the Roman empire, had always been loose, although it was represented at the first ecumenical council (Nicaea, 325). The full independence of the church in Persia was formally proclaimed by local councils held at Seleucia in 410 and at Markabta in 424. The bishop of Seleucia-Ctesiphon (the capital of the Sassanid kingdom) was acknowledged as the supreme head of the church in the realm—"the great metropolitan and the head of all bishops." The primary reason for this declaration of independence seems to have been political: relations between Persia and the Roman empire were strained and inimical, and administrative links with the foreign churches would expose the church to suspicion on the part of the government. There was also a national motive: the church in Persia was Syriac-speaking, only slightly touched by Greek culture. On the other hand, it was theologically dependent upon the school of Edessa, commonly known as "the school of the Persians."

Under pressure from Barsauma (Barsumas), a refugee from

Edessa and bishop of Nisibis (Nisibin), the council of the Persian church at Beth Lapat (or Jundishapur), in 484, acknowledged Theodore (*q.v.*) of Mopsuestia as the guardian of right faith. Accordingly, the teaching of the Western churches was censured as erroneous. After several years of internal struggle, the allegiance to Theodore was reconfirmed once more under the patriarch Babai (497–502). Since that time the Christian church in Persia has been Nestorian. This name of course was never officially used—it was a discriminatory label, invented by enemies (probably the Monophysites). The official name, still retained, is simply "the Church of the East."

Christians have always been a minority in Persia, and the church went through a period of troubles and persecutions. But finally it was recognized as a kind of national minority and, as such, obtained legal status. By the end of the 5th century there were seven metropolitan provinces in Persia proper and several bishoprics abroad—in Arabia (especially in the state of Hira) and in India. The church's intellectual centre was the new school in Nisibin, which carried on the venerable traditions of Edessa. It was at once a school and a community under rigid discipline; its statutes (496) are preserved. The program was restricted to the study of theology, primarily of the Bible. Theodore was regarded as the chief authority, and his exegetical writings were closely followed. Greek learning was disavowed, though Aristotelian logic was admitted; indeed the main logical treatises of Aristotle, together with Porphyry's famous "Introduction," had been translated into Syriac at Edessa, by Bishop Ibas. It was primarily through Syriac translations that the Arabs became acquainted with Greek thought. In the course of time, other schools of the same type were established in the country.

The church was greatly strengthened by the wise leadership of the patriarch Mar Aba I (in office 540–552), a convert from Zoroastrianism, an able scholar and efficient ruler, and also by the renewal of monasticism, on the Egyptian pattern, guided by Abraham of Kaskar (491/2–586), the founder or restorer of the monastery on Mt. Izala, near Nisibin. Another great leader was Mar Babai the Great (569–628), a monk of Mt. Izala, who was in charge of the vacant patriarchate in the troubled years of the reign of Khosrau II and his struggle with Byzantium.

Babai was a scholar, and his treatise on Christology, *The Book of Union*, is still regarded as an authoritative exposition of doctrine in the Church of the East. On the whole, the doctrine was gradually stiffened, in opposition to the growing spread of Monophysitism and, indeed, in response to the formal condemnation of Theodore and Ibas by the fifth ecumenical council (553) (*see* COUNCIL: *Second Council of Constantinople* [553]). Moreover, there was defection within the church itself. Hanana, head of the Nisibin school in 572–610, advocated the acceptance of the Council of Chalcedon and actually replaced Theodore with St. John Chrysostom in the field of exegesis. Though he was strongly censured he continued in the school till his death.

From the Arab Conquest to the Mongol Invasion.—The Arab conquest of Persia, completed by 651, did not change the legal status of the church there. In spite of certain restrictions, the church in the caliphate was recognized as a separate national group and was granted legal protection. Nestorian scholars played a prominent role in the formation of Arab culture, and the patriarchs occasionally gained influence with the rulers. After the foundation of the new capital, Baghdad (762), under the Abbasid dynasty, the residence of the patriarch was transferred there.

For more than three centuries the Church of the East prospered under the caliphate, and some modern scholars have suggested that this very prosperity was the main reason for its ultimate decline. The church became worldly and its standards were lowered. It lost leadership in the cultural life. Externally, however, it expanded greatly. By the end of the 10th century there were 15 metropolitan provinces in the caliphate itself and 5 beyond the border, including those as far away as India and China. Nestorians spread also to Egypt, where Christianity was under Monophysite control. Nestorian missions were an important move, but they represented rather a spreading, with the shift and migration of population, than an organized propagation of faith. In many places Christian communities retained their foreign character and were not integrated into the native life. In many cases Christianization was superficial. Western travelers of the 13th century speak of the ignorance and superstition of Nestorian clergy in the Mongol empire. In China there was a considerable Nestorian Christian community in the 8th century, but it did not survive the fall of the T'ang dynasty in the early 10th. The spread of Christianity in central Asia was of another character. Certain Tatar tribes were almost entirely converted to Nestorian Christianity, Christian expansion reaching almost to Lake Baikal.

The Mongol invasion of Asia did not destroy the church. Prior to their conversion to Islam, the Mongols were tolerant in religion, and western travelers to the Mongol realm found Christians well established there, even at the court of the Great Khan. The conquest of Baghdad (1258) by Hulagu did not affect the Church of the East. It is uncertain whether Hulagu himself was a baptized Christian, but his wife certainly was, and the Mongol dynasty of the Il-khans in Persia was closely allied with the Christian kingdoms of Armenia and Georgia. Kublai Khan was favourably disposed toward Christians.

But the situation was ambiguous. The Mongol attitude was controlled by political calculations: they had to choose between Islam and the Christian west. The victory of Islam and the collapse of the crusades by the end of the 13th century led finally to their adoption of Islam, and the fate of Christianity in the east was decided. The Church of the East was reduced in size and numbers, and during the 14th century its defeat was sealed by the raids of Tamerlane. Nestorian communities lingered on in a few towns of Mesopotamia, but were concentrated mainly in Kurdistan, in the area between the Tigris and Lakes Van and Urmia, partly in Turkey and partly in Persia.

Modern Times.—The church was split in 1551, and one group went over to Rome. Since that time the Nestorian group has been denoted as Assyrian, while the Uniate group is commonly described as Chaldean (*see* ROMAN CATHOLIC CHURCH: *Organization: The Catholic Eastern Rites*). The Nestorian church in India allied itself with Rome (1599), then split, half its membership transferring allegiance to the Syrian Orthodox (Monophysite) patriarch of Antioch (1653) (*see* MALABAR CHRISTIANS).

In the 19th century the tiny Nestorian remnant in Kurdistan was rediscovered by western Protestants, who were eager to counteract the influence of the Roman Catholic missions in the area and also to raise the cultural level of the neglected Christian group. It seemed that this was the oldest church in Christendom still using the original language of the Gospels (Syriac = Aramaic). Both British and American societies were at work. The "Archbishop of Canterbury's Assyrian Mission" began its activities in 1881, the purpose being to reform or to renew the church from within. The question of formal intercommunion with the Anglican Church was raised in 1912. The work of the Presbyterian mission of the United States led to the formation of the Syrian Evangelical Church in Iran, now called the Evangelical Church of Iran. A considerable group of Nestorians in northern Iran, led by bishop Mar Yonan (Jonas) of Supurghan and Urmia, was reunited with the Orthodox Church in Russia (1898), and a Russian missionary centre was established in Urmia.

The Assyrians suffered heavy losses during World War I through massacre, disease and exposure. It is estimated that up to one-third of the nation perished at that period. A considerable group migrated to Mesopotamia and others left for the United States. There is still a group resident in Iran. For political reasons the patriarch of the Assyrians was compelled to leave for England and later for the United States.

See also SYRIAC LANGUAGE; SYRIAC LITERATURE; and references under "Nestorians" in the Index.

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NESTORIUS (d. *c.* 451), patriarch of Constantinople and heresiarch, was born (exact date unknown) and spent his early years at Germanicia in Syria Euphratensis (present-day Maras in southern Turkey). He studied at Antioch, probably as the pupil of Theodore of Mopsuestia, and imbibed the principles of the famous theological school there. He became a monk at the nearby Euprepius monastery and, after being ordained priest, acquired a great reputation for asceticism, orthodoxy and eloquence. Mainly because of this Theodosius II nominated him to the see of Constantinople in 428. His debut was a stormy one, for he immediately set to work extirpating heretics of every sort, showing leniency only to Pelagians. A crisis, however, developed when his chaplain, Anastasius, denounced the practice of giving the Blessed Virgin the title *Theotokos* ("God-bearer"), and Nestorius, who had already expressed doubts on the subject, rushed to his support. Orthodox theologians had long used the title, which the growing cult of the Virgin made highly popular; but Nestorius considered that, unless carefully qualified, it compromised Christ's full humanity.

In the controversy which flared up Nestorius' opponents found an ally in Cyril of Alexandria, who, much more alive to the political issues, was only too eager to make capital for his own see (*see* CYRIL, SAINT). Both sides appealed to Pope Celestine I, whom Nestorius' tactlessness had already alienated, and in Aug. 430 a Roman synod decided that correct Christology required the use of *Theotokos* and requested Nestorius to disown his errors. When Cyril, who had been charged to execute the sentence, produced a string of provocative anathemas for him to subscribe, Nestorius and his Antiochene-minded friends took alarm, and he persuaded the emperor to convene a general council. When it met, however, at Ephesus in June 431, he found himself hopelessly outmaneuvered by Cyril (*see* COUNCIL: *Council of Ephesus* [*431*]). His teaching was condemned and he himself deposed from his see. Theodosius was induced to ratify these decisions, and Nestorius after languishing in his old monastery near Antioch was exiled in 436 to Upper Egypt, where he died, protesting his orthodoxy, *c.* 451. Apart from his apologetic *Book of Heracleides*, a Syriac version of which came to light *c.* 1895, only fragments of his sermons and letters survive. A Syriac anaphora bearing his name is probably inauthentic.

Nestorianism.—Nestorius is reckoned one of the principal heretics in Christology, and the heresy traditionally linked with his name, Nestorianism, was formally condemned at the Councils of Ephesus (431) and Chalcedon (451). Whereas orthodox Christology holds that Christ incarnate has two natures, divine and human, ineffably united in one person or hypostasis (the "hypostatic union"), Nestorianism so stresses their independence as to suggest that they are in effect two persons or hypostases loosely joined by a moral union. It envisages the divine Word as having associated with himself at the incarnation a complete, independently existing man, and thus approximates to adoptionism (*q.v.*). From the orthodox point of view it therefore denies the reality of the incarnation, representing Christ as a God-inspired man rather than as God-made-man. Hence Cyril (*Anathema* iii, viii) could condemn anyone who "divides the hypostases after the union . . . connecting them by a mere association in dignity or authority or rule, and not rather by a conjunction of real union," or who asserts that "the man assumed" (*i.e.*, the human nature) is to be co-worshiped along with God the Word, instead of the Word-made-flesh being adored with a single, indivisible worship; while the Chalcedonian definition outlawed "those who presume to rend the mystery of the incarnation into a duality of Sons." Since the 5th century all the principal branches of the Christian church have united in condemning Nestorianism as thus defined, affirming that Christ is a single person, at once wholly human and wholly divine. Even the so-called Nestorian church (*see* NESTORIANS) is not Nestorian in the strict sense, although it venerates Nestorius' name and refuses to accept the title *Theotokos*.

Nestorius' Own Teaching.—It is questionable whether Nestorius himself ever taught, or intended to teach, the heresy named after him. Admittedly he gave colour to his opponents' accusations by his habit of speaking of Christ's natures as "the God" and "the man" or "him who assumed" and "him who was assumed" respectively, by insisting on a loose, voluntary union between them defined as *synapheia* ("conjunction") rather than *henosis* ("union"), and by his suspicious attitude, illustrated by his critique of the *Theotokos*, toward the *communicatio idiomatum*, *i.e.*, the convention by which, in view of the absolute oneness of Christ's person, the attributes, experiences, etc., of each of his natures could properly be predicated of the other. The fact remains, however, that he was convinced of, and repeatedly affirmed, the perfect unity of the incarnate Lord, repudiated any suggestion of there being two persons or two Sons existing side by side in his being, and scornfully rejected the charge of being virtually an adoptionist.

His authentic teaching, it would seem, though expounded in crudely provocative terms, showed little difference from, or advance on, that of his great predecessors in the Antiochene school, Diodore of Tarsus and Theodore of Mopsuestia, who had been admired as orthodox in their lifetime. Like theirs, his Christology was of the "Word-man" type rather than the "Word-flesh" type accepted in the Alexandrian school and sponsored in particular by Cyril. Whereas the latter started with the idea of the eternal Word who at the incarnation became "enfleshed," the former tended to hold the divine and human natures apart, emphasizing their completeness and independence, and thus was faced with the difficult problem of explaining their union. The motive for this distinctive approach was twofold: to safeguard the impassibility of the Word, and to ensure in the interests of sound soteriology that Christ should have lived a genuinely human life of growth, temptation and suffering. In particular the Antiochenes rejected the Alexandrian view that the Lord's humanity was vivified by its union with the Word, with the result that in the field of eucharistic doctrine Nestorius was unfairly charged by Cyril with teaching cannibalism, since the sacramental body consumed by the faithful was according to him the body of a mere man.

Nestorius' own original contribution was the suggestion that, each nature subsisting in its own *prosopon* (*i.e.*, external, undivided presentation), there was at the incarnation a mutual exchange of *prosopa* resulting in the emergence of a common *prosopon*. Thus "*prosopon* of union," by which he in effect understood the historical figure of the Gospels, was identical with neither the *prosopon* of the Word nor the *prosopon* of the humanity but resulted from the coming together of the two.

Modern estimates of Nestorius' teaching differ widely, some applauding its honest attempt to do justice to the reality of Christ's humanity and incarnate life, others condemning it either for its internal difficulties or, more radically, for failing to recognize that the subject of the God-man must be the divine Word and for thus opening a door to Nestorianism proper. There can be no doubt, however, that it was far removed from the latter in intention at any rate. Nestorius was the victim at once of his own intolerant temperament and of the rivalries between great sees which was a feature of the times. It was ironical that very

soon after his condemnation several important elements in his doctrine, such as the conception of two natures itself, came to be recognized as indispensable to sound Christology and were incorporated in the Chalcedonian definition.

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NESTROY, JOHANN NEPOMUK EDUARD AMBROSIUS (1801–1862), Austria's greatest comic dramatist and a brilliant character actor who dominated the Viennese popular stage in the mid-19th century, was born at Vienna on Dec. 7, 1801. He made his debut as an opera singer in Vienna in 1822 and from 1823 to 1831 had engagements in Amsterdam, Brünn, Graz and Pressburg, gradually abandoning operatic for dramatic roles. In 1831 he returned to Vienna and became the leading character actor and comic dramatist of his day. From 1854 until his retirement in 1860 he managed the Carl-Theater. He died at Graz on May 25, 1862.

Nestroy represents the last phase of the Viennese popular drama which originated in the 17th century. In his comedies the pathos and humour of his contemporary F. Raimund are replaced by satire, irony and parody (C. F. Hebbel and Richard Wagner were among his victims) and by a realistic portrayal of Viennese types and manners. His plays abound in memorable aphorisms. *Der böse Geist Lumpazivagabundus* (1833), *Die beiden Nachtwandler* (1836), *Das Mädl aus der Vorstadt* (1841) and *Einen Jux will er sich machen* (1842) are typical examples of his work.

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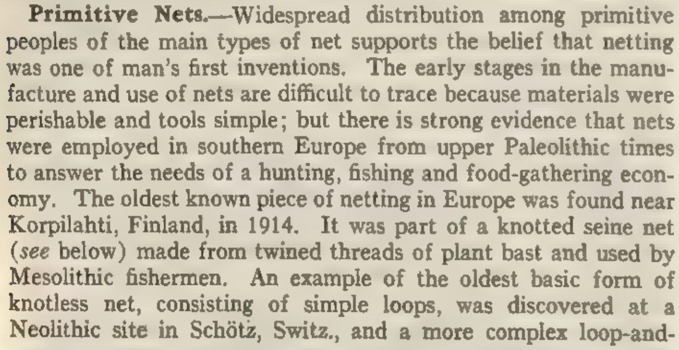
NET, a fabric of thread, cord or wire, the intersections of which are looped or knotted so as to form a mesh. Netting, intimately related to weaving, knitting, plaiting and lacemaking, is one of the most ancient and universal of arts.

Primitive Nets.—Widespread distribution among primitive peoples of the main types of net supports the belief that netting was one of man's first inventions. The early stages in the manufacture and use of nets are difficult to trace because materials were perishable and tools simple; but there is strong evidence that nets were employed in southern Europe from upper Paleolithic times to answer the needs of a hunting, fishing and food-gathering economy. The oldest known piece of netting in Europe was found near Korpilahti, Finland, in 1914. It was part of a knotted seine net (*see* below) made from twined threads of plant bast and used by Mesolithic fishermen. An example of the oldest basic form of knotless net, consisting of simple loops, was discovered at a Neolithic site in Schötz, Switz., and a more complex loop-and-twist net of the same period was recovered from the bog of Ordrup, Denmark. In Australia the geographical distribution of net types among the aborigines suggests that knotted nets may have come before knotless. But netting appears to have remained completely unknown in southwest Australia and in Tasmania.



BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM, LONDON

BAS-RELIEF FROM NINEVEH, 7TH CENTURY B.C., SHOWING A NET USED BY THE ASSYRIANS IN HUNTING. IN THE BRITISH MUSEUM, LONDON

BY COURTESY OF THE ROYAL LIBRARY, COPENHAGEN

PERUVIAN MANUSCRIPT (17TH CENTURY) SHOWING AN INCA BOY HUNTING BIRDS WITH A NET. IN THE ROYAL LIBRARY, COPENHAGEN

Primitive netting was fabricated with thread or cord made from a wide range of vegetable fibres (*e.g.*, bark, bast, cotton, coconut, leaves, roots, stems) and animal tissues (*e.g.*, hide, sinew, hair, intestine, baleen). Needles and mesh gauges for netmaking were of wood, bone, ivory, antler and shell.

Many specialized forms of netting were developed for articles such as hammocks and snowshoe lacings; but, apart from carrying nets, the most important nets are those for hunting and fishing. Lines of land nets were early adopted to capture animals driven into them by beaters. Primitive fishermen evolved numerous varieties of nets suited to the conditions of river, estuary, shore or open sea. These varieties may be described as self-acting, *i.e.*, stationary nets fixed so as to entangle fish in their meshes or trap them in chambers; and manipulated, *i.e.*, nets handled by one or more persons. This second group embraces framed or unframed hand nets, seine nets with floats and sinkers, weighted cast nets and trawl nets. (D. M. Bo.)

Modern Nets are made both from vegetable fibres (*e.g.*, cotton, hemp, flax, manila, sisal) and from man-made fibres (*e.g.*, nylon, polyester, polypropylene and polyethylene). The man-made fibres are inherently rotproof whereas the vegetable fibres have to be treated against rot with substances such as tar. Three types of net, all with diamond-shaped mesh, are used for fishing: gill nets, seine nets and trap nets.

Gill nets, sometimes called drift nets, entrap fish by their gills. A variant, the trammel net, composed of two outer panels of large-mesh netting enclosing an inner panel of smaller mesh netting, entangles the fish in pockets formed by the passing of the inner net through the mesh of the outer net or "wall." The size of the fish trapped depends on the coarseness or fineness of the meshing. Gill nets can be used at the surface, at mid-water or at the bottom of the water (salt or fresh) according to the adjustment of floats at the top and of lead sinkers at the bottom of the net.

Seine nets are large nets used for enclosing schools of fish and are sufficiently fine meshed not to entangle them by the gills. Some, called beach seines, can be hauled onto the beach with their contents; others, called purse seines, are operated from boats in deep water far from shore. The two ends of the net are hauled aboard the boat and the catch is secured by closing the bottom of the net with a rope called a purse-seine line. Seine nets are always operated at the surface and are fitted with floats at their upper edge to ensure buoyancy and with leads or chain at the bottom so that they hang in the water to maximum depth. They catch sardines, herring, pilchards, salmon, tuna, etc., and can enclose at one time schools of fish weighing up to 100,000 lb. They are called ring nets in Scotland and are there sometimes operated by two boats. Variants of the seine are the trawl net, the Danish seine and the wing or vinge trawl. These are dragged along the seabed, from which they scoop up, for example, cod, haddock, plaice and sole.

Trap nets, staked to the shore or in estuaries, form a labyrinth-like chamber into which fish swim. The mesh must be fine enough to prevent the escape of fish of marketable size and coarse enough to allow unmarketable fish to swim through

Salmon, trout and eels are their principal catch. A floating trap net, used especially in North America, has buoys and anchors instead of stakes. Eel traps and lobster traps, consisting of a framework covered with netting, are also forms of trap net.

Nets used for purposes other than fishing are made of the same materials but are often square meshed, especially those used for sports, *e.g.*, tennis nets, cricket practice nets and goal nets. Netting is used in horticulture for supporting peas and beans, for protecting crops from birds and frost and for the bags in which produce is marketed; in industry as safety netting for workers; in transport for securing loads on vehicles, hoisting cargoes aboard ship and for parcel racks on trains and aircraft. Netting made from wire differs from netting made from fibres in that the wires are twisted at the intersections and not knotted.

Manufacture.—Net is still made (in small quantities) by the ancient method of forked needle and mesh pin, but most commercial production is machine manufactured. A netting machine was patented in England in 1778 by William Horton, William Ross, Thomas Davies and John Golby. An early 19th-century incomplete French model by Joseph Jacquard is in the Conservatoire des Arts et Métiers, Paris. The first machine efficient enough to commence a new netmaking industry was designed by James Paterson of Musselburgh, Scot., who established a net factory there about 1820, but his early form of machine was imperfect, the knots it formed slipped readily and, there being much prejudice against machine nets, the demand for his products was small. In 1835 Walter Ritchie, also a native of Musselburgh, patented a machine involving a method of forming the ordinary hand knot; and this became the foundation of an extensive and flourishing industry. Another form of net loom was invented and patented in France by Onésiphore Pecqueur in 1840; and again in France and in Great Britain in 1849. This was subsequently often improved, principally by Baudouin and Jouannin. In the United States a manufacturer of cotton yarns at Canton, Mass., initiated net manufacture for the fisheries about 1844; and the success of his experiments in cotton twine resulted in the first netting machine in the United States starting production in 1858 and the later development of improved models for handling heavy twines. Modern netting machines are manufactured in the United States, the United Kingdom, Finland, France and Japan. Improvements make it possible to manufacture nets with double knots as well as with single knots; double knotting is often desirable because of the slipperiness of man-made fibres.

See also references under "Net" in the Index. (E. F. Gu.)

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NETBALL, a popular game in English girls' schools, is similar to girls' basketball in the U.S. (*see* BASKETBALL: *Women's Basketball*). It is played on a hard-surfaced rectangular outdoor court measuring 100 ft. by 50 ft. with half circles 16 ft. in radius marked at either end for shooting. The goal posts stand 10 ft. high with circular rings, or baskets, and nets at the top for the ball to pass through. The ball is usually of leather, about 27 in. in circumference and weighs 14 to 16 oz.

The game is played between two teams of seven players each—three centre players, two attacks and two defenses. The ball must be passed hand to hand from player to player and no one may run with it. The centre players try to pass the ball up the court into the circle for the attackers to shoot. The defenders, by guarding their opponents and by intercepting, try to prevent goals from being scored.

The game is played for 15 or 20 min. each way with a 5-min. break at half-time. (C. T. E.)

The game called netball in the United States is similar to volleyball (*q.v.*) except that the ball is thrown and caught instead of being batted. The player may not walk with the ball, which must be thrown from the place where it is caught. The penalty is loss of serve if the foul is committed by the serving side or one point to the serving side if committed by the receiving side. As in volleyball, a game may be played on a time instead of a point basis. (M. D. HA.)

NETHERLANDIC LANGUAGE. Netherlandic is the national language of Holland (kingdom of the Netherlands) and one of the two national languages (besides French) of Belgium. Popular English usage applies the term "Dutch" to the Netherlandic of Holland and "Flemish" to the Netherlandic of Belgium, but in actual fact they are the same language. In its various forms, standard and dialectal, Netherlandic is the indigenous language of most of Holland (all but the Frisian-speaking province of Friesland), of northern Belgium and of a small part of France immediately to the west of Belgium. Netherlandic is also used as the language of administration in the colonies of Holland, and a derivative of it (with slightly different sounds, simplified grammar, but similar vocabulary) is the Afrikaans spoken besides English in the Republic of South Africa.

As a written language, Netherlandic is quite uniform; it differs in Holland and Belgium no more than written English does in the United States and Great Britain. As a spoken language, however, it exists in far more varieties than does the English of North America. At one extreme is Standard Netherlandic (*Algemeen Beschaafd Nederlands* "General Cultured Netherlandic"), which is used for public and official purposes and is the language of instruction in schools and universities. It is everywhere quite uniform, except that speakers usually show by their accent the general area from which they come. At the other extreme are the local dialects, used among family and friends and with others from the same village. Some dialects are very similar to the standard language, while others are markedly different from it.

Sounds and Spelling.—Netherlandic has three classes of vowels and diphthongs: (1) six checked vowels, which are short and occur only before consonants; (2) thirteen free vowels, most of them long, which can occur in all positions (though three are found only in foreign words); and (3) a vowel that occurs only in unstressed position.

Usual spelling						Phonetic value					
			ie	uu	oe				i	y	u
i	u	o	ee	eu	oo	e	ø	o	e:	ø:	o:
			ij,ei	ui	ou				ei	œy	ɔu
e		o				ɛ		ɔ			
			(e	eu	o)				(ɛ:	œ:	ɔ:)
a				aa		ɑ				a:	
Unstressed: e						Unstressed: ə					

Examples of the checked vowels: *bit* "bit," *put* "well," *bot* [bot] "flounder," *bed* "bed," *bod* [bɔt] "offer," *bad* "bath." Many speakers have no contrast between [o] and [ɔ], but generally use [o] before nasals (*bom* "bomb"), [ɔ] elsewhere (*bot, bod*). The free vowels spelled *ie, uu, oe* are long only before *r: bier* "beer," *buur* "neighbour," *boer* "farmer"; short otherwise: *biet* "beet," *buut* "goal," *boet* "mends." The other free vowels and diphthongs are long: *beet* "bite," *beuk* "birch," *boot* "boat," *bijt* "bites," *buit* "booty," *bout* "bolt," *baat* "benefit"; and, in foreign words, *scène* "scene," *freule* "young lady of noble birth," *zone* "zone." When the free vowels *uu, ee, oo, aa* occur in an open syllable (before a single consonant plus another vowel), they are written singly: *buur, beet, boot, baat* (as above), but plural *buren, beten, boten, baten.* When the checked vowels occur in an open syllable, the following consonant letter is doubled: *bit, put, bot* (as above), but plural *bitten, putten, botten.*

Standard Netherlandic has the following system of consonants:

stops	p		b	t		d		k			*other:*	l	r
spirants	f		v	s		z	ch		g	h		w	j
nasals		m			n			ng					

p, t, k are unaspirated; *ch, g, ng* are phonetically [x], [ɣ], [ŋ]; *r* is uvular with some speakers, apical with others. After vowels *w* is a bilabial semivowel, but initially or after consonants it is a fully voiced labiodental spirant; it contrasts with the weakly voiced labiodental *v*. *j* is like English *y*.

Of the stops and spirants, *p, t, f, s, ch* are fortis and voiceless, while *b, d, v, z, g* are lenis and weakly voiced. *k* is usually fortis and *h* usually lenis; but *see* below. The contrast between lenis and fortis is suspended before pause, where only fortis stops and spirants occur. The spelling shows this in the case of *v* and *z: geven, lezen* "give, read," but *ik geef, ik lees* "I give, I read"; it does not show it in the case of *b, d, g: hebben, redden, leggen* "have, save, lay," but *ik heb, ik red, ik leg* "I have, I save, I lay," pronounced *hep, ret, lech*. In normal transition, fortis stops and spirants become lenis before a following *b* or *d: dat boek* "that book," pronounced *dad boek; vijf dagen* "five days," pronounced *vijv dagen; poetsdoek* "polishing cloth," pronounced *poedzdoek;* and similarly, *ik ben* "I am," with lenis *k*. On the other hand, lenis spirants become fortis after any preceding fortis stop or spirant: *het vuur* "the fire," pronounced *het fuur; op zee* "at sea," pronounced *op see; vijf ganzen* "five geese," pronounced *vijf chanzen;* and similarly, *vijf honden* "five dogs," with fortis *h*. When these assimilations would give long consonants, they are simplified: *dat ding* "that thing," pronounced *dading; vijf vingers* "five fingers," pronounced *vijfingers; zes zakken* "six sacks," pronounced *zesakken*.

History.—Together with English, Frisian and German, Netherlandic belongs to the West Germanic group of languages. (*See* GERMANIC LANGUAGES.) It is descended primarily from the speech of the Franks who entered this area in the 4th and 5th centuries; in historical studies it is therefore often called Low Frankish. At the same time, it shows a few non-Frankish features ("Inguaeonisms"), which were probably borrowed from the former Germanic inhabitants of the coast. Documents written in Netherlandic do not begin to appear until the end of the 12th century. From the immediately preceding period there are only a few glosses, the names and occasional words that appear in Latin documents, and the single sentence *hebban olla uogala nestas bigunnan hinase hi[c] enda thu* "all birds have begun [their] nests save I and thou."

The development of Standard Netherlandic is closely tied to the political and economic history of the area. During the 13th and 14th centuries Flanders (in western Belgium) was culturally predominant, and Bruges the leading city. Toward the end of the 14th century the cultural centre began to shift eastward to Brabant, with Antwerp as the leading city. By the middle of the 16th century the speech of this region was well on its way to becoming standard for the whole area. Then came the revolt against Spain, in which the northern province of Holland played the leading role. Holland's cultural importance was greatly increased by the fact that many of the most influential southern families fled to the north, above all to Amsterdam, especially after the fall of Antwerp (1585).

The political split between the United Netherlands in the north and the Spanish Netherlands in the south had far-reaching linguistic effects. In the prosperous and vigorous north a standard language rapidly developed, based on the speech of the big cities of the province of Holland (especially Amsterdam) but also showing the influence of the culturally important refugees from Brabant. This has continued to develop as the standard language, down to the present. In the south, French came more and more to prevail among the upper classes. The less privileged classes continued to use dialectal Netherlandic, but no supradialectal standard was developed.

The cultural predominance of French increased during the period of French rule (1795–1814), abated somewhat during the years when Belgium and Holland were united independently (1815–30), but rose again after the founding of the kingdom of Belgium in 1830. At this time French was the only official language, used exclusively in government, courts and schools. Then there began a long struggle to give Netherlandic equal status with French, ending with the Language act of 1938, which made it the only official language of the northern part of Belgium. During these years of struggle there were attempts to set up a standard Flemish, different from that of the north; but in the end the standard Netherlandic that had become established in Holland was accepted for northern Belgium as well.

The close relationship of Netherlandic with English is most obvious in the consonants of the two languages: *plug* "plug," *tong* "tongue," *kan* "can," *bloed* "blood," *doen* "do," *gras* "grass," *hand* "hand," *man* "man," *naam* "name," *lip* "lip," *recht* "right," *winter* "winter," *jaar* "year." Former *f-* and *s-* are now *v-* and *z-*: *vinger* "finger," *zingen* "sing"; former *th* and *d* have coalesced as *d: dief* "thief," *diep* "deep"; former *al, ol* before *d, t* have changed to *ou*: *koud* "cold," *bout* "bolt"; former *ft* has changed to *cht: zacht* "soft." Former *sk* (English *sh*) gives *sch* initially: *schip* "ship," but *ss* or *s* elsewhere: *vis* "fish," plural *vissen;* former *hs* (English *x*) has also given *ss* or *s: vos* "fox," plural *vossen*.

Dialects.—At the border separating Holland or Belgium from Germany, the use of the standard language changes abruptly: Netherlandic is used to the west, German to the east. In the local speech, however, there is no such change: from the point of view of village dialects, the entire Netherlandic-German territory from the North sea to the Alps is a single dialect area with only gradual transitions from one village to the next.

In an area bounded roughly by Amsterdam, The Hague and Rotterdam, the local dialects are relatively uniform and do not differ greatly from the standard language. But north, east or south of this area, the local dialects diverge more and more from the standard language, until finally the two become mutually unintelligible. By tradition, dialects are named after the provinces in which they are spoken: Gronings in Groningen, Limburgs in Limburg, etc. In actual fact there are no sharp boundaries between dialects, but only more or less gradual transitions; and the relatively sharp transitions do not necessarily occur at provincial borders.

The use of dialect varies markedly. In the area Amsterdam-The Hague-Rotterdam, most rural inhabitants are puzzled at the suggestion that they speak a "dialect." Their speech is so similar to the standard language that they are not aware of any real differences. Even a few miles from this area, however, the differences become so great that everyone is fully aware of them. The result is that, throughout most of Holland, the vast majority of people in effect speak two closely related but distinct languages: Standard Netherlandic and local dialect, in varying degrees of proficiency.

In Netherlandic Belgium the use of Standard Netherlandic is much more limited, and that of local dialect is much more extensive. Some of the better educated speak the standard language fluently and use it regularly, while others prefer French. The less well educated use dialect almost exclusively, and are often able to handle the standard language only with difficulty.

See also references under "Netherlandic Language" in the Index.

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NETHERLANDS, THE (NEDERLAND; officially KONINKRIJK DER NEDERLANDEN, popularly HOLLAND), a constitutional monarchy of northwestern Europe, bounded on the east by the Federal Republic of Germany, on the south by Belgium and on the west and north by the North sea. Its maximum length from north to south is 190 mi. and its greatest breadth is 160 mi. The coastline including estuaries is about 429 mi., which length is increased to 1,076 mi. if the coasts of close-lying islands are included. The Belgian municipality of Baarle-Hertog forms an enclave within the Dutch territory.

The area of the country has shown a continual variation. It has been decreased by coastal erosion and flooding by sea; on the other hand, these losses have been overcompensated by extensive silting and by artificial land reclamation, especially in the IJsselmeer area. The total land area of the Netherlands was estimated to be 13,96[illegible] sq.mi. by 1963. Approximately two-fifths of the country lies be-

The Peace palace, seat of the International Court of Justice, The Hague

A typical farm in Giethoorn (Overijssel province), a scattered water village interlaced with tree-planted canals which are the chief means of local transportation

SCENES OF THE NETHERLANDS

Aerial view of Nieuwerkerk (Nijkerk) on the IJssel, one of many villages set beside the river dikes of South Holland

Quaint old houses and one of the many small bridges that span the tree-shadowed canals of Delft, an ancient town in South Holland known for its pottery

A section of the Singel canal in Amsterdam showing the flower market (foreground) and the 17th-century Munttoren or Mint tower (right background)

PHOTOGRAPHS, (TOP LEFT) STOPPELMAN—PIX FROM PUBLIX, (TOP RIGHT) PETER DE VRIES, (CENTRE LEFT) NETHERLANDS INFORMATION SERVICE, (BOTTOM LEFT) J. ALLAN CASH, (BOTTOM RIGHT) JEAN ROUBIER

NETHERLANDS

The cattle market at Purmerend, situated in the rich pastoral polder regions of North Holland, from which famed Holstein-Friesian cattle are exported

Porters, wearing traditional guild costume, carrying Edam cheese to the market weighhouse in Alkmaar. Cheese is one of Holland's principal exports

A workshop of the Philips industrial complex in Eindhoven which ranks among the world's largest suppliers of radio and electronic equipment

One of the many flower fields that extend between Leiden and Haarlem. Tulip and other flower bulbs form an important export commodity

Unloading herring for the fish auction at IJmuiden. Fishing is a mainstay of the economy

The port of Rotterdam on the Nieuwe Maas, a commercial ce... of the Netherlands and one of the largest seaports in the world

INDUSTRY AND COMMERCE OF THE NETHERLANDS

PHOTOGRAPHS, (TOP RIGHT) WIES MEERTENS, (CENTRE RIGHT) NETHERLANDS INFORMATION SERVICE, (OTHERS) STOPPELMAN—PIX FROM PUBLIX

low sea level and without protection by dunes and dikes would be subject to tidal inundation twice daily. A large part of the remainder is composed of sandy regions and rarely rises above 300 ft. except in south Limburg. Through the centre of the country flow in close proximity and roughly parallel three great rivers, which have formed a wide alluvial plain.

The capital of the Netherlands is Amsterdam, though The Hague ('s Gravenhage) is the seat of the government; the principal residence of the sovereign is at Soestdijk, in Utrecht province.

This article is subdivided mainly as follows:

I. PHYSICAL GEOGRAPHY

1. Geology and Structure.—The geology of the Netherlands is relatively simple, as most natural physical features date from the Quaternary stages (Pleistocene and Holocene periods), and their deposits cover most of the country in considerable depth. Tertiary sediments and earlier Mesozoic rocks are only met in borings on the east and south of the country or in rare outcrops in south Limburg and in the eastern part of the country. Carboniferous strata in which Coal Measures occur approach the surface in the northeastern part of south Limburg and, less closely, in De Peel region (between North Brabant and Limburg). In Limburg near Kerkrade these measures, lying close to the surface, have been worked since the middle of the 13th century. The Limburg mines work Coal Measures at a depth of 300 to more than 1,000 ft., while De Peel region coal lies at depths between 2,000 and 3,000 ft.

Permian and Triassic rocks underlie a great part of the country at considerable depths. They contain beds and domes of salt, which are exploited at Hengelo in Overijssel and near Winschoten in Groningen, and considerable quantities of oil and gas, chiefly at Schoonebeek (Drenthe) and near The Hague.

During the Pliocene period, the forerunners of the Rhine, Meuse (Maas) and Scheldt rivers deposited huge quantities of sediment, mostly sand, over the area. In the succeeding Pleistocene period ice spread over the northern part during the third (Riss) glaciation, depositing, in the provinces of Drenthe, Friesland and Groningen, large areas of boulder clay. Another legacy are the glacial ridges (*stuwwallen*) of Gelderland, Utrecht and Overijssel, which are the result of the folding up of the western slopes of the preglacial river valleys by the advancing ice sheet. Another element of the glaciated landscape is the broad depressions by which the melting water of the regressing ice sheet flowed off to the sea. Equally, the alluvial plain of the Rhine and Meuse rivers served this function. The glaciated regions, as well as the provinces of North Brabant and Limburg, that were not reached by the ice were later partly covered by aeolian deposits (*dekzanden*) during a dry part of the glacial period.

The postglacial period saw the return of sea level to approximately its present position. Then followed the initiation and subsequent development of an offshore bar, which was breached by the estuaries of the Scheldt, Meuse and Rhine but swept unbroken from the Hook of Holland to Den Helder and then continued in what are now the Frisian Islands. In time this bar was covered with sand dunes. The large lagoon behind the bar was partly filled up by a delta of river clay, built up by the Rhine and Meuse; partly, too, extensive peat areas developed in it, which were in some places covered by marine clay, where for a time the sea had breached the bar.

According to its geological history the Netherlands can be roughly divided into the following four areas:

The Southern Limburg Plateau.—This small plateau, thrusting for about 20 mi. between Belgium and Germany, and to the north reaching to about the town of Sittard, forms the oldest and most mountainous part of the country. Except for the valley of the Meuse, it consists of Cretaceous rocks, generally rising to more than 300 ft. and at some places in the south to more than 1,000 ft. The plateau is dissected by deep valleys with swift streams. Its surface is covered with a fine aeolian soil (loess) that is suited to wheat and sugar beet; the valleys are used for meadowland. Underlying Carboniferous deposits, a continuation of those in Belgium, have led to coal mining.

The Sand Areas of the South and East.—There at least three subareas may be distinguished: the most extensive of these is the nonglaciated region of North Brabant and northern Limburg, sloping gradually from southeast to northwest, with altitudes that rarely exceed 150 ft. The broad alluvial valleys of various streams and patches of peat bog, of which many are now reclaimed, form the most characteristic elements of this subarea. In the central part of the country there is a sandy region with alternating glacial ridges and broad valleys. The most westerly of these is the narrow belt of moraine hills of Gooiland and Utrecht, running from the Zuider Zee to the (Lower Rhine) Neder Rijn. The region is strongly wooded and the northern part is an extensive residential district. The ridge sinks to the east into the Geldersche valley, a region consisting mostly of sands. Between this plain and the broad valley of the IJssel lies the Veluwe plateau, consisting of a complex of glacial ridges that rise at some places to more than 300 ft. For its greater part it is still covered by heaths and woods and it serves to a high degree as a residential and recreational district. The valley of the IJssel consists of a rather narrow belt of river clay along the river, on both sides accompanied by a broader belt of low-lying sands. Across the valley of the IJssel the sandy regions of eastern Gelderland and Overijssel equally contain a number of glacial ridges, separated by broad alluvial plains. Formerly these plains were often marshy but, now drained, they are mostly used for meadows.

To the north of this latter region is the boulder clay plateau of Drenthe and the eastern half of Friesland. Formerly an area of extensive heaths, notably in Drenthe, it is now mostly reclaimed for agriculture. A series of depressions through which the melting water of the ice sheet was carried off border the plateau east and south. The sandy soil of these depressions was formerly covered by peat bogs as a result of insufficient natural drainage and the high level of the ground water. The peat has now been removed, giving rise to a special style of agriculture.

The Alluvial Plain of the Rhine and the Meuse.—The broad alluvial plain that stretches out through the central Netherlands is in fact a delta of the Rhine and its divergent distributaries. The Rhine itself divides soon after entering Dutch territory into the Waal and a more northerly stream, the Lower Rhine, later called Lek. At Arnhem the Rhine throws off an important distributary, the IJssel, which flows northward into the Zuider Zee. A third great river, the Meuse (Maas), flowing first north through Limburg, turns westward just below Nijmegen and winds several miles south of the Waal. The rivers are slow moving and meandering and deposit much silt. They are diked along considerable stretches, usually at some distance from their summer beds. The villages and their arable land are mostly situated on sandy levees along the river. The interior parts of this area lie at a lower

MODERN PROVINCES, MAJOR CITIES AND DRAINAGE OF THE NETHERLANDS

level and often show a marshy character (*komgronden*). The delta of the Rhine and the Meuse consists of fluvial clay that continues into the peat and marine clay of the coastal belt, with which it finally merges.

The Coastal Belt.—This can be divided into several zones. Stretching northeast from the Belgian frontier it is deeply indented by the wide estuaries of the West and East Schelde (Scheldt) and by those of the Rhine-Meuse, such as the Grevelingen and the Haringvliet. These estuaries themselves divide about the large islands of Walcheren, South and North Beveland, Schouwen-Duiveland, Tholen and Goeree-Overflakkee. Most of this area (including the islands), which is protected by dikes or sand dunes, is impoldered. Land reclamation has been in progress there for many centuries; the soil, a fertile marine clay, is suitable for arable farming. From the Hook of Holland a coast of sand dunes runs northward in a continuous sweep to Den Helder at the northern tip of the mainland. All its hinterland is below sea level; it is mostly protected by dikes and includes much polder land. Much of the surface area is peat or clay (on the bottom of the reclaimed lakes) and is suitable for various types of agriculture.

Stretching from the tip of North Holland in a northeasterly curve are the Frisian Islands (*q.v.*). They comprise, from southwest to northeast, Texel, Vlieland, Terschelling, Ameland, Schiermonikoog and Rottumeroog. The first three enclose a shallow stretch of tidal sea, the Wadden Zee, which led formerly into the Zuider Zee but was separated from it in 1932 by the Afsluitdijk (enclosing dike). The dam that connects North Holland with Friesland is 18½ mi. long and carries a motor road. The northeastern coastal belt of Friesland and Groningen to the German frontier is also extensively diked. Land reclamation is made in the more suitable places and the entire zone is poldered. The area consists largely of heavy clays and less extensive districts of peat.

2. Dikes and Polders.—To a great extent the physiogeographical structure of the country also decided the pattern of human occupation. The southern parts of Brabant and Limburg and the boulder clay plateau of Drenthe (with many megalithic monuments) form the oldest inhabited parts of the country. The lower and more marshy sand regions of the eastern sections of the country were occupied at a somewhat later stage, as was the inner side of the belt of the dunes. From these sandy areas settlement radiated first to the river clay delta and finally to the coastal belt of peat and marine clay. In the extreme north, in Friesland and Groningen, the earliest inhabitants settled on the unprotected marsh, but about the 1st century A.D. marine transgressions compelled them to build extensive mounds. Perhaps even as early as the 8th and 9th century attempts were made to secure greater protection by building dikes, and about the end of the 13th century different regions of the coastal belt were enclosed by dikes as protection against either the sea or the rivers. Later other dikes were built, sometimes as a consequence of flooding after the bursting of a dike, by which many villages often were devastated or even whole areas disappeared. In this manner the area southeast of Rotterdam was profoundly changed after floodings in the 14th and the first half of the 15th century. Most later dikes form part of successive reclamations, as for example the greater part of the isle of South Beveland, the whole isle of Overflakkee and extensive parts of Groningen and the southern part of South Holland. The most extensive undertaking by mid-20th century was the reclamation of a large part of the Zuider Zee (*q.v.*). Under a reclamation law (June 14, 1918) this was begun in the early 1920s with the creation of various polders; viz., the Wieringer meer, the Northeast Polder and East Flevoland. The reclamation of a fourth polder (South Flevoland) was begun in 1960. After the catastrophe of Feb. 1953, created by storm tides, in which 1,835 persons were drowned and 450,000 ac. of land flooded, a Delta commission was established to explore the possibilities of sealing off the Schelde and Rhine estuaries in South Holland and Zeeland. The Delta project, scheduled for completion in 1978, was accepted in 1957 and it was planned to dam

the estuaries and to shorten the southern coast line; dike building would eventually close the mouths of the Haringvliet, Grevelingen and East Schelde.

The problem that first arose from the embankment of the various parts of the coastal belt in the 12th and 13th centuries was the artificial removal of the superfluous precipitation. Since the beginning of the 13th century a complicated organization of the landholders has gradually developed to deal with this problem, by which the smallest units (polders) directly or indirectly (by the way of storage basins) have their superfluous water removed to the sea or the rivers. Formerly numerous windmills lifted the water from the land. Another form of reclamation consists of the breakup of the wasteland in the sand areas.

A most spectacular piece of reclamation in this field was that of the extensive peat bog in the northeastern part of the country, which was already started at the beginning of the 17th century. After the peat was dug off, the sterile sandy subsoil has been changed into arable land by means of manure and artificial fertilizers. In this way an extensive district of arable land was added to the Netherlands. (*See* LAND RECLAMATION.)

3. **Climate.**—The climate is rather uniform throughout the Netherlands, although in general the northern provinces are colder than the central and southern parts of the country. The prevailing winds are westerly and southwesterly, with a late spring period of cool northerly winds. High winds are fairly frequent in coastal areas. The mean winter temperature is around freezing and mean summer temperature about 21° C. (70° F.). Mean average rainfall varies between 22 and 32 in.; the wettest parts are the regions behind the dunes, the sandy areas in the middle of the country and southern Limburg. Marsh mists and sea fogs are common, particularly in winter. (H. J. KE.)

4. **Vegetation.**—Coniferous plantations cover 7% of the country and occupy 70% of the total woodland area. Deciduous woods are of three main kinds: oak-birch on poor sandy soils; oak-birch-beech on richer soils; mixed woods of oak, ash, hornbeam, cherry, etc., on the rich loam and chalk soils in the east and south. In the wetter places ash, alder, elm and willow trees are conspicuous. The extensive coastal dunes carry a varied flora: in the north, where the soil is poor in lime, their lichen carpet has been colonized by heaths, while the southern dunes, rich in lime, support scrub with common and sea buckthorn, privet, rose and spindle. Inland there are dry (*Calluna*) and wet (*Erica*) heaths, with crowberry in the north, and fens, swamps and sphagnum bogs. The salt marshes may be occupied mainly by *Salicornia*, salt-marsh grass, mud rush, or *Artemisia*, together with the cord-grass *Spartina townsendii*. Characteristic Atlantic species are bellflower, bell heather, myrtle and bog asphodel. (V. W.)

5. **Animal Life.**—The fauna of the Netherlands is characteristically western European. It shows a greater variety on the higher land than in the lower wetter areas. Fox, pine marten and tree frog are found only in the south and east. The southern part of Limburg, where there is limestone, has a fauna of its own with dormouse, midwife toad and wall lizard. In the national parks and nature reserves rare plants and animals are protected; *e.g.*, red deer in the forests and heathlands of the Hoge Veluwe National park (23 sq.mi.); bearded tit, purple heron, Savi's warbler and other marsh and water birds in the Naardermeer nature reserve (one of the most important bird sanctuaries in Europe); spoonbill on Texel Island (its most northerly breeding place); halophytes (salt-loving plants) and marsh and water birds on the Bosplaat sands of Terschelling Island. The change in the IJselmeer from salt to fresh water, following the closing of the Zuider Zee by a dike in 1932, has brought about interesting changes in the flora and fauna of that body of water. (X.)

II. THE PEOPLE

The modern Dutch people are descended from a few German tribes, chiefly the Frisians in the north of the Netherlands, the Saxons in the east and the Franks, who were of more southern origin, in the south. The Frisians arrived before the Christian era; the others came with the barbarian invasions in the 4th century A.D. In the course of many centuries these elements have become somewhat intermingled, especially in the western part of the country, which has been highly urbanized since the end of the middle ages. In the 17th century began a small and gradual influx into the towns of Jews (at first Portuguese, later German), of French Huguenots and of Malays and Eurasians from the (former) Netherlands East Indies.

Throughout history dwellers in the inland areas of the Netherlands have confined themselves largely to self-sufficient agriculture and to small industries; the spread of industry in the eastern and southern sandy regions is due to the availability of cheap labour.

In most aspects of their life the people are divided along confessional lines. According to 1959 estimates they were 44.5% Protestant, of whom about three-quarters (including the royal family) belonged to the Netherland Reformed Church (Nederlanse Hervormde Kerk) and the rest to a smaller Reformed body and such smaller groups as Mennonites and Lutherans. The Roman Catholic Church claimed 38% of adherents; and 17% of the population subscribed to no denomination. The proportion of Roman Catholics is slowly increasing because their higher birth rate coincides with the higher Protestant emigration rate. Political parties are divided along confessional and ideological lines. Religion and ideology exert influence also on schools, trade unions, occupational and recreational societies and even the national broadcasting and television systems, which are divided into several denominational branches in more or less sharp competition.

The Dutch people are also characterized by a strong family life and therefore greatly prefer one-family houses to flats, which have only begun to be built fairly extensively since World War II. The Dutch set much store by privacy and private initiative; they appreciate the moral value of autonomy and responsibility. Nevertheless, lack of space has obliged them to accept a high degree of material and social organization. Their rights are safeguarded by their strong democratic spirit, manifested in a long history of municipal government, water-defense corporations and, among the Protestants, by the Calvinistic church order which has penetrated all their denominations.

In general the Dutch are tolerant, sturdy and somewhat phlegmatic. Their artistic awareness is more visual than auditive—which, added to the fact that their language is not widely spoken, may account for the superiority of their painting and architecture over their literature. The average cultural standard is high; illiteracy is almost unknown and over 60% of young people receive secondary education.

There are many regional variations in Dutch life which play an important part in culture. These have, naturally, maintained themselves best in the rural areas and among the fishing population.

See also NETHERLANDIC LANGUAGE; DUTCH LITERATURE; PAINTING. For an account of the evolution of the Reformed Church *see* REFORMED CHURCHES. (H. D. DE V. R.)

III. ARCHAEOLOGY

Paleolithic Remains.—The oldest remains of human industry in the Low Countries are Clactonian and Acheulean flints from gravels in the Mons (Hainaut) region of Belgium dating from the third (Riss) glaciation. Middle Paleolithic Mousterian industry is very well represented in Belgian alluvial and cave deposits (Hainaut, Liège and Brabant). Human (Neanderthal) fossils have also been found, especially in the cave at Spy. The Upper Paleolithic inhabitants (*homo sapiens*) of the northern provinces of the Netherlands were reindeer hunters, fishermen and food gatherers, who appeared in the final phase of the last glaciation (*c.* 10000 B.C.). They left flint implements closely related to the Hamburgian industry of northwest Germany. The Upper Paleolithic cultures in Belgium represent the northwesternmost limit of the classic Aurignacian, Perigordian and Magdalenian industries as known in France, Spain, Switzerland and southern Germany. The Low Countries have no Upper Paleolithic cave art; but some objects are decorated in typical French style.

During the final Paleolithic phase (Alleröd oscillation and younger Dryas, *c.* 9000–8000 B.C.) there were three cultures in the Low Countries, of which two appeared both in the Netherlands and

in Belgium, viz., the Tjonger group (so called from the Tjonger river in Frisia [Friesland]), related to the British Cheddar and Creswellian cultures; the Ahrensburgian, which derives from the Hamburgian; and, in southern Belgium only, the epi-Magdalenian.

Mesolithic Food Gatherers.—During Mesolithic times (8000–c. 4000 B.C.), which include the preboreal, the boreal and part of the Atlantic period, three groups of cultures are found. The first, the Maglemosian people, lived near lakes and rivers in the Netherlands, Flanders and most of the north European plain. Their remains consist largely of bone and antler points and harpoons. A fire-hollowed canoe of about 6000 B.C. discovered near Pesse, Drenthe, in 1955 probably belongs to this culture. The second group, the Tardenoisians, lived on high plateaus and in sandy regions throughout the Low Countries. They were hunters of small game and their remains consist of arrowheads and parts of composite implements made of geometrical microliths. Lastly there were the people who lived in the forests, whose characteristic remains are heavy tools suitable for woodworking, such as axes and adzes. These are found in Frisia (northern Netherlands) and around Liège (Belgium).

Danubian Farmers.—Farming people from central Europe settled in the Dutch province of Limburg and in the Hesbaye district (Belgium) at the end of the 5th millennium B.C. They brought the Neolithic way of life, based on agriculture and stockbreeding. Excavation has shown that their village consisted of large, wooden long houses, stables and barns. They cultivated cereals on loess soil cleared of forest by the slash-and-burn method and bred pigs, sheep and cattle. Among their most typical remains are shards of pottery decorated with wavy and angular incised lines and adzes made of polished hard or volcanic rock.

Spread of Neolithic Life.—After a few centuries the Danubians departed and were replaced by a second wave of Central European immigrants whose arrival originated two civilizations: the Funnel-Beaker culture in the Netherlands and the Michelsberg in Belgium. Both date from the third millennium B.C. The Belgian Michelsberg culture is much the same as the German, but it has also some affinities with the Windmill Hill culture of Great Britain. Among its most important remains are the flint mines of the Mons region (Spiennes), the products of which were used over a wide area. Its most characteristic feature is its pottery, with tulip beakers and flat baking disks. The remains of the Funnel-Beaker culture in the Netherlands are found mainly in the eastern provinces, especially Drenthe. There are numerous large megalithic passage graves, and pottery remains consist of funnel beakers, collared flasks, buckets and bowls decorated with deep horizontal and vertical grooves forming geometrical patterns. Excavations along the North sea coasts have revealed a series of farmers' and fishermen's settlements. These seem, however, to belong to an autochthonous Mesolithic population which had adopted the Neolithic way of life; their remains show strong Funnel-Beaker and western Neolithic influences.

Late Neolithic Migrations.—The end of the Neolithic period in the Netherlands is marked by a series of invasions and migrations. Warlike herdsmen arrived in the Netherlands from the east about 2200 B.C. Avoiding the Funnel-Beaker area, they settled in the Veluwe (Guelders) and at the western limit of the northern sandy areas. They buried their dead in single graves under barrows and left battle-axes of hard stone and cord-impressed beakers. About 2000 B.C. groups of prospectors of the Bell-Beaker civilization arrived, settling along the Belgian and Dutch coasts and in the provinces of Gelderland (Guelders) and Drenthe in the eastern Netherlands. They introduced the first metal objects. Some of them traveled on to the British Isles.

The Bronze Age (1600–600 B.C.) was a quiet period for the Low Countries as they lay outside the main trade routes. The period is chiefly memorable for its complicated timber-structured grave barrows. At the end of the Early Bronze age, people came from the British Isles to settle in the northern provinces of Belgium and the Netherlands. They cremated their dead and put the bones into urns which they placed under barrows. Typical of their rough funerary urns are those of Hilversum and Drakenstein.

Late Bronze Age: Urn Field Invasions.—During the Late Bronze Age, bronze weapons and implements began to be imported into the Low Countries from many parts of central and northern Europe, including the British Isles. Urn field people (probably Celtic), so called from their custom of putting the cremated bones of their dead into urns, came from Switzerland and the Rhineland to settle in northern Belgium and the southern Netherlands; *i.e.*, south of the Maas, Waal and Rijn rivers. Their equipment and grave goods were poor. In Flanders and central Belgium the genuine urn field tradition of flat graves was kept; while toward the north, barrows were adopted from the autochthonous population. North of the rivers came a large Germanic Urn field immigration originating from northwest Germany.

The Iron Age.—This period (600 B.C. to the Roman conquest, 12 B.C. onward) was very quiet north of the three rivers; the population of agriculturists and herdsmen continued the traditions of urn field times. About the beginning of the 3rd century B.C. the lower coastal stretch of Frisia was inhabited for the first time, by a population of cattle breeders. In order to protect themselves and their cattle from the high tidal floods, these new people built their villages on artificial mounds or *terpen*. The systematically excavated *terp* of Ezinge has yielded much information about their life. The area south of the rivers, however, presents a different picture. In the 7th century B.C. a group of Celtic (Hallstatt) warriors, probably from Bavaria, conquered central Belgium and established their rule over the autochthonous population. The Hallstatt influence was also felt in northern Belgium and the southern Netherlands; here there are a number of graves of chieftains, containing rich grave goods, including golden trinkets, mostly imported from the Mediterranean. During the La Tène period there were three cultural groups south of the great rivers. In the northernmost, the urn field traditions were still carried on, but the pottery was strongly influenced by the French Marne civilization. The strongest La Tène influence shows in the pottery, metal objects and gold ornaments of Hainaut. The Ardennes formed part of the Eifel-Hunsrück civilization. These last people built numerous hill forts (*oppida*) surrounded by stone and earthen walls.

The prehistoric period in the Low Countries ended with the conquest by Nero Claudius Drusus of the regions north of the Rhine (12 B.C. onward). (S. J. DE L.)

IV. HISTORY

For historical purposes, the name Netherlands, or Low Countries, is generally understood to include not only the territory of the Kingdom of the Netherlands, with which the nonhistorical sections of this article are concerned, but also what is now Belgium (*q.v.*) as well as parts of northeastern France and Luxembourg. Belgium, however, though it was not constituted as an independent kingdom till 1831, had a distinct history of its own from 1579, when the southern provinces of the Low Countries began to be separated from the northern. Here, therefore, the history of the Low Countries will be surveyed as a whole down to 1579; thenceforward the article will be concerned with the history of the northern area.

A. Early History, to 1384

Roman Occupation.—In 57 B.C. the Romans entered the northern borderlands of Gaul. There they found Celtic tribes: the Morini and the Menapii in the coastal belt west of the Scheldt, the Nervii in Hainaut and in Brabant east of the Scheldt and the Aduatuci in Namur. The Eburones, who were probably Germanic and who lived in the rest of Belgium and along the Rhine, were annihilated in war against the Romans. Their territory was then occupied, with the permission of the Romans, by other Germanic tribes, about the beginning of the Christian era: the Tungri in Limburg, the Toxandri in northern Brabant, the Cugerni and the Ubii in the Rhineland. In the region of the Rhine delta and to the north of that area the Romans encountered mainly the Batavi and the Frisians (*q.v.*), who were subjugated by Nero Claudius Drusus in A.D. 12. The Low Countries thus became part of the Roman empire for more than 400 years: revolts such as those of the Frisians (A.D. 28 and 47) and of the Batavi under

Gaius Julius Civilis (A.D. 69) did not permanently break Roman dominance.

Roman rule left clear and lasting traces and exercised a strong influence on the material civilization. The original centres of this Gallo-Roman civilization were the military camps, which in many cases were also centres of government. The network of roads and waterways connecting these camps remained important in later centuries. Such centres were founded along the Rhine border —at Trajectum ad Rhenum (Utrecht) and at Noviomagus (Nijmegen)—and also in the interior—at Aduatuca Tungrorum (Tongres), at Trajectum ad Mosam (Maastricht) and at Turnacum (Tournai). There were also numerous nonmilitary settlements and landed estates (*villae*), especially along the middle Meuse and in Limburg. Stimulated by commerce, industries developed; *e.g.*, iron mining, stone quarrying, pottery glazing and metalwork. One of the most important industrial regions was the Meuse valley.

The Franks.—In the first half of the 5th century A.D. the Romans evacuated the Low Countries. The Salian Franks (*q.v.*), who since the 4th century had been established as *dediticii*, or protected subjects of the Romans, in Toxandria (northern Brabant), used this opportunity to make themselves masters; they advanced in a southwesterly direction, settled in the area of Tournai and penetrated into Gaul. There, in the latter years of the 5th century, Clovis, at the head of the united Salian Franks, created the Frankish realm of the Merovingians, which thus had its centre outside the Low Countries. The Belgian territories, which in this way became borderlands of the Frankish dominion, stayed under Frankish rule, but they were very thinly populated. The Frisians meanwhile penetrated into the Rhine delta, and the coastal area was still very scantily peopled. This situation continued into the 7th century but was reversed toward the end of it: when Austrasia (*q.v.*) emerged as the most important part of the *regnum Francorum*, eastern Belgium (the middle Meuse area and the Ardennes) became one of its centres. Thereafter the Frisians were forced back behind the Rhine, and Utrecht was incorporated in the Frankish realm, at first provisionally but later definitely by Charles Martel, the mayor of the palace.

In the 8th century, when the Austrasian Carolingians came to power, Frankish rule was extended over the whole of Frisia. Thus the Low Countries—except for a Saxon area in the east—were absorbed into the Frankish empire. The form of government and administration which had been inaugurated under the Merovingians, and was continued under the Carolingians, provided the foundation for later institutions.

Subsistence was mainly from agriculture, though there were a few industries (metal on the middle Meuse and pottery in Hainaut and Namur) and some commerce (at Quentovic and at Dorestad), which was directed partly toward England, Scandinavia and northern France. Some municipal centres of Roman times continued to exist (Arras, Tournai, Maastricht, Utrecht).

Outside the centres of military and civil government there had been few traces of Christianity in Roman days. With the establishment of the Frankish realm and the conversion of Clovis, Christianity began to penetrate into the interior of the Low Countries, and a few dioceses (Thérouanne, Tournai, Tongres) were established in Belgium. The lasting Christianization of the southern Netherlands, however, was not achieved till the 7th century, largely thanks to missionaries belonging to the regular clergy (St. Amandus, St. Omer). In the river deltas and in Frisia, the Anglo-Saxon St. Willibrord (*q.v.*) began to preach the Gospel c. 690, choosing Utrecht and later also Echternach as his bases. In the north, evangelization was possible only with the support of the Frankish conquerors of Frisia. St. Willibrord's work was carried farther by St. Boniface (*q.v.*).

Christianization in the Low Countries was accompanied by monastic foundations, especially in the south (Elnone, Echternach, St. Vaast, St. Wandru, etc.); in the north, only the *monasterium* of Utrecht was of importance. A beginning was also made with the building of churches, mainly endowed by great landowners. While the south was evangelized by the Frankish mission and the north by the Anglo-Saxon, a third group of missionaries, the Irish-Scottish, was also of importance to the Low Countries in general because of its influence over Franks and Anglo-Saxons alike.

In the latter part of the 8th century, only the region east of the river IJssel (the modern province of Overijssel and the eastern part of Gelderland) remained outside the Frankish empire. St. Lebuinus tried in vain to propagate Christianity in this Saxon area, which was converted only after Charlemagne (*q.v.*) had finally subdued the Saxons at the end of the century. St. Liudger, of Frisian origin, then preached in the neighbouring Westphalia, where the diocese of Münster was established, and became its bishop. Pacification, Christianization and the development of the Frankish governmental and juridical institutions (feudalism, tribal laws, administrative organization) were, for the Low Countries, the most important results of Charlemagne's rule (768–814). When he was not at Aachen, Charlemagne resided frequently at Herstal on the Meuse north of Liège or at other places in the southern Netherlands, less often at Nijmegen.

The accession of the Austrasian Carolingians to power, the conquest of Frisia and the subjection of Saxony gave to the Low Countries south of the Rhine delta a central position in the Frankish empire, which they retained under the emperor Louis I the Pious. In his reign (814–840), however, peace was more and more disturbed by the devastating incursions of the Vikings, or Northmen; and toward the end of the 9th century these raids were penetrating ever deeper into the interior. Not until the beginning of the 10th century did peace return.

The disputes among the sons and successors of Louis the Pious and the resulting divisions of the Frankish realm likewise had a disturbing effect on the Low Countries. The treaty of Verdun (843), which assigned the West Frankish kingdom (Francia Occidentalis, or France) to Charles II the Bald and the East Frankish (Francia Orientalis, or Germany) to Louis the German, gave the so-called Middle kingdom (Francia Media) to the emperor Lothair I. This Middle kingdom included the Low Countries except the regions west of the Scheldt (the later counties of Artois and Flanders), which went to Charles the Bald; but after Lothair I's death (855) the Middle kingdom was once more divided. The northern part, which included the Low Countries, again with the exception of Artois and Flanders, went to the second Lothair (a younger son of Lothair I), after whom it came to be known as *Lotharii regnum*, or Lotharingia (*see* LORRAINE). Lotharingia was in turn partitioned between West and East Franks (870), attached in its entirety to the East Frankish kingdom (880), restored as an independent kingdom for the East Frankish king Arnulf's illegitimate son Zwentibold (895), attached again to the East Frankish kingdom (900) and even transferred by the local nobility to the West Frankish king Charles III the Simple (911). In 925, however, the Low Countries, once more with the exception of Artois and Flanders, were definitely attached to the East Frankish or German kingdom under the Saxon dynasty.

Territorial Independence and the Rise of the Towns.—In the course of the middle ages the Low Countries, linked as they were politically and ecclesiastically both with Germany and with France and economically and culturally with England, were able to exploit their position to make themselves gradually more independent. They also began to make an important contribution to the material and spiritual civilization of Europe.

In the movement toward greater independence the southern Netherlands took the lead. The merging of the numerous Carolingian administrative districts, or *pagi*, from the 10th century onward, brought larger political units into being. The feudal link between the kings and their greater vassals grew weaker (*see* FEUDALISM), and in the 12th and 13th centuries the counts, who had originally been officials of the kings, transformed their fiefs into practically independent lordships. The county of Flanders, the duchy of Brabant, the duchy of Limburg and the counties of Hainaut and of Namur (*qq.v.*) exemplified this in the south.

In the 11th and 12th centuries larger territorial units emerged likewise in the northern Netherlands, with the emergence of the county of Holland (*q.v.*) and the county of Gelder (*see* GELDERLAND), though Friesland remained in immediate dependence on the emperor.

Beside these secular territories two great episcopal territories had earlier come into being as a result of Otto I's ecclesiastical policy: Liège (*q.v.*) in the south and Utrecht (*q.v.*) in the north—the latter including also Drenthe and Overijssel. Until the concordat of Worms at the end of the Investiture controversy (1122; *see* GERMANY: *History*) the bishops strongly supported the authority of the empire and maintained close relations with the German kings. Of the northern territories, well into the 13th century, the principal centre was Utrecht, where the German kings frequently resided. Holland was next in importance, with its interests directed rather toward the south, while Gelder was more closely connected with the Rhineland and with Westphalia.

In the south, Flanders and Brabant, which both politically and economically developed earlier and more vigorously than any of the northern provinces, became pre-eminent. Their political institutions advanced under French influence, their towns grew up and their commerce and industry expanded. The towns of Bruges, Ghent, Ypres, Antwerp, Mechelen and Brussels owed their prosperity mainly to trade; and in the 14th century Flanders, with its cloth industry, became one of the commercial centres of Europe, while the count of Flanders was one of the most powerful rulers of the Low Countries. For the towns' emancipation from the control of the territorial lords *see* COMMUNE (MEDIEVAL).

In the north, towns and industries were of later origin: only in the 13th and 14th centuries did Middelburg, Dordrecht, Delft, Leiden, Haarlem, Arnhem, Nijmegen, Zutphen, Deventer and Kampen obtain municipal privileges, and in the 14th century they were still behind the towns of Flanders and Brabant.

The rise of the towns was accompanied by their struggle for political influence in their respective territories, in which they co-operated with the nobility and the clergy. This led to the growth of representative assemblies which were to become essential political institutions (*see* ESTATES-GENERAL).

In European affairs of the 13th–14th centuries, the Low Countries played a particularly notable role in the war between Otto IV of Brunswick and Frederick II for the German kingship, during which the Flemings, on Otto's side, took part in the campaign which ended in a victory for Frederick's ally, Philip II of France, at the battle of Bouvines (1214); in the troubles after the papal deposition of Frederick II, during which William, count of Holland, was proclaimed German king (1247); and at the outbreak of the Hundred Years' War, when both the English and the French sought allies in the Low Countries.

Meanwhile the principles of hereditary succession (through females in default of males), sometimes enforced by military action, had brought about dynastic unions between some of the great secular states of the Low Countries. Hainaut, after being temporarily linked with Flanders from 1067 to 1070 and from 1191 to 1280, was from 1299 linked with distant Holland, to which in turn Zeeland was attached from 1323. Brabant and Limburg were united under a single duke from 1288. The county of Artois, on the other hand, which had passed from Flanders to the royal house of France in 1191, was from 1329 linked dynastically with the county of Burgundy (*see* FRANCHE-COMTÉ). In 1382, however, Louis II de Male, the last count of Flanders of the house of Dammartin, inherited the counties of Burgundy and Artois from his mother, Margaret of France. Two years later Louis died, leaving his daughter Margaret as heiress, who in 1369 had been married to Philip the Bold, duke of Burgundy. (W. J. AL.)

B. BURGUNDIAN AND HABSBURG PERIODS, TO 1579

Burgundian Period.—The entry of Burgundian rule into the Low Countries proved decisive in their history. The Burgundian dukes of the house of Valois and the Habsburgs to whom their possessions in this area passed (*see* BURGUNDY) were bent on enlarging their patrimony and were successful, in the course of 160 years, in uniting the greater part of what came to be known as the Netherlands. The outcome was the birth of a Netherlands nation, but this was split into two parts before it could achieve maturity.

On Jan. 30, 1384, Philip the Bold (*q.v.*), duke of Burgundy, succeeded by right of his wife, Margaret de Male, to the counties of Flanders and Artois in the Low Countries, together with the county of Burgundy or Franche-Comté on the eastern frontier of his duchy, the county of Nevers on the western and the county of Rethel to the north of Champagne. Furthermore, Margaret's maternal aunt Joan, duchess of Brabant, in 1385 promised to leave Limburg and Brabant to the Burgundian couple and its descendants. She substantiated this promise in later transactions and as early as 1396 ceded Limburg (mortgaged to Philip from 1387). Philip meanwhile, to consolidate his position in the north, made full use of the opportunities offered by the virtual regency that he exercised in France during the minority and then during the madness of King Charles VI. After Philip's death (April 27, 1404), however, a partition of his dominions took place: the eldest son, John the Fearless (*q.v.*), received the duchy of Burgundy, to which Flanders, Artois and Franche-Comté were to be added on Margaret de Male's death (1405); the second son, Anthony (d. 1415), received Limburg and the administration of Brabant pending the duchess Joan's death, which took place in 1406; and a third son, Philip (also d. 1415), received Nevers and Rethel.

The energies of John the Fearless were chiefly absorbed in his struggle for supremacy in France till he was killed there (Sept. 10, 1419). His only legitimate son and successor, Philip the Good (*q.v.*), was able in a few years to triple his dominions in the Netherlands. Heir presumptive to his cousin Jacoba (*q.v.*), countess of Hainaut, Holland and Zeeland, Philip compelled her to surrender to him the government of her territories in 1428 and the titles also in 1433. With Holland went a claim to the Frisian lands, and so a perspective of expansion northeastward was opened. In 1429, moreover, the county of Namur came into Philip's possession in consequence of a purchase agreement of 1421. Then, in 1430, by the opportune death of his cousin Philip, Anthony's younger son, the collateral line ruling over Brabant and Limburg became extinct, so that these duchies also fell to Philip the Good. These important acquisitions made the house of Burgundy a power in its own right and loosened its bonds with France. By the peace of Arras (Sept. 21, 1435), Philip retired from the Hundred Years' War with substantial profits, including territorial gains in Picardy. His alliance with England had previously suffered from a clash of interests over Holland and Hainaut.

Nor was this all. From his uncle Anthony's widow, Elizabeth of Görlitz (d. 1451), Philip acquired the duchy of Luxembourg and county of Chiny (east of Sedan) through a series of transactions in the 1440s. By procuring the bishopric of Cambrai (Cambrésis) for his half-brother John (1439), that of Utrecht for his bastard son David (1456) and that of Liège for his nephew Louis of Bourbon (1456) he brought the territories of these sees under his protectorate. Other relatives ruled the duchies of Cleves and Gelder, and a number of petty dynasts in adjacent parts of Germany moved into the Burgundian orbit. Since, moreover, the German kings or Holy Roman emperors had by this time long ceased to exert any authority over Philip's new dominions, it was no mere flight of fancy when in 1447 it was proposed to raise them to the status of an independent kingdom, to which the suzerainty over a number of the peripheral principalities should be transferred.

Philip the Good never obtained a royal title, but he was in fact the equal of kings. He had united under his sway some of the richest and most populous regions of Europe, duchies and counties on both sides of the historical boundary between the kingdom of France and the empire—lands with different traditions, institutions and languages (though the linguistic and the political frontiers coincided hardly anywhere). A consequence of this personal union was the introduction of a certain uniformity into the administration of the various countries and the slow growth of a central government under the direction of the chancellor of Burgundy, from 1422 the able Nicolas Rolin (d. 1462). The unequaled splendour of the Burgundian court enhanced the prestige of the duke, who created a new vassalage by instituting (1430–32) the Order of the Golden Fleece, which strictly bound the most influential members of the nobility to their overlord. The foundation of a university at Louvain in 1425–32 introduced yet another unifying element. In Philip's last years deputies of the "estates" of all the Burgundian

dian Netherlands were called together for a common session—for the first time at Bruges, in Jan. 1464: thus emerged the estates-general, or states-general as they are generally called in connection with the Netherlands, later to become a factor of paramount importance.

The arrival of Burgundian rule encountered opposition in some territories, particularly in Holland and Zeeland; but everywhere the partisans of a strong government able to maintain law and order favoured the duke. In Holland these were to be found mainly among the burghers of the larger towns. In Flanders, however, the great cities, Ghent in the first place, strove to defend their position as virtually autonomous republics dominating the surrounding country. Their declining prosperity made them all the more intractable. The rebellions of Bruges (1437–38) and of Ghent (1451–53) were suppressed—that of Ghent only through a regular war culminating in the battle of Gavre (July 23, 1453)—and the more obnoxious of their privileges were revoked.

The decline of Flemish economy was caused partly by England's growing export of cloth, which had severe repercussions on the woolen industry of Ghent and Ypres; partly by the rising textile industries of Brabant and Holland; and partly by the gradual shifting of trade from Bruges to Antwerp. On the other hand, Brabant and, to a lesser degree, Holland profited from the relative tranquillity that prevailed under Philip's rule. Shipping from Holland and Zeeland expanded and penetrated into the preserve of the Hanseatic league, challenging its claim to a monopoly in the northern seas (naval war, 1438–41).

The vast complex of territories that Philip the Good had assembled passed undivided at his death (June 15, 1467) to his only surviving legitimate son, Charles the Bold (*q.v.*). Charles proceeded to augment and consolidate it. The gap between Brabant and Namur on the one side and Limburg and Luxembourg on the other was closed in 1468, when the episcopal principality of Liège was forcibly annexed, in all but name, to the duke's dominions; the duchy of Gelder was acquired in 1473; and for a short time a junction was achieved between the two Burgundies in the south and the Netherlands in the north by the overrunning of Lorraine in 1475. Other plans for territorial expansion—on the upper Rhine, on the lower Rhine, in Champagne and in Friesland—miscarried or failed to materialize. In the autumn of 1473, at a conference in Trier with the emperor Frederick III, Charles demanded to be elected king of the Romans or successor designate to the empire. Having been denied this, he seems to have fallen back on his father's project of 1447: a sovereign kingdom comprising his possessions within the empire, together with a number of dependencies, among them the duchies of Lorraine (as yet not conquered) and Savoy. Likewise, in this treaty of July 25, 1474, with his brother-in-law Edward IV of England against Louis XI of France, he stipulated for complete sovereign rights over his French fiefs.

Meanwhile, Charles reorganized the central government of the Burgundian Netherlands after the French example. Already, under Philip the Good, the specialized judicial and financial sections of the ducal or grand council had tended to become autonomous. A parliament was then created as a supreme court of justice, its seat being fixed at Mechelen. At the same time two boards of finance were set up, likewise at Mechelen, as was also a single chamber of accounts (ordinances of Thionville, Dec. 1473). These measures were partly due to the need for exploiting to the utmost the resources of the Burgundian "state" in view of Charles's incessant wars. Yet his harsh and exacting regime was far from popular and most of his reforms were swept away by the reaction that followed his death on the battlefield of Nancy (Jan. 5, 1477).

The catastrophe of Nancy put an end to the expansion of Burgundy. Lorraine was lost again. Louis XI of France claimed the reversion of the French fiefs, and his troops invaded Burgundy and Picardy. At the same time insurrection was rife in the Netherlands, where Charles's sole heiress, the duchess Mary (*q.v.*), had to face a strong particularistic, though not antidynastic, movement led by Ghent and encouraged by the French king. The states-general, which under Charles the Bold had been reduced to a machine for voting supplies of money, then came into their own. Meeting at Ghent, they forced the duchess to grant the "Great Privilege" (Feb. 11, 1477), which was supplemented by similar charters for the individual countries, strengthening local liberties and weakening central authority. The states-general moreover pressed at first for negotiations with France, but they gave Mary full support when they saw the true nature of French aims: particularism notwithstanding, a common loyalty prevailed. They also heartily approved her marriage, contracted by proxy in April and solemnized at Ghent in Aug. 1477, to the Austrian archduke Maximilian, son of the Holy Roman emperor Frederick III, of the Habsburg dynasty (*see* MAXIMILIAN I, Holy Roman emperor).

The First Habsburgs: Maximilian, Philip and Charles V.—When Mary of Burgundy died at the age of 25 (March 27, 1482), Maximilian became regent (1482–94) for their only son, the archduke Philip the Handsome, who was Mary's heir. Maximilian was compelled by the states-general (once again Ghent was the driving force) to conclude with France the second peace of Arras (Dec. 23, 1482). This confirmed the loss of the duchy of Burgundy and Picardy and also ceded Artois, Franche-Comté and other possessions in the south as the dowry of Philip's sister Margaret, who was promised in marriage to the dauphin, later Charles VIII of France. The states-general did not care much for these outlying districts, already occupied by the French king. After these amputations the Burgundian "state" could be identified with the Netherlands dominions, themselves then rather shrunken. Not only had Artois been lost, but Liège had regained its freedom, while Gelder and Utrecht had risen in rebellion. The peace, disastrous as it was for Burgundian dynastic interests, at least freed Maximilian to deal with the widespread insurrections and civil wars. It took him ten years to master them. A long conflict with Ghent after 1488 developed into something like national resistance when part of the higher nobility, led by Philip of Cleves-Ravenstein (a grandson of Philip the Good's sister Mary), joined the opposition against the unpopular foreign regent. But in 1492 internal peace was restored, though Gelder had to be given up. The war with France, which had been resumed in 1483, also came to an end. At the peace of Senlis (May 23, 1493), Franche-Comté and Artois returned into the Habsburg-Burgundian fold, as the proposed marriage of Margaret of Austria with Charles of France had fallen through. So Maximilian, then king of the Romans, could hand over to his son in 1494 a country that was reasonably tranquil and secure, and in which central government was functioning again.

More than any of his predecessors Philip the Handsome was a national ruler. He and his councilors kept up good relations not only with England (in Feb. 1496 a commercial treaty, the *Intercursus Magnus* or "Great Intercourse," was concluded with Henry VII) but also with France. Apart from a war, spasmodically waged, with Gelder, all was quiet, and the Netherlands began to recover from the years of turbulence. In 1504 the parliament of Charles the Bold was re-established under the name of grand council of Mechelen, while the former grand council continued to function through its more or less specialized departments. But not for long did Philip remain solely the ruler of the Netherlands. In 1496 he was married to Joan, daughter of Ferdinand II of Aragon and Isabella I of Castile; and a series of deaths in her family made him heir apparent to the Spanish kingdoms in 1500 and king of Castile in 1504. When he unexpectedly died at Burgos on Sept. 25, 1506, his Burgundian and Spanish lands passed to his eldest son Charles, born in Ghent in 1500 (*see* CHARLES V, Holy Roman emperor).

Maximilian, who became regent once more (1506–15), in 1507 appointed his daughter Margaret, then the widow of Philibert of Savoy, as governor general (*see* MARGARET of Austria). This office she held till 1515, when, at the instance of the states-general, the 15-year-old Charles was declared of age. Born and brought up in the Netherlands, he was popular there. These lands, however, had become connected with an empire with which they had few interests in common. At the age of 20 Charles was also king of Castile and Aragon (with their Italian and American possessions), head of the house of Austria and Holy Roman emperor as Charles V. So he had again to leave the Low Countries to the care of his aunt Margaret (from 1519 to 1530) and, after

her death, to his sister Mary, the widow of Louis II of Hungary (from 1531 to 1555). He had to make large financial demands on these rich provinces for purposes that did not concern them. Once more Ghent rebelled. The emperor dealt sternly with his native town: he revoked its privileges and gave it a new constitution (April 30, 1540). The rapid growth of Protestantism was another source of troubles for the government. Severe edicts against heresy were issued and enforced, and the papal Inquisition was introduced (1522) to supplement the activities of the bishops. On the whole, however, the rule of Charles and the "governesses" was moderate and successful. They extended the Burgundian dominions considerably in a northeasterly direction. The purchase and subjugation of Friesland (1515–24) was followed by the annexation of the bishop of Utrecht's lands (1528) and of Groningen and Drenthe (1536) and by the final recovery of Gelder (1543)—while control was also strengthened over smaller territories not formally incorporated (Cambrai and its environs; *i.e.*, Cambrésis) or only feudally annexed to one of the provinces (Tournai, *i.e.*, Tournésis). By 1543 Charles ruled over the so-called "17 Netherlands," a number perhaps not to be taken too literally, by which may have been meant Brabant, Limburg, Luxembourg, Gelder with Zutphen, Flanders proper, Artois, Hainaut, Holland, Zeeland, Namur, Walloon Flanders (Lille, Douai and Orchies), Tournai, Mechelen, Friesland, Utrecht, Overijssel with Drenthe, and Groningen—though sometimes Walloon Flanders and Tournai are not counted separately, while Zutphen and also Antwerp are.

By the middle of the 16th century the Burgundian Netherlands may have had a population of nearly 2,000,000, of which probably one-quarter was domiciled in Brabant, one-quarter in Flanders and one-sixth in Holland. This population was urbanized to an exceptional degree: more than one-third lived in Brabant, perhaps the same proportion in Flanders and more than half in Holland. Antwerp, the great commercial and financial metropolis, was by far the largest city: it had about 50,000 inhabitants in 1526 and more than 100,000 in 1566. The population of Ghent was steadily declining, from nearly 60,000 in the middle of the 14th century to 30,000 at the end of the 16th. Amsterdam was rapidly rising: it had perhaps 13,500 inhabitants in 1514, but already 30,000 by 1550; and it was to reach 100,000 early in the next century.

Charles V applied himself to welding these provinces together with constitutional links. He made the rules of hereditary succession the same for all of them, so that they should never be divided among different heirs (1549). He formalized the connection of his Burgundian lands with the Holy Roman empire by re-creating the "Burgundian circle" (nominally existing from 1512) in 1548 as one of the "imperial circles" or *Reichskreise*. In this circle, moreover, Flanders and Artois, previously fiefs of the French crown, were included, since Francis I of France had renounced French suzerainty over them in the treaty of Madrid, signed during his captivity in Spain (Jan. 13, 1526). Charles also developed the governmental machinery taken over from his predecessors. On Oct. 1, 1531, the chancellorship was abolished, and the grand council (*i.e.*, the nonjudicial sections) was divided along departmental lines into three councils collateral to the governor general: the executive privy council, the council of state and the council of finance. At the same time the seat of government was transferred from Mechelen to Brussels. The different principalities, which had gradually become provinces, retained their own particular councils with administrative and judicial competencies, under their stadholders (governors), who were high noblemen appointed as representatives of the sovereign.

THE NETHERLANDS AFTER THEIR CONSOLIDATION UNDER CHARLES V IN 1543

Philip II of Spain and the Revolt.—On Oct. 25, 1555, at a meeting of the states-general in Brussels, Charles V abdicated the sovereignty of the Netherlands in favour of his son, who next year likewise became king of Spain as Philip II (*q.v.*). The new ruler aimed at the further unification of the Netherlands under a strong monarchy—a policy less acceptable to his northern subjects because he was a Spaniard in his sympathies and views. In 1559 the peace of Câteau-Cambrésis, which terminated the French-Spanish war, opened the gate for Calvinist preachers from France who soon made many converts in

the Netherlands. Philip was determined to crush heresy, now growing into a formidable force. Therefore, but chiefly in order to adapt the ecclesiastical organization of the Netherlands (Luxembourg excepted) to the political structure, he began in 1559, with papal approbation, to divide the Low Countries into smaller dioceses with a more efficient and subservient episcopate: 18 in all were set up (including 3 archiepiscopal sees), 14 of which were entirely new. This measure was resented in many quarters, especially in Brabant and in the northeastern provinces, not only by the Protestants but also by the higher nobility and clergy and by all who opposed monarchical absolutism and ecclesiastical rigorism.

At first, religious questions were not foremost among the causes of discontent, but gradually they became of increasing significance. The encroachments on cherished liberties and traditional rights and the subordination of the Burgundian lands to Spain were the primary, and remained the most general, grievances. In the face of the hesitation of the authorities, however, during the governorship of Philip's half sister Margaret of Austria, duchess of Parma, whom he appointed on his departure to Spain in 1559, the opposition grew more radical in successive stages as the leadership of it passed from the great nobles to the gentry and then from the gentry to the Calvinist ministers and burghers. The league of the magnates, headed by William I the Silent (*q.v.*), prince of Orange, by Lamoral, count of Egmond (*q.v.*), and by Phillip de Montmorency, count of Horn, obtained in 1564 the retirement from the Netherlands of the cardinal archbishop of Mechelen, Antoine Perrenot de Granvelle (*q.v.*), who had been made to bear most of the blame for the grievances; but soon there emerged a league of the lesser nobility, at the head of which were William's brother Louis of Nassau and Hendrik, lord of Brederode (*q.v.*). This league on April 5, 1566, forcefully presented to the government a "request" for the withdrawal of the Inquisition and of the most rigorous edicts against heresy; and at a subsequent banquet Brederode's friends bound themselves together in the confederacy of the Gueux (*q.v.*). Thereafter extreme Calvinists and fanatics of all sects redoubled their activity. Field preaching spread like wildfire; social discontent, caused by inflation and by the slump in the textile trade, was rife. In Aug. 1566 many places, especially Antwerp, were alarmed by iconoclastic riots. The Calvinist burghers and gentry (as yet a small minority) were forming armies. The general confusion, however, caused most of the great nobles, many of the gentry and orderly people in general to rally to the government. William, by attempting to mediate, lost the confidence of both sides. Margaret raised a considerable force of German mercenaries, which destroyed the ill-organized Calvinists in West Flanders and before Antwerp. She now had the situation well in hand, but in Aug. 1567 a veteran Spanish general, the duque de Alba (Fernando Alvarez de Toledo) arrived from Italy at the head of an army.

Alba, whom King Philip soon appointed to Margaret's place as governor (1567–73), at once inaugurated a reign of terror. A special tribunal, the Council of Troubles, nicknamed the Council of Blood, was set up; there were wholesale executions, the most famous victims being Egmond and Horn (June 5, 1568). William was outlawed (Jan. 1568) and his attempts to invade the Netherlands from Germany were defeated. By the end of 1568 Alba was the undisputed master of the country.

In 1572 events took a new turn. The Gueux captured the port of Brielle (Brill) on April 1 and Flushing a week later. Henceforth the rebels, who recognized William as their chief, had a foothold of their own in the Netherlands. Thanks to their naval superiority they could maintain themselves in the "sea provinces" (Holland and Zeeland), which became a refuge for Protestants from the south. In the south, however, as also in the eastern provinces, almost simultaneous movements of rebellion were overpowered: Louis of Nassau took Mons in May, but had to surrender it in September when William's army from Germany failed to relieve him. Even so, by pinning the Spanish field force down in the south, Louis and William had given the insurgents in Holland their chance: three months after the capture of Brielle, Amsterdam was the only town in Holland in the hands of the government. In July the estates of Holland re-appointed William as their stadholder and on Oct. 21 he himself arrived to take command. Meanwhile Alba's son, Don Fadrique de Toledo, and his army moved northward, committing abominable atrocities at Mechelen, Zutphen and Naarden. Yet Haarlem heroically held out from Dec. 11, 1572, till July 13, 1573, and the eventual slaughter of its garrison did not paralyze further resistance. Finally, at Alkmaar, victory passed to the side of the rebels: the dikes were cut and Don Fadrique withdrew his troops before the advancing floods (Oct. 8, 1573). Three days later Alba's fleet was defeated on the Zuider Zee. His soldiery was unpaid and mutinous. He had lost the confidence of the king, and in Dec. 1573 he left Brussels forever.

By the time of Alba's departure his successor, the more conciliatory Luís de Zúñiga y Requesens, had already arrived. Hampered by lack of money and by the stiffening resistance of the provinces still under Spanish rule, he sought for a compromise. On the religious issue, however, the views of the king and those of the rebels were irreconcilable; so fighting went on. In 1574 the defeat of a Spanish fleet on the Scheldt (Jan. 29) led to the surrender of Middelburg to the Gueux (Feb. 18); then a great victory over the Orangists on the Mookerheide or Mook heath near Nijmegen, where William's brothers Louis and Henry were both killed (April 14), enabled the Spaniards to resume their siege of Leiden; but the final relief of Leiden by the Gueux (Oct. 3) was a triumph which the estates of Holland and Zeeland commemorated by the foundation of a university there. A new Spanish offensive against Holland met with some success in 1575, and another offensive against northern Zeeland culminated in the capture of Zieriksee on June 30, 1576. By then, however, Requesens had died (March 5, 1576) and the council of state had taken over the government. All the money had run out, and in July the unpaid troops in Zeeland mutinied (as other Spanish forces did elsewhere) and marched off to Brabant and Flanders.

The Pacification and the Unions.—At the sudden collapse of Spanish power the smouldering discontent in the south burst into flame. The estates of Brabant, Flanders and Hainaut clamoured for peace and pressed the council of state to convene the states-general, which then entered into negotiations with William. A peace conference was opened at Ghent on Oct. 19, 1576, between representatives of William, Holland, and Zeeland on the one hand and of the states-general in Brussels on the other. The Pacification of Ghent was signed on Nov. 8. Meanwhile, on Nov. 4, the mutineers had fallen upon Antwerp and sacked the city with a barbarous ferocity long remembered as "the Spanish fury."

By the Pacification of Ghent the unity of the "common fatherland" was restored, and it was agreed that Spanish troops should be expelled from the Netherlands. The religious question, however, was left undecided. On Jan. 9, 1577, a formal union, concluded at Brussels, strengthened the bond between the provinces, though its religious provisions did not satisfy the Protestants. William then prevailed on the states-general to make its recognition of the new regent, Philip II's half brother Don John of Austria, conditional on his acceptance of the Pacification. Don John accepted it unwillingly, by the "Perpetual edict" (Feb. 12), on the understanding that Catholicism was to be maintained everywhere. The Spanish troops were paid and they left the country.

Hitherto the great majority of the population had been neither adherents of the Counter-Reformation nor downright Calvinists, but gradually the religious issue became more clearly defined, with the beginning of a rift between Catholic and Protestant provinces. As the Union of Brussels and the Perpetual edict gave them insufficient guarantees, the estates of Holland and Zeeland withdrew their deputies from the states-general. The difference was temporarily overcome by the action of Don John, who suddenly took the citadel of Namur (July 1577) and defied the states-general. William then became the leader of the Union, though his position was not undisputed. To counter his ascendancy, some southern nobles invited the archduke Matthias (later Holy Roman emperor), a nephew of Philip II, to come to Brussels; and the states-general in Jan. 1578 put Matthias at the head of a national government, but with William as his lieutenant general. Shortly

before (Dec. 10, 1577), a new Union of Brussels had insisted on the duty of mutual assistance by adherents of both religions.

Unity and union were short-lived. Once again the revolution slid toward religious and political extremism. William was compromised by his alliance with the turbulent democrats and Calvinists in Brabant and in Flanders, such as Jan van Hembyze; and the violent introduction of Calvinism in a number of towns, together with the excesses of the Reformed and radical factions, were strongly resented by the Catholics. A religious peace, proclaimed at William's instigation by the states-general on July 12, 1578, availed little.

In the meantime Philip II had sent a new Spanish army under Alessandro Farnese (*q.v.*), Margaret's son and the heir to the duchy of Parma, to help Don John. After defeating the national troops at Gembloux (Jan. 31, 1578), Don John had then conquered a number of towns. He also won some adherents in the Walloon, or French-speaking, provinces and among the nobility; and this gravitating of alarmed traditionalists toward the king's legal representative continued when the duc d'Anjou (François Hercule; *see* ALENÇON, DUCS D'), chosen regardless of Matthias by the states-general as "defender of the liberties of the Netherlands" in Aug. 1578, failed to establish himself promptly. When Don John died (Oct. 1) and was succeeded by the able Farnese, the general union of the Netherlands provinces was already breaking up.

On Jan. 7, 1579, Hainaut, Artois and Douai inaugurated a league of their own, the Union of Arras for the defense of the Pacification and of the Catholic religion. Thereupon another league, the Union of Utrecht, based on the Pacification and the religious peace, was concluded on Jan. 23 between Holland, Zeeland, Utrecht, the nobility of Gelderland and rural Groningen (the Ommelanden), soon to be joined by Ghent, Bruges, Ypres, West Flanders, Antwerp and other towns of Brabant, the towns of Gelderland, Drenthe and parts of Friesland and also by William. This Union of Utrecht did not yet create a separate republic of the northern Netherlands: the general union was broken only when the Union of Arras withdrew from the Union of Brussels and submitted to the king (May–June 1579). It was left to the fortunes of war to decide the future dividing line between the two Netherlands. (A. G. J.)

C. THE UNITED PROVINCES

Spanish Reconquest of the South.—Under Alessandro Farnese the Spaniards and their adherents in the Netherlands made such progress against the forces of the Union of Utrecht that in less than seven years from 1579 the whole of the south was reconquered from it. Already in 1579 Maastricht fell to Farnese and 's Hertogenbosch opened its gates to the Spaniards; and in 1580 the stadholder of Groningen went over to the Spanish side. Philip II then felt strong enough to outlaw William I the Silent, leader of the Orangists, again, but William continued to seek foreign help and finally succeeded in persuading the duc d'Anjou to accept the sovereignty of the Netherlands. Anjou's expected arrival forced the states-general, meeting at The Hague, at last to repudiate the sovereignty of Philip II. The document (the so-called *Verlatinge*) to which they assented on July 26, 1581, enumerated all the tyrannical acts whereby Philip was held to have forfeited his right to rule the Netherlands. Yet though Anjou was subsequently installed as sovereign in some provinces, these provinces made conditions severely restricting his powers, while Holland and Zeeland refused to receive him at all. In any case, Anjou proved not only useless as a general against Farnese but also inept as a statesman. Irritated by the restraints on his power, he tried to subjugate Antwerp by a *coup d'état*, the so-called "French fury," in Jan. 1583. When this failed, he retired, completely discredited, to France, where he died on June 10, 1584. William, who remained organizing resistance from his refuge in Delft, was about to accept the offer of Holland and Zeeland to appoint him as their count when he was assassinated on July 10, 1584, by a fanatical young Catholic, Balthazar Gerard.

With the Spaniards steadily overrunning Flanders and Brabant, the Dutch in their desperate plight offered the sovereignty of the Netherlands to Anjou's surviving elder brother, Henry III of France, but in March 1585 Henry declined the offer. The states-general then addressed themselves to Elizabeth I of England. These negotiations were still proceeding when Farnese, after a long siege, took Antwerp (Aug. 1585), thus completing his reconquest of the southern Netherlands. The representatives of the southern provinces then withdrew from the states-general.

English Intervention.—Elizabeth of England declined the sovereignty of the Netherlands, but the news of the fall of Antwerp made her decide to come to the rescue of the Dutch. By a treaty of Aug. 20 (new style; 10, old style), 1585, she agreed to send 6,000 men under her favourite, Robert Dudley, earl of Leicester, while the Dutch were to guarantee payment of the English expenses and to surrender the towns of Flushing and Brielle and the fort of Rammekens as security (only in 1616, when the Dutch debt was settled, did the English leave these places). In Dec. 1585 Leicester arrived in Holland. Meanwhile Holland and Zeeland had in Nov. 1585 appointed as stadholder the 17-year-old Maurice (*q.v.*), William the Silent's second son (his elder half brother Philip William was in the hands of the Spaniards). A new council of state was established in order to improve the working of the government of the union; but meanwhile Johan van Oldenbarnevelt (*q.v.*), advocate of Holland from March 1586, acquired great influence. There was at first great willingness among all the Dutch statesmen to co-operate closely with Leicester, and the states-general appointed him governor general—an office which, against his queen's orders, he accepted. After the first few months, however, deep misunderstandings between Leicester and the Dutch ruling classes became apparent. He tried to transform the loose federation of provinces into a more united state, but lost Holland's support by disregarding the fact that Holland was by far the strongest of the provinces and the real centre of the union (he himself resided at Utrecht). He wanted moreover, to accentuate the strictly Calvinistic character of the state and thereby alienated the most influential latitudinarian groups in the various towns and estates. His attempt, finally to forbid trade with Spain was disastrous, as this trade provided the Dutch with the means to carry on the war against the Spaniards. Leicester was also incompetent as a general. Farnese, then duke of Parma, proved his superiority by taking Grave and Venlo in 1586 and Sluis in Aug. 1587 (after Deventer and the siegeworks before Zutphen had both been betrayed to the Spaniards by the English Catholic commanders appointed by Leicester). Made still more unpopular by a peace move which Elizabeth compelled him to undertake, Leicester attempted a *coup d'état* but failed. In Dec. 1587 he left Holland; and in April 1588 the states-general accepted his resignation.

Emergence of the Republic.—After Leicester's departure it became clear that the state for which the United Provinces were fighting would probably not be a monarchy, and no more approaches to foreign princes were made. The government of the union, however, which was kept as Leicester had left it, without fundamental alterations, was essentially that of a truncated monarchy. Because the seven provinces which eventually came to form the Dutch republic—namely, Gelderland, Holland, Zeeland, Utrecht, Friesland, Overijssel and Groningen (Drenthe was only a "territory" and sent no delegation to the states-general)—never concluded a new treaty among themselves, the Union of Utrecht of 1579, to which in fact not all of them had subscribed, remained the only formal link which could be regarded as a constitution for the United Provinces as a whole. Yet its only purpose had been to make possible some measure of collaboration between the provinces after the collapse of the Habsburg central authority and it had done nothing to determine the form of government for the union. Thus the Dutch republic emerged as a loose federation in which sovereignty resided not with the states-general but with the estates of the seven provinces. Each of these had one vote in the states-general, whose decisions were, in principle, taken unanimously. The various estates also acquired the right to appoint the stadholders of the provinces, but in practice Holland and Zeeland never appointed anyone other than the prince of Orange and Friesland and Groningen usually appointed the count of Nassau, while most of the other provinces generally followed the ex-

ample of Holland and Zeeland. From 1625, moreover, the stadholder of Holland and Zeeland was nominated as captain- and admiral-general of the union by the states-general; and though the states-general acted as the official representative of the union it was generally the prince of Orange or the pensionary (*q.v.*) of Holland who determined foreign policy. In the years following 1588 the European powers gradually recognized the existence of the new republic of the United Provinces.

"The Ten Years" (1588–98) and the Truce of 1609.—The old Burgundian territories north of the Rhine and Meuse rivers which the Union of Utrecht had lost between 1579 and 1588 were recovered by the Dutch in the following decade, thanks chiefly to the diversion of the Spanish military effort to other fields. First Parma's strength suffered from the defeat of the Armada (1588) and then he was ordered by Philip II to intervene in the French civil wars. Also, his immediate successors, after his death in 1592, were less able soldiers and statesmen. Meanwhile Maurice, stadholder and also captain general of Holland and Zeeland from 1585, of Utrecht and Overijssel from 1590 and of Gelderland from 1591, reorganized the army in close collaboration with his cousin William Louis, stadholder and captain general of Friesland from 1584. Inspired by Roman military science and mathematical studies, Maurice and William Louis designed a new strategy and created a small but efficient fighting force, strictly disciplined and well-equipped: it soon became a model and a training school for Europe. Maurice captured Breda, Crèvecoeur and Steenbergen in 1590, Zutphen, Deventer, Delfzijl, Hulst and Nijmegen in 1591, Steenwijk and Coevorden in 1592, Geertruidenberg in 1593 and Groningen in 1594. Thus most of the territory north of the Rhine and the Meuse was firmly in Dutch hands; and in 1595 the states-general laid garrisons in the German towns of Emden and Leerort. The year 1596 brought the *de facto* recognition of Dutch independence by France and England, which concluded a triple alliance with the new republic. In Jan. 1597 Maurice's cavalry defeated a superior Spanish force at Turnhout; and later in the year he drove the remaining Spanish troops out of the eastern parts of Gelderland and Overijssel. Thereafter Maurice was unable to make further conquests, except Sluis in 1604. The great consolidating period called "the Ten Years" (1588–98) was terminated.

In 1598 Henry IV of France, considering the support that England was providing to be insufficient, made the peace of Vervins with Spain, promising however to continue to help the Dutch with money. But Spain, weakened by unsuccessful maritime expeditions and financially exhausted, did not profit by this peace. Philip II tried to bring about a reconciliation between the northern and the southern Netherlands: just before his death he arranged the marriage of his daughter Isabella to the cardinal archduke Albert of Austria, granting them as dowry the sovereignty of the Netherlands—in theory of the whole country, in practice of course only of the southern provinces (1598). The Dutch, however, declined Albert's offers of reconciliation, as neither party could make concessions in the religious sphere. Yet the Dutch resigned themselves to the south remaining Catholic and gave up their hope of winning it. This attitude was to some extent determined by economic reasons. The closing of the estuary of the Scheldt, by which the states-general had reacted to the Spanish occupation of Antwerp, proved a boon to the commerce of Amsterdam; and it was clear that the unparalleled economic development of the republic, which began in this period and was demonstrated by Dutch ventures in the East Indies (*see* DUTCH EAST INDIA COMPANY), would be hampered if the southern Netherlands were to acquire free access to the sea. The war on land became subordinate to the maritime conflict.

Maurice's famous march through Flanders, ending with his fruitless victory at Nieuwpoort (1600), was aimed at the Dunkerque privateers. The Spaniards succeeded in taking Ostend from the Dutch after a three-year siege (1604). The formidable general and statesman Ambrogio di Spinola, who was the leading personality in the government of the southern Netherlands, then started attacking the eastern frontiers of the republic and took Oldenzaal and Lingen in 1605 and Grol and Reinberg in 1606. Since James I of England had made peace with Spain in 1604, Oldenbarnevelt, the political leader of the republic, then became convinced of the necessity to end the war and accepted the archduke Albert's long-standing offer to start negotiations. Partly thanks to French mediation, a 12 years' truce was at last concluded on April 9, 1609; for the duration of the truce, the *status quo* was to be preserved in Europe as well as in the East and West Indies. This great success of Oldenbarnevelt's diplomacy was, however, contrary both to the mercantile interests of Amsterdam, which wished to carry on the war against Spain in the West Indies, and to the political aims of Maurice; it was therefore one of the causes of the domestic conflicts which filled the period of the truce.

Arminians and Gomarists.—A conflict within the Reformed or Calvinist Church (which represented as yet only a minority of the Dutch population) led to a political conflict of long-lasting effect. In an effort to define the Calvinistic dogma of predestination the Leiden professor Franciscus Gomarus (*q.v.*) challenged the views of his older colleague Jacobus Arminius (*q.v.*). Gradually the whole church was compelled to take sides. The estates of Holland, many of whose members did not belong to the Reformed Church at all, tried at first to mediate; then, when mediation failed, most of them—with the notable exception of Amsterdam—supported the Arminians because they were a minority in danger of being driven out of the church by their opponents and because their views, being less strict and exclusive, were less likely to estrange outsiders. In 1610 the Arminians addressed a "remonstrance" to the estates of Holland, asking for help, after which they were called Remonstrants; it was answered by a counter-remonstrance of the Gomarists, then called Counter-Remonstrants. In 1614 the majority of the estates of Holland forbade the ministers of the church to meddle in the dispute; the Gomarists who refused to submit to this order were driven out of those towns where the municipal administrations were in favour of the Arminians. In July 1617 Maurice, although not interested in the doctrinal problem, openly declared his support for the Gomarists, and the majority of the states-general followed him. The conflict became one between Maurice, the majority of the states-general, Amsterdam and the Gomarists on the one hand and Oldenbarnevelt, the majority of the estates of Holland and the Arminians on the other. In Aug. 1617 Oldenbarnevelt attempted to strengthen the municipalities of Holland by means of the so-called "Sharp Resolution," whereby the estates authorized them to engage troops of their own for the preservation of order, thus undermining the authority of the captain-general. After a year of tension, Maurice, backed by the majority of the states-general, had the leaders of the opposition, including Oldenbarnevelt himself and the great jurist Hugo Grotius, arrested (Aug. 1618). A special tribunal sentenced Oldenbarnevelt to death (he was executed on May 13, 1619) and some of his followers, among them Grotius, to life imprisonment. A national synod was convened at Dordrecht (Dort) and, as expected, condemned Arminian doctrine (Nov. 13, 1618–May 9, 1619). The leading Remonstrants left the country and found refuge in Antwerp.

Maurice then wielded nearly unlimited power. But he failed to use it for improving the constitution or for breaking the power of the urban oligarchies in Holland. The only important political decision taken by him after 1619 was his refusal to allow an extension of the 12 years' truce of 1609 in 1621—when, moreover, the archduke Albert's death without issue had brought the southern Netherlands back under Spanish rule. Thus war was resumed and public attention was once more diverted from internal strife to the struggle with Spain. The international situation, however, became complicated by the course of the Thirty Years' War (*q.v.*), which had begun with Bohemia's revolt against the Austrian Habsburgs in 1618. Maurice was not equal to the new circumstances, and the few years left to him were years of frustration. He died on April 23, 1625.

Frederick Henry and the Thirty Years' War.—Maurice was succeeded by his younger half brother Frederick Henry (*q.v.*) as stadholder of five provinces and as captain- and admiral-general of the union. An abler politician than Maurice and a competent soldier, he resumed in many respects the ideals of his father, Wil-

liam I the Silent. He was religiously tolerant and allowed the Remonstrants to return and to preach their doctrine openly: they acquired much influence among the patricians of the municipalities and the intellectuals. Also, the political power that Maurice had won for the stadholdership but had left unused then became effective. Frederick Henry could assume a semimonarchical status which enabled him to determine foreign as well as domestic policies. No longer did the advocate of Holland—called the grand pensionary (*raadpensionaris*, or salaried councilor)—dominate the republic as in Oldenbarnevelt's days. Only men prepared to follow the prince's directives were appointed to the standing committee of the states-general, which from 1630 onward administered foreign affairs. Frederick Henry moreover maintained a fashionable court at The Hague and was interested in painting and architecture. His court however did not become the centre of that Dutch civilization which, retaining its essentially bourgeois character, in this period reached its greatest achievements in all fields. At the same time Dutch economy developed at an astonishing pace into unchallenged European supremacy. Dutch settlements were established in the East and West Indies and in South and North America, including New Amsterdam, which later became New York city (*see* DUTCH EAST INDIA COMPANY; DUTCH WEST INDIA COMPANY). All this makes Frederick Henry's time of office one of the most brilliant periods in the history of the republic.

When the war with Spain had been resumed in 1621, the Dutch had at first been unable to halt Spanish raids in the eastern and northern provinces; and in June 1625 they had lost the important town of Breda. After 1625, however, they were fairly successful in defending their small territory. The stadholder of Friesland, Ernest Casimir of Nassau-Dietz, took Oldenzaal in 1626, and Frederick Henry captured Grol in 1627. Then the capture of the Mexican silver fleet from the Spaniards by Piet Hein in 1628 provided the Dutch with the money that they so badly needed; and in 1629 Frederick Henry was able to besiege and take 's Hertogenbosch, thus carrying the war south of the big rivers and opening the possibility of reconquering the southern Netherlands. This prospect met with some encouragement in the southern Netherlands themselves, but the Dutch campaign of 1632, which was intended to strengthen the southerners' opposition to Spain, petered out after some initial successes, the most notable of which was the capture of Maastricht in August. Peace negotiations between the southern and the northern Netherlands failed in 1633.

When France, under the ministry of the cardinal de Richelieu, was about to enter the war openly against Spain, the states-general and the French agreed to divide the southern Netherlands between them and promised to make peace only "jointly and by common consent" (treaty of Paris, Feb. 1635). It proved impossible, however, to conquer the southern Netherlands. Frederick Henry took Breda in 1637 but failed in his attack on Antwerp in 1638 and achieved only two more successes in the remaining ten years of the war: the capture of Sas van Ghent in 1644 and of Hulst in 1645. At sea, on the other hand, Spanish power received a smashing blow when on Oct. 21, 1639, a great fleet of warships and transports was destroyed in the Downs by Maarten Tromp.

During the 1640s Frederick Henry's position grew gradually weaker. Holland was not prepared sufficiently to support his attacks on the southern Netherlands and also regarded with aversion the dynastic policies that he was pursuing. In 1641 Frederick Henry succeeded in marrying his 14-year-old son, later prince of Orange as William II, to Mary, daughter of Charles I of England—a marriage which enhanced the glory of his house but laid on him the burden of supporting the English king in his domestic conflicts. Holland insisted on making peace as soon as possible, and when Frederick Henry died on March 14, 1647, the peace negotiations, started against his wishes in 1646, were about to lead to results. On Jan. 30, 1648, the Dutch and the Spaniards signed the peace of Münster; since the French remained at war with Spain the Dutch signature to this peace was a clear violation of the treaty of 1635. The peace of Münster confirmed the settlement of 1609 and extended it insofar as the Dutch were allowed to keep the border districts of Flanders, Brabant and Limburg which they had conquered in the recent warfare and which were then known as the Generality lands (being under the authority of the states-general, without separate representation as provinces). The Scheldt moreover was to be kept closed. The Spanish king had at last recognized Dutch independence.

William II of Orange.—Frederick Henry was succeeded in all his offices and dignities by his son William II of Orange, an able young man whose dynastic and military ambitions brought him into a grave conflict with the republican and pacific rulers of Holland. He seems to have intended to start a new war against Spain on France's side and, after forcing Philip IV of Spain into peace with Louis XIV, to intervene, in conjunction with France, in the English Civil War on behalf of the Stuarts; but the issue which actually brought the republic to the verge of civil war was of a more limited nature. Holland wanted in 1649 to reduce the army further, but William II and the states-general refused. After long but fruitless negotiations Holland simply dismissed a number of commanders of companies which were paid out of Holland's contribution to the states-general (June 4, 1650). The next day William II had himself ordered by the states-general "to prevent disturbances," but Holland refused to submit. At the end of July the stadholder put six leading members of the estates of Holland into prison and marched his troops on Amsterdam. Warned in time, Amsterdam was not taken but accepted a compromise, and the six prisoners were set free. It is doubtful whether this solution could have lasted, but William II suddenly died of smallpox on Nov. 6, 1650. Eight days later, on Nov. 14 (new style; 4, old style), his son William III of Orange was born.

First Stadholderless Period.—The years from 1651 to 1672 are generally called the "first stadholderless period." The term is misleading in two respects: (1) because though Holland, Zeeland, Utrecht, Gelderland and Overijssel did not appoint a stadholder during these years, Friesland and Groningen did appoint one; and (2) because the term may be wrongly taken as implying that a government without a stadholder was abnormal. In fact, the provinces were certainly allowed not to appoint a stadholder: if 1588 be taken as the beginning of the republic as an independent state and 1795 as its end, it can be shown that, out of 207 years, in no less than 67 years some important provinces were stadholderless. Nevertheless, in 1650 the decision of five provinces not to appoint a successor to William II and not to make any arrangements concerning his son was unprecedented. It is to be explained by the fear which William II's policies had aroused and by the idea that a stadholder was essentially a military leader and thus superfluous in peacetime.

Holland made an attempt to lay the foundation for a new form of government by summoning to The Hague the so-called grand assembly (Jan.–Aug. 1651), which, although composed in the same way as the states-general, was to have power to work out a new constitution. But as the other provinces refused to authorize their deputies to take binding decisions the assembly was just as weak as the states-general and no new constitutional rules were defined. Actual power then reverted to the ruling urban oligarchies of Holland, whose leading statesman, Johan de Witt (*q.v.*), was appointed grand pensionary of Holland in 1653 and remained in office until 1672. A highly cultured man with a keen scientific mind, an excellent mathematician, well-read in the classics and supported by original political theorists of whom Spinoza is the best-known, De Witt yet pursued conservative policies designed to maintain, not to increase, the economic power and political influence of the republic. Two closely related factors threatened his system and finally wrecked it: English hostility and the house of Orange.

The first Anglo-Dutch War (May 1652–April 1654; *see also* DUTCH WARS for the naval wars with England discussed below) was caused by economic and colonial rivalry and by the English Commonwealth's distrust of the influence which the Orangist party in the Netherlands, closely linked with the interests of the deposed Stuart dynasty, was apparently still exercising. It was a naval war in which the Dutch, although led by such distinguished commanders as Maarten Tromp and Michiel de Ruyter, finally had to yield. Oliver Cromwell, however, then protector of the Commonwealth, was averse to continuing the war against a Protestant republic and

concluded the treaty of Westminster (April 1654) on the understanding that the Dutch would pay compensation for damage to English commercial interests overseas and would guarantee that the prince of Orange should never again be in a position to further the Stuart cause. As De Witt would not ask the states-general to bar the house of Orange, only the estates of Holland passed the so-called Act of Seclusion (May 4, 1654), which excluded the prince of Orange from the office of stadholder of Holland.

Thereafter Dutch foreign policy was more successful. De Witt intervened in the Danish-Swedish war of 1657–60 and brought about a settlement which secured the safety of the Baltic trade. The restoration of Charles II to the English throne in 1660 had no immediate effect on Dutch domestic policy, though the estates of Holland repealed the Act of Seclusion. As Charles was unwilling to conclude an alliance with the republic, De Witt established more friendly relations with France (alliance of 1662). Then, after attacks by the English Africa company on Dutch possessions in west Africa and in North America (New Netherland with New Amsterdam), a second Anglo-Dutch war was officially declared in 1665. This was purely a commercial war in which the Dutch had the upper hand. The French supported their allies against the bishop of Münster, Bernhard von Galen, who as an ally of England attacked the eastern provinces. Peace negotiations, opened at Breda in April 1667, proceeded rapidly after the Dutch raid on the Medway (June), and the peace of Breda, concluded on July 31 (N.S.) was a compromise: New Netherland was ceded to England; Surinam (central Guiana) and Run (Pulau Run in the Banda islands) went to the Dutch.

Meanwhile Louis XIV of France had begun his War of Devolution by invading the Spanish Netherlands in May 1667. This threat to the security of the United Provinces gave Charles II of England an opportunity of breaking the Franco-Dutch alliance. He left De Witt no choice but to sign an anti-French alliance with England which became a triple alliance on Sweden's accession to it (1668). Charles however very soon turned to Louis XIV for subsidies and in 1670 concluded the secret treaty of Dover (*q.v.*), whereupon both kings prepared for a decisive blow against the completely isolated republic. In the face of this threat, William III of Orange was in Feb. 1672 provisionally appointed captain-general for one campaign. In March and April the two kings declared war; and in June a magnificent French army under Louis XIV himself occupied the greater part of the republic, though it did not enter Holland. Then, in July, William of Orange was appointed stadholder by Zeeland and Holland and full captain- and admiral-general of the union. Irresistible popular movements forced the oligarchs to give him all the rights and offices of his ancestors. On Aug. 20, just after having resigned his office of grand pensionary, De Witt was murdered at The Hague by an Orangist mob.

William III of Orange.—One of the first decisions of the new stadholder was his refusal of the humiliating peace terms offered by England and France. Louis XIV did not succeed in conquering Holland; the Dutch fleet maintained its supremacy over the English navy in a series of battles. In 1674 Charles II had to make peace: the treaty of Westminster, concluded on Feb. 19 (N.S.), was based on the *status quo ante bellum* but secured recognition by the Dutch of British sovereignty in the narrow seas (straits between Great Britain, Ireland and France). Anglo-Dutch relations were to be improved further when William married Mary, the elder daughter of Charles's heir presumptive, James, duke of York (1677). Meanwhile Spain and Austria had allied themselves with the Dutch in 1673, and Brandenburg and Denmark were also supporting them in the continuing war against the French, who in 1674 had to withdraw from all the republic's territory except Maastricht. No decisive battles, however, were fought, and the peace treaties of Nijmegen (1678–79) were advantageous both for the Dutch and for France. The Franco-Dutch treaty was signed on Aug. 10, 1678.

From 1678 to 1685 William found support for his anti-French policy neither in the republic nor among the other powers. But after 1685 resistance to Louis XIV's aggressive designs grew again, and in 1688, with the backing of the states-general, William set off on the expedition that won him the English crown in 1689 (*see* WILLIAM III). Thenceforward he became the leader of the coalition against French imperialism (*see* GRAND ALLIANCE, WAR OF THE). His policy, though it was essential for the safety of the republic, in the long run exhausted the republic's reserves and forced it to concentrate so exclusively on the war on land that it neglected its fleet and let England's sea power eclipse its own. William's domestic policy was moreover designed only to secure for himself the power and the money that his expensive foreign policy required. To this end he often resorted to unscrupulous practices, including corruption. The internal situation of the Netherlands deteriorated, and the republic, while still performing tasks of great international importance, was on the decline.

Second Stadholderless Period.—William III died childless on March 19 (N.S.; 8, O.S.), 1702. His nephew, John William Friso, stadholder of Friesland and Groningen, was a minor, and the five other provinces were not prepared to appoint him. Thus once again the majority of the provinces remained stadholderless. Power reverted to the urban oligarchies and their representative, the grand pensionary of Holland, Antonius Heinsius (*q.v.*). Heinsius continued the foreign policy of William III. During the War of the Spanish Succession (*q.v.*), the republic acted for the last time as one of the great powers, bore the brunt of the fighting and maintained a large army; but Heinsius was unable to compete with Great Britain's diplomatic superiority and resigned himself to signing the treaty of Utrecht in 1713. This treaty, it was thought in Holland, gave England the fruits of the victory won by the Dutch. The only concrete gain was the right to maintain a military barrier (*see* BARRIER TREATY) against France in the southern Netherlands—which moreover were to be transferred from Spanish to Austrian sovereignty. But as French policies changed and the Dutch generally neglected their defenses, the barrier never served a useful purpose.

From 1713 Heinsius sought to avoid international commitments. The states-general subscribed to the conservative triple alliance with Great Britain and France in 1717 but kept out of the ensuing diplomatic conflicts. After Heinsius' death (1720) one of his successors, Simon van Slingelandt, grand pensionary from 1727 to 1736, took action when the East India company, which had been established by the Austrians at Ostend in 1722 (*see* OSTEND COMPANY), threatened Dutch economic supremacy in the southern Netherlands as well as in India: in collaboration with Great Britain and France he secured its dissolution in 1731. During the War of the Austrian Succession (*q.v.*) the republic, despite its alliance with Great Britain and Austria, tried to stay out of the fighting as long as possible, even after the French had taken many of the Dutch barrier towns (1744), won the battle of Fontenoy, captured the rest of the barrier (1745) and conquered nearly all of the Austrian Netherlands (1746). In April 1747, however, the French invaded Dutch Flanders; they had no intention of conquering the republic, but merely wanted to force it to make peace officially. Reminiscences of 1672 then brought about a complete change.

The internal situation had gradually been deteriorating: the treasury of the union was exhausted; taxes in the provinces, especially in Holland, were extraordinarily high but were farmed out and did not yield enough; and the navy and army were neglected. A grand assembly, convened in 1716, had broken up in 1717 without having been able to improve the constitution, and the rule of the patrician families had degenerated to a narrow oligarchy which shamelessly abused its position to increase its wealth. From about 1730, moreover, the Dutch economy had begun to stagnate: the tendency to specialize in financial transactions rather than in the carrying trade, growing competition from British and French industries and the decline of the Amsterdam staple market together led to increasing unemployment on the one hand and to the increasing wealth of a few capitalists on the other. The republic was still a rich country, but its wealth was less equally divided than in the 17th century. In economic power, no longer supreme in Europe, it was to cede the first place to Great Britain and the second to France before the end of the 18th century. Politically it was already virtually powerless when the French invasion of

1747 aroused for a moment the old passions.

William IV of Orange.—John William Friso's posthumous son William IV of Orange, stadholder of Friesland from 1711, of Groningen from 1718 and of Gelderland from 1722 and the husband of George II of England's eldest daughter Anne from 1734, was in April–May 1747 elevated to the stadholdership of all the other provinces and made captain- and admiral-general of the union. His power was greater than that of any of his predecessors but he was completely incapable of using it. He was unsuccessful as a general, did nothing to improve the Dutch defenses and was quite unequal to the task of improving the constitution and the financial system and of bringing about the reforms needed in order to grant some influence in local and provincial government to larger groups of the population. By making it clear that only substantial British military and financial support could prevent the republic from falling into French hands, William IV obliged the British, who had wanted to continue the war, to sign the peace of Aix-la-Chapelle in 1748.

William V of Orange and the Patriots.—On his death in 1751 William IV was succeeded as stadholder by his three-year-old son William V. During the latter's minority his mother (until her death in 1759) and then the provincial estates acted as regents. They maintained Dutch neutrality during the Seven Years' War—a policy which was highly profitable commercially. In 1766 William V was declared of age. The last of the stadholders, he was the least able of them. His excessive conservatism made him use his great power exclusively to perpetuate the existing constitutional paralysis and to protect the oligarchy against increasing resistance, but his identification with the interests of the ruling classes did not make him acceptable even to them. He was unable to strengthen the army and navy, though he did his best to carry out some reforms in this field. The few reasonable decisions that he took were inspired by his intelligent and spirited wife, Wilhelmina of Prussia, whom he distrusted because of her will power.

William's incompetence and the Anglophile policy that he pursued brought about a fundamental change in the structure of the Dutch political parties. Traditionally the prince of Orange found support among all classes except the patrician oligarchy and was regarded by the lower middle classes and the workmen as a counterpoise to the urban aristocracy. But as the revolution of 1747 had not brought about any reform, the bourgeoisie gradually lost confidence in the stadholder's ability to introduce a more democratic system of government. Moreover the close connection with England was becoming distasteful to large sections of the population which thought British expansion overseas just as intolerable as Louis XIV's megalomania and rejoiced at seeing it beaten by the American Revolution. For the first time in Dutch history nationalistic feelings, caused by frustration and despair about the decline of the republic, gave rise to a new party.

This was the Patriot party. As yet it was not properly constituted, but the men who later became its leaders helped the oligarchs to undermine William V's authority. They were jubilant when in 1780 Great Britain, refusing any longer to tolerate the highly profitable carrying trade of the Dutch merchants with America and France, declared war on the republic. But the British blockaded the Dutch coast and captured Dutch colonies, and the Dutch economy received blows from which it never recovered. During the negotiations preceding the peace of Paris (the Anglo-Dutch treaty was signed in May 1784) France hardly supported the states-general, who had to cede Nagapatinam in southern India to the British and to grant them the right of navigating through the Moluccas. Denounced by the Patriot movement for his political mistakes, for his lack of energy and for his inability or perhaps unwillingness to beat Great Britain, William V left The Hague in anger in 1785. Thenceforward democratic movements sprang up everywhere, but mainly in Utrecht and in Holland, and the power of the oligarchies was broken in several towns. It is remarkable that the Patriots, although partly democrats and all of them supporters of the French alliance, were influenced by English rather than by French political theories. What really inspired them, however, was not abstract ideology but the desire to reform the system of government in a supposedly conservative way through the restoration of those democratic practices which, it was thought, the stadholders and the regents had nullified.

In 1787 the development of the Patriot party was suddenly stopped. The king of Prussia, Frederick William II, on the pretext of an insult offered to his sister Princess Wilhelmina, sent an army which met no resistance and brought the stadholder back to The Hague—to the great relief of the British ambassador, Sir James Harris (afterward 1st earl of Malmesbury). Thousands of Patriots found refuge in France.

End of the Old Republic.—The restored Orangist regime was rootless and was effectively opposed by the great banking houses, which refused loans. It was unable to strengthen the army and could hardly put up any resistance when in Jan. 1795 the French revolutionaries, who had declared war on the stadholder in 1793, invaded the republic. It was thus the army of Gen. Charles Pichegru that brought the revolution for which the Patriots had been hoping since 1787. (*See* FRENCH REVOLUTIONARY WARS.)

In May 1795 Franco-Dutch relations were defined in a treaty according to which the Dutch were to pay 100,000,000 guilders, to cede some territory and to allow the French to occupy some important fortresses. A treaty of alliance was concluded at the same time, bringing the Dutch into war against Great Britain. In the following years the British conquered all the Dutch colonies, and the war dealt another serious blow to the shattered economy. Nevertheless, plans for thorough reforms were made in an atmosphere of great rejoicing and hope. A national assembly was elected (1796) and charged to draft a new constitution, but was frustrated by the paralyzing conflicts between the radical "unitarians" and the moderate "federalists." A series of *coups d'état* supported by France led to the institution of a new form of government (April 1798).

D. Batavian Republic and the Napoleonic Regimes

The new regime of 1798, officially called the Batavian Republic, was modeled on that of the Directory in France. It was regarded with indifference by a population now gravely suffering from the economic slump: in many towns one-third or even one-half of the inhabitants depended on charity. Then, in Oct. 1801, at the behest of Napoleon Bonaparte, then first consul of the French Republic, a more conservative government was set up, in which some Orangists were allowed to take part. This prepared the way for the reconciliation of the old political parties, oligarchs and Orangists. In March 1805 the system of government was changed once more, the Batavian Republic was renamed Batavian Commonwealth, and executive power was given to a kind of dictator called the council pensionary. Rutger Jan Schimmelpenninck, who was appointed to that function, was an extremely able man and carried out many overdue and lasting reforms. Very soon, however, in June 1806, the Batavian Commonwealth had to make place for the Kingdom of Holland under Napoleon's brother Louis (*see* BONAPARTE). This monarchy lasted until July 1810, when Holland was incorporated into Napoleon's French empire and divided into *départements:* Bouches-du-Rhin, Deux-Nèthes (these two including some Belgian territory), Bouches-de-l'Escaut, Bouches-de-la-Meuse, Zuiderzee, Yssel-Supérieur, Bouches-de-l'Yssel, Frise and Ems-Occidental. When news of Napoleon's defeat in the battle of Leipzig reached Holland at the end of Oct. 1813 a national revolt broke out, which immediately called for the return from exile of the prince of Orange, William V's son William VI. He was to return, however, not as stadholder but as sovereign prince.

(E. H. K.)

E. Kingdom of the Netherlands

William I.—It was only after some hesitation that the prince of Orange, in Dec. 1813, accepted the title of sovereign prince of the Netherlands, for he disliked the popular origin of his new sovereignty. He was inaugurated (without any coronation) in Amsterdam on March 30, 1814, by an assembly of notables who on the day before had approved the first written constitution of the state. This fundamental law retained many institutions of the French period and established a constitutional monarchy and a centralized state with a single legislature, uniformity in adminis-

tration, justice, finance and the fiscal system and legal equality for all recognized creeds. The one-chamber parliament kept the old name of states-general and was elected by indirect vote, representing only the upper and upper-middle classes. It had very limited rights, and the sovereign, whose progressive economic policy could not win a majority in it, was in fact to bypass it as much as possible and to govern mainly by orders in council, as the ministers were responsible to him only.

In July 1814 William undertook the provisional government of the southern Belgic provinces of the Netherlands, which the Austrians had lost to the French Revolutionary armies in 1794 and which the European powers were intending to transfer, together with the former bishopric of Liège, to the sovereign principality. The congress of Vienna, however, had not yet ratified the transfer when William, on March 16, 1815, at the news of Napoleon's return to France from Elba, proclaimed himself king of the Netherlands. The congress soon confirmed the creation of the new kingdom, with its increased territory; and in Aug. 1815 a new fundamental law came into force. The principles of the new law remained as firmly monarchical as those of 1814, but the states-general then consisted of two chambers and the seat of the government was to alternate yearly between The Hague and Brussels. Moreover, in exchange for his hereditary territories in Germany, William received Luxembourg as a grand duchy. Though the kingdom and the grand duchy were in personal union only, William proceeded to treat Luxembourg (a member of the German confederation) as a Dutch province.

The kingdom of the united Netherlands was launched in very difficult circumstances. While Europe in general was undergoing an economic crisis, there was a clash of interests within the kingdom between the predominantly commercial north and the highly industrialized south. Also the clergy and the ruling class of the *ancien régime* resented the new state's system of religious and political equality. Nevertheless the king, dedicating himself to the task of government, tried to give a sound basis to the union through a policy of economic welfare. These very endeavours vexed the north, which clung to the archaic system of free staple-trade and found its spokesman in G. K. van Hogendorp, to whose activities at the end of the French period the king owed his throne. Through new institutions such as the General company (1822) and the Netherlands Trading company (1824) the king promoted industry and commerce, including colonial trade.

Later Dutch historians (P. Geyl, C. Gerretson and L. Verberne) have stressed this positive side of William's reign as a real contribution to the viability of the new state. they point to his care for agriculture, in which north and south alike were interested on a large scale, and to the important economic recovery made by the whole country. They also stress the fact that the kingdom's manifest difficulties cannot all be attributed to the generally overstressed opposition between the so-called Calvinistic northern and Catholic southern parts of the country: there were numerous Roman Catholics in the north as well as in the south; and the language decrees of 1819 and 1822, favouring Dutch as opposed to French as the official language, were in force only in the Flemish regions, where they served to strengthen national feelings among the lower classes.

These so-called "Great Netherlands" historians regard the Belgian revolution of 1830 as the second rupture (after the split between north and south in the 16th century) in what ought to be a whole. They offer a useful corrective to the "Belgicist" and "Little Netherlands" historians in whose opinion the kingdom of the united Netherlands had no chance of survival and the emergence of the Belgian nation was inevitable. The kingdom set up by the congress of Vienna was a somewhat artificial creation, but its disastrous end was brought about mainly by misconceptions and by the narrow self-interest of the various groups, both in the north and in the south, combined with the effect of tactless and presumptuous measures taken by the king.

It was William I's great misfortune that two parties of the south which had originally opposed one another joined hands in 1828 in a common resistance to his meddlesome and autocratic government: the Roman Catholics, shifting under the influence of the French *abbé* Hugues Félicité Robert de Lamennais toward a sort of Liberal Catholicism, and the Liberals, eager to achieve ministerial responsibility and similar reforms. At first the Belgian rebels of 1830 (*see* BELGIUM: *History*) did not aim at an independent Belgian state and might have been satisfied with a redress of grievances, but hesitations and tactless measures by the king and his government, together with revolutionary influences from France, brought about the rapid disintegration of the Netherlands union. The Flemish provinces followed the rebellion of Brussels reluctantly and only after the government had suffered reverses, while Dutch public opinion on the whole welcomed the breakup of the union. Yet even after the great powers had recognized Belgian independence (1831–32) and had forced the Dutch to renounce hostilities (Convention of London, May 1833), the king persisted in refusing to accept the conditions of the separation till 1838. Meanwhile the Belgians remained in occupation of Luxembourg and Limburg (except Maastricht) and the Dutch had to maintain large forces in case war should break out again. This strained the Dutch finances more and more, but the king's secret "amortization syndicate" enabled him to withhold the administration of public money from parliamentary control. Also the so-called "plantation" or "cultures" system, which guaranteed to the government large quantities of East Indian agricultural produce obtained by forced labour, prevented an immediate public bankruptcy. On the whole the financial policy of this "merchant-king" must be considered the dark side of his courageous and far-seeing economic projects. Under the settlement of 1839 between the Netherlands and Belgium (treaty of London) part of Limburg was restored to the Dutch, while the Belgians retained part of Luxembourg.

The Belgian revolution and its repercussions brought a resurgence of national sentiment to the Dutch people: the diminished Netherlands kingdom began to awake from its religious, cultural and political apathy. In 1834 a group of orthodox Calvinists, the Separatists, seceded from the Dutch Reformed Church, whose "liberal" and "enlightened" spirit corresponded to William's Erastian ideas of enlightened absolutism. The foundation of the monthly *De Gids* by E. J. Potgieter and R. C. Bakhuizen van den Brink in 1837 signified a literary revival of a rationalistic and liberal character, whereas the religious and literary movement known as the "Reveil," with G. Groen van Prinsterer as one of its leaders, represented the romantic conservatism of the Restoration. The nation was definitely turning away from the ideas which King William I personified, and in 1840, as a result of increasing opposition by the Liberals, the constitution was revised. Though this revision was by no means radical and greatly disappointed the Liberals, to the king it meant the end of his reign. He abdicated voluntarily a few weeks afterward (Oct. 7, 1840), in favour of his son.

William II.—During William II's reign (1840–49) the liberal trend gathered strength while the new king, at first mildly progressive, gravitated more and more toward conservatism. His minister F. A. van Hall succeeded in stabilizing the public finances. The king, whose Belgian experiences had contributed to his good relations with Roman Catholics, won the good will of that community by revoking some restrictive decrees that his father had passed; and the Calvinist Separatists were also treated more leniently. The Liberals grew more and more discontented, but the largely conservative second chamber rejected without discussion a motion sponsored by J. R. Thorbecke (*q.v.*) and eight other Liberal members for the revision of the constitution (1844). Meanwhile, signs of a social disturbance in the Netherlands were discernible during the "hungry forties," when more than one-third of the population had to receive outside relief. These signs were exploited by former friends of the capricious king in their criticism of him, which moreover was made easier by his own personal behaviour. Finally, under the influence of revolutionary events in France and Germany, the king in March 1848 made a characteristic *volte-face:* bypassing his cabinet and the majority in parliament, he convened a commission of convinced Liberals, who, under Thorbecke's direction, drew up a new constitution. It was accepted that very year by parliament.

The constitution of 1848 established the inviolability of the sovereign; ministerial responsibility; direct elections to the second chamber, to the provincial estates and to municipal councils; an extension of the power of parliament; and new or enlarged rights of free assembly and public meeting, education and religion. William II, who was said to have turned from a conservative into a Liberal within 24 hours, died a year later, on March 17, 1849, and was succeeded by his eldest son.

William III.—William III, though he did not sympathize with the new constitution, bowed unwillingly to the changed circumstances. After some hesitation he appointed Thorbecke, whom he came near to hating, as his principal minister. Thorbecke consolidated the constitution: he drafted important organic laws regulating the electoral system and the provincial and municipal administrations. In April 1853, however, when a Protestant deputation presented a petition against Pope Pius IX's restoration of the Roman Catholic hierarchy in the Netherlands, the king, against Thorbecke's advice, addressed it in terms derogatory to Catholics. The second chamber approved Thorbecke's attitude, but Thorbecke nevertheless resigned. The episode exemplified the personal authority of the king, who in fact, after Thorbecke's second ministry (1862–66), was to rule through his cabinet without or against parliamentary majorities till 1868. Thereafter no Dutch ministry ignored parliamentary disapproval, though the king's influence could still be considerable whenever there was no working majority in parliament.

Political Clubs and Parties.—In the time of Thorbecke, who formed his third and last cabinet in 1871, there were no political parties in the proper sense but only "clubs" in the second chamber, backed at best by embryonic electoral organizations in the country. The political movements vaguely represented in these clubs were: (1) the Liberals led by the typical "lone-wolf" Thorbecke, who was adverse to political parties; (2) the Conservative Liberals, who did not constitute a club as such and whose most prominent spokesman, F. A. van Hall, headed the cabinet twice (1853–57 and 1860–61) between Thorbecke's first and second ministry; (3) the Conservatives proper, who opposed the constitution of 1848 and represented a diminishing reactionary minority but enjoyed the king's sympathy; and (4) the increasing group of "Antirevolutionaries," who under Groen van Prinsterer's leadership were developing from a position close to the Conservatives into a constructive and efficient political body with orthodox Protestant principles and were recruiting most of their followers from among "the people behind the electorate," namely, the classes not yet enfranchised. The Roman Catholics (about one-third of the population) long failed to constitute a club of their own and adhered partly to the Conservative Liberals, partly to the Liberals.

About 1870 the Conservative Liberals merged with the dwindling Conservatives, but this combination, in which Jan Heemskerk played a leading part in the 1870s and '80s, did not establish an effective political organization and eventually disappeared. The first political party proper was the Antirevolutionary party, founded in 1878 by Abraham Kuyper (*q.v.*). Though after Thorbecke's death (1872) the "Young Liberals," including Samuel van Houten, J. Kappeyne van de Coppello and Hendrik Goeman Borgesius, won influence in government circles, the Liberals as a whole were too much divided to achieve an efficient organization: the "Liberal union" of 1885 united only a minority of them. The Roman Catholics, who by this time had formed their own parliamentary club, could not yet be induced to form a political party: the attempts of Herman Schaepman in this direction were unsuccessful—not least because of dissension on such problems as the extension of the franchise and collaboration with the Calvinists. At the end of William III's reign the Socialists had one seat in the second chamber and their political organization was only in a provisional stage.

The Education Question and the Coalition Ministry of 1888–91.—The question of education gradually became a dominant factor in Dutch politics. The constitution of 1848 had given freedom of teaching but made the government responsible for public elementary instruction; and the Education act of 1857 had laid down that the public elementary school was to educate the child in "all Christian and social virtues." It was hoped that this provision would meet the objections of the orthodox to the nondenominational, or, as they said, "godless" state schools. It did nothing of the sort, however, and, when in 1878 the Liberals under Kappeyne van de Coppello revised the act of 1857 without making any concessions to religious scruples, the agitation gathered strength. The Roman Catholics, who had benefited from the constitution of 1848 and had long supported a more or less liberal policy, began to desert the Liberals. Both orthodox Calvinists and Catholics maintained that it was unfair to make people pay for the upkeep of nondenominational state schools when conscience required them to send their children to private denominational ones instead; but their demand—that the state should give financial support to private denominational schools as well as to the nondenominational ones—was strenuously resisted by the Liberals, who regarded denominational schools as seedbeds of national disruption and invoked the constitution against the demand.

In 1887 the constitution was changed to permit an extension of the franchise. This more than doubled the electorate, raising it to about 300,000, with the result that the Liberals—divided as they were among themselves—had to give way to the representatives of the lower classes. The first coalition ministry between the Antirevolutionaries and the Roman Catholics (1888–91), of which the Calvinist Aeneas Baron Mackay was the head and the Catholic Schaepman the mainspring, was an entirely unprecedented combination which indeed owed its existence chiefly to reaction against the education policy of the Liberals. After an attempt to introduce the possibility of state support for private denominational schools into the revision (1887) of the constitution had been defeated by the first chamber, the government took the view that such support need not be regarded as unconstitutional; and in 1889 a new Education act brought the first modest subsidies for denominational schools. The dominance of the Liberals was already diminishing when William III died on Nov. 23, 1890.

Economic and Social Development, 1849–90.—Not only in political matters was William III's reign the heyday of liberalism—despite the king's own preferences. Following the English example, Thorbecke during his first ministry had introduced navigation acts to facilitate international commerce; and in 1862 free trade was initiated. In the 1860s likewise a number of excise duties were abolished. On the other hand it was the state which built the railways to be exploited by private concerns (1860). Thorbecke's second ministry sponsored the construction of the North Sea canal linking Amsterdam to IJmuiden (completed 1876) and of the Nieuwe Waterweg (New waterway) from Rotterdam to Hook of Holland (completed 1871). Thorbecke was also the founder of the polytechnic school at Delft and of the burgher high school, a new type of secondary school for the middle classes.

The "cultures" system, surviving in the colonies from William I's time, was attacked both because of the hardship that it inflicted on the indigenous population and because it contradicted liberal economic theory: free labour was advocated in the interests of the Javanese workers and the Dutch capitalists alike. On this point, however, Thorbecke did not agree with his more radical minister for the colonies, I. D. Fransen van de Putte; and it was not until 1870 that the system was abolished for all crops except coffee, government plantations of which were maintained for some more decades.

At the same time the methods of modern capitalism were applied to the textile industry in Twente and North Brabant and to the steel industry. The pulse of industrial life was quickening in the '70s and '80s, but the lack of sufficient capital still retarded the progress of the "industrial revolution."

Social legislation was likewise late in development. The first law against child labour was passed in 1874 and was not very effective, but in 1889 the coalition ministry put greater restrictions on the employment of women and children. From the late 1860s trade unions were springing up, but the general Netherlands Workmen's association of 1871 was inspired by liberal ideas and patronized by the employers. The orthodox Calvinist labourers seceded from the association and formed a trade union of their own, Patrimonium, in 1876.

The Socialists' first national labour organization was the Soci

Democratic union (1881), a body also politically active under the leadership of the ex-pastor Ferdinand Domela Nieuwenhuis, a spectacular fighter who was put in prison for some months for *lèse-majesté* (he was prosecuted for publishing an article disrespectful of the king). The Roman Catholics began to form unions about 1889, inspired by the priest Alphons Ariëns.

(H. A. Bo.)

Accession of Queen Wilhelmina.—With William III the male line of the house of Orange-Nassau became extinct, so that on his death the kingdom of the Netherlands passed to his daughter Wilhelmina (*q.v.*). The personal union between the Netherlands and Luxembourg, however, was then ended, as the grand duchy reverted to the ducal house of Nassau-Weilburg.

The new queen was only ten years old in 1890. Consequently her mother, Emma of Waldeck-Pyrmont, whom William III had married as his second wife in 1879, acted as regent till Wilhelmina came of age on Aug. 31, 1898. Wilhelmina was married in 1901 to Henry, duke of Mecklenburg-Schwerin, and a daughter, Juliana, was born in 1909. Thus the house of Orange, surviving only in a female line and confronted with republican sentiments in the parties of the left, came gradually to consolidate itself as the constitutional power envisaged by the Liberals of 1848; *i.e.*, as a monarchy that would exert its authority mainly in times of cabinet crisis.

Internal Affairs, 1890–1913.—In the opening period of Wilhelmina's reign cabinets remained regularly in office for the four years between elections to the second chamber. The only break in this regularity occurred between the elections of 1905 and those of 1909, when Theodoor de Meester's government had to be replaced by a coalition after less than three years of office. This governmental regularity, however, did not mean that political life developed on regular lines.

The Dutch economy was slowly reviving. From the 1870s Amsterdam and Rotterdam had both had direct access to the North sea, and their trade was benefiting from a twofold stream of products: (1) from the Netherlands East Indies, freely exploited by international capital; and (2) from the big new German industries of the Ruhr. By the later 1890s, moreover, agriculture, which had undergone a great crisis in 1885, was prospering because of modern methods of production and distribution, in which the farmers' cooperatives played a conspicuous part (mostly concentrating on dairy produce). At the same time larger firms grew up in the textile and shipbuilding industries, attracting many more people to the towns and greatly increasing the number of unskilled workers. Some industries even emerged from the beginning in the form of large producing and exporting units, spanning the whole world and sometimes working in combination with British firms; *e.g.*, margarine (Van den Bergh), petroleum (Royal Dutch) and electric apparatus (Philips). These developments promoted the growth of organized labour on the one hand and the large-scale integration of finance, trade and industry on the other.

A simultaneous revival can likewise be traced both in the arts (literature, painting and architecture) and in the life of the most important religious groups. In the latter case this revival had a bearing on politics. The Roman Catholic population, which constituted a large minority in the western cities and an overwhelming majority in the southern areas, had begun to take political action as a distinct force on its own account in the 1880s, under the powerful spell of Schaepman. Despite strong opposition from other politicians on the Roman Catholic side, Schaepman sought not only to collaborate with the Calvinists in the struggle for private schools but also to promote the formation of Roman Catholic trade unions in accordance with Pope Leo XIII's encyclical *Rerum Novarum* (1891). These Catholic unions organized themselves on a nationwide scale in 1909.

Trade unionism played its role also in the Calvinistic north, where Abraham Kuyper likewise worked for democratic reforms. Yet, though Kuyper took the chair at the first Christian-Social congress in 1891 in order to arrange terms between his party and the Protestant workers, no really effective Calvinist trade union came into being until 1909. Kuyper, however, combined a progressive social policy with insistence on Calvinist orthodoxy, and the result was a double schism in the Calvinist ranks: already in 1886 he had seceded from the Dutch Reformed Church, which he accused of yielding to heterodox opinions of a few; and finally, in 1897 he had forced the right wing of his own Antirevolutionary party to split off from the majority. This right wing formed a party of its own, the Christian Historical union, led by A. F. de Savornin Lohman.

Meanwhile the nascent socialist movement was being penetrated by a number of atheist intellectuals, who gave it a revolutionary, republican and anticlerical slant, with a strong tendency to anarchism. This individualistic and anarchist trend effected the Social Democratic union under Nieuwenhuis; and to counter it the parliamentarians and Marxists under Pieter Jelles Troelstra set up a new Social Democratic Labour party, which practically ousted the Social Democratic union after 1900 and founded its own trade union organization in 1906. Both forms of socialism, however, had some affinity with bourgeois liberalism in their intellectual attitude, which alienated both Kuyper's Calvinistic "small people" and the Roman Catholics.

The first coalition government of Roman Catholics and Calvinists (1888–91; *see* above) had marked the end of an era in which Liberal or Conservative Liberal groupings had been supreme in Dutch public life; though there were Liberal governments in the succeeding decade to 1901 (the "last ten Liberal years") the Liberals were too much divided among themselves to reverse the new course of affairs. Moreover the advent of the coalition had shown that the political system could no longer be built only upon the parliamentary groups: the organization of the masses became important. With this development the question of universal suffrage came to the forefront. When the Liberal minister J. P. R. Tak van Poortvliet proposed in 1894 to extend the franchise to nearly general suffrage, he raised an issue that was to test the coherence of the various parties severely. The Liberals, indeed, were eventually to be split into three sections: the conservative section, against Tak; the radical section, for Tak; and finally the strong radical wing under M. W. F. Treub, who as an alderman in Amsterdam was working out a program of his own, municipalizing the telephone service and the water supply (previously run by private companies). After a limited extension of the franchise, raising the electorate to about 700,000, had been enacted in 1896, the Christian parties and the majority of the Liberals were more or less satisfied; but Treub's adherents continued to stand for universal suffrage and, in 1901, formed a party of their own, as Liberal Democrats. The Socialists also concentrated their activities on the campaign for universal suffrage, organizing huge demonstrations in 1912 and 1913. This enhanced their popularity, so that their representation in parliament rose from 2 seats in 1897 to 16 in 1913 (out of 100). The Roman Catholics, who had had 25 seats in 1888 but only 17 in 1905, had 25 again in 1913; but Kuyper's Antirevolutionaries fell from 25 seats (1888) to 11 (1913), while the Christian Historicals rose from 6 (1897) to 10. The Liberal representation slowly declined from 46 in 1888 to 38 in 1913 (only in 1905 increased to 55).

N. G. Pierson's cabinet of 1897–1901 was important for the social legislation that it inaugurated. This extension of governmental activity was to remain characteristic of the next decades: the Christian parties supported it against the Conservative Liberals, while the Social Democrats for the most part stood critically aloof. When the government in 1898 proposed that the state should run an insurance scheme against industrial accidents, the implicit threat of centralization caused employers to react by building up organizations of their own, and the government, failing to win a majority in parliament, had to change the bill in a decentralizing direction. The new employers' unions, however, having originally been designed to oppose the workers' unions, later came to collaborate with them. In social affairs, furthermore, a tradition grew up of endowing private institutions with some governmental executive tasks. This practice appealed to progressive Roman Catholics and Calvinists and was accepted by Socialists insofar as it did not undermine the role of the government as the final instance; but the conservative elements in the religious groups united with the Liberals in opposing it as prejudicial alike to personal liberty and to the constitution.

The period of Kuyper's ministry of Calvinists and Catholics (1901–05) was especially eventful. At home the ministry had to face the great strike movement of 1903. This started when the railwaymen, in sympathy with a strike in Amsterdam harbour, refused to handle goods from ships there: their action spread fast throughout the country and developed into pressure on the railway boards to improve labour conditions. The Kuyper government then intervened, making a political issue out of the social unrest with a bill to ban strikes of government employees as well as of railwaymen. In the face of strong Socialist opposition this bill was passed, and a new strike, intended to be a general one, broke down. Kuyper was also instrumental in settling at university level the old struggle for denominational schools: "private" universities received official recognition. The attempt of the Socialists and Liberals to take religion out of Dutch politics had failed.

Hostile to Kuyper, the Socialists backed the Liberals in the elections of 1905. There followed an extraparliamentary cabinet with a Liberal tendency under Theodoor de Meester, but this cabinet resigned in Dec. 1907. Then in Feb. 1908 the Christian coalition was brought back to office—with Theodoor Heemskerk, however, instead of Kuyper at its head. Winning 60 seats at the elections of 1909, the coalition resumed the task of social legislation and in 1910 proposed a system of social insurance chiefly for benefit of sick and aged workers. Discussions on this took up most of parliament's time till 1913.

The Policy of Neutrality and World War I.—From 1899 foreign policy became of increasing importance. A first international peace conference, convened at The Hague in 1899 by Queen Wilhelmina and the Russian emperor Nicholas II, had little effect but bore witness at least to the alarming predicament of a small country surrounded by great powers in rivalry. A reconsideration of the neutrality that the Dutch had traditionally maintained since Napoleon's time seemed to be necessary, and in 1905 the queen broached the possibility of foreign alliances in a note to the prime minister Kuyper. Apart from the embarrassment felt when the Russians had sought permission for their ships to bunker in the Netherlands East Indies during the Russo-Japanese War, it was clear that Dutch neutrality could be maintained only so long as none of the European powers attacked the Netherlands; and at this very moment the German general staff was planning to send its armies through the southern part of the Netherlands if war should break out with France.

The East Indian colonies were believed to be the object of German expansion, though as yet the island of Java was alone of major economic importance and parts of Sumatra were still only under precarious control; and the first signs of Indonesian nationalism were appearing. Consequently the new "ethical policy" for the colonies was introduced, with special emphasis on better educational facilities for the Indonesians. The export trade of the Netherlands East Indies doubled itself between 1900 and 1914 and greatly enhanced Dutch prosperity. On the other hand the German transit trade on the Dutch rivers was also a considerable source of wealth for the Netherlands, and it was undoubtedly difficult for many Dutchmen to resist the fascination of Germany's prestige, while anti-British feelings had been stimulated by sympathy for the Boers in the South African War.

Strategically and economically the country was extremely vulnerable, and the strengthening of its defenses was therefore imperative. This became, from 1911, the special concern of Hendrikus Colijn (*q.v.*). Already in 1898 universal military service had been introduced, and in 1901 the reorganization of the army had been started. The long coast line called for special attention: in 1911 a new fortress was built at Flushing. Further measures, however, could be carried out only to a limited extent in the face of objections from the Belgians, who feared the closing of the Scheldt, and from the British, who feared that such measures might eventually serve Germany's purposes.

Though commercial interests remained of importance, foreign relations became more and more subject to purely political considerations, as can be seen from the several pacts of arbitration concluded between 1904 and 1913 (Denmark, Portugal, France, Great Britain and the United States). There was a remarkable German project for a North Sea pact in 1908 to secure for Germany the benevolent neutrality of Netherlands in the event of war; but the Dutch government assented to it only after France had done so too, thus making the pact ineffectual.

When World War I broke out in 1914 the policy of neutrality was put to the test. The army was mobilized for four years and the frontiers were closed (even so, temporary homes had to be found for thousands of Belgian refugees from Antwerp and its vicinity). Commercial activity was severely restricted: the British extended the list of contraband goods by an order in council of Aug. 20, 1914, and exercised their right of search on Dutch ships; Germany declared all British waters a war area (Feb. 4, 1915), thus exposing neutral ships to the threat of torpedoing; and the Allies retaliated with a blockade of Germany which formally limited Dutch imports to the quantities estimated necessary for home consumption. Germany's declaration of unrestricted U-boat warfare in 1917 made matters even worse. When the Allies tried to charter all Dutch vessels not needed for Dutch importation, the Netherlands objected, since necessary imports for the Netherlands and for Germany alike were often carried in the same ships; then all Dutch ships in the harbours of the Allies were requisitioned by right of angary.

On various occasions it seemed likely that one or another of the belligerents would violate Dutch territory or demand such measures from the Dutch government as would provoke retaliation from the other side. In particular the question of the transit of sand and gravel from Germany across Dutch Limburg to Belgium nearly led to war: the Dutch allowed the transit of these materials for road repairs but objected to their being sent for the reinforcement of fortresses; and in 1918 the German general Erich Ludendorff wanted to take military measures to secure unrestricted use of the Dutch railways for Germany.

The extraparliamentary cabinet under the Liberal P. W. A. Cort van der Linden, in office from Aug. 1913, instituted general unemployment insurance with governmental subsidies (Aug. 1914) and took several financial measures (loans, paper money, exchange regulations, prohibition of export of gold); but neither these nor other emergency provisions, such as the Committee of National Aid, the rationing of food and fuel and a National Overseas Trading trust, were remedies against famine and epidemics prevalent during the later years of the war.

The wartime truce on which the parties had agreed in 1914 was seriously strained by the growing contrast between the economic distress of the masses and the ostentatious spending of ill-gotten riches by a handful of speculators. This contrast strengthened the tendency toward greater democratization. A far-reaching revision of the constitution was achieved in 1917: on the one hand the schools controversy was finally solved by granting state subsidies to the private schools on the same basis as to the public (mostly communal) schools; on the other, universal male suffrage was adopted, with proportional representation. The ensuing elections, held in July (1918), resulted in a clear majority for the old Calvinist-Catholic coalition, and two months later C. J. M. Ruys de Beerenbrouck formed the first cabinet in the kingdom's history to be headed by a Roman Catholic.

The Netherlands Between the Wars, 1918–40.—Though the example of the German revolution stirred the left wing of the Social Democrats under Troelstra, who seemed ready to assume power on Nov. 11, 1918, the majority of the Social Democratic party as well as of the Socialist trade unions refused to follow this revolutionary drift. Ruys de Beerenbrouck's government therefore, including as it did a new ministry for labour affairs under the Catholic P. J. M. Aalberse, remained in power to pursue a social program of its own. While the masses were demonstrating for Queen Wilhelmina and against revolutionary socialism, the old Socialist demand of the eight-hour working day was conceded—at first by private firms, before the revised labour law of 1921. A Council of Labour was set up, and the insurance laws on labour accidents and old-age pensions were renovated. Women's suffrage was established in 1919.

Three postwar problems in the international field had to be

settled: the claims to Dutch Flanders and Limburg raised by the Belgian annexationists; the victorious Allies' demand for the extradition of the German ex-emperor William II, who had fled to the Netherlands in Nov. 1918; and the Netherlands' entry into the League of Nations, which was then being organized by the Allies. The Dutch steadfastly rejected the demand for extradition but gave assurances that William II would not use his refuge in the Netherlands as a base from which to attempt to recover Germany (March 1920). Relations with Belgium, however, remained difficult, even though the Paris peace conference had dismissed the Belgian claims to Dutch territory: the Belgians still resented the sovereignty of the Netherlands over the left bank of the Scheldt estuary in the west and over part of the Meuse valley in the east. A treaty drawn up in 1920, involving concessions by the Netherlands, was signed at last in 1925, and the second chamber approved it in 1926; but after vehement popular protests it was repudiated by the first chamber in 1927.

Membership in the League of Nations, which the government regarded as a safeguard for Dutch neutrality, was represented by some of the opposition parties in the 1920s as a reason for urging disarmament. This gave rise to a long dispute, which was complicated by the rise in the government's expenditure in nonmilitary directions. Apart from the cost of its social and educational commitments, the government had to face an economic crisis (1920–23) and to find money for mining, for the railways (organized in one national company in 1920) and for air transport (first flight to Indonesia, 1923).

Colijn, leader of the Antirevolutionary party from 1922, became finance minister in Aug. 1923 in Ruys de Beerenbrouck's second cabinet (formed in Sept. 1922). A specialist on Indonesian and military affairs as well as finance, Colijn proposed a series of economy measures, mostly in the field of social welfare and education, while at the same time he wanted to build some more cruisers for Indonesian waters. He succeeded in restoring the gold basis of the gulden, but the navy bill was rejected by the combined opposition of the Socialists, the leftist Liberals and some Catholics (Oct. 1923). The government then tried to resign but was finally kept in office because no alternative government could be found. After the elections of July 1925, however, a new ministry was formed under Colijn, but it fell in the following November, when the left joined with the Christian Historicals to vote against the maintenance of a Dutch legation at the Vatican. The left correctly foresaw that this issue would terminate the Calvinist-Catholic coalition.

All subsequent governments from 1926 to 1939 were to depend for their majorities on the Liberals no less than on the confessional parties, while the Socialists remained in opposition. The distribution of the 100 seats in the second chamber was fairly constant throughout the period: after the elections of 1929, which can be taken as typical, the Roman Catholics had 30 seats, the Social Democrats 24, the Antirevolutionaries 12, the Christian Historicals 11, the right-wing Liberals 8, the left-wing Liberals 7 and the Communists 2, with 6 others. General discontent at this parliamentary stalemate, exacerbated by the world economic crisis, caused a political reorientation in the 1930s. There was revolutionary murmuring against the government's economy measures, a mutiny broke out on a ship of the East Indian navy (Feb. 1933) and, in reaction, people began looking for a "strong man." Some thought to find him in Colijn, who, after D. J. de Geer's first ministry (1926–29) and Ruys de Beerenbrouck's third (1929–33), became prime minister for the second time in May 1933 and formed three more ministries in succession (July 1935–May 1937, June 1937–June 1939 and July 25–27, 1939). His merit was that he combined democratic principles and staunch Calvinism with a Conservative Liberal approach to economics. Some extremist opinion, on the other hand, saw the "strong man" in Anton Mussert, leader of the National Socialist or Nazi movement, which for a short moment, in the provincial elections of 1935, enlisted 8% of the voters; and simultaneously the Communists gained in strength. The Social Democratic party, however, then turned away from its revolutionary, antinationalist tradition and adopted a program envisaging a welfare state: having to choose between revolution and democracy, which it had formerly regarded as virtually identical, it chose democracy. This decision was due partly to a reaction against the antidemocratic menace of fascism or national socialism at home and abroad, partly to the influence of the trade unions, whose interests had been progressively reconciled with those of the state by legislation for sickness insurance, for protection of agricultural workers and for collective bargaining. The defense of democracy thus brought together a united anti-Fascist and anti-Communist front. All parties backed the policy of sanctions against Italy at the time of the Italo-Ethiopian War; the clamour for disarmament was silenced when Germany began rearming; and the Dutch Nazi movement was discredited. Another symptom of the change was the entry of the Socialists into the cabinet for the first time, when D. J. de Geer formed his second coalition ministry in Aug. 1939.

Colonial policy meanwhile was marked by a certain readiness to meet the demands of the rising Indonesian nationalism. A *volksraad* ("people's council"), set up in 1918 in accordance with an enactment of 1916, included Indonesian members, some of them elected by local councils. Proposals for enlarging Indonesian membership and for giving greater independence to the governor general were passed by parliament (1925) only with a conservative amendment. This watering-down of the original bill evoked protests both from the Islamic and Socialist sections of the Indonesian nationalist movement and from the Socialists in the Netherlands, and a rebellion broke out in Java in Nov. 1926. Nationalist leaders such as Mohammed Hatta and Sukarno were arrested and interned for varying periods in the following years. A petition of the *volksraad* for a round-table conference at which the whole position of Indonesia could be discussed was rejected by the Dutch government in 1936.

World War II.—The German invasion of the Netherlands began on May 10, 1940. The centre of Rotterdam was completely destroyed by aerial bombardment on May 14, and the Dutch armies had to capitulate after five days of fighting. The royal family and the government went into exile in London. In the occupied Netherlands a German administration was set up, and Arthur Seyss-Inquart, as *Reichskommissar*, tried with increasing severity to bring the country into conformity with the Nazi pattern. Parliament and parties were dissolved, Dutch Nazis were nominated to various posts and the process of integrating the Dutch economy with the German started with the compulsory delivery of huge quantities of foodstuffs and culminated in the deportation of thousands of men to labour in German factories. The "Labour Front" absorbed the trade unions one by one, and a Chamber of Cultural Activities subjected literature and the arts to Nazi ideology. Of the Jewish population only about one-tenth survived.

The distribution of illegal newspapers started the resistance movement in June 1940. There followed strikes, such as those against the deportation of Jews (Amsterdam, Feb. 1941) and against the retention of Dutch soldiers as prisoners of war (May 1943) and the railway strike during and after the battle of Arnhem (1944). The resistance movement was supported by the overwhelming majority of the people, though hundreds were put to death or imprisoned. Contact with the London government was maintained throughout the war. The worst experiences of the population came in the winter of 1944–45, when the Allied and German forces were fighting over the country. The island of Walcheren was flooded when the Allies bombarded the dike at Westkapelle in the struggle for Antwerp, the Germans resorted to thoroughgoing terrorism and food and fuel were quite unobtainable to civilians except by scavenging or expensive barter. (*See* also appropriate subsections of WORLD WAR II.)

De Geer was relieved of the prime ministership in London after an abortive attempt to mediate between Great Britain and Germany (Sept. 1940). His successor, Pieter Gerbrandy, in close contact with Queen Wilhelmina, continued the struggle. When the Japanese attacked Indonesia, the Netherlands East Indian navy under Adm. Karel Doorman perished in the battle of the Java sea (1942) and Indonesia, too, fell under enemy occupation. Until the Netherlands and Indonesia were liberated by the Allies,

the government in exile exerted its authority through its control over the remainder of the navy and merchant marine and the Caribbean colonies.

The Postwar Situation and the Accession of Juliana.—On the defeat of Germany, Gerbrandy's government offered its resignation to the queen. An interim government under Willem Schermerhorn, formed in June 1945, included representatives of all parties except the Communists, who refused the one seat offered them. Economic and social life had to be rebuilt. The productive capacity of the country had been reduced by 60%, stocks were almost exhausted and only 63% of the houses remained undamaged. Deported workers and prisoners had to be brought back and employed; financial regulations were needed for commerce; salaries and prices were fixed. In the first postwar years the Netherlands was economically dependent on the U.S., and Marshall Plan aid (1947) made possible the rebuilding of Dutch industry. Meanwhile a special tribunal to deal with traitors, collaborators and war criminals was set up. Also, the Dutch claimed indemnity from Germany and annexed some areas in April 1949. (In April 1960 the villages of Elten, Dinxperlo and Tuddern were retroceded to Germany, while some minor concessions were made to the Netherlands in return.)

Queen Wilhelmina relinquished her powers on two occasions (Oct.–Dec. 1947 and May–Aug. 1948) to her daughter Juliana and abdicated in her favour on Sept. 4, 1948.

Internal Politics After World War II.—The churches and the political parties began gradually to renounce the idea that party and denomination must automatically coincide. A new political group, the Party of Labour (1946), included former Social Democrats, left-wing Liberals, progressive Roman Catholics and Calvinists and stressed its nondenominational character; but the majority of the Catholic party kept away from it. The dividing line between religious and nonreligious parties remained in being, but was much more fluid than it had been.

Four successive elections to the second chamber (1946, 1948, 1952, 1956) enabled the Catholics and the Socialists of the Party of Labour, together, to command an effective majority in parliament. Thus the first ministry of the Catholic Louis Beel and the four ministries of the Socialist Willem Drees consisted of coalitions in which these two parties shared most of the portfolios. A system of economic councils on which government, employers and employees were seated was set up, culminating in a Social Economic council as an advisory chamber; and the development of the welfare state was promoted by a further extension of old-age pensions and unemployment insurance, side by side with collective wage-fixing. This expansion of the state's control over economic life, however, provoked a revival of Liberal feeling and was the real reason why the Liberals, having participated in the cabinets of 1948 and 1951, left the coalition in 1952, though they made the Indonesian question their pretext for leaving. The growing demand for greater freedom in private enterprise moreover benefited the Liberal party in the elections, in which their strength rose from 6% of the votes in 1945 to 12% in 1959 (it fell however to 10% in 1963).

When Drees resigned in Dec. 1958 a caretaker government of Catholics and Calvinists, under Beel, took office till the elections of March 1959. Then, however, the Catholic party inclined to the Liberal view on the matter of wages, with the result that the postwar Labour-Catholic coalition broke up. In May 1959 a new coalition ministry under the Catholic Jan Eduard de Quay was formed, in which all the major parties except the Socialists took part (the Antirevolutionaries and the Christian Historicals had respectively 9.4% and 8.1% of the vote). In fact, the differences between government and opposition were largely a matter of degree rather than of principle, except for the Communists, who for a short time after the liberation strongly influenced a section of the trade unions and were able to organize widespread strikes.

At the elections of May 15, 1963, the Catholics slightly increased their strength, obtaining 50 seats out of a total of 150, while the Socialists declined from 48 seats to 43. The Liberals also fell, from 19 seats to 16. The newly formed Farmers' party won 3 seats. The Communist vote, which had declined between 1946 and 1959 from 10.5% to 2.4%, increased to 2.8% in 1963 (4 seats instead of 3 in 1959). A 69-day cabinet crisis was resolved on July 23 when Victor Marijnen, a Catholic, formed a new coalition government comprising the Catholics, the Liberals, the Antirevolutionaries and the Christian Historicals. The year 1964 saw the engagement and marriage (without parliamentary approval) of the queen's daughter, Princess Irene, to Prince Hugo Carlos of Bourbon-Parma, a Carlist pretender to the Spanish throne.

Marijnen's government resigned in Feb. 1965, and on April 12 another Catholic leader, Joseph Cals, formed a Catholic-Labour coalition. This government faced widespread objections to the engagement of the crown princess, Beatrix, to a West German diplomat, Claus von Amsberg; and the marriage, in Amsterdam on March 10, 1966, was the occasion of a major demonstration by the so-called "provos"—juvenile enthusiasts who agitated persistently on public affairs. Defeated in the second chamber on a budgetary question, Cals resigned on Oct. 15, 1966. Five weeks later Jelle Zijlstra, an Antirevolutionary, formed an interim cabinet. The elections of Feb. 15, 1967, were contested by 24 parties. Representation of both Catholics and Socialists in the second chamber was reduced, to 42 and 37 respectively. The Farmers got 7 seats, the Communists 5, the Christian Historicals 12, the Antirevolutionaries 15, and the Liberals 16. A new party, Democrats '66 comprising mainly young intellectuals and advocating abandonment of the system of proportional representation, won 7 seats. Four smaller parties shared the 9 other seats. On April 3 the Catholic Piet de Jong formed a new government: Catholics, Liberals, Christian Historicals, and Antirevolutionaries. A son, the first of the royal house since 1851, was born to the crown princess on April 27, 1967.

External Affairs.—The greatest problem in foreign policy was presented by the independence movement in Indonesia. The Japanese surrender (1945) left a power vacuum in the Netherlands East Indies which was filled only slowly by the arrival of British and Dutch forces. Meanwhile Sukarno, Mohammed Hatta and other Indonesian nationalists proclaimed a republic, which soon established its authority over Java and Sumatra. The Dutch government at first refused any contact with the republicans and, even after discussions with more moderate leaders (April 1946), continued to dispatch large forces to Indonesia. Hoping to create a United States of Indonesia that would be a partner in a Netherlands-Indonesian union, the Dutch sought to bring the states into being beside Sukarno's republic; and H. J. van Mook, as lieutenant governor-general, proceeded to recognize 15 such states, as approved by a special commission under Schermerhorn. Yet neither the right in the Netherlands, led by Gerbrandy, nor the republican extremists in Indonesia were satisfied by the "Renville" agreement of Jan. 1948, and a second military action was launched in December. Though this was stopped at the behest of the U.N. Security council, guerrilla fighting went on. Finally the round-table conference that had been demanded in 1936 met at The Hague; and under the agreement of Nov. 1949 sovereignty was conceded to Indonesia. Yet no solution could be found for the symbolic function of the monarchy at the head of a loose union of the Netherlands with a federal Indonesia. In fact Sukarno's republic, having absorbed the partner states, declared the union with the Netherlands null and void (1954). All Dutch economic and educational activities in Indonesia were gradually brought to an end; some Dutchmen were brought to trial for subversive activities; and at last the Dutch were virtually expelled. The Indonesian claim to Netherlands New Guinea (West Irian), as part of the East Indian inheritance, led to the breaking off of diplomatic relations in Aug. 1960 and, in Oct. 1962, to a Dutch-Indonesian agreement for the temporary administration of that territory by the United Nations. (*See* INDONESIA, REPUBLIC OF; NEW GUINEA.)

Meanwhile Queen Juliana in Dec. 1954 had signed the new Statute of the Realm, whereby the colonial status of Surinam and the Netherlands Antilles was abolished. These territories and the Netherlands proper were recognized by the statute as fully autonomous parts of a single kingdom.

Apart from the Indonesian question, the foreign policy of the Netherlands after World War II clearly showed that the idea of

association had replaced that of neutrality. A member of the United Nations from 1945, the Netherlands in 1950 sent a contingent to the U.N. forces in the Korean War. The Netherlands also joined the North Atlantic Treaty organization, the Council of Europe, the European Defense Community and the Western European union. In the sphere of international economic co-operation, plans for the Benelux union (Belgium, the Netherlands and Luxembourg) had already been put forward during the war (1944), but the divergent interests of agriculture proved an obstacle to full integration. Similarly the Netherlands, having been a member of the European Coal and Steel Community from 1952, joined the European Economic Community from its inception; but here again agricultural interests caused problems even before France's revolt, in the mid-1960s, against the ideal of "supranationality" to which the Netherlands, with other members, still adhered. (F. DE J.; X.)

V. POPULATION

The population of the Netherlands (1960 census) was 11,461,964. The average density was 821 per square mile. This density, one of the highest in the world, was chiefly the result of an intense concentration within the two provinces of North and South Holland (1,832 and 2,194 per square mile).

Between the years 1830 (the date of the separation of Belgium from the Netherlands) and 1962 the population of the Netherlands rose by 9,000,000. The greater part of this increase took place during the 20th century, mainly through the birth rate exceeding the death rate. In the years after World War II there was a large increase in the birth rate, and between 1945 and 1956 it averaged approximately 1% of the population yearly. A high proportion (37.4% in 1954, 38% in 1963) of the population is within the age group under 20. When Indonesia became independent about 200,000 Dutch nationals were repatriated to the Netherlands.

As a result of this population increase and of accompanying postwar economic difficulties, emigration, which was only moderate before 1939, increased for a time after the war (62,737 in 1956). But above all the Netherlands was compelled to intensify industrialization. The start of industrialization in the Netherlands was rather late, but during the 20th century there was an increasing drift into urban areas and in 1962 the 98 towns of more than 20,000 inhabitants contained about 60% of the population. Of the working population—in 1960 numbering more than 4,000,000 (about 3,241,000 male and 920,000 female)—41% worked in industry, 11% in agriculture and fisheries and 48% in other services.

The highest concentrations of population are found in South Holland, southern North Holland and the greater part of Utrecht, an area which is less than one-fifth of the country, but which contains about 43% of the total population. Most of the largest towns are to be found there, six of which have more than 100,000 inhabitants. The area is of a complex structure, comprising the strongly industrialized port districts of Rotterdam and Amsterdam. The towns of Utrecht, Haarlem, Leiden, Hilversum, Delft, Dordrecht and Amersfoort, the most eastern outpost of this area, are also much industrialized, as is the commune of Velsen at the mouth of the North Sea canal. The Hague, as the seat of government, is an administrative as well as a residential and industrial centre. The environs of Haarlem (Kennemerland) and the Gooiland, and the sandy area of the glacial region of Utrecht comprise a densely populated residential region.

Outside this main area, industry is spreading all over the region of the glacial ridges in the central part of the country. Although this region is predominantly one of mixed farming in addition to some traditional centres of industry (*e.g.*, Deventer, Apeldoorn, Arnhem, etc.), new small centres of industry (often in old towns) have developed. The most industrialized and thus densely populated is the district of Twente, the centre of Dutch cotton milling, with Enschede (1966 est. 135,407), Almelo (56,877) and Hengelo (67,053) as the largest towns.

In the province of North Brabant and the adjacent sandy parts of north Limburg and Gelderland, the abundance of superfluous labour on many of the small holdings has fostered the growth of light industries. The chief industrial town in this region is Eindhoven, which has risen from a modest market centre of 6,448 (1912) to a town of 181,609 (1966 est.). Tilburg (146,770), Breda (117,427), Nijmegen (142,022), 's Hertogenbosch (77,957, the largest cattle market in the Netherlands) and Helmond (46,142) have taken part in this industrialization. Another area with a relatively high density of population is southern Limburg, where the fertile loess plateaus and the coal mines support a density up to 1,100 persons per square mile. The agglomerations Heerlen-Kerkrade (127,659) and Sittard-Geleen (70,294) are the principal mining centres. A second densely populated area clusters around the industrial town of Maastricht (94,992).

The most sparsely populated regions are Zeeland and the adjoining clay region of North Brabant and the three northern provinces, all of which are largely farming country. More industrialized is the former peat-bog region of Veenkolonien, where a varied industry is gaining over the formerly exclusively agricultural industries. The only large town in this region, Groningen (pop. [1966 est.] 154,092), has market and service functions. (H. J. KE.)

Area and Population of the Netherlands

Provinces	Area (1966; sq.mi.)	Population (1966 est.)	Density (1966; per sq.mi.)	Census (1960)	Capital	Population (1960)
Drenthe	1,036	342,280	334.6	312,176	Assen	25,216
Friesland	1,452	500,935	383.7	478,931	Leeuwarden	78,247
Gelderland	1,979	1,410,086	728.0	1,274,042	Arnhem	120,091
Groningen	932	502,560	558.8	475,462	Groningen	140,234
Limburg	853	968,739	1,153.8	886,026	Maastricht	85,188
North Brabant	1,971	1,670,632	877.8	1,495,559	s'Hertogenbosch	71,597
North Holland	1,124	2,181,454	2,107.9	2,057,322	Haarlem	167,673
Overijssel	1,517	874,493	230.0	775,759	Zwolle	52,109
South Holland	1,260	2,875,628	2,615.2	2,706,810	The Hague	602,435
Utrecht	538	745,892	1,463.4	680,678	Utrecht	251,257
Zeeland	1,042	292,267	433.2	283,465	Middelburg	21,982
South IJsselmeer Polders*	253	7,343	35.0	863	...	...
Total	13,958	12,377,194†	959.0	11,461,964‡	Amsterdam§	849,335

*Reclaimed land from the IJsselmeer, known as IJsselake polders, unincorporated as of 1966.
†Includes 4,885 persons not allocated by provinces.
‡Includes 6,326 persons not allocated by provinces.
§*De jure* capital; The Hague is the *de facto* seat of government.

VI. ADMINISTRATION AND SOCIAL CONDITIONS

1. Constitution and Government.—The kingdom of the Netherlands is a decentralized unitary state with a hereditary monarchy vested in the house of Orange-Nassau. The constitution regulates the powers of the monarch, parliament and franchise, administration of justice, provincial and municipal administration, defense, public finance, education, etc. It also safeguards freedom of religion and speech, of association and assembly and of the press. First promulgated in 1814, it has been frequently revised.

In default of a male heir, succession to the throne passes to the female. Executive power resides in the sovereign (*i.e.*, the monarch and the ministers, together called "the crown"). It comprises command of the armed forces; conduct of foreign relations, with the proviso that the assent of the states-general (statengeneraal, or parliament) is necessary for making war or peace and, in most cases, for the ratification of treaties; the appointment and dismissal of ministers; and the right to dissolve the two chambers of parliament separately or jointly. In this capacity the crown is assisted by the council of state (*raad van state*) of 20 members, which advises it on bills before their submission to parliament and on royal decrees of a legislative character. The council also advises the crown on administrative litigation requiring crown decision. The council of ministers (*ministerraad*), which is the *de facto* executive, consists of the minister-president (prime minister), appointed by the sovereign, and the ministers, including those without portfolio, and the undersecretaries of state (introduced in 1948). The ministers plenipotentiary designated by the governments of Surinam and the Netherlands Antilles (*see* below) have an advisory vote. In the event of a dispute between government and parliament, the sovereign, on the responsibility of the cabinet, may make use of his constitutional right to dissolve parliament, but only once.

Legislative power is exercised jointly by the sovereign and by the states-general. It consists of a lower house (*tweede kamer*, or second chamber) of 150 members elected for four years by direct, compulsory universal suffrage (of persons 23 years of age and older) through a system of proportional representation; and of an upper house (*eerste kamer*, or first chamber) of 75 members sitting for six years; every three years half of the latter resign. Members of the first chamber are elected by the provincial estates. Members of both chambers must have attained the age of 30. Voting is compulsory for all elections of the states-general and of the provincial estates and municipal councils.

Bills are sent by the sovereign to the second chamber after consultation with the council of state. Public discussion is preceded by inquiries by committees or departments. The second chamber may pass or defeat bills and has also the right of amendment. The first chamber, although it may discuss bills passed by the second, can thereafter only accept or reject them. In the latter case, it returns them to the sovereign to be reconsidered. Bills passed by both chambers become acts through the signature of the sovereign. The right of the second chamber to initiate legislation is seldom used. Control of the state's finances is entrusted to the auditing court (*Algemene Rekenkamer*), consisting of three life members.

Overseas Territories.—Under the constitution the kingdom of the Netherlands includes Surinam and the Netherlands Antilles (*q.v.*), which have complete domestic independence. Legislation concerning the whole kingdom (*e.g.*, on defense) is passed only after consultation with the overseas representatives. The former Indonesian possessions now constitute the independent Republic of Indonesia.

Local Government.—The Netherlands is divided into 11 provinces (*see* Table) with identical legal structures. Each province is governed by a representative assembly known as the provincial states (*provinciale staten*), composed of 35–82 members (depending on the number of inhabitants) and elected for four years with power to establish provincial regulations, which generally require approval of the crown. Its executive consists of six members with a royal commissioner, who together constitute the council of deputed states (*gedeputeerde staten*), which supervises municipal administration and the water boards. Both provincial and deputed states are presided over by the royal commissioner, who is responsible for the implementation of their decisions and for the maintenance of public order in his province.

The unit of local government is the municipality (*gemeente*). Its principal organ is the municipal council (*gemeenteraad*), consisting of 7–45 members (according to the number of inhabitants). It can institute bylaws with penalties for their infringement and may be called upon to execute the laws and decrees of the central and provincial governments. The municipal executive is composed of a burgomaster, appointed by the crown for six years, and two to six aldermen elected for four years by the council from its members. The burgomaster is responsible for public order and the council appoints a town clerk and a treasurer. Municipal co-operation is regulated by the Joint Organization act (1950) and assisted by the Union of Netherlands Municipalities, created in 1912.

The water boards (*waterschappen*) control water, dikes and certain roads, through ordinances which require the approval of the deputed states of the provinces. Usually there is a board elected by local landowners from among themselves; and an executive committee consisting of a dike reeve (*dijkgraaf*) and other reeves (*hoogheemraden*) charged with daily administration. The water board is one of the oldest forms of legal corporation in the Netherlands.

Purely functional decentralization is met with in the statutory organization of industry and trade, based on the Industrial Organization act, 1950, which provides a legal basis on which industry and trade can regulate their own affairs. A central statutory body, the social and economic council (*Sociaal-Economische Raad*), consists of 45 members appointed by the crown and by the organizations of employers and employees. It is both an advisory body to the government and the highest executive body of public industrial organization. There are also industrial boards (*bedrijfsschappen*) and commodity boards (*produktschappen*), which are set up by organized industry.

2. Political Parties.—The principal parties are: the Catholic People's party (*Katholieke Volkspartij*), which takes as its basis the principles of natural moral law and divine revelation; the Anti-revolutionary party (*Anti-Revolutionaire Partij*), which is Calvinist and accepts the Bible as the source of truth with regard to political as well as religious aims and is opposed to the principles of the French revolution; the Christian Historical union (*Christelijk-Historische Unie*), which is Protestant and considers the government to be the servant of God in the history of nations; the Political Reformed party (*Staatkundig Gereformeerde Partij*), also Protestant, which stands for government entirely based on God's law revealed in Scripture; the People's Party for Freedom and Democracy (*Volkspartij voor Vrijheid en Democratie*), which is liberal and lays stress on the individual liberty and responsibility of man; the Labour party (*Partij van de Arbeid*), a democratic-socialist party with a moderate socialist program; the Netherlands Communist party (*Communistische Partij van Nederland*), with a dogmatic Marxist program; and, finally, the Pacifist Socialist party (*Pacifistisch Socialistische Partij*), founded in 1957, with general disarmament as its principal aim.

3. Trade Unions.—The trade union movement in the Netherlands derives from mid-19th-century workmen's associations. Federation began in 1893, with the nonsectarian unions. Next, partly in reaction against them, came the socialist federation in 1905 (membership at mid-20th century, over 510,000). Catholic unions, organized on a local and diocesan basis and not according to trades, were federated in groups in 1924 and, after a period of internal disagreement, were united in the Catholic Workers' movement (*Nederlandse Katholieke Arbeidersbeweging*, 410,000). The Christian National Federation of Trade Unions (*Christelijk Nationaal Vakverbond*, 220,000) was formed largely in reaction against the syndicalist tendencies of the late 19th century. There are also nonaffiliated unions, with a membership of about 250,000. Membership in a union is not a condition of employment.

The unions have greatly contributed to the creation of a body of social legislation and to the general improvement of social conditions. Apart from the sphere of terms of employment, the federations are represented in numerous social and economic organs which act as advisory bodies to the government; they are also co-partners in the sphere of public law.

4. Taxation.—Taxation in the Netherlands consists chiefly of direct and indirect taxes, excise and customs duties. The most important direct taxes are the following: (1) corporation income tax on net profits; (2) dividend tax on share and bond dividends; (3) directors' tax on income derived from directorship of a company; (4) real estate tax on the sales value of property; (5) personal property and rental value tax, levied on the rental value of dwelling houses and the value of the furniture therein; (6) individual income tax, on income both of residents and of nonresidents with resources in the Netherlands. The principal indirect tax is that on sales or turnover, levied upon delivery of goods by a manufacturer or trader to another manufacturer or trader or to a consumer. Also subject to this tax are the importation of goods and the rendering of services for payment. Estate, transfer and donation duties, regulated by the Succession act, are collected from heirs or recipients.

The Benelux countries apply a common tariff of import duties to merchandise on importation into the various territories, in accordance with their customs agreement, the rates being moderate. As members of the Common Market, these countries keep their tariff policy in harmony with the obligations of the treaty of Rome.

5. Living Conditions: *Wages and Wage Policy.*—Before World War II, employers and employees were free to fix wages and other conditions of employment by joint consultation. Government intervention was restricted to a few exceptional cases. However, in 1945 the Extraordinary Employment Relations decree instituted a board of government conciliators (*college van rijksbemiddelaars*), which became the chief executive organ of wage policy. After 1955 the tendency was toward a freer wage policy, giving organized industry and trade unions a greater part in wage

determination. However, the ultimate decisive power remained with the central government.

Social Insurance.—In the 20th century extensive legislation accumulated in this field, comprising the Industrial Accidents Insurance act, 1921; the Agricultural Accidents Insurance act, 1922; the Seamen's Accidents act, 1919; the Disability act, 1913; the Unemployment act, 1949; the Children's Allowance act, 1939 (revised 1962); the Sickness Insurance act, 1930; and the Sick-Fund decree, 1941. Some acts set a wage limit which is periodically revised in the light of the national price index figures. Administration of the system is partly in the hands of the social insurance bank and the regional labour boards and partly entrusted to the 26 occupational associations established by the employers' and employees' unions. General supervision rests with the social insurance council.

Pensions.—The General Old Age Insurance act, which came into operation on Jan. 1, 1957, provides for compulsory old age insurance through contributions by all persons between 15 and 65 years of age. Pensions may be claimed at the age of 65 and fluctuate with the wage index figures. The act is administered by the social insurance bank, contributions being collected by the income tax authorities. The General Widows' and Orphans' act (1959) allows a pension varying with the age of the widow and the number of her children.

There are also a considerable number of private industrial pension schemes. Under the Industrial Pension Funds act (1949) the minister of social affairs may declare that participation in the branch fund is compulsory for a whole branch of industry, provided that he is so requested by a representative body of that branch. The Pension Funds and Savings Funds act (1954) contains regulations with which an employer has to comply once he has set up a fund for his company. Separate regulations, laid down in the Superannuation act (1922), apply to old age and disability pensions for civil servants. Contributions are made by both the civil servants and the authorities, and the amount of pension is correlated with the length of service and the latest salary.

Protection of Workers.—Adult male workers are limited by law to a 48-hour week and an 8½-hour day; but by the early 1960s a 45-hour week was being worked throughout industry, trade and the civil service. Special regulations apply to dangerous or unhealthy work and to overtime. There is legislation for the safety of workers, the prevention of industrial accidents and for special groups. Supervision of the observance of labour protection legislation is entrusted to the labour inspectorate.

Housing.—The Housing act (1901), frequently amended, is the legal basis for improvement of housing conditions. It provides for municipal bylaws laying down detailed rules for house construction, for the best use of land and for municipal financial support to local housing societies. Drastic government intervention was necessitated by the destruction and damage of World War II. This control was gradually relaxed; and by the 1960s municipalities and housing societies were the chief initiators of building. The total number of dwellings increased from 2,109,000 in 1945 to nearly 3,000,000 in the early 1960s.

6. Welfare Services.—Social work in the Netherlands is of long standing, though before the 20th century it was mainly confined to religious and private charity, concentrating on such groups as neglected children, old persons and delinquents. With the growth of the social insurance system there developed various kinds of aid of a more individual trend, in which stress was rather on personal guidance than on the material element. After World War II the development of social work was impressive.

Institutions can be classified as denominational (Protestant, Roman Catholic and humanist) or organizational. The latter group include the Central Council for Homemakers' Services, the National Federation for Child Welfare, the Netherlands Federation for Care of the Aged and the Netherlands Family council. Local collaboration between voluntary organizations and public authorities is effected by social councils. The ministry of social affairs (set up in 1952) has mainly co-ordinating, stimulating and subsidizing functions; it regulates subsidies to the various services or to village and district centres, etc. The organizations usually receive provincial and municipal as well as state subsidies.

State legislation concerning poor relief is represented by the Poor act (1912). In accordance with tradition this act starts from the principle that aid given by churches and private bodies comes first and that public assistance is only subsidiary. With the rise of social insurance the importance of the act is for those groups which do not come under the provisions of social legislation.

7. Health.—Health services are the care both of the government (including provincial and municipal authorities) and of private organizations. Supervision of public health is the responsibility of a directorate operating through five divisions: medical, pharmaceutical, veterinary, licensing and mental health. There are also specialized state institutions such as the institute for public health and the institute for drinking water supplies. Municipal activities comprise medical supervision of schools and disease control. The most important private organizations are the "Cross" associations, which originally had the improvement of home nursing as their principal purpose. They are Protestant, Roman Catholic or nonsectarian and have nearly 2,000,000 members. Their activities consist chiefly of preventive health care (operation of health centres, baby clinics and advice bureaus) and of home nursing through district nurses. Other private organizations specialize in tuberculosis, cancer, rheumatism, etc. Hospitals, sanatoriums and institutions for mental diseases are mainly run by private organizations; about 25% of hospitals are municipal. The population of the Netherlands is among the healthiest in the world and the average life expectancy of a Dutch child born at mid-20th century was more than 70 years.

8. Justice.—The judiciary occupies a position of independence because judges are appointed for life; furthermore under the constitution all civil disputes must be adjudicated upon by judges unless the parties agree to settlement by arbitration. In general, professional judges try both civil and criminal cases; trial by jury is unknown in the Netherlands. Laymen may preside only in a few civil cases and in cases concerned with administrative justice.

The ordinary courts comprise 62 magistrates' courts, 19 district courts, 5 courts of appeal and the supreme court at The Hague. The magistrates' courts (*kantongerechten*) are competent to deal with all ordinary civil cases involving amounts up to 500 guldens, besides disputes relating to leases, rents and labour contracts. These courts can also try minor criminal cases.

The district courts (*arrondissementsrechtbanken*) are competent in the first instance in all civil cases not left to the magistrates' courts and in all serious criminal cases. These courts also adjudicate on appeals against magistrates' courts' decisions. They consist of a number of chambers, some with three members, some with one, constituted by specialist judges for: (1) petty offenses (*politierechter*); (2) cases involving juveniles (*kinderrechter*); and (3) economic cases of a criminal nature (*economische politierechter*). The president of the court has the power to give immediate decisions in civil cases in summary procedure.

The courts of appeal (*gerechtshoven*) decide in the first instance on tax matters only. Their principal task is to consider appeals against the judgments of the district courts. They are divided into chambers consisting of three judges.

The supreme court (*De Hoge Raad der Nederlanden*) has three chambers, for civil, criminal and tax cases, and also tries ministers, high civil servants, members of parliament, etc. Its chief function, however, is to interpret rules of law in the last instance and to guarantee the uniform application of the law throughout the kingdom. To this end it has the power to reverse decisions of lower courts which it judges to be at variance with the law (*cassatie*), but it may only consider appeals in cases where appeal to a lower court is no longer possible. Its judgment is confined to points of law. Although its decisions have not the force of binding precedent, they are generally taken into consideration by lower courts in similar cases.

Legal assistance for parties to civil cases is compulsory except in magistrates' courts. In lower courts the legal representative is called *procureur;* in general, legal counsel is given by *advocaten.* In both civil and criminal cases free legal aid is given to persons without means.

The Public Prosecutor's Office.—Only in criminal cases can the public prosecutor's office institute proceedings; it is not obliged to prosecute every case of which it takes cognizance. However, a wronged party may petition a court of appeal to order the office to prosecute; such an order may also be given by the minister of justice. The public prosecutor's office consists of the attorney general and the solicitors general, who are attached, respectively, to the supreme court; and the public prosecutors and deputy prosecutors attached to the courts of appeal and to the lower courts.

Administrative Justice.—Courts concerned with the dispensation of administrative justice exist in certain special fields. There are courts dealing with social insurance laws and with regulations for civil servants. Appeals against the judgments of these courts are dealt with by the central council of appeal; a different council of appeal deals exclusively with appeals against decisions of statutory trade-organization bodies.

Police.—The Police act (1956) distinguishes between state police (*Rijkspolitie*) and municipal police. The state police corps comes under the minister of justice and is commanded by an inspector general. The corps is divided into districts and these into groups (the latter often subdivided into posts); it serves all municipalities with less than 10,000 inhabitants besides those with between 10,000 and 25,000 inhabitants which are listed in the act. The remaining municipalities of this latter group and all those with more than 25,000 inhabitants have police forces of their own, controlled by the burgomaster. The military corps of royal constabulary (*Koninklijke Marechaussee*) is charged with certain civil police tasks, such as guarding the frontiers: it is also especially charged with guarding the royal family. Other duties include the keeping of law and order and the investigation of offenses in the armed forces.

9. Education: *Primary Education.*—The constitution lays down that the cost of voluntary general primary education (fulfilling certain conditions imposed by law) is to be defrayed from public funds on the same scale as public education. State primary schools are run by the municipalities; voluntary schools by the organizations which set them up. The costs of both state and voluntary primary education are mainly borne by the municipalities; teachers' salaries are reimbursed by the state. State supervision is exercised by the schools' inspectorate. Primary education (compulsory since 1900) is free throughout the period of obligatory schooling (7–15 years of age).

In the early 1960s more than 1,500,000 pupils in nearly 8,000 schools (27% municipal) were receiving ordinary education. There were also 500 special schools for children with physical or mental handicaps. Infant education, which is not compulsory, is given in about 4,000 schools (75% voluntary) to more than 400,000 children in the age group 4–7 years.

Preparatory Higher and Secondary Education.—In this field, state and voluntary schools are not on the same financial footing. The oldest type of school is the gymnasium, developed from the former Latin school. It provides a six-year course; pupils may choose either the A stream, which stresses Latin and Greek, or the B stream, concentrating on the exact sciences. The Hogere Burgerschool (H.B.S.) gives a broad, general five-year course; it too has an A stream (literary and economic) and a B stream (stressing the exact sciences). The lyceum is a combination of the other two in the sense that after an initial course of one or two years its pupils choose either the gymnasium stream or the H.B.S. stream. There were about 450 of these types of schools in the early 1960s, with more than 170,000 pupils, about one-third of whom were girls.

The foregoing types of school prepare pupils for universities. Other types, which do not, are the commercial day schools, which give a three- or four-year course stressing modern languages, mathematics and commercial sciences; and the girls' secondary schools, which provide a five-year course. Commercial training is also given in commercial evening schools.

Technical and Vocational Education.—In this field there are about 1,370 schools and courses (technical, advanced technical, domestic, etc.), with about 450,000 pupils. In addition, there are more than 450 agricultural and horticultural primary and secondary schools, while more than 50,000 young people learn crafts or trades through apprenticeships.

University Education.—The Netherlands has six universities: Leiden (founded 1575), Groningen (1614) and Utrecht (1636), all state universities; Amsterdam (municipal, 1632); the Free (Vrije) University of Amsterdam (Orthodox Protestant, 1880); Nijmegen (Roman Catholic, 1923). There are two state institutes of technology (Delft and Eindhoven); and two schools of economics, Rotterdamse Economische Hoogeschool (private, nonsectarian) and Tilburg (private, Roman Catholic). The agricultural University (Landbouwhogeschool) of Wageningen is run by the state. The total number of university students is more than 35,000, of whom about one-sixth are women.

As a rule, universities have faculties of theology, law, medicine, mathematics, natural sciences, literature and philosophy. The universities of Amsterdam and Groningen also have faculties of economics and of political and social sciences. A degree in dentistry can be obtained at Groningen and Utrecht; the latter university has also a faculty of veterinary science. The expenditure of the state institutions is fully borne by the state; voluntary institutions receive state support varying from 70% to 90% of their costs. Student life is highly organized, both on the local and the national level.

10. Defense.—During the 19th century the armed forces were made up of various components, viz., a standing army of volunteers, a militia (mainly volunteers) and the local civic guards. A system of universal military training came into force in the 20th century. As provided in the Compulsory Service act (1920), all able-bodied men, on reaching the age of 20, are enlisted for military service. Army training is of 18 months' duration, cadre and specialized categories serving an additional period. Primary training may be followed up by periodical refresher courses. Regular officers are trained at the Royal Military academy at Breda; there is also a school for regular noncommissioned officers.

The naval forces of the Netherlands, drastically reduced during World War II, consist of a fleet of postwar-designed cruisers, destroyers, submarines, aircraft patrol boats and an aircraft carrier. The navy incorporates the naval air service and the royal marine corps. The naval officers' training institute is at Den Helder, the main naval base in the Netherlands. The royal air force, which had also lost most of its craft during World War II, was gradually re-equipped with modern squadrons of jet fighters, fighter-bombers and other types. It has 13 operational air bases. The three women's voluntary auxiliary corps (attached to the army, navy and air force) function mainly in the field of liaison and medical care. The Netherlands' post-World War II forces were built up according to the country's NATO obligations; and they are also responsible for the defense of the oversea possessions.

Civil Defense.—Under the responsibility of the royal commissioners and the burgomasters, civil defense corps are set up and trained for emergencies. In addition, undertakings of a certain size are obliged to provide for self-protection. A number of mobilized military units were created to assist in the defense of the interior and to support the civil defense corps. (P. W. v. W.)

VII. THE ECONOMY

Although agricultural products form an important part of the national exports, the Netherlands is a highly industrialized country. Next to the export of industrial products, the export of services (shipping, investment, brokerage, etc.) contributes to the balance of payments.

A. Production

The agricultural prosperity of the Netherlands probably owes more to the ingenuity and labours of its engineers and farmers than to the natural fertility of the soil, which is rather poor. The total of farm and horticultural land is about 5,700,000 ac., approximately 70% of the country's area; of this, nearly two-fifths is plowland, about three-fifths grassland and 340,000 ac. horticultural area. Woodland covered 690,000 ac. in 1961 and infertile regions, 525,000 ac.

Arable Farming.—The main agricultural area comprises parts of the reclaimed polder lands of the coast from Zeeland to Groningen. Those of the southwest (Zeeland, northwestern North Brabant and the islands of South Holland) and along the Frisian and Groningen coast are composed of heavy marine clays which, after preparation, yield good grain (especially wheat and barley) and root crops. A second agricultural area is formed by the former peat-bog regions of Groningen, Drenthe and northeastern Overijssel. The specialized farming of this region produces cereals, especially rye, oats for fodder and potatoes. A third and new agricultural region consists of the reclaimed Zuider Zee polders with wheat as their main crop.

In the polder lands of North and South Holland and in western Utrecht, arable farming is mainly restricted to the surface of drained lakes. The rest is rich pasture which supports a dairy and cattle industry. In the south, because of the proximity of large communal centres, there is an emphasis on market gardening. The polders of Friesland are cattle-raising areas and rival those of North and South Holland. The clays of the central river deltas do not offer such good farming land as the marine clays. Large districts are therefore given over to grazing land, though where conditions have been improved there is mixed farming and horticulture. A part of this region (especially the Betuwe) is also one of the principal orchard districts. The sands and gravels of southern and eastern Netherlands have a somewhat poor soil. Cultivation, through clearing and reclaiming of local peat areas and marshes, drainage and irrigation, has been much extended during the 20th century. The sand regions have become the most important region of cattle farming, and at 's Hertogenbosch and Zwolle the largest cattle markets of the country are held. Farming is of a mixed type; the arable land is planted with rye, oats and potatoes, which are all used for fodder. Next to horned cattle, pigs and poultry make up the livestock.

Southern Limburg forms a district apart. Instead of sand, it possesses a high proportion of fertile loams which are roughly half arable and half pasture. The development of the region as an industrial area stimulated dairy farming and market gardening.

On the whole the farms of the Netherlands are of small and medium size. In the clay regions, where farming is mostly arable, the holdings have an average size of 100 ac.; holdings larger than 250 ac. are frequent. In the sandy regions many small farms still occur, but through reallocation and the buying up of small holdings more and more farms are attaining the size that is normal for this type, about 40 ac. Holdings of the former peat-bog region have an average size of about 70 ac.

The area under wheat has increased, partly as a consequence of the reclaiming of the Zuider Zee polders. Similarly, the area under oats is increasing with more intensive cultivation. Of the other crops, potatoes are grown for human consumption, for seed and for commercial preparations such as potato flour, glucose and dextrine. Sugar beets and fodder beets are grown particularly in the north and the southwest. Traditional crops like madder and rapeseed, chicory, hemp and even flax have either vanished or are in decline, being supplanted by caraway, poppy and colza and especially by seed potatoes. Agricultural processing also includes the making of strawboard and cellulose. Both these industries, whose products are much exported, are concentrated in the northeast, especially in the former peat-bog region (Veenkolonien).

Horticulture.—Horticulture, long an important aspect of Dutch agricultural life, became in the 20th century a principal item in the export trade. The area under market gardening in the 1960s was about 340,000 ac. It flourishes particularly in the provinces of North and South Holland. A strong regional specialization occurs. In the region between Rotterdam and The Hague (Westland) and to the north of Rotterdam the growing of vegetables under glass predominates. The inner side of the dunes between Leiden and Haarlem is almost entirely devoted to bulb growing (principally tulips, hyacinths, daffodils, gladioli, crocuses and narcissuses). The region north of Alkmaar specializes in cabbage, that between Hoorn and Enkhuizen in fruit and flower seeds. There are also some local centres for flower growing (Aalsmeer) and for pot plants and shrubs (Boskoop). Main centres of horticulture elsewhere are in Zeeland, western North Brabant and Limburg.

Cultivation of fruit has developed considerably throughout the whole country. Pasture or arable orchards predominate in southern Limburg and on the river-clay districts of Gelderland and western Utrecht. Orchards of apples, pears and plums, among which grow various bush fruits, are found particularly in Zeeland (South Beveland), in the west of North Brabant and in South Holland.

Animal Husbandry.—Animal husbandry is mainly concerned with the production of milk and its derivative products. There is also considerable breeding and export of dairy cattle (famed Holstein-Frisian cows). The supply of meat for the home market is obtained by fattening part of the dairy herd, which in the early 1960s exceeded 3,800,000 head. Special breeds of beef cattle do not occur in the Netherlands. The oldest centre of the dairying industry is the pasture polders of North and South Holland and of western Utrecht. More important, however, for the production of butter, cheese and other milk products are the dairy farms of Friesland and the sandy regions. This production is almost entirely centred on about 500 dairy factories, of which almost 70% are co-operative.

Pigs (between 2,500,000 and 3,000,000) are of two kinds: the Dutch pork pig, bred chiefly for the home market, and the bacon and ham pig for export. They form part of the mixed-farming economy of Overijssel, Gelderland and North Brabant. Poultry raising and egg production are important in the same areas.

Forestry.—Although the government has planted large forests in the sandy regions, especially in Drenthe, forestry plays only a small part in the economy of the Netherlands.

Fisheries.—From the middle ages, herring fishing was a principal occupation of the Dutch. During the 20th century, chiefly because the country failed to keep its fleet modernized, deep-sea fishery tended to decline; the rich fishing grounds of the North sea were favoured in preference to more distant grounds. Herring constitutes the chief catch, with plaice, sole, cod and mackerel of less importance. Chief fishing ports are IJmuiden, mainly for fresh fish, and Scheveningen and Vlaardingen for herring. Coastal fisheries concentrate on mussels, oysters and shrimps.

Industry.—The industrialization of the Netherlands, though retarded by a lack of natural resources and by a paucity of coal, grew steadily after the mid-19th century. An increasing population and limited land made it essential to exploit economic resources other than commerce. Local agriculture and tropical products were developed and the traditional industries such as shipbuilding, textiles and paper production were modernized. As a commercial country, the Netherlands had an abundance of private capital. Initially the emphasis was upon the technical improvement of existing industries in the ports. The agricultural resources of the Netherlands were adapted to milk processing, margarine manufacture, potato-flour milling and strawboard production. Later, capital and scientific research were applied to technical industries which required a minimum of raw material, such as electrical and radio equipment, synthetic fibres, and component parts. At the beginning of the 20th century the introduction of heavier basic industries began with the exploitation of the Limburg coal field and, later, of the salt beds in eastern Overijssel, near Hengelo, and Groningen (Delfzijl). As a result coking, chemical and, later, iron and steel industries have developed.

Damage and loss in World War II was aggravated by the loss of Indonesia, by shortages of both dollars and sterling and by a lack of skilled labour. Further industrialization of the country (necessary in view of the great increase of population) became more and more dependent upon a close integration of Dutch industry with that of western Europe and a comprehensive liberalization of trade, together with financial support from such plans as the European Recovery program till 1954. The percentage of population engaged in industry rose steadily from about 34% of the working population in 1899 to more than 40% in the early 1960s (see *Population*, above). Industrial production rose considerably after World War II, especially from 1954, while labour productivity rose satisfactorily. After 1955 it was even necessary to import workers

from other European countries to meet a labour shortage.

The chief industrial regions are North and South Holland and Utrecht. Outside Holland and Utrecht there are industrialized regions in North Brabant, parts of Gelderland, Overijssel, Groningen and southern Limburg. Industry is largely based on medium-sized or small private undertakings. After 1960 there were about 10,500 undertakings (of 10 or more workers) with a labour force exceeding 1,000,000. Governmental policy has been to stimulate further industrialization, especially in those parts where economic development is lagging, as in the northern provinces.

Mining, Fuel and Power.—Coal, in the south of Limburg, is worked by state and private enterprise, the latter by a concession from the state. Technically the industry is well advanced.

The refining of petroleum was not important in the Netherlands before World War II. Of the total oil import in 1938, about 26% was crude oil. In postwar years domestic production was increased, chiefly from the Schoonebeek oil field in Drenthe, and later from the western part of the Netherlands, around Rijswijk. In the early 1960s about 20,000,000 tons were imported annually and refined at Pernis, along the New waterway. By 1960 the Netherlands was already the most important exporter, after Great Britain, of petroleum products in Europe.

Natural gas was discovered in the Netherlands in 1948. It remained economically unimportant till the Slochteren field, in the province of Groningen, was discovered in 1960. Proven reserves are 1,100,000,000,000 cubic metres, which is about half the west European total. The state and the state-owned coal mining company, together with the two leading oil companies in the Dutch market, share the ownership of the gas distribution company, thus making a well-balanced energy policy possible. Inland distribution started in 1964; export to Germany and other countries was the subject of negotiation. To increase consumption an aluminum plant was projected in Delfzijl. Prospecting for oil and natural gas was taking place in the Frisian isles and adjacent seas.

Electricity is furnished by thermoelectric plants which are fired by coal or oil. The annual consumption is 15,500,000,000 kw.hr.

Metallurgy.—Despite its great lack of mineral deposits, during the 20th century the Netherlands has built up a metal industry. Between 1930 and 1950 the number of workers rose by 95%. Iron smelting was begun in 1924 at IJmuiden with ore chiefly from Spain and Sweden, and steel is produced there and in Utrecht. Nevertheless, steel is imported from Belgium, Germany and Great Britain (for shipbuilding). Tin and zinc are smelted.

Shipbuilding.—Shipbuilding and repairing has long been one of the Netherlands' chief industries. Numerous shipyards are found along the rivers between Schiedam and Dordrecht in the southwest, at Amsterdam and, to a lesser extent, Hoogezand-Sappemeer (Groningen), which specializes in smaller vessels (coasters). In the mid-1960s there were nearly 200 shipyards with more than 25 workers. Shipyards have tended to switch to the more profitable business of petrochemical plant construction.

Engineering.—The Dutch metal industry has been created chiefly as an ancillary to shipbuilding and maintenance of the merchant navy. At first the engineering industry specialized in marine engines, and in machinery for domestic and colonial industries and for public works, such as oil-well equipment, tin dredges, pumps and metal constructions such as bridges and house frames (the latter in particular at Gorinchem, Dordrecht). Lighter electrical and wireless equipment have since become important. Chief centres are at Eindhoven and Nijmegen. Since World War II the aircraft industry, including the manufacture of component parts and specialized technical equipment, has developed increasingly.

Chemicals.—The Dutch chemical industry developed in connection with the salt deposits at Boekelo (Overijssel) and at Delfzijl (Groningen). Nitrogenous and phosphate fertilizers, coal derivatives, refinery products, paints and pharmaceuticals, etc. are also manufactured or processed.

Textiles.—The manufacture of woolen cloth in most of the medieval towns, but in particular at Leiden, was formerly the Netherlands' most important industry, which benefited from the immigration of skilled workers from Flanders in the 16th century. Later the linen industry developed in the Twente district. In the 19th century this industry turned its attention to cotton, and gradually Twente and North Brabant became the chief textile areas, with the woolen and linen manufacture concentrated in North Brabant. Other textile manufactures were rayon, lace and carpets. Hosiery is made in many towns, and ready-made clothing especially at Amsterdam, Groningen and in the Twente district.

Other Industries.—Leather and footwear are produced in the towns of North Brabant and also at Nijmegen in Gelderland; production after World War II was roughly adequate to home demands. A timber trade, chiefly concentrated in the towns of North and South Holland, especially at Zaandam, produces wood for building and supplies the pulp and paper industries. The latter is supplemented by the production of strawboard from cereal straw. The rubber industry expanded after World War II, chiefly in the production of tires (The Hague, Enschede, 's Hertogenbosch) and other consumer articles. Food industries are principally concerned with sugar (manufacturing and refining), milk products and vegetable oils; cigars are made. The diamond-cutting industry of Amsterdam declined greatly after World War II.

Tourism.—Receipts from tourism are significant to the economy and by the early 1960s more than 4,000,000 tourists from abroad were visiting the Netherlands annually. The coast line of the North sea with its broad beaches of sand are popular vacation areas. Scheveningen, Zandvoort and Noordwijk are the chief seaside resorts. The Frisian islands have also become popular holiday places. The many lakes and broad waterways of Friesland are good for yachting, as are the broad estuaries of the southwest. The Netherlands has many old towns of which Amsterdam (with its canals), Delft, Leiden, Gouda, Alkmaar, Zierikzee, The Hague and Maastricht are of great interest. Outside the provinces of North and South Holland are many remarkable, and mostly smaller, old towns, and many rural regions (in particular the province of Drenthe and the eastern part of Gelderland) still offer an unspoiled landscape. The new polders in the Zuider Zee region, as interesting examples of new developments, attract many sightseers.

B. Trade and Finance

Foreign Trade.—The Netherlands shows the characteristics of a densely populated and industrialized country, which has by its increasing population been compelled to stimulate its exports. Nevertheless, imports exceed exports, though the cover of visible imports by exports is increasing (1938, 73%; 1962, 88%).

Imports are largely made up of agricultural raw materials, particularly linseed, peanuts for chemical production, maize (corn) for fodder and wheat for human consumption; mineral raw materials, mineral oil and chemical raw materials; hides, raw rubber and rubber produce; wood, chiefly timber for constructional purposes; textiles and clothing; base metals, chiefly iron and steel, and finished machinery and rolling stock. Exports comprise agricultural produce, chiefly dairy products, vegetables, flowers, bacon, stock guts and oils; chemicals, mainly coke and fertilizers; paper and wood products; textiles, chiefly cotton goods and rayon yarns; metal products, such as ships, dredgers, instruments, radio and electrical equipment and tin.

In the early 1960s Belgium and Luxembourg, the Federal Republic of Germany, the United States and Britain were the Netherlands' chief suppliers. Its exports go mainly to Germany, Belgium and Luxembourg, Britain and the United States.

The Royal Netherlands Industries fair (Koninklijke Nederlandse Jaarbuers) organizes the important spring and autumn fairs at Utrecht and other specialized trade events.

Currency and Finance.—The monetary unit, the gulden or guilder (*f* designating the ancient florin), dates from 1795; it is divided into 100 cents. The Netherlands was the last country to abandon the gold standard (Sept. 19, 1936). The gulden was devalued with the pound in Sept. 1949; its exchange rate in relation to the U.S. dollar fell from *f* 2.65 to 3.80 and in relation to the pound was fixed at *f* 10.64. In 1961 the gulden was revalued; its relation to the dollar was fixed at *f* 3.62 or *f* 10.90 to the pound. (*See* Monetary Unit.)

The Netherlands bank, founded in 1814, was for long a private

institution but was nationalized on Aug. 1, 1948. It acted as the government's banker, and the state, in return for its privilege of issuing notes, shared in the profits.

The Netherlands possesses about 40 joint-stock banks, of which the larger are intimately concerned with industrial financing; farmers' credit banks, serving agricultural co-operatives, form a substantial section of Dutch banking.

Budget.—The Netherlands budget is divided into ordinary and capital services, both on the revenue and expenditure side. Until 1931 budgets usually showed a surplus. As a result of the economic depression of the earlier 1930s this was transformed into a small deficit. With the devaluation of the gulden in 1936, however, revenue began to increase, and in the years after World War II a surplus was once more being recorded. Postwar budgets had to provide for increasing expenditure particularly for education, social services, defense, construction of houses, roads and dikes (Delta project) and agriculture.

The local provincial and communal authorities possess some degree of financial autonomy and derive small revenue from various types of taxation, mostly supplemented by grants from the state. A chief responsibility of these local bodies is the maintenance of local roads, etc., public health, education and the police.

The national debt steadily increased after the 19th century. The 1938 total of *f* 3,986,000,000 had increased about five-fold by the early 1960s and included £974,000,000 of foreign debt.

C. Transport and Communications

Railways.—The Dutch railway network (Nederlandsche Spoorwegen, a limited liability company with the state as sole shareholder) has been maintained at an economic length. The total length in the early 1960s was 2,021 mi., of which about 1,009 mi. were electrified. Passenger traffic is of greatest importance, and little bulk freight is handled by rail.

Roads.—The development of the road system was handicapped in many areas by the nature of the land surface which is broken by large rivers and estuaries. Just before World War II considerable progress was made toward a national network by the building of many bridges for road traffic. Roads comprise main state highways, secondary and third-class roads; motorways are growing in importance. The road system, relative to others in Europe, is well developed.

Inland Waterways.—The artificial waterways were constructed originally for land drainage rather than for the carriage of goods. Later, with the considerable stretches of navigable rivers, they were found very suitable for carrying both domestic and transit goods and their network was extended. Open rivers and the main shipping canals are mostly state controlled, except in the northeast, where they are partly administered by the provincial authorities. The total length of navigable waterways was 3,600 mi.; the length navigable by barges carrying more than 1,500 tons was 1,081 mi. (which includes 429 mi. in the IJsselmeer and Delta areas).

Of the main systems that of the Rhine and its offshoots is the most important and can carry barges with a capacity of 4,000 tons. Amsterdam is connected to the sea by the North Sea canal. Another large canal (for vessels of more than 2,000 tons) connects with the Waal at Tiel, and smaller canals lead to Rotterdam, which also has an artificial connection with the sea by the New waterway. A second system is that of the Meuse, the Juliana canal and the canals of North Brabant; this links central and western Netherlands with southern Limburg and the eastern Belgian system. In the eastern and northern provinces many smaller canals carry agricultural goods. The Twente canal, which connects the industrial Twente district with the Rhine system, and the new canal system in the northern provinces (from Delfzijl-Groningen to Harlingen and Lemmer) take ships up to 1,350 tons.

Before World War II the Dutch inland fleet was the largest of western Europe, with around 20,000 craft (4,454,000 ton capacity). In the early 1960s it possessed more than 19,000 vessels of about 5,325,000-ton capacity. The waterways are responsible for more than half of the internal traffic of the country. They also play an extremely important part in transit trade. Rhine-borne traffic figures alone were 28,200,000 tons downstream and 27,600,000 tons upstream in 1938, to be compared with 25,033,000 and 53,388,000 in 1961.

Sea-Going Shipping.—The Dutch have long been a seafaring people, though during the Napoleonic wars their flag practically disappeared from the seas. A revival of their maritime importance began in the latter part of the 19th century, when several shipping lines were established. In spite of severe damage during World War II, the mercantile fleet by Jan. 1963 comprised 1,525 ships of 5,037,000 gross registered tons. The earnings of the Dutch merchant navy were second only to revenue derived from investments abroad. A particular feature of the Dutch merchant fleet is the many small vessels (coasters), which are mostly engaged in carrier trade; many of these are based on Groningen.

The chief Dutch ports are the ports of the Rotterdam district (Rotterdam, Vlaardingen, Hook of Holland, Schiedam and Dordrecht) and Amsterdam. The Port district of Rotterdam comprises a large series of docks on the southern side of the New waterway at the mouth of which there are new docks of large capacity (Europoort). Amsterdam benefited from the cutting of the North Sea canal across the centre of North Holland and from its artificial connection with the Rhine. Of the remaining ports Delfzijl (on the Ems), Flushing (on the isle of Walcheren) and Harlingen (on the Wadden zee) are the most important.

In cargo traffic Rotterdam overshadows all other ports of the country, its chief rival being Antwerp rather than any Dutch port. It handles eight times as much as Amsterdam, its nearest Dutch competitor. Through Rotterdam also passes by far the greater part of transit traffic that makes up about 40% of the total imports and 30% of the total exports.

Airways.—The Royal Dutch airlines (Koninklijke Luchtvaart Maatschappij or K.L.M.), founded in 1919 with government aid as a private enterprise, provides regular air services throughout Europe and between Europe and America, to the near and far east and to Australia.

Telecommunications, Radio and Television.—The post office, telegraph and telephone systems are operated by the postal administration. Radio broadcasting is controlled by five noncommercial associate companies (owned by religious or political organizations) which under a charter of 1947 merged their facilities in the Nederlandsche Radio Unie (Netherlands Radio union). They each retain autonomy in planning and transmission during hours allotted by government decree. They also control the Nederlandse Televiesie Stichtung (Netherlands Television foundation). Overseas broadcasting is carried on by Radio Nederland Wereldomroep (Netherlands World Broadcasting), controlled by the ministry of education, arts and sciences.

See also references under "Netherlands, The" and "Holland" in the Index. (H. J. Ke.)

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NETHERLANDS ANTILLES (NEDERLANDSE ANTILLEN), two widely separated groups of Caribbean islands in the Lesser Antilles. The southern group, comprising Curaçao (*q.v.*), Aruba and Bonaire, lies less than 60 mi. off the Venezuelan coast. The northern group includes St. Eustatius (*q.v.*), Saba and the southern part of St. Martin (Sint Maarten); geographically this group lies within the Leeward Islands.

Area, Population and Principal Towns

Island	Area (sq.mi.)	Population 1960 census	Population 1965 est.	Principal town
Curaçao	173	125,181	136,289	Willemstad
Aruba	69	58,743	59,415	Oranjestad
Bonaire	95	5,812	6,908	Kralendijk
St. Martin (Dutch part)	17	2,728	4,243	Philipsburg
Saba	5	980	1,019	Bottom
St. Eustatius	12	1,014	1,222	Oranjestad
Total	371	194,458	209,086	

The Southern Islands.—These islands are generally low, though hills rise to 1,230 ft. in Curaçao, 787 ft. in Bonaire and 617 ft. in Aruba. They consist mainly of igneous rocks and are fringed with coral reefs. Temperature varies little from an annual average of 27° C. (81° F.) and the heat is tempered by the easterly trade winds. The islands lie west of the hurricane zone. Rainfall is low and variable, often less than 20 in. a year, and the vegetation, much overgrazed by animals, is sparse. Cacti and other drought-resistant plants abound.

This group was discovered in 1499 by Alonso de Ojeda and settled in 1527 by the Spanish. The native Carib Indians were exterminated, except on Aruba, where their descendants form nearly two-thirds of the population. The Dutch, attracted by salt deposits, occupied the islands in 1634 and, except for brief British occupation in 1800 and 1807–16, they have remained Dutch possessions. The population is racially mixed and speaks Dutch (the official language), English, Spanish and Papiamento, a local patois composed of European and African words.

Through much of the 17th and 18th centuries the islands prospered from Dutch trade in slaves, plantation products and contraband, but they declined from 1816 until 1914, when the opening up of the Venezuelan oil fields turned the economic tide. A large oil refinery was opened in 1918 on Curaçao. Another began operating in Aruba in 1930, and by the 1960s was one of the largest in the world. The industry is now the economic mainstay of the islands, employing more than one-third of the working population and providing over 98% by value of all exports. The tourist industry and the entrepôt trade of the free ports of Curaçao and Aruba are also significant.

The Northern Islands.—These islands consist of volcanic rocks rising to 1,266 ft. on St. Martin, 1,968 ft. on St. Eustatius and 2,821 ft. on Saba. The climate is similar but rainfall is greater and hurricanes occur. They were first settled by Europeans between 1625 and 1640. Plantations of sugar and cotton were established on St. Martin and on St. Eustatius, which later became an entrepôt comparable to Curaçao. Saba, with precipitous slopes and no harbour, had no commercial value. Most of the population now engages in small-scale agriculture, but many men leave to work in the oil refineries in the southern islands. English is the principal language.

Administration.—The Netherlands Antilles are an integral part of the kingdom of the Netherlands. Executive authority is vested in the governor, appointed by the crown, and in a council of ministers of 7 members. They are responsible to the legislature (*staten*) of 22 members (12 from Curaçao, 8 from Aruba, 1 from Bonaire and 1 from the northern islands) elected by universal suffrage.

See P. H. Hiss, *Netherlands America* (1943), *A Selective Guide to the English Literature on the Netherlands West Indies* (1943); W. N. van de Poll, *Netherlands West Indies*, Eng. trans. by J. Dolman (1951). (D. R. H.)

NETHERLANDS EAST INDIES: *see* DUTCH EAST INDIES; INDONESIA, REPUBLIC OF.

NETHERLANDS GUIANA: *see* SURINAM.

NETHERLANDS NEW GUINEA (WEST NEW GUINEA, IRIAN BARAT or WEST IRIAN): *see* NEW GUINEA.

NETLEY, a village in Hampshire, Eng., about 6 mi. S.E. of Southampton by road (4 mi. by ferry), is situated in the parish of Hound and on Southampton water. There are extensive and picturesque Early English remains of the abbey founded in 1239 by Henry III and colonized by Cistercian monks from Beaulieu. The modern Netley Castle Convalescent home incorporates parts of one of Henry VIII's south coast forts. The Royal Victoria Military hospital is now the army's mental hospital; the original red-brick building (1856–63), with corridors a quarter of a mile long, is no longer used as an infirmary. Netley Marsh is another village about 5 mi. W. of Southampton. (A. G. G.)

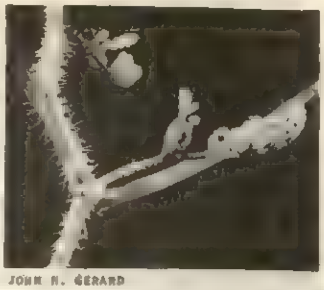
NETSCHER, CASPAR (1639–1684), painter of the Dutch school, was born at Heidelberg in Germany. His father died soon afterward and his mother moved to Arnhem, where his first master was Hendrick Coster. Later he was a pupil of Gerard Terborch and a copy, dated 1655, of Terborch's "Paternal Advice" already displays full technical mastery. In 1658 or 1659 he set out by sea for Rome, but went no farther than Bordeaux, where he was married in 1659. By 1662 he had returned to the Netherlands and settled in The Hague, where he spent the rest of his life, after establishing a fashionable practice as a portrait painter. He died on Jan. 15, 1684.

His most satisfying works are the earlier genre pieces, which maintain a high standard within the traditions of Terborch, from whom he acquired great skill in rendering textures, and of Gabriel Metsu. The "Lace Maker" in the Wallace collection, London, is a fine example. Though superficially elegant, the later biblical and mythological subjects and the small, glossy portraits that made his reputation in his lifetime are mostly deficient in true feeling or perception.

Netscher's sons THEODOR (1661–1732) and CONSTANTIJN (1668–1723) were among his many pupils and imitators. (R. E. W. J.)

NETTLE, the common name given to several plants with stinging hairs belonging to the family Urticaceae, especially to the genus *Urtica* and a few related genera. *Urtica* contains about 35 species of wide distribution. Three are found in the eastern United States, mostly as weedy plants introduced from Eurasia. The commonest is the stinging or great nettle (*U. dioica*) a cosmopolitan weed, often troublesome. Equally stinging is the native wood nettle (*Laportea canadensis*), found in rich woods throughout eastern North America. As in all nettles the stinging quality (which is not lasting, except in some tropical relatives) is caused by minute quantities of formic acid secreted in the extremely sharp-pointed hairs, which upon entry into the skin set up

instant irritation. In treelike Australian relatives (*Laportea*), the effect may last for months and has been credited with the ability to kill a horse by inducing a sudden rage.



JOHN H. GERARD
WOOD NETTLE (LAPORTEA CANADENSIS)

In southern and western United States there are other nettles, among them *U. chamaedryoides* of the southeastern states, *U. holosericea* of the western states and the closely allied western nettle (*Hesperocnide tenella*) of California.

Three species of nettle are wild and abundant in the British Isles and across Europe: the stinging nettle (*U. dioica*), a hairy perennial with male and female flowers on separate plants; the small nettle (*U. urens*), which is annual, has male and female flowers on the same plant and is also often a naturalized weed in North America; and the Roman nettle (*U. pilulifera*), also an annual, largely restricted to southern Europe. The small nettle (*U. urens*) once had some use as a fibre.

The eradication of the annual species of nettle can be accomplished by cutting off the tops before flowering, to prevent the setting of seed. The perennials are more difficult to eradicate; spraying with 2,4-D in bright weather or with chlordane provides the most effective control (*see* also WEED: *Control of Weeds*).

(N. TR.; X.)

NETTLE TREE, the name sometimes applied to certain trees of the genus *Celtis*, belonging to the elm family (Ulmaceae), especially to *C. australis*, common in Eurasia and northern Africa. The best-known species have usually obliquely ovate or lance-shaped leaves, toothed, rough-hairy above and marked by three prominent veins. The flowers are inconspicuous; the fruit is succulent, drupelike, a character that serves to separate the genus from the elms. It is a rapidly growing tree, from 30 to 40 ft. high, with a remarkably sweet fruit, recalling a small black cherry, and was one of the plants to which the term lotus was applied by Dioscorides and the older authors. The wood, compact and hard like its North American relative, the hackberry (*q.v.*), is used for many purposes.

The Australian nettle or stinging tree and the wood nettle of eastern North America belong to the family Urticaceae (*see* NETTLE).

NETWORK THEORY is a branch of engineering theory concerned with the evaluation of the properties of interconnections (networks) of basic components and with the synthesis of such interconnections for prescribed system characteristics. Network theory has been developed primarily by electrical engineers, particularly for the design of the systems for electrical power distribution and telephone transmission, but has subsequently been applied to the design or understanding of systems for water and gas distribution, industrial automation, missile and vehicle guidance and control, and automobile or aircraft traffic control. Other applications include such systems as those involved in the spread of communicable diseases and in various human functions such as seeing and hearing. The three elements of network theory are analysis, synthesis and identification.

1. Analysis is the evaluation of the properties of a given system; *e.g.*, the determination of the behaviour of an electrical power distribution system involving thousands of individual components including local loads, distribution lines, generators and protective devices. A typical analysis problem is the determination of the performance of the system when a short circuit occurs at one point.

2. Synthesis is the design of a system for specified performance. A classical problem in network synthesis is the design of electric circuits to separate 480 telephone conversations carried simultaneously on a single cable. At the sending end, the signals are combined by shifting each to a different portion of the frequency spectrum. With normal speech involving frequency components from 100–4,000 cycles per second (c.p.s.), one signal is transmitted from 0–4,000 c.p.s., one from 4,000–8,000 c.p.s., one from 8,000–12,000 c.p.s., and so on. At the receiving end, the signals must be separated by electrical networks, each of which transmits only one of the incoming messages.

3. Identification is the determination of a mathematical or analytical model from measurements of an actual system. For example, the dynamic characteristics of an airplane are measured by firing a bullet from the craft and observing the oscillation which results from the reaction force; or the characteristics of an industrial process can be evaluated by feeding into it a small randomly varying signal; or an automobile driver can measure road conditions and vehicle dynamics by continual small perturbations of the steering-wheel position.

Historically, network theory has developed from the work in classical mechanics by I. Newton, J. L. Lagrange and W. R. Hamilton, and the original studies of electric circuits by G. R. Kirchhoff. Until the advent of transcontinental telephone systems at the beginning of the 20th century, network theory emphasized the dynamic properties of vibrating mechanical systems. The field is now a central element of electrical engineering, with fundamental contributions in synthesis aspects from Ronald Foster, Wilhelm Cauer, O. Brune and S. Darlington. The rapid technological development during and following World War II included an expansion of network theory to encompass nonlinear networks (with analysis based on the work in nonlinear mechanics by L. Poincaré in France and by P. P. Lyapunov, A. N. Krylov and N. Bogoliuboff in Russia), feedback networks (with work developing from the pioneering efforts of H. S. Black, H. Nyquist and H. W. Bode at the Bell Telephone laboratories during the 1920s and 1930s), and such diverse areas as switching circuits and finite automata.

The basic analytic techniques of network theory are concerned with the evaluation of mathematical models (*e.g.*, sets of differential equations or the response of the system to a specified input signal) for the interconnection of the basic electrical components: resistors, capacitors, inductors, transformers, and voltage and current sources. Analysis is based on Kirchhoff's two laws which state that (1) the instantaneous sum of the currents entering any node of the network must be zero, and (2) the instantaneous sum of the drops in voltage around any closed loop must be zero. When these two laws are combined with the voltage-current relation for each element, differential equations can be written for the system without the direct utilization of the principle of the conservation of energy. The number of equations which must be written to describe network behaviour and the particular equations which can be used are determined from considerations of mathematical topology. Network theory also includes a large number of theorems which permit simplification of the analysis in many special cases of importance.

In the basic synthesis problem, with the input and output signals given, a network is to be realized by a suitable interconnection of the available components. In 1931 Brune showed that any specified driving-point impedance function (the ratio voltage to current at a single pair of terminals) can be realized if the impedance is a positive real function of the complex frequency s. In subsequent work, the necessary and sufficient conditions were established for the realization of a wide variety of different network functions (*e.g.*, the ratio of output voltage to input voltage, and the ratio of output current to input voltage).

Network theory has been extended to the study of feedback configurations, systems in which a portion of the output signal is compared with the input, with the difference used to control the output. Such systems are fundamental in automation (*q.v.*) and automatic control since the accuracy of the over-all transmission (the ratio of output to input) can be made insensitive to changes in the characteristics of the motor element. As a result of this insensitivity, engineering systems can operate properly even when the environment varies radically (*e.g.*, as the weather around an aircraft changes, as a space vehicle passes from outer space into the relatively dense atmosphere or as the road conditions for an automobile vary from dry to icy).

The analysis and synthesis of feedback systems is complicated by the stability problem, which is fundamental in network theory. Physical systems may oscillate out of control either because of

the feedback of energy from the output to a preceding point in the system (as in the case of ataxia observed in a man when he is an element of a feedback loop), or because of excitation of the system at its natural resonant frequency. (As a motor is brought up to speed, uncontrolled vibrations occur if the motor resonates at a frequency lower than the normal operating frequency.) Mathematical tests for stability in linear time-invariant systems (systems described by linear differential equations) were formulated by E. J. Routh in 1883 and for feedback systems by Nyquist in 1928. Fundamental contributions to the much more difficult problem of the stability of nonlinear systems have been made by Poincaré and Lyapunov, but the general problem of stability analysis and associated design techniques to insure stability still provide fundamental research problems in network theory.

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NEUBER, (FRIEDERIKE) CAROLINE (née Weissenborn) (1697–1760), one of the earliest and best-known German actress-managers, was born in Reichenbach, Saxony, March 9, 1697. The family moved to Zwickau when she was five. Rebelling against her tyrannical father, she ran away with a young clerk, Johann Neuber, at the age of 20 and married him in 1718. They served their theatrical apprenticeship in the traveling companies of Christian Spiegelberg (1717–22) and Karl Caspar Haack (1722–25), and in 1727 formed their own company, being granted a patent by the elector of Saxony, Augustus the Strong, to perform at the Leipzig Easter Fair. As early as 1725 her acting had attracted the attention of Johann Christoph Gottsched (*q.v.*), the critic and drama reformer who modeled his work on classical French tragedy and comedy. "Die Neuberin," as he came to call her, substituted in her company the careful learning of parts and rehearsal by the actors for the highly improvised farces and harlequinades that then dominated the German stage, and she elevated the moral tone of her company's lives. The collaboration of Gottsched and the Neuberin, which lasted until 1739, when they fell out, is usually regarded as the turning point in the history of German theatre and the start of modern German acting. The Neuber company found, upon returning to Leipzig in 1737 after three years of engagements in other German cities, that their patent, after the death of Augustus in 1733, had gone to the company of Johann Ferdinand Müller, a proponent of the old improvisations and harlequinades. The Neuberin reacted by burning Harlequin on stage to announce his dismissal. The company never regained its hold, however—the popularity of musical shows adding to the difficulty, and musical interludes between the acts not proving enough to offset the musical shows. In 1740 the Neuber company accepted an invitation of the Empress Anna to appear in St. Petersburg (later Leningrad); but the empress died in 1741, and though the company had introduced modern theatre to Russia, by the time it returned to Leipzig, Gottsched had allied himself with another company. His difference with the Neuberin intensified: she replaced the togas he had specified for his *Sterbenden Cato* with flesh-coloured tights; he attacked her in his reviews; she represented him in a prologue as a bat-eared censor; an obscene pamphlet in reply cast aspersions on the actress' private life.

In 1747 she quit the stage but in the following year returned with a new company, which successfully presented Lessing's first play, *Der junge Gelehrte*. Indifferent success, however, dogged the company as it played at Dresden, Frankfurt, and Warsaw, as well as Leipzig. In 1753–54 the Neuberin attempted to establish herself at Vienna, but failed; and the outbreak of the third Silesian War (1756), her husband's death (1759), and the bombardment of Dresden (1760) forced her to leave. She died in a peasant's hut at Laubegast near Dresden on Nov. 30, 1760; and although she was refused burial in holy ground, a monument to her was erected in the town in 1776, commemorating her as "the foundress of good taste in the German theatre." She had already been immortalized as Madame Nelly in Goethe's *Wilhelm Meister*.

See P. Wurche, "Der Schritt in die Kunst: die Neuberin und die Gottscheds," in *Theater der Zeit*, IX (1954). (A. M. N.; X.)

NEUBRANDENBURG, a town of Germany, headquarters of the *Bezirk* (district) of the same name which after partition of the nation following World War II became part of the German Democratic Republic. It lies at the outflow of the Tollense See about 134 km. (83 mi.) N. of Berlin and is a rail and road junction. Pop. (1964) 37,394. Neubrandenburg was incorporated in 1248. It was severely damaged in World War II, and of many medieval brick buildings only a few remain. It became a district capital in 1952. Since then it has been much rebuilt and has a new town centre. Manufactures include foodstuffs, building materials, paper, agricultural machinery, chemicals and leather.

NEUCHÂTEL, a canton and town of western Switzerland situated in the central Jura; the loftiest summit of the area is Mont Racine, 4,731 ft., in the Tête-de-Ran range. The canton, with an area of 308 sq.mi., most of which is reckoned productive, had an estimated population of 160,000 in 1965 (about two-thirds Protestant and one-third Catholic, all French-speaking). It consists, for the most part, of the longitudinal ridges and valleys characteristic of the Jura (*q.v.*), while its drainage is unequally divided between the Lake of Neuchâtel (leading to the Rhine) and the Doubs river (leading to the Rhône). The canton can be divided into three regions: (1) an area along the shore of the lake, called Le Vignoble (from its vineyards), which varies from about 1,500 ft. to 2,300 ft. above sea level; (2) an intermediate region, Les Vallées, consisting of the two principal valleys of the canton (the Val de Ruz, watered by the Seyon, and the Val de Travers, watered by the Areuse) which lie at a height of about 2,300 ft. to 3,000 ft. above sea level; and (3) the highest region, known as Les Montagnes Neuchâteloises (3,000 to 3,500 ft.), and mainly composed of the long valley in which stand the industrial centres of La Chaux-de-Fonds (*q.v.*), Le Locle, La Sagne, Les Ponts-de-Martel and La Brévine.

The main railway line, Paris-Pontarlier-Neuchâtel-Bern-Interlaken-Milan, traverses the canton while La Chaux-de-Fonds and Le Locle are connected by rail with Morteau and Besançon in France. Other lines link Neuchâtel, the cantonal capital, with La Chaux-de-Fonds and Le Locle, as well as with Lausanne (for Geneva and the Valais to the south) and Biel (for Basel and Zürich to the north). There are also a number of local railways. The canton is served by an excellent road network.

The most valuable mineral product is asphalt, concentrated in the Val de Travers. The wine of Le Vignoble is plentiful and of excellent quality. The most characteristic industry is watchmaking, which has been prominent since the early 18th century in the highland valleys of La Chaux-de-Fonds, Le Locle and Fleurier.

The canton is divided into 6 administrative districts, which comprise 62 communes. All elective offices are held for four years. The legislature or *grand conseil* consists of members elected in proportion to population, and the executive or *conseil d'état* consists of five permanent *conseillers*. The canton in 1963 sent five representatives to the national council (*Nationalrat*), the lower chamber of the Swiss parliament. It sends, as do all the other members of the Confederation, two members to the council of states (*Ständerat*), the upper chamber.

History.—Novum Castellum (Neuchâtel) was first recorded in the will (*loll*) of Rudolf III, the last king of Burgundy, on whose death (1032) that kingdom reverted to the western empire. About 1034, Conrad II, the Salic emperor, gave the town and its territories to Ulrich von Fenis, count of a neighbouring fief, and although the numerous medieval feudal divisions cannot be traced in modern political geography, the nucleus of Neuchâtel canton was then created. The dynasty gradually increased its dominions, so that by 1373, when Count Louis died, it held practically all the area occupied by the present canton, with the exception of the lordship of Valangin, which was held by a cadet line of the house till about 1592. The dynasty ended with the death of Count Louis' daughter, Isabelle, and the estate was inherited by her nephew, Conrad, lord of Freiburg im Breisgau in the German Rhineland. During Isabelle's reign, in 1406, Neuchâtel entered into union with Bern, and therein played an important part in shaping Swiss destiny. In 1504 it passed through marriage to the

ducal house of Orléans-Longueville. The Reformation was introduced there by Guillaume Farel (*q.v.*) in 1530. It became a principality and remained a possession of Orléans-Longueville until 1707, when that house became extinct. A struggle arose as to the succession and, finally, the parliament of Neuchâtel decided in favour of Frederick I, the first king of Prussia. The nominal role of the Prussian king (for the country enjoyed practical independence) lasted until 1848, with a brief interval from 1806 to 1814, when the principality was held by Marshal L. A. Berthier by virtue of a grant from Napoleon. In 1814 its admission into the Swiss Confederation was proposed and in 1815 it became the 21st canton and the only nonrepublican member. The hereditary rulers of Neuchâtel were the last to maintain their position in Switzerland. This anomaly led in 1848 to the establishment (attempted in 1831) of a republican form of government, brought about by a peaceful revolution. A royal attempt to regain power in 1856 was easily defeated and finally, after long negotiations, the king of Prussia renounced his claims to sovereignty. Consequently in 1857 Neuchâtel became a full republican member of the Swiss Confederation.

NEUCHÂTEL, the cantonal capital, is situated on the lake of the same name. Pop. (1960) 33,430, mainly Protestant and all French-speaking. The town is built partly on the slopes of Chaumont (3,871 ft.), and partly on land reclaimed from the lake, supplemented by the growth of alluvial deposits; later an artificial embankment added much ground, which is now the site of fine promenades, quays and a harbour, official institutions and schools.

The castle (dating from the 12th to the 16th centuries and now the seat of the cantonal administration) and the adjoining medieval Collegiate Church of Notre Dame (now Protestant) are built on a hill. They were originally founded when Ulrich II, count of Neuchâtel, took up his residence in the town, to which he granted in 1214 a charter of liberties. The Collegiate church contains the monumental tomb of the counts of Neuchâtel (erected in 1372). There are a number of fine 17th- and 18th-century patrician dwellings, including the Palais du Dupeyrou (1768), and fountains. The town hall (1782–90) is in classic style.

Among the buildings on the quays are the Collège Latin, with the public library (1835); the Musée des Beaux-Arts, with modern Swiss paintings and various antiquities (including the collection of P. J. E. Desor relating to old lake dwellings, and the notable collection of automated dolls created by Pierre Jaquet-Droz [1721–90] and his son Henri-Louis [1752–91]); a hall dedicated to Ferdinand Hodler; and a modern education centre comprising the university (founded as an academy in 1838), the gymnasium, the institute of physics and the Swiss Laboratory of Horological Research. (G. PD.)

NEUCHÂTEL, LAKE OF (Ger. NEUENBURGERSEE). The lakes of Neuchâtel, Biel (Bienne) and Morat, connected by canals, are survivors of a former glacial lake in the lower Aare valley. Neuchâtel is the largest lake wholly in Switzerland. Its total area is 83 sq.mi. divided among the cantons of Neuchâtel, Vaud, Fribourg and Bern (about 2 sq.mi.). It is about 23½ mi. long, from 3¾ to 5 mi. wide, its greatest depth is 502 ft., and its surface is 1,407 ft. above sea level. The Thièle or Zihl river enters at its southwestern end and issues from it at its northeastern end, but it also receives the Areuse and Seyon (northwest) and the Broye (northeast). On its southeastern shore is the picturesque and historic little town of Estavayer. At the southwestern extremity of the lake is Yverdon, the Eburodunum of the Romans and the residence (1806–25) of Johann Heinrich Pestalozzi, the humanist-educator. The northwestern shore is far more thickly settled, where from southwest to northeast the towns are Grandson, Cortaillod, Serrières and Neuchâtel itself. On the north shore is La Tène (*q.v.*), famous for prehistoric finds, which gives its name to the late Iron Age culture. There are steamer services between the lakeside towns.

NEUHOF, THEODOR, BARON VON (1694–1756), German adventurer, for a short time nominal king of Corsica, was born at Cologne on Aug. 24, 1694, the son of a Westphalian nobleman. Educated at the court of France, he served first in the French army, then in the Bavarian. Görtz, minister to Charles XII of Sweden, having discovered Neuhof's capacity for intrigue, sent him to England and to negotiate with Cardinal Alberoni in Spain, where he was made colonel and married one of the queen's ladies-in-waiting. Deserting his wife soon afterward, he went to France and became mixed up in John Law's financial affairs; then he wandered about Europe under various disguises. At Genoa he made the acquaintance of some Corsican prisoners and exiles, and persuaded them that he could free their country from Genoese tyranny if they would make him king of the island. With their help and that of certain merchants in Tunis he landed in Corsica in March 1736, where the islanders, believing that he had the support of several of the powers, proclaimed him king as Theodore I. He forthwith issued edicts, instituted an order of knighthood and waged war on the Genoese, at first with some success. He was soon defeated; civil war broke out in the island; and he left Corsica in Nov. 1736, ostensibly for foreign assistance. He returned to Corsica in 1738 and 1743, but in the face of combined Genoese and French hostility he attempted no military action. Imprisoned for debt in London, he regained his freedom by mortgaging his "kingdom" of Corsica and subsisted on the charity of Horace Walpole and other friends until his death in London on Dec. 11, 1756.

BIBLIOGRAPHY.—Accounts of Neuhof diverge greatly. The *Memoirs of Corsica* (1768) by "Colonel Frederick," who claimed to be his son but was apparently a Polish adventurer otherwise known as Vigliawischi (perhaps properly Wieloweyski), are misleading. *See* A. Le Glay, *Théodore de Neuhoff, roi de Corse* (1907); A. Vallance, *The Summer King* (1956).

NEUILLY, TREATY OF, the peace treaty concluded between Bulgaria on the one hand and the Allied powers and their associates on the other after World War I. Signed by the Bulgarian prime minister Aleksandr Stamboliski at Neuilly, outside Paris, on Nov. 27, 1919, it came into force on Aug. 9, 1920.

Territorially, Bulgaria's western frontier was adjusted in favour of the new Kingdom of Serbs, Croats and Slovenes, that is, the future Yugoslavia, which gained: (1) an area in the north, west of Vidin; (2) the town of Tsaribrod with adjacent areas, making any Bulgarian advance on Nish over the Pirot area more difficult; (3) the upper part of the Dragovishtitsa valley, due west of Sofia; and (4) the western half of the salient in the Strumitsa valley which Bulgaria had acquired under the treaty of Bucharest in 1913 (*see* BALKAN WARS). More serious, however, were Bulgaria's losses in the south, where not only a small area in the Rhodope mountains southwest of Pashmakli but also the whole of western Thrace had to be ceded to Greece, so that Bulgaria's immediate access to the Aegean sea at Dédéagatch, the country's major gain under the treaty of Bucharest, was forfeited. For ethnic reasons, however, Bulgaria received a slight accession of territory on the southeastern frontier, at Turkey's expense, in the area northwest of Edirne. Altogether, Bulgaria lost about 300,000 people, not all of them Bulgars.

Bulgaria was allowed to maintain a regular army of 20,000 men, together with 10,000 gendarmes and 3,000 frontier guards. This total of 33,000 was not enough to keep order in the country, which consequently suffered serious internal disturbances.

The clause of the treaty dealing with reparations constituted the most realistic approach to the matter in the peacemaking after World War I. No attempt was made to seize or to distribute the Bulgarian merchant marine; the amount to be paid was fixed at the lump sum of 2,250,000,000 gold francs; and a reparation commission, consisting of French, British and Italian representatives, eventually remitted 75% of the amount fixed; and the annual sum required to meet the charges on the outstanding 550,000,000 gold francs of the debt, payable over 60 years, was well within the capacity of the new Bulgarian state.

See H. W. V. Temperley (ed.), *A History of the Peace Conference*, vol. iv and v (1921).

NEUILLY-SUR-SEINE, a fashionable northwestern suburb of Paris, France, *département* of Hauts-de-Seine, stands on the right bank of the Seine river, 8 km. (5 mi.) west of Notre Dame cathedral, and on both sides of the Avenue de Neuilly. Pop. (1962) 72,570. It is chiefly residential, and notable for its large areas of open spaces, mainly the remains of former estates. The

18th-century bridge was rebuilt 1935–46. A large modern office building occupies the site of the château de Villiers. The château de Neuilly, a favourite residence of Louis Philippe I, was burned in riots in 1848. Neuilly is served by the Paris electric railway, the Métro. Perfumes, chemicals, medicines, plastic materials, automobile parts, electric fittings and aircraft are made on the outskirts and on the Ile de la Grande Jatte. (H. DE S.-R.)

NEUMANN, (JOHANN) BALTHASAR (1687–1753), German architect of diverse talents, a master of the late Baroque style, was born in Eger, Bohemia, in 1687. In 1709 he emigrated to Würzburg, where he learned his profession. Neumann designed palaces, housing, public buildings, bridges, a water system, fireworks, and more than 100 churches. He ran a glass factory, became a colonel of engineers, and was a professor of architecture. A stolid and conventional man, he produced works brilliant in design and elegant in engineering.

Neumann the dreamer would conceive the most intricate and original interiors; Neumann the builder realized them, achieving a maximum of security from a minimum of material. He directed squadrons of painters, sculptors, woodcarvers, iron founders, and landscape gardeners in creating the sumptuously harmonious decoration of his masterpieces. The Residenz Palace in Würzburg (1719–46), designed by Neumann and Germain Boffrand, is one of the great palaces of the Baroque period. Neumann's church of Vierzehnheiligen is a triumph in Rococo styling. Among his other works are the episcopal palaces of Bruchsal and Werneck and the pilgrimage churches of Neresheim and Käppele near Würzburg.

See Max H. von Freeden, *Balthasar Neumann* (1953). (J. P. C.)

NEUMANN, FRANZ ERNST (1798–1895), German mineralogist, physicist, and mathematician, made important contributions to the mathematical theory of electrodynamics by establishing laws of the induction of electric currents in 1845 (*see* PHYSICAL UNITS: *Electrical Standards*). He was born at Joachimstal on Sept. 11, 1798. In 1815 he interrupted his studies at Berlin to serve as a volunteer in the final campaign against Napoleon and was wounded. Subsequently he entered the University of Berlin as a theology student, but soon turned to scientific subjects. His earlier papers were mostly concerned with crystallography (*see* METEORITES: *Structure*), and the reputation he earned led to his appointment as *Privatdozent* (lecturer) at the University of Königsberg, where in 1828 he became extraordinary professor and in 1829 ordinary professor of mineralogy and physics.

Working with minerals, he extended to compounds in 1831 the Law of Dulong and Petit on the heat of elements, formulating Neumann's Law that a compound's molecular heat is the sum of the atomic heats of its constituents. His work in optics produced papers that place him among the early searchers after a dynamic theory of light. In 1832 he used the then popular theory of the ether (*see* LIGHT: *History: The Dynamical Theories of the 19th Century*) to calculate results agreeing with those obtained by A. L. Cauchy, and succeeded in deducing laws closely resembling those of A. J. Fresnel (*see* LIGHT: *History: The Age of Fresnel*). In subsequent years he attacked the problem of giving mathematical expression to the conditions that hold for a surface separating two crystalline media and worked out from theory the laws of double refraction in strained crystalline bodies (*see* SURFACE TENSION: *General Properties of Surface Tension*). His last publication, one on spherical harmonics, appeared in 1878. Neumann had a part in founding a notable seminar in mathematics and physics to give students practical acquaintance with the methods of original research. He retired in 1876 and died in Königsberg on May 23, 1895. His works were published in three volumes (1906–28).

See biographies by I. Neumann (1929) and A. Wangerin (1907).

NEUMANN, JOHN NEPOMUCENE (1811–1860), Bohemian-U.S. Roman Catholic bishop of Philadelphia, the first American Catholic prelate proposed for canonization (1886), was born in Prachatitz, Bohemia, on March 28, 1811. He studied at the *Gymnasium* at Budweis, the diocesan seminary of Budweis, and the University of Prague, emerging with a reputation for a clear, penetrating, analyzing mind and for solid piety. His zeal for the American missions took him to New York, where he was ordained priest in June 1836. Neumann joined the Redemptorists in 1840, his holiness of life and administrative abilities winning for him the post of superior of St. Philomena's parish in Pittsburgh, Pa., and later command of all Redemptorists in the United States. He became rector of St. Alphonsus' parish, Baltimore, Md., in 1851, and was named by Pope Pius IX in March 1852 to rule the see of Philadelphia. For eight years Neumann worked to build churches, schools, and asylums, legislating for his priests and people and visiting every corner of his spiritual domain. He combated trusteeism; was the first prelate to organize a diocesan school system; and introduced the diocesan-wide celebration of the devotion called the Forty Hours.

A deep personal love of God and a resolve to lead others to him were the goals of Neumann's life. He died on Jan. 5, 1860, and in 1921 Pope Benedict XV declared his virtues heroic. He was beatified Oct. 13, 1963.

See Michael J. Curley, C.SS.R., *Venerable John Neumann, C.SS.R.* (1952), with bibliography; Johann Berger, C.SS.R., *Leben und Wirken des hochseligen Johannes Nep. Neumann* (1883), Eng. trans. by Eugene Grimm, C.SS.R., *Life of the Right Reverend John N. Neumann* (1884).

NEUMANN, JOHN (JANOS) VON (1903–1957), U.S.-Hungarian scholar was an outstanding mathematician and a scientist of extraordinarily broad interest and competence who contributed to several disciplines. Born in Budapest, Hung., Dec. 28, 1903, he was a general scientific prodigy. In 1923 he received a doctorate in mathematics from the University of Budapest and a degree in chemical engineering from the Eidgenössische Technische Hochschule (Federal Institute of Technology) at Zurich, Switz. He was *Privatdozent* (lecturer) at the University of Berlin from 1926 until 1929 when he became an assistant professor at the University of Hamburg. A visiting lecturer at Princeton University, he became professor of mathematical physics there. Von Neumann was appointed professor of mathematics in the Institute for Advanced Studies when it was founded at Princeton, N.J., in 1933, a post he held until his death in Washington, D.C., on Feb. 8, 1957.

His international reputation was based on contributions to mathematical and physical theory, most notably: his invention of the theory of rings of operators (Von Neumann algebras), initiated in the late 1920s; his *Mathematical Foundations of Quantum Mechanics* (1926; Eng. trans., 1955); his elaborate theory (1923) of numbers as sets; and, with Oskar Morgenstern, his *Theory of Games and Economic Behavior* (1944). He well may be remembered longest for his work in pure mathematics during 1933–43 (*e.g., see* GROUPS, CONTINUOUS: *Hilbert's Fifth Problem*); and his work on the theory of operator rings (*see* OPERATORS, THEORY OF) represents a high point of the axiomatic and integrative tendencies characteristic of 20th-century mathematics. This work showed that analysis (*q.v.*) had interesting and unsuspected connections with algebra and geometry.

In addition to his teaching, in the late 1930s Von Neumann began work as a consultant for the U.S. Navy and Army. During World War II, his concept of implosion speeded development of the atomic bomb at Los Alamos, N.M. From 1945 to 1955 he was director of the federal electronic computer project, his efforts substantially expediting development of the hydrogen bomb. Appointed to the U.S. Atomic Energy Commission in 1954, he won its $50,000 Enrico Fermi Award in 1956. He continued work for the commission even after cancer confined him to Walter Reed Hospital from 1956 until he died.

Von Neumann's posthumously published *Theory of Self-reproducing Automata* (1966; ed. and completed by A. W. Burks) is an attempt to move from an understanding of the human nervous system to a general cybernetic theory that would generate an increasingly sophisticated computer technology. His *Collected Works* (vol. 1–3, 1961–62; vol. 4–6, 1963) reveal distinguished contributions to several other disciplines including: logic, theory of sets, quantum mechanics, ergodic theory, almost periodic functions in a group, continuous geometry, design of computers, numerical analysis, astrophysics, hydrodynamics, and meteorology. (I. E. S.; X.)

See S. Thomas, *Men of Space* (1960); F. B. Stonaker, *Famous Mathematicians* (1966).

NEUMANN, THERESE (1898–1962), German stigmatic, was born in the Bavarian village of Konnersreuth as the eldest daughter of a country tailor on April 8, 1898. At the age of 20 she underwent a severe nervous shock through the outbreak of a fire and subsequently suffered from hysterical paralysis, blindness and gastric troubles for several years. In 1926 a blood-coloured serum began to ooze from her eyes, and during Lent of the same year the stigmata (wounds resembling those of Christ in hands, feet and side) appeared. Throughout the next 30 years these continued to bleed on many Fridays, especially in Passiontide, and were accompanied by trances and other striking phenomena which attracted many visitors. Following her stigmatization, Therese claimed to live without food or drink, being sustained only by Holy Communion. At the request of her bishop she was subjected to a fortnight's investigation in 1927. Later the church authorities recognized this to have been inconclusive, as hysterical subjects are known to be able to sustain a complete fast for more than three weeks; in 1932 and 1937 she was requested to submit to another examination but refused, alleging that her father forbade her to do so. Hence her bishop issued no more permits for visits to her, which nevertheless reached a new peak in the years after World War II, when U.S. soldiers and others came to Konnersreuth in large numbers.

After 1950 the Passion ecstasies became much less frequent, though she continued to be visited by thousands each year until her death at Konnersreuth on Sept. 18, 1962. The controversy about the supernatural or purely neurotic origin of the phenomena continues.

See H. C. Graef, *The Case of Therese Neumann* (1951). (H. C. G.)

NEUMES: *see* MUSICAL NOTATION.

NEUMÜNSTER, a town of Germany, *Land* (state) of Schleswig-Holstein, which after partition of the nation following World War II became part of the Federal Republic of Germany, lies 66 km. (41 mi.) N. of Hamburg by road. Pop. (1961) 75,045. Its name derived from *novum monasterium* ("new minster"), the church of the monastery that was founded in 1125 by the Augustine missionary Vicelin, known as the apostle of the Wends; St. Vicelin's church (1829) is in the town, which was chartered in 1870.

Neumünster, which suffered heavy air-raid damage during World War II, has been rebuilt on modern lines. There are many schools, including one for textile engineering, and a textile museum noted for its collection of ancient textiles. A large public park has a zoological garden for native animals. Neumünster is a rail and road junction on the main routes from Hamburg to Kiel and Denmark. More than half the inhabitants are employed in industry (textiles, leather, chemical fibres, switch gears and paper) and the Bundesbahn (Federal Railways) repair plant. (R. U.)

NEUNKIRCHEN, a town of Germany in the Saarland, which in 1957 became part of the Federal Republic of Germany, stands on the Blies, 20 km. (12 mi.) by road N.E. of Saarbrücken. Pop. (1961) 45,625. Blast furnaces and pit derricks dominate the town which is surrounded on all sides by extensive woods. In addition to many administrative buildings and a new town hall, there are a park with a zoo, sports grounds and one of the most modern indoor swimming baths in West Germany. Neunkirchen is a junction on the railway from Saarbrücken to Mainz and has the steepest tram (streetcar) route in Europe. The town is a centre of mining, industry, communications and of cultural life for eastern Saarland. Besides coal mines and ironworks there are sawmills, breweries and textile factories. Neunkirchen was first mentioned in 1281. There is evidence of early iron founding (1595) and ironworks rebuilt in 1652. The town gained civic rights in 1922. (K. F. H.)

NEUQUÉN, an inland province of Argentina on the Chilean frontier, between the Colorado and Limay rivers. Pop. (1960) 109,890; area 58,448 sq.mi. (94,079 sq.km.). The greater part of the territory is mountainous, with fertile, well-watered valleys and valuable forests. The eastern part, however, contains large plains showing only stunted vegetation and having numerous saline deposits. The long droughts that prevail in this region have deterred agricultural settlement. Nevertheless, agriculture and stock raising provide the chief sources of wealth. The temperature of the Andean region is cold even in summer, but on the lower plains the summer is hot. The Neuquén, which meets the Limay near the 68th meridian to form the Río Negro, is the principal river of the province. The largest of a group of beautiful lakes in the higher Andean valleys is the celebrated Nahuel Huapí (*q.v.;* lion grass), which lies partly in the southwestern angle of the province, and partly in Río Negro and Chile. It is the source of the Río Limay and receives the overflow from two smaller neighbouring lakes.

The territory of Neuquén, officially created in 1884, was promoted to the status of a province in 1955. The population is concentrated in a few small towns on the rivers and in some colonies in the fertile districts of the Andes. The provincial capital, Neuquén (pop. [1960] 16,738), was founded on Sept. 12, 1904. Near the capital is the Río Negro dam, source of irrigation for a large area. The province is reached by a light-draft river steamer which ascends the Río Negro to the capital, at the confluence of the Limay and Neuquén, and by railway from Bahía Blanca to Zapala, via Neuquén. (GE. P.)

NEURALGIA. A symptom, not a disease, neuralgia is manifested by pain along the course of a nerve. Various forms are distinguished according to the nerve affected: suboccipital neuralgia when the pain is in the back of the head and neck, intercostal neuralgia when it is between the ribs, etc. Strictly speaking, the term is restricted to those nerve pains for which no specific cause and no evidence of impaired function of the nerve can be found. Actually the word is often employed for pain caused by local nerve damage when pain is the prominent symptom. Most sciatic neuralgia, for example, is attributable to mechanical compression and stretching of a sensory root of the sciatic nerve from displacement of an intervertebral disc within the spinal canal. Neuralgic pain is frequently the forerunner of hidden organic disease, and the first consideration in treatment is the search for a definitive cause.

Characteristically the pain of neuralgia is sharp, acute, darting and paroxysmal. The attacks, commonly brief in themselves, may succeed each other without respite for hours or days, robbing the victim of appetite and sleep and reducing him to a state of exhaustion and mental depression. Neuralgia of a nonspecific kind tends to occur during states of debility and malnutrition from any cause and in association with infections. Exposure, chilling and fatigue are sometimes precipitating causes.

Treatment for relief of symptoms is sometimes of little use, many cases proving refractory to all measures. Pain is controlled, as well as can be, by ordinary analgesics, together with hypnotics if required for sleep, avoiding narcotics if at all possible. Hot or cold applications, diathermy or repeated local anesthesia with procaine hydrochloride (Novocaine) may be beneficial. For extremely severe or prolonged attacks, palliative operations on sensory nerves, roots or their central connections have been resorted to with differing success.

Trigeminal Neuralgia.—In this condition, also called *tic douloureux*, the pain is strictly confined to one or all of the three divisions of the main sensory nerve of the face. Pain appears in the lower jaw, cheek, tongue and temple, in the upper jaw, cheek and side of the nose or in the forehead, depending on the division affected. The flashing, stabbing, boring pains, usually lasting less than a minute, are excruciating, and the sufferer commonly recoils from his agony with a spasmodic facial contortion. Characteristically, stimulation of circumscribed areas of the face or mouth, eating, talking or even the lightest touch may provoke an explosion of neuralgic pain. There is little, if any, discomfort during the intervals between paroxysms. The condition, for which no cause can usually be found, afflicts the elderly by preference and may have spontaneous remissions. Medical therapy is undependable, but surgical treatment is effective. Injection of the affected branch with alcohol gives prompt relief but rarely for more than a year or two. Cutting of the sensory roots within the skull affords almost certain permanent freedom from pain.

Atypical Facial Neuralgia.—This differs from trigeminal neuralgia in that the pain, although felt in the face, tends to be more diffuse, is duller in quality, persists for minutes or hours and is not ordinarily provoked by sensory stimulation. The nature of

the condition is obscure but it seems probable that it is a disorder of the sympathetic nervous system and may be a variant of migraine (*q.v.*). Some cases respond to a regimen of treatment for migraine, but most are more intractable. All do poorly with surgical treatment. A variety of paroxysmal, unilateral nocturnal neuralgic pain involving the eye and temple, often called histamine headache in the United States, is a closely related condition.

Postherpetic Neuralgia.—This is merely the continuation for weeks, months or sometimes years of the nerve-root pain which is present in the region of the skin eruption during the acute stage of an attack of shingles. This distressing sequel of the disease affects mostly elderly persons. X-ray therapy appears to benefit some patients. Otherwise, once established, the pain stubbornly resists treatment. *See* SKIN, DISEASES OF. (R. B. R.)

NEURITIS (NEUROPATHY) denotes a disease of nerves. Characteristic of neuritis are pain and tenderness; impaired sensation, strength and areflexia; and abnormal circulation and sweating in the distribution of the diseased nerve or nerves. Neuritis of the special sense organs and viscera has other, but equally specific, characteristics.

A unique feature of the nerve cell is its extraordinary length. In its course a nerve may lie next to skin or bone; it may pass through muscles or tunnels; proximally its roots lie in relation to the spinal column and distally its fibres diminish in calibre. All these anatomic vicissitudes represent hazards. Nerve fibres are sites of elaborate enzymatic systems that can be blocked by toxins or can fail through lack of specific vitamins. Nerve fibres are richly supplied with blood vessels, and disease of these vessels may have devastating effects. Nerve fibres are housed in connective tissue that may become infected, scarred, edematous or invaded by tumours, events that may cause injury to nerve fibres. (*See* also NERVE; NERVOUS SYSTEM, DISEASES OF.)

There are many causes of neuritis, but in general it may be said that when neuritis affects one nerve (mononeuritis) or a plexus of nerves (plexitis) the cause commonly is a mechanical one; that when several single nerves are affected simultaneously (mononeuritis multiplex) the cause often is a vascular or allergic one; and that when nerves are affected diffusely (multiple neuritis) the cause often is toxic, metabolic, viral or allergic. Electromyography, a procedure by which changes in the electric potential of muscle may be recorded through stimulation of its nerve, is of decisive help in the diagnosis of neuritis.

Mononeuritis and Plexitis.—Bell's palsy (neuropathy of the facial nerve) often follows exposure to a draft. The facial nerve passes through a bony canal that can accommodate little more than the nerve and its attendant blood vessels, and in about two-thirds of the cases of Bell's palsy the nerve is injured here. If continuity of the fibres is interrupted, they must grow anew. Growing fibres and their branches often arrive at a wrong destination, and this results in extraneous movements that ever after betray an old Bell's palsy.

One of the nerves most commonly afflicted is the ulnar, which serves the hand and arm. In about two-thirds of the cases this nerve is injured at the elbow, where it lies between skin and bone. The nerve again becomes vulnerable at the wrist, and ulnar neuropathy therefore is conspicuous among the occupational neuropathies.

The median nerve, serving muscles of hand and forearm, carries large complements of sensory and vasomotor fibres and is especially intolerant of injury. The commonest cause of median neuritis is compression of the nerve in the carpal (wrist) tunnel. This is convincingly demonstrated by electromyography. Slight injury to the nerve at higher levels may result in a prolonged and distressing affliction of the hand known as causalgia.

The radial nerve spirals the humerus (the bone of the upper arm) immediately under the skin and here is subject to compression. The wrist and finger drop that results is sometimes called Saturday night paralysis. A small cutaneous branch of the radial nerve may be compressed at the wrist by the band of a wrist watch, with resulting chiralgia paraesthetica.

In at least half of 400 cases of neuropathy of the brachial plexus that were reviewed, the brachial plexus (the great nerve plexus of the neck and armpit, where meet all the nerves supplying shoulder, arm and hand) was injured by traction or compression. In a fifth of the cases, cancer of the breast or lung had invaded the plexus.

Involvement of the sciatic nerve (the great nerve supplying the thigh and leg) or its roots accounts for about 40% of cases of neuritis. Among the causes are protrusion of intervertebral disks, arthritis of the spine and trauma of the nerve itself.

Crossed leg palsy is caused by wedging of the common peroneal nerve (serving the anterior muscles of the leg) between the head of the fibula and the opposite knee. When prolonged squatting compresses the nerve between the head of the fibula and the tendon of the biceps femoris muscle, a foot drop results, sometimes called gardener's paralysis.

Numbness of the lateral aspect of the thigh because of neuritis of the lateral femoral cutaneous nerve is known as meralgia paraesthetica. The nerve usually is injured where it traverses or passes under the inguinal ligament.

Mononeuritis Multiplex.—When several isolated and even widely separated nerves are involved simultaneously, it is usually found that trouble has started within the nerve itself. This may occur in leprosy (*q.v.*), in serum paralysis, in periarteritis nodosa and in porphyria (*q.v.*).

Multiple Peripheral Neuritis.—This term (also polyneuritis or polyneuropathy) denotes diffuse and symmetrical involvement of nerves. Symptoms usually begin in the feet, then in the hands, then progress upward. The usual causes are bacterial, viral, chemical and metabolic poisons, allergy or the lack of substances that are needed to support the function of nerves. Associated with multiple neuritis may be the Guillain-Barre syndrome, in which the content of protein of the spinal fluid is elevated without increase in the number of cells.

Treatment of Neuritis.—The general principles of treatment include management of the underlying cause, care of the afflicted limbs, application of heat, adequate nutrition and physical therapy. Specific forms of therapy include the administration of BAL (2,3-dimercapto-1-propanol) in the treatment of arsenical polyneuritis; of EDTA (ethylenediaminetetraacetic acid) in the treatment of lead poisoning; of cortisone in the treatment of serum paralysis and the neuritides of collagen diseases; and of vitamins of the B complex in the treatment of neuropathies associated with poor nutrition. (H. W. WN.)

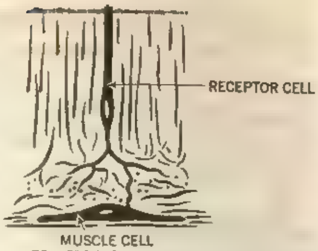
NEUROLOGY is the area of science that deals with the nervous system. *See* NERVE; NERVE CONDUCTION; NERVOUS SYSTEM; NERVOUS SYSTEM, DISEASES OF; NERVOUS SYSTEM, SURGERY OF.

NEUROLOGY, COMPARATIVE. The field of comparative neurology comprises the nervous mechanism and activities of all animal types, from the most primitive to man. Nearly all living organisms are sensitive to sudden changes in environmental conditions. This property of sensitivity is one of the fundamental characteristics of living matter and is termed irritability. Changes in environment, which may be of many kinds, act as stimuli; because of the irritability of living matter, a stimulus results in some form of response that usually is advantageous to the organism.

Introduction.—Stimuli as a rule are localized as to point of impact, and all animals except the lowest forms possess special cells or aggregations of cells for the reception of different types of stimuli. Such specialized cells are called receptors; in their most elaborate form, such as the eye and the organ of hearing of higher animals, they constitute the special sense organs. Both in man and in lower animals there are many types of simpler organized receptors that are activated by a variety of external and internal stimuli including touch, temperature changes, chemical substances, pain-producing contacts and contraction of muscle. The stimulus typically produces a change in the part of the cell to which it is applied or in the receptor, and is followed by a wave of change that progresses to points distant from that of impact.

The power of transfer of an impulse initiated by a stimulus is called conductivity and represents another characteristic of living matter. All living cells probably possess it in some degree, but

nervous tissue is especially adapted for the reception and conduction of stimuli. The response may be accomplished by another part of the same cell, which may or may not be modified for that purpose, or by specialized cells connected with the receptors by conducting fibres. The structure that has the capacity for response is called the effector.



ADAPTED FROM G. H. PARKER, "THE ELEMENTARY NERVOUS SYSTEM," J. B. LIPPINCOTT COMPANY, PHILADELPHIA, 1919

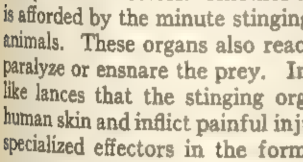
FIG. 1.—SIMPLE RECEPTOR-EFFECTOR SYSTEM

INVERTEBRATES

Protozoans.—These animals consist of a single cell. Some protozoans possess a system of delicate threads or fibrils that interconnect the bases of whiplike locomotory cilia. These fibrils centre in a small body, the motorium, which is situated near the gullet. Co-ordinated movements of the cilia adapted to propel the animal forward or backward indicate the presence of a special conducting mechanism; this is provided by the fibrils, which constitute a primitive neuromotor system.

Sponges.—In sponges, which consist of many cells, no nervous structures have been identified. These animals have a system of channels with inlet and outlet pores through which a current of water may pass through their bodies. Minute organisms that serve for food are extracted from the water by cells lining the channels. The chief movements of sponges consist of opening and closing the pores that govern the circulating stream. These movements are accomplished by very simple contractile cells that appear to be activated by direct stimulation without the intervention of nervous elements. Such musclelike elements have been designated independent effectors. Another example of an independent effector is afforded by the minute stinging organs of jellyfishes and related animals. These organs also react directly to stimuli and serve to paralyze or ensnare the prey. In the larger jellyfishes the threadlike lances that the stinging organs discharge can penetrate the human skin and inflict painful injuries. In the higher animals more specialized effectors in the form of muscles, glands and electric organs are activated by impulses transmitted to them by nervous tissue.

Coelenterates.—The coelenterates, jellyfishes and related animals, also possess effectors in the form of well-differentiated muscles, whose cells can change their shape rapidly. Certain of these muscles may respond directly to stimuli but as a rule muscle responds to a nervous impulse. In the tentacles of sea anemones and related animals a simple receptor-effector apparatus is found that consists of a sensory cell and muscle.



ADAPTED FROM G. H. PARKER, "THE ELEMENTARY NERVOUS SYSTEM," J. B. LIPPINCOTT COMPANY, PHILADELPHIA, 1919

FIG. 2.—COMPLEX RECEPTOR-EFFECTOR SYSTEM OF SEA ANEMONE

The sensory cell reaches the external surface and constitutes a receptor. The receptor is stimulated by mechanical impact or by dissolved substances, such as meat juices, in the water. The deep part of the receptor cell gives rise to a fibrous process that serves as a conductor. This process has numerous branches that form a plexus in the layers beneath the surface and end in relation to the muscles in the deep layers. The plexus spreads the stimulus so that a widespread response of muscle is produced from a localized stimulus. This response results in movements of the tentacles to carry food to the mouth. The combination of specialized receptor cells and muscle makes possible relatively quick movements in response to slight stimuli.

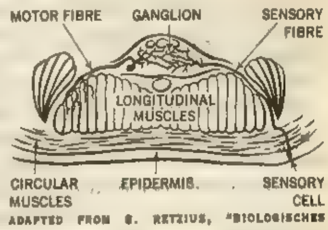
A further elaboration of the receptor-conductor-effector apparatus, found in hydroid polyps, sea anemones and jellyfishes, includes primitive nerve cells and their processes which are interposed between the receptors and effectors. Each of these primitive nerve cells has numerous branching fibres that form an intricate plexus beneath the surface of the animal and penetrate to internal structures. There is good histological evidence that the processes of the nerve cells do not fuse but only interlace or run parallel with each other. They have points of contact at which the nerve impulse is transmitted from one fibre to another. Such a point of contact between individual nerve cells or their processes is known as a synapse.

Synaptic junctions are characteristic features of the nervous systems of higher animals, and in these animals they serve as one-way valves that transmit impulses in only one direction. In the jellyfishes, however, transmission may be in either direction. An impulse initiated at any point, accordingly, may spread through the entire nerve plexus to all parts of the body, in contrast with the manner of its spread in the greater part of the nervous system of higher animals in which the one-way synaptic connections direct the impulses into specific channels.

Higher Invertebrates.—The nervous system of animals above the jellyfishes assumes such a variety of forms that only a few examples can be given. In all of the bilaterally symmetrical animals, however, it is made up of specific nerve cells, which, with their processes, long and short, are known as neurons. Typically the cell bodies are grouped into masses called nerve centres, whereas the longer processes are collected into bundles in a central nervous axis that connects the nerve centres with each other and into peripheral bundles known as nerves. The nerve centres and connecting bundles form a central nervous system. The nerves connect the peripherally or internally situated receptor and effector organs with the central nervous apparatus.

As represented in segmented invertebrates such as the earthworm and the insects, the central nervous system comprises an anterior collection of nerve cells and fibres, usually called the brain, and two elongated strands of nerve fibres and groups of cells extending throughout most of the length of the body.

The groups of nerve cells, called ganglia, constitute nerve centres that occur in pairs, one pair for each body segment. Each pair is interconnected by short transverse bundles of nerve fibres so that a ladderlike pattern of the central nervous system results. The brain is situated in the head region, above the digestive tube, but is connected to an enlarged nerve centre at the anterior end of the nerve cord by a strand of nerve fibres that passes downward on either side of the forward part of the alimentary canal. In the invertebrates the nerve cord lies beneath the digestive tract.



ADAPTED FROM G. RETZIUS, "BIOLOGISCHES UNTERSUCHUNGEN"

FIG. 3.—TRANSVERSE SECTION THROUGH VENTRAL BODY WALL AND A GANGLION OF CENTRAL NERVOUS SYSTEM OF THE EARTHWORM

Earthworm.—In the earthworm a pair of ganglia occurs in each of the segments of the body. From these ganglia, and from the brain, nerves pass to the adjacent body parts, to the muscles and to the skin. The earthworm has sensory cells in the skin, especially in the anterior part of the body. The outer ends of these cells reach the external surface and are modified as receptors. Their inner ends are elongated as small nerve fibres that collect together to form nerves, which extend to the nerve centres. Within the latter these fibres make synaptic connections with the cell bodies, or their processes, of a second set of neurons whose long fibres become included in the nerves and are distributed to muscle. A stimulus applied to the skin may produce a muscular movement, the nervous mechanism involved consisting of receptor or sensory neuron, connections in the nerve centre and an effector or motor neuron. Such a chain of neurons from receptor to effector constitutes a reflex arc, the simplest comprising two elements and their synaptic connection in the nerve centre.

A third type of neuron situated between the sensory and the motor neurons is also found in the earthworm. It is known as the internuncial neuron and serves as an adjustor. Such neurons occur only within the brain and the nerve cord and its centres, extending lengthwise from one nerve centre to another and conduct-

ing impulses that influence the activities of segments of the body remote from the point of stimulation.

Even in the worms there is some degree of control by the anterior nerve centres over other parts of the nervous system. After the brain of an earthworm is removed the animal can eat and crawl, right itself and perform other functions normally. It is restless and active, however, its anterior segments are lifted upward and it requires a much longer time to burrow than the normal worm.

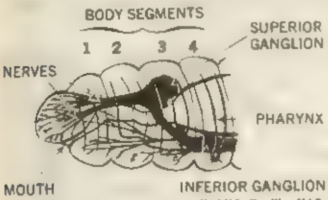


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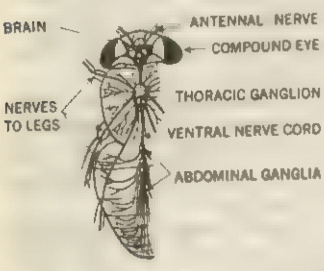
FIG. 4.—SIDE VIEW OF BRAIN AND ANTERIOR NERVES OF THE EARTHWORM

Marine Clam Worm.—The clam worm, *Nereis,* whose nervous system is built on the same general plan, has few sensory cells in the skin but possesses several pairs of eyes and feelers and tentacles that are stimulated by chemical substances. These all are attached to the head region and their nerves are connected with the brain. When the brain is removed, the animal loses sensitivity to light and chemical changes; it ceases to feed and to burrow and it becomes overactive.

Much more definitely than in the earthworm the brain of the clam worm is a sensory centre that normally exercises a restraining control over the chief motor centres. These centres, situated in a nerve centre beneath the gullet, have connections with the segmental nerve centres.

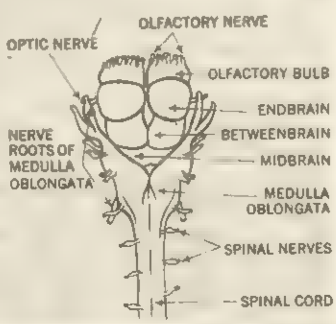


FROM A. LANG, "TEXTBOOK OF COMPARATIVE ANATOMY," THE MACMILLAN COMPANY, NEW YORK, 1891–96 (AFTER BRAND)

FIG. 5.—NERVOUS SYSTEM OF HORSEFLY

Insects.—Some of the activities of many animals are instinctive. Much of the behaviour of insects is of this type. Such animals have no basis of learning but rest on a structural pattern of the nervous system which is preformed in each individual. Instinctive acts require only an appropriate stimulus to start them but are much more complicated than reflexes.

Bees, for example, build their combs and do other things instinctively and without training, but their nervous system also is adaptable to some degree so that they can learn to find their way and are helped by their fellows. Even higher animals perform many instinctive acts, such as the suckling of young mammals or the crying of a newborn infant.



ADAPTED FROM O. LARSELL, "JOURNAL OF COMPARATIVE NEUROLOGY," VOL. 86, PP. 359–446, 1947

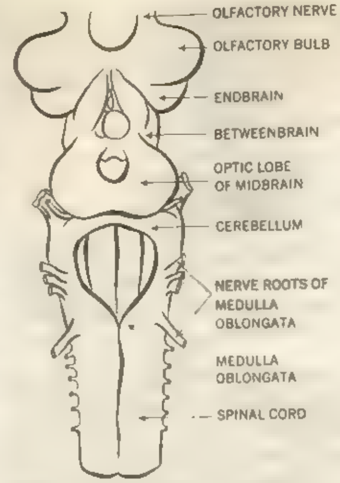
FIG. 6.—BRAIN OF HAGFISH

VERTEBRATES

The central nervous system of the vertebrates (animals with spinal axis of cartilaginous or bony segments) consists of a spinal cord surrounded by the vertebrae and a brain situated in the head.

Spinal Cord.—The spinal cord is largely a reflex organ but is influenced by impulses from the brain centres. It also relays to the brain sensory impulses brought by the spinal nerves. In mammals the motor activities of the cord are more strongly influenced by the brain than in lower vertebrates. In addition there is a voluntary motor pathway, originating in the cerebral cortex, the impulses of which result from integrations at the highest levels of the nervous system rather than at reflex levels.

The relative functional importance of the sensory and some of the motor systems of the brain varies in different species. Also many water vertebrates, such as fishes, have a special system of sensory organs and nerve centres, the lateral line system, that is lacking in air-breathing animals. The relative size of the nerve centres of the brain corresponds with the importance of such centres to the different groups of animals; for example, in birds, which have extremely good visual powers, the optic centres are large, whereas the lateral line centres are absent.



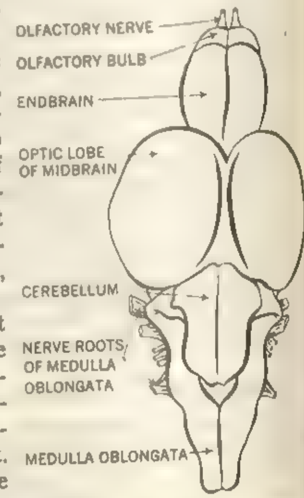
ADAPTED FROM O. LARSELL, "JOURNAL OF COMPARATIVE NEUROLOGY," VOL. 86, PP. 359–446, 1947

FIG. 7.—BRAIN OF LAMPREY

Through observation and experimental studies most of the functional regions and related fibre bundles of the vertebrate brain have been determined and their activities investigated.

Brain.—In all animals from the worms and insects to the highest forms the brain is an important and characteristic part of the nervous system. It is always situated at the anterior end of the animal and with it are connected the principal sense organs of the body. In man and other higher animals the brain is thus associated with the organs of sight, hearing, smell and taste. The development of these special receptors and of the brain has progressed hand in hand in the evolutionary process. This process has involved transformation of several of the sense organs of the head from surface receptors, which require contact of the stimulus with the body surface, to distance receptors, the stimuli of which come from more or less remote points although they must impinge on the specialized structures, such as the eye or the ear, to be effective.

There is reason to believe that the distance receptors have evolved from the contact receptor type and with this transformation the brain has also undergone a far-reaching development. As the distance receptors become increasingly important the brain becomes a more complex switchboard to meet the needs of increased sensory reception. With the development within it of more and more internuncial neurons the brain becomes in the higher animals the centre for increasingly complex nervous activities.



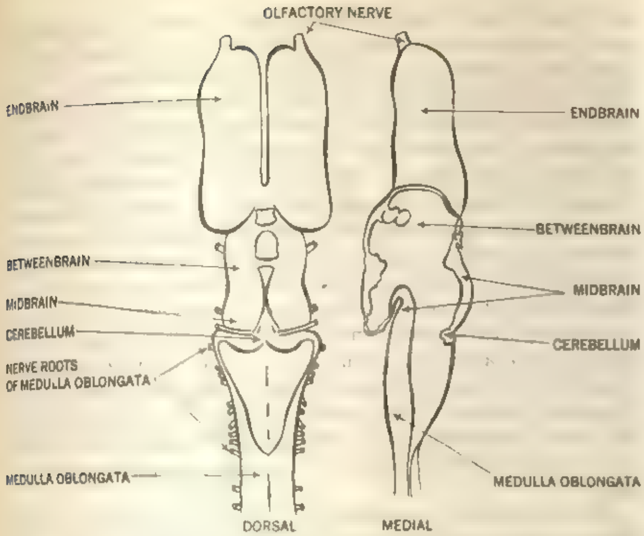
O. LARSELL

FIG. 8.—BRAIN OF YOUNG SALMON

The brain comprises five divisions (*see* below) whose relative size varies with the sensory equipment and other variables of the different groups of vertebrates. Paired nerves are attached both to the brain and the spinal cord. The spinal nerves include both sensory and motor fibres and are similar in all vertebrates but vary in number. The nerves connected with the brain are made up of diverse combinations of sensory and motor fibres and some are entirely sensory or entirely motor.

Each of the five divisions of the brain, termed the endbrain (telencephalon), betweenbrain (diencephalon), midbrain (mesencephalon), cerebellum (metencephalon) and medulla oblongata (myelencephalon), has characteristic structural patterns and functions. Part of the endbrain and all of the betweenbrain, midbrain and medulla oblongata constitute the basis of the entire organ; collectively these subdivisions are termed the brain stem (*see* BRAIN).

Lower Vertebrates.—In all but the lowest vertebrates a covering layer, the mantle or pallium, is superposed on the deep part of the endbrain, and a cerebellum is found above the anterior part of the medulla oblongata. From the pallium the cerebral cortex

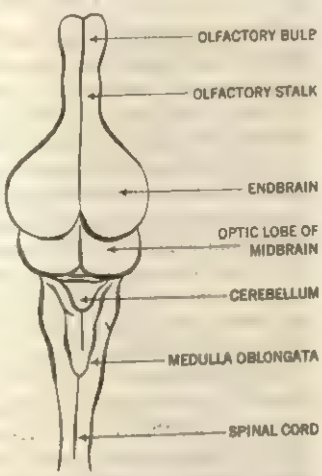


ADAPTED FROM O. LARSELL IN H. MORRIS, "MORRIS' HUMAN ANATOMY," 11TH EDITION, BLAKISTON DIVISION, MCGRAW-HILL BOOK COMPANY

FIG. 9.—BRAIN OF SALAMANDER

is differentiated. This is lacking in fishes and lower urodeles but beginning with the frog and upward through the animal series it assumes increasing size and importance; in man it is so extensive as to hide the remainder of the brain when viewed from above. The cortex consists entirely of internuncial neurons and constitutes the adjustor apparatus, which is at the same time the most complex and also of the highest order in the nervous system. The brain stem consists of complex reflex centres and their connecting fibre bundles, many of the centres having connections with the cerebral cortex as well as with the lower centres.

Mammals, Including Man.—The cortex of mammals is divided into sensory, motor and association areas. The sensory areas receive relayed impulses, such as visual and auditory, from centres in a subdivision of the betweenbrain called the thalamus. The motor areas give rise to fibres that reach lower centres related to motor activity. The association areas are small in lower mammals, but in man they constitute the greater part of the cortex. In these areas more complex patterns of integration are formed from impulses supplied by other centres, cortical and thalamic.

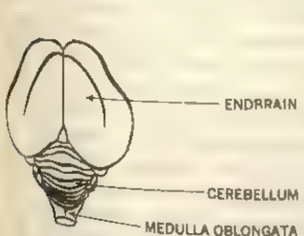


ADAPTED FROM A. FREDERIKSE, "THE LIZARD'S BRAIN," NIJKERK, NETH., 1931 (DISSERTATION, UNIVERSITY OF AMSTERDAM)

FIG. 10.—BRAIN OF LIZARD

The frontal lobe of the cerebrum, in which the most complex integrations occur, is very small in lower mammals but increases in size until in the higher apes it forms a large subdivision of the brain. In man it is especially prominent and includes the cortex involved in the highest activities of the human mind. Other lobes of the cerebral cortex also increase in size and complexity from the lower to the higher mammals.

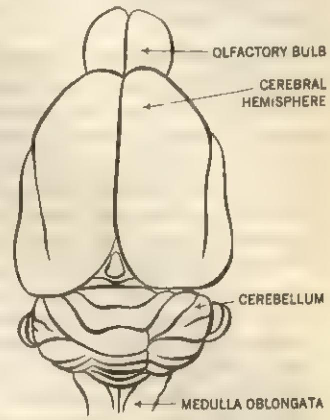
In the ascending scale, from the lowest to the highest animals and man, the nervous system becomes increasingly complex in structure. The impulses that reach it provide an increasing amount of information regarding environmental conditions, and the brain exercises an increasing dominance over the activities of lower nerve centres.



ADAPTED FROM C. J. HERRICK, "JOURNAL OF COMPARATIVE NEUROLOGY," VOL. 1, 1893

FIG. 11.—BRAIN OF GOLDEN EAGLE

In mammals as well as man the dominance over lower centres may express itself in inhibitions or modifications of behaviour that result from integrations of impulses from the most important sense organs or from memory of past experiences. Such integrations may overcome or modify responses organized at lower levels; for example, an individual with social training may suppress so purely a reflex act as a sneeze, which in the untrained person may take explosive force. Some acquired functions such as speech, recognition of spoken or written words and various skills, furthermore, are localized in one or the other hemispheres of the cerebrum. In right-handed persons the so-called dominant hemisphere is the left; in left-handed persons it is the right.



ADAPTED FROM E. HORNE CRAIGIE, "CENTRAL NERVOUS SYSTEM OF ALBINO RAT," P. BLAKISTON'S SON AND CO., PHILADELPHIA, 1925. BY COURTESY OF UNIVERSITY OF TORONTO PRESS

FIG. 12.—BRAIN OF RAT

Trends in the Nervous System.—Comparative studies of the nervous system by anatomical and physiological methods have revealed the following trends: increase in the speed of conduction of stimuli and the impulses resulting from them—for example, the rate of conduction in the nerve plexus of the jellyfish attains a maximum speed of 120 cm. (48 in.) per second, whereas in a human nerve it may be more than 100 times as fast; integration of impulses so that a given stimulus may result in increased response or in failure to respond; modification of the pattern of response; dominance by the brain as a result of connection with it of the most important sensory organs; and control of motor centres by the brain through the action of its adjustor mechanism.

The human brain is the most intricate mechanism in nature. It comprises pathways of many degrees of complexity, from a relatively simple reflex arc, illustrated by the pathway involved in constriction of the pupil in response to light (sensory impulses emanating from receptor cells in the retina of the eye travel along the optic nerve to a specific centre in the midbrain, which in turn relays these impulses to a motor centre from where new impulses are dispatched to the muscles of the iris to cause constriction), to extremely complex integrations that affect behaviour.

These latter integrations may involve not only present experience and the individual's memories of his own past, but also

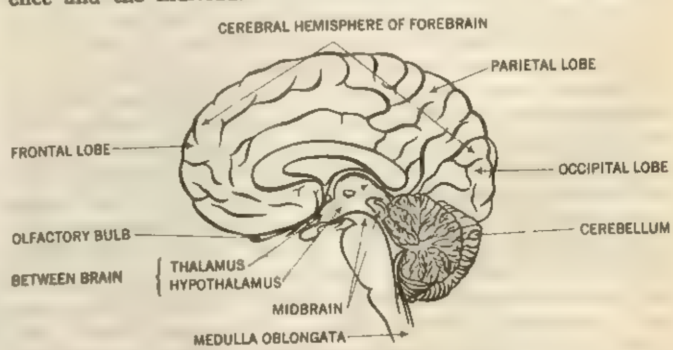


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FIG. 13.—MEDIAL VIEW OF HUMAN BRAIN

"racial memories" of man as stored in folklore and books. The mind, of which the brain is the organ, can analyze, synthesize and project to the future; it is capable of imagination and other qualities that give man predominance by reason of the complexity of the cerebral cortex and its connections.

See also BRAIN; NERVE; NERVE CONDUCTION; NERVOUS SYSTEM; SPINAL CORD.

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NEUROPHARMACOLOGY AND PSYCHOPHARMACOLOGY are, respectively, the study of the physiological action of drugs on the nervous system and the study of the effects of drugs as seen in behaviour. The drugs of interest are said to be neurotropic; *i.e.,* they have special affinities for nerve tissue. They include anesthetics, analgesics (pain relievers), stimulants, alcohol and other depressants, barbiturates and other hypnotics, opiates and other narcotics, and tranquilizers. Most of them are discussed in detail under group titles (*e.g.,* ANESTHESIA AND ANESTHETICS; TRANQUILIZING DRUGS) or under particular drug names (*e.g.,* MARIJUANA; MORPHINE) in separate articles (*see* Index). The present article offers, first, a discussion of neurotropic drugs as a class—their history and use. The rest of the article is concerned with one subclass: the so-called psychedelic drugs, which include LSD-25, mescaline, and psilocybin. These are described in terms of their chemistry, their profound effects on the conscious state, and the social and legal issues raised by their use.

For anatomical structures mentioned in this article *see* BRAIN; NERVOUS SYSTEM. For an overview of the behavioural disorders named here *see* PSYCHOLOGY, ABNORMAL: *Abnormalities of Behaviour.*

NEUROTROPIC DRUGS

History.—Man has been experimenting for thousands of years with a variety of naturally occurring substances that act on nervous tissue: alcohol to intoxicate his weary mind, belladonna to calm an angry intestine or to poison an adversary, curare to stupefy prey from the tip of an arrow, strychnine to eliminate barnyard pests. The relief of pain, in particular, is an age-old aim of mankind, and various narcotic and sleep-producing agents were undoubtedly used by primitive man. But there is another kind of pain—the pain of being—and from time immemorial man has been trying to expand his vision, change his mood, alter his inner existence, or stupefy his awareness with such drugs as alcohol, opium, and cannabis. It is written in Genesis (9:20) that Noah planted a vineyard; "and he drank of the wine, and became drunk, and lay uncovered in his tent." Alcohol has been used by many cultures and even worshiped as a god. Opium has also been used extensively since the time of ancient Greece. Homer tells how some of Odysseus' crew succumbed to forgetfulness in the land of the Lotus-eaters. The ancient Vedic philosophers of India spoke of soma, a mysterious and probably mythical plant. Coca, coffee, and tobacco have also played their parts in history.

Several of the important early studies in physiology were directed toward understanding the site and mode of action of some of these agents; *e.g.,* the work of J. J. Wepfer in 1679 on the toxicology of water hemlock, Peter Daries' observations in 1776 of the effect of belladonna on the pupil of the eye, and the discoveries in the first part of the 19th century by two great physiologists, François Magendie and his pupil Claude Bernard, of the localization of the action of the convulsive drug strychnine to the spinal cord and of the skeletal-muscle paralyzing drug curare to the myoneural junction. These and other early studies were confined to the more accessible parts of the nervous system. Only in recent years have techniques been available for the study of chemical and electrical changes in the tissue of the brain itself—although brain responses had been inferred, from behaviour, since ancient times.

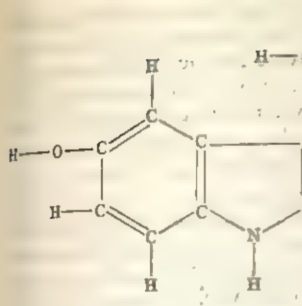
Uses.—Many of the chemical agents that affect living protoplasm are not capable of acting on the brain, but some of those that do are important in medical therapeutics (and in social relations). Examples are alcohol, the general anesthetics, the analgesic opiates, and the hypnotics, which produce sleep—all classified as central nervous system depressants. Certain other drugs, *e.g.,* strychnine, nicotine, picrotoxin, caffeine, cocaine, and amphetamine, stimulate the nervous system. These stimulants and depressants are of little if any value in psychiatric therapy. In fact, drugs truly useful in the treatment of mental illness were unknown to science until the middle of the 20th century. With the discovery of reserpine and chlorpromazine some of the major forms of mental illness, especially the schizophrenias, became amenable to chemotherapeutic treatment. Reserpine, a *Rauwolfia* alkaloid introduced in the 1940s, was soon displaced in psychiatric practice by chlorpromazine and a number of other phenothiazine derivatives, first synthesized in the 1950s. These tranquilizing drugs seem to reduce the incidence of certain kinds of behaviour, particularly hyperactivity and agitation. A second group of drugs has achieved popularity in the management of milder psychiatric conditions, particularly those in which patients manifest anxiety; this group includes meprobamate and the two benzodiazepine derivatives, chlordiazepoxide and diazepam—drugs which have a mild calming, or sedative, effect and are also useful in inducing sleep.

Not all drugs in psychiatric use have a tranquilizing action. The management of depression requires a different pharmacological effect; and the drugs of choice have been described as being euphorizing, mood-elevating, or antidepressant, depending on their particular pharmacological properties. Monoamine oxidase inhibitors such as isocarboxazid, nialamide, and tranylcypromine have been employed for this purpose, but in the 1960s the dibenzazepine derivatives such as imipramine and amitryptaline, which are closely related structurally to the phenothiazines, were more widely used. There are also drugs useful in overactive states such as epilepsy and Parkinsonism; examples are the anticonvulsant drugs diphenylhydantoin sodium and trimethadione, and the antiparkinsonian drug trihexyphenidyl. The psychedelic drugs, discussed below, also may have therapeutic uses.

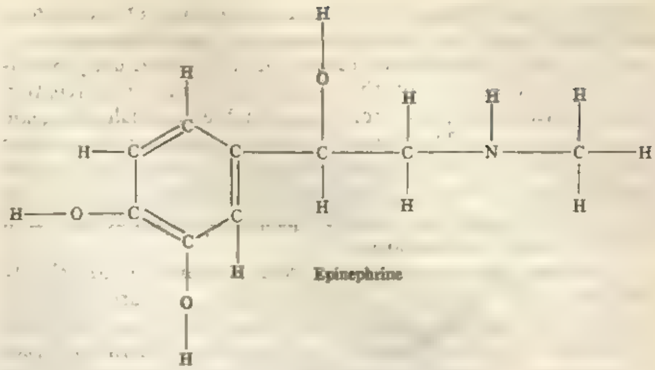
THE PSYCHEDELICS

The psychopharmacological drugs that have aroused widespread interest and bitter controversy are those that produce marked aberrations of behaviour. The most important of these are *d*-lysergic acid diethylamide, commonly known as LSD-25, which originally was derived from ergot (*Claviceps purpurea*), a fungus on rye and wheat; mescaline, the active principle of the peyote cactus (*Lophophora williamsii*), which grows in the southwestern United States and Mexico; and psilocybin and psilocin, which come from Mexican mushrooms (notably *Psilocybe mexicana* and *Stropharia cubensis*). Other drugs of this group include bufotenine, originally isolated from the skin of toads; harmine, from the seed coats of a plant (*Peganum harmala*) of the Mediterranean region and the Near East; and the synthetic compounds *d*-methyltryptamine (DMT) and dimethoxyphenylethylamine. Cannabis is not usually included in this group, but there is no particular justification for its exclusion. It is a resin obtained from the leaves and tops of the hemp plant (*Cannabis sativa*), and is known by several names: bhang in India, hashish in Asia Minor and Egypt, kef in northern Africa, and marijuana in the Western Hemisphere.

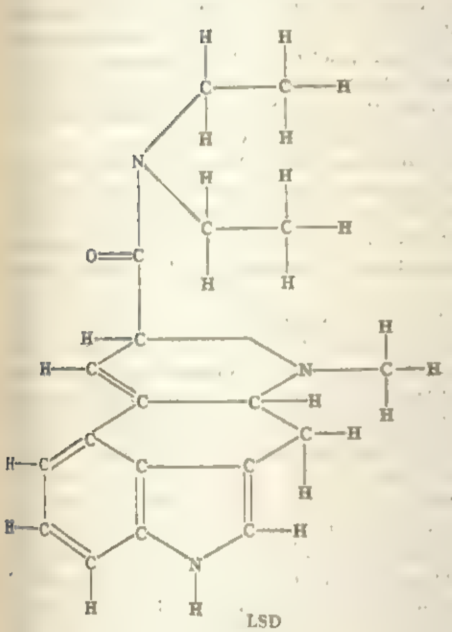
Terminology.—It is difficult to find a suitable generic name for a class of drugs having as many diverse effects as have been reported for these substances. Abnormal behaviour as profound as the swings in mood, disturbances in thinking, perceptual distortions, delusions, and feelings of strangeness that sometimes occur with these drugs is usually indicative of a major mental disorder; consequently these substances are often called psychotomimetic to indicate that their effects mimic the symptoms of a naturally occurring psychosis. There are indeed points of similarity between the drug states and the natural psychoses, but there are also many dissimilarities—so many as to make the resemblance quite superficial. However, such exogenous substances as the bromides, heavy metals, belladonna alkaloids, and intoxicants can cause abnormal behaviour to a degree sometimes described as psychotic, and if the list is extended to include the drugs being discussed here, then the objection—that the term psychotomimetic should refer only to the mimicking of natural



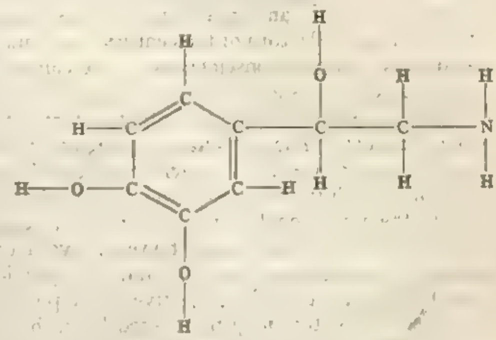
Serotonin



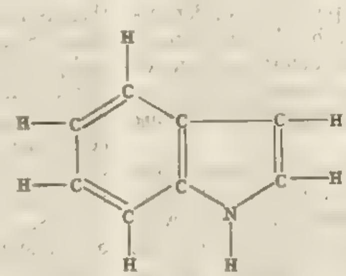
Epinephrine



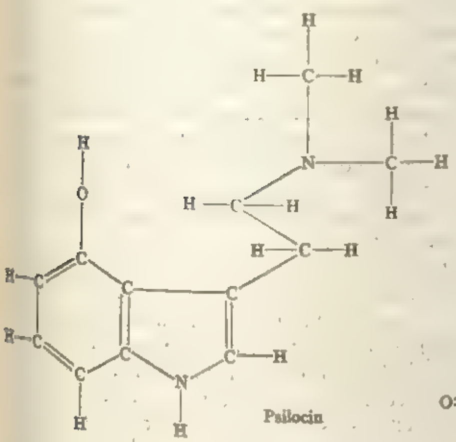
LSD



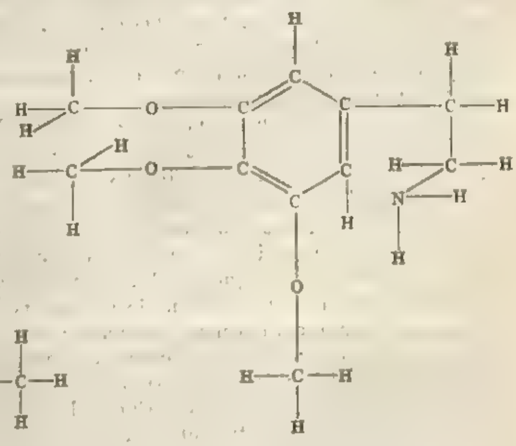
Norepinephrine



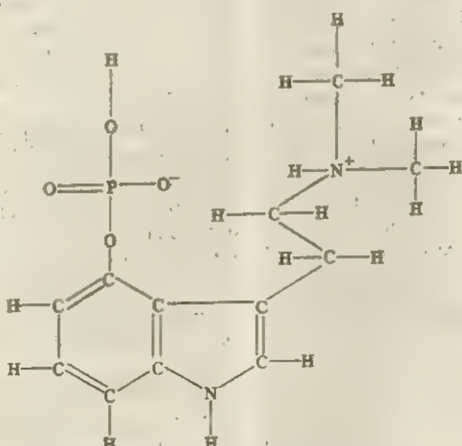
Indole ring



Psilocin



Mescaline



Psilocybin

CHEMICAL STRUCTURE OF MAJOR PSYCHEDELIC DRUGS AND CERTAIN IMPORTANT INDOLE AMINES AND CATECHOLAMINES THAT OCCUR NATURALLY WITHIN THE CENTRAL NERVOUS SYSTEM

LSD, psilocybin, and psilocin resemble structurally the brain amine serotonin in possessing the indole ring (centre). Mescaline and the two neurohumoral amines which it resembles, epinephrine and norepinephrine, are not indole compounds, but their structures can be represented to suggest a relationship to the indole ring: the carbon chain at the side, which is conventionally represented as a straight chain, can be visualized as curling around (dashed arrows) and finally forming an incomplete indole ring as drawn for mescaline, where only the bond between the final nitrogen and the carbon is missing

psychoses—is no longer valid. Taking this point of view, some investigators prefer the term psychotogenic ("psychosis-causing"). One of the most conspicuous features of this kind of drug experience is the occurrence of the distinctive change in perception called hallucination (*q.v.*). For this reason the term hallucinogenic is sometimes used. Most people are aware, however, even while under the influence of the drug, that their unusual perceptions have no basis in reality; so this is not a very accurate use of the term. Strictly speaking, very few people truly hallucinate as a result of taking a hallucinogen.

All of these terms are borrowed from medicine and are closely identified with pathology. In this sense, all are negative. Humphry Osmond proposed in 1957 that these drugs be called psychedelic ("mind-manifesting"). This term shifts the emphasis to that aspect of the drug experience that involves an increased awareness of one's surroundings and also of one's own bodily processes—in brief, an expansion of consciousness. William James observed at the turn of the century that "our normal waking consciousness, rational consciousness as we call it, is but one special type of consciousness, whilst all about it, parted from it by the filmiest of screens, there lie potential forms of consciousness entirely different" (*The Varieties of Religious Experience*, 1902). This is the experience that is sought and valued by the drug user. The term also shifts emphasis from the medical or therapeutic aspect to the educational or mystical-religious aspect of the drug experience. Only certain people, however, ever have a psychedelic experience in its fullest meaning, and the question of its value to the individual is entirely subjective. The possibility of dangerous consequences, too, may be masked by such a benign term.

None of these terms, then, is entirely satisfactory, and one or two are distinctly misleading. Since a choice must be made for convenience, the term psychedelic has been adopted here as being nonpejorative and is widely current.

History.—Native societies of the Western Hemisphere have utilized, apparently for thousands of years, plants containing psychedelic substances. The sacred mushrooms of Mexico were called "god's flesh" by the Aztecs (seemingly in close parallel with "the body of our Lord" in the Christian Eucharist). During the 19th century the Mescalero Apaches of the southwestern U.S. practised a peyote rite which was adopted by many of the Plains tribes. Peyotism (*q.v.*) eventually became fused with Christianity, and the Native American Church was formed in 1918 to protect peyotism as a form of worship. The drugs are old, and so is the controversy surrounding their use.

Scientific interest in these substances developed slowly. In the mid-19th century the psychiatrist B. A. Morel used hashish to instruct his students in the subjective nature of mental illness. The neurologist Weir Mitchell wrote about his experience with peyote before the turn of the century, and his account attracted the serious attention of two distinguished psychologists, Havelock Ellis and William James. Mescaline was finally isolated as the active principle of peyote in 1896, and its structural resemblance to the adrenal hormone epinephrine was recognized by 1919. Some interest in model psychoses (*i.e.*, drug-induced simulations of abnormal behaviour patterns) followed, but it was not until 1943, when the Swiss chemist Albert Hofmann accidentally ingested a synthetic preparation of lysergic acid diethylamide and experienced its psychedelic effects, that the search for a natural substance responsible for schizophrenia (*q.v.*) became widespread. Gordon Wasson, a New York banker and mycologist, called attention to the powers of the Mexican mushrooms in 1953, and the active principle was quickly found to be psilocybin.

Chemistry.—LSD is an amine alkaloid derived from lysergic acid, an indole compound. Both the levorotatory (*l*-form) and dextrorotatory (*d*-form) alkaloids of ergot have been isolated, but only the *l* isomers, which are derivatives of lysergic acid, are pharmacologically active. The *d* isomers are derivatives of isolysergic acid. The optical isomerism is due to the presence of an asymmetrical carbon atom in the lysergic acid portion of the molecule. LSD also has stereoisomers because of an asymmetrical side chain. The psychedelic effects of LSD occur only with the *d* isomer of lysergic acid diethylamide; the *l* isomer is inactive, as are both isomers of isolysergic acid diethylamide. Changes in the structure of the LSD molecule also alter significantly the actions of the drug. With the monoethylamide, which has one of the two ethyl groups removed from the side chain, the effects on the central nervous system are greatly reduced; and the monobrom derivative, which has a bromine atom in the 2-position of the indole portion of the nucleus, is virtually devoid of psychedelic effects.

The indole moiety in the LSD molecule is of considerable interest because of the ability of LSD to antagonize serotonin, the indole amine of natural occurrence in the brain. Several of the other drugs of this group—psilocybin, psilocin, bufotenine, harmine, and *d*-dimethyltryptamine—also have an indole moiety. It was supposed at first that this blocking property against an important brain amine might account for the psychedelic action of LSD. Subsequent study, however, with congeners of LSD indicated that the relationship is quite imperfect: methysergide and the monobrom derivative of LSD are both potent inhibitors of serotonin, yet have little psychedelic activity.

Mescaline does not have an indole moiety; it is structurally related to the adrenal hormones epinephrine and norepinephrine—catecholamines that are very active in the peripheral nervous system and are suspected of playing a role also as neurohumors (chemical mediators of nerve impulses) in the central nervous system.

Physiological Action.—The psychedelics are capable of producing a wide range of subjective and objective effects; however there is apparently no reaction which is distinctive for a particular drug. Subjects are unable to distinguish among LSD, mescaline, and psilocybin when they have no prior knowledge of the identity of the drug ingested. These drugs induce a physiological response in man that is consistent with the type of effect expected of a central-nervous-system stimulant. Usually there is constriction of the peripheral arterioles, elevation of the systolic blood pressure, dilatation of the pupils, and some facilitation of the spinal reflexes. These effects are characteristic of an excitatory response of the sympathetic nervous system and are probably mediated centrally. The brain response, as measured by the electroencephalograph (EEG), is also excitatory, presenting the familiar low voltage, rapid activity associated with states of arousal.

Experimental animals are not very susceptible to the effects of the hallucinogens; large doses generally are required to induce even a slight response. LSD in animals has effects resembling those caused by the ergot alkaloid ergonovine, which induces contractions of the uterus and is used also to relieve migraine; but LSD, unlike ergonovine, produces distinctive psychological effects at doses that have virtually no effect on the reproductive or other organ systems. It seems therefore that the psychedelics exert their principal actions on the central nervous system.

There is considerable difference in the potency of these drugs. A grown man requires about 500 mg. of mescaline or 20 mg. of psilocybin or only 0.1 mg. of LSD for full clinical effects when the substances are ingested orally. There are also differences in the time of onset and the duration. Psilocybin acts within 2 to 30 min. and the effects last about 5 to 6 hr. LSD acts within 30 to 60 min. and the effects usually last for 8 to 10 hr., although occasionally some effects may persist for several days. Mescaline requires 2 to 3 hr. for onset, but the effects last for more than 12 hr. All psychedelics presumably are lethal if taken in large enough quantities, but the effective dose is so low compared to the lethal dose that death has not been a factor in experimental studies.

Physiological tolerance for these drugs develops quite rapidly in man and monkeys: fastest for LSD, somewhat more slowly and less completely for psilocybin and mescaline. The effects are lost for a particular dose level of LSD within three days of repeated administration, but the original sensitivity is quickly regained if several days are allowed to intervene. Cross-tolerance has been demonstrated for LSD, mescaline, psilocybin, and certain of the lysergic acid derivatives. Tolerance to one of these drugs reduces the effectiveness of an equivalent dose of the second drug—which suggests a common mode of action for this group. LSD is rap

idly absorbed from the gastrointestinal tract, to become widely distributed throughout the body; it is localized particularly to the liver, but very little of it appears in the brain. It is probably excreted by the liver as 2-oxy-LSD and then eliminated in the feces. Of considerable interest is the finding that LSD disappears from the brain at about the time when the full clinical effects occur; this suggests that the action of LSD is not direct but, instead, is mediated by some alteration of biochemical events in the brain.

Attempts to localize the site of action of these drugs have been only partially successful. The reticular formation of the brainstem appears to be more sensitive to incoming sensory stimulation following LSD, and all of the psychedelics are capable of inducing an alert type of EEG pattern in the intact brain of experimental animals but not in animals having the brainstem transected just below the midbrain. This would place one site of action in the brainstem at a level above the first cervical vertebra and below the midbrain. LSD and mescaline induce paroxysmal electrical activity in rhinencephalic structures, particularly the septal region, and this activity correlates grossly with the appearance of disturbed behaviour in man and monkeys. Psychedelic agents also induce high amplitude, seizurelike wave discharges in the hippocampal structures—EEG phenomena that are associated with a disruption of learned performances in the cat. Finally, transmission in the lateral geniculate nucleus can be selectively depressed with LSD—a finding which would have a bearing on the visual effects that are so frequently reported by users of psychedelic drugs.

Psychological Effects.—Most persons regard the drug experience as being something totally removed from anything they have ever encountered in normal, everyday experience. The subjective effects vary greatly among individuals and even for a particular person from one drug session to the next. The variations seem to reflect such factors as the mood and personality of the subject, the setting in which the drug is administered, his expectation of a certain kind of experience, the meaning for the individual of the act of taking the drug, and his interpretation of the motives of the person who is administering the drug to him. Nevertheless, certain invariant reactions seem to stand out. The one most easily described by users is the effect of being "flooded" with visual experience when the eyes are closed as well as when they are open. Light is greatly intensified; colours are vivid and seem to glow; images are numerous and persistent, yielding a wide range of illusions and hallucinations; details are sharp; perception of space is enhanced; and music may evoke visual impressions, or light may give the impression of sounds. A second important aspect, which people have more difficulty in describing, involves a change in the feelings and the awareness of the self (*see* PERSONALITY: *Self-Realization and the Self-Concept*). The sense of personal identity is altered. There may be a fusion of subject and object; legs may seem to shrink or become extended, and the body to float; space may become boundless and the passage of time very slow; and the person may feel completely empty inside or he may believe that he is the universe. This type of reaction has been called depersonalization, detachment, or dissociation. Increased suspiciousness of the intentions and motives of others may also become a factor. At times the mood shifts. Descriptions of rapture, ecstasy, and an enhanced sense of beauty are readily elicited; but there can also be a "hellish" terror, gloom, and feelings of complete isolation. For some people the experience is so disturbing that psychiatric hospitalization is required. Studies of performance on standardized tests show some reduction in reasoning and memory, but the motivation of the subject probably accounts for much of the performance decrement, since many people are uncooperative in this type of structured setting while under the influence of a drug.

Medical Uses.—Interest in these drugs was routinely scientific for the first few years following the discovery of LSD, but in the 1950s professional groups began to explore the use of the psychedelics as adjuncts to psychotherapy and also for certain purposes of creativity (*q.v.*). It was at this juncture, when the drugs were employed to "change" people, that they became a centre of controversy.

LSD is not an approved drug (*see* below, *Sociolegal Aspects*); consequently its therapeutic applications can only be regarded as experimental. In the 1960s LSD was proposed as an aid in the treatment of neurosis, particularly in cases recalcitrant to the more conventional psychotherapeutic procedures, but further research was needed. LSD also was being given serious trial in the treatment of alcoholism. This type of psychiatric problem does offer an objective criterion of success: the alcoholic stops drinking. Early reports were sufficiently encouraging to warrant continued study.

LSD has also been employed to reduce the suffering of terminally ill cancer patients; here, too, preliminary results were encouraging. The drug was also under study as an adjunct in the treatment of narcotic addiction, of autistic young children, and of the so-called psychopathic personality; and the use of various psychedelics continued to be advocated in the experimental study of abnormal behaviour, because of the degree of control which they offer.

Sociolegal Aspects.—If the psychedelic drugs have social utility, it is likely to reside in their rather unusual ability to evoke a mystical-religious experience. Positive change in religious feeling is a rather common finding with these drugs. Whether they are also capable of producing religious lives is an open question. These drugs appear to enhance personal security. Out of self-trust should spring trust of others—basic trust; and this may be the psychological soil for trust in God.

The other social aspects are more debatable. Timothy Leary, a leading spokesman for LSD users, repeatedly asserted that these drugs have great educational and religious value. In June 1962 he established a Psychedelic Training Centre at Zihuantanejo, Mex., where he attempted to apply the findings and theories which he, Richard Alpert, and others had evolved while at Harvard University. The experiment was interesting but short-lived: powerful social forces were aroused (as they had been at Harvard) and the program was closed in June 1963. Various cults have since sprung up, dedicated to a mystique characterized by Leary's slogan, "Turn on, tune in, and drop out"; *i.e.*, take the drug, explore the self and universe under its influence, and renounce contemporary Western values.

LSD can be dangerous when used improperly. Mood swings, time and space distortion, "hallucinations," and impulsive behaviour are complications specially hazardous to the individual when he is alone. In the 1960s the suicide rate was not high in the various investigational groups, but the rate of serious untoward psychological effects requiring psychiatric attention climbed steadily. Technically, LSD is not addicting; however, there is a tendency on the part of those who take the psychedelics informally to repeat the drug experience and to experiment with other drugs. The special language, method of proselytizing, and psychological dependence surrounding the use of psychedelics bear striking resemblance to the context of narcotics addiction. (*See* DRUG ADDICTION.)

Cultists and scientific investigators alike, in the U.S., were handicapped after 1966 by a federal order restricting experimentation with LSD to a few laboratories; its manufacture, sale, and general use otherwise became illegal. A black market flourished, however, since the drug is readily synthesized and even a small quantity—less than an ounce—provides thousands of "trips" (individual dosages). The use of peyote (*i.e.*, mescaline) was prohibited under narcotic laws in some states and uncontrolled in others.

Psilocybin, like LSD, was limited to investigational use, with supplies under the control of the pharmaceutical company licensed to manufacture it in the U.S.

Many of the questions which these drugs pose can be answered in time by sufficient scientific research. The overriding question, however, is one which no laboratory experiment can answer, and that is the question of value. Ultimately, society as a whole must decide whether or not the psychological effects of the psychedelic drugs are desirable.

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NEUROPTERA, an order of insects that includes the alder flies, snake flies, ant lion flies, lacewings and their allies. It comprises about 4,500 species of small to rather large soft-bodied insects with usually elongate antennae and two pairs of similar, net-veined, membranous wings; the wings are closed rooflike over the body when at rest and the hind pair is usually without a plicated posterior lobe. The mouth parts are for biting, the tarsi are five-segmented, and there are no cerci or tail filaments. All Neuroptera undergo complete metamorphosis, and the larvae are active and predatory with well-developed antennae, sense organs and legs; they are mostly terrestrial, but some are aquatic. The pupae have the appendages free and are generally enclosed in silken cocoons.

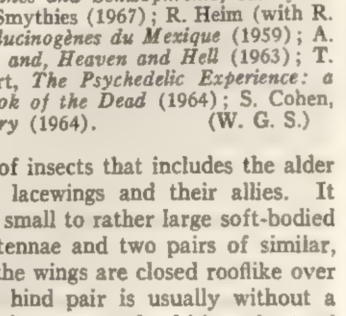

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FIG. 1.—GREEN LACEWING (CHRYSOPIDAE)

Neuroptera are all insects of weak flight. They are rarely abundant as individuals. In the adult stage, they feed mostly upon soft-bodied insects or liquid matter such as honeydew. Most of the species have beautiful net-veined wings that often exhibit a complex reticulation formed by numerous accessory veins. In the larval stages neuropterans are exclusively predaceous.

GENERAL FEATURES

The eggs of Neuroptera are ovoid and in several families, including the green lacewings, the female exudes a sticky secretion that she draws out into a hairlike stalk upon which the egg is laid for safety. The larvae are mostly terrestrial or arboreal and in the suborder Planipennia are all characterized by the greatly drawn out mandibles and maxillae, which are used for seizing and perforating the prey. The mandibles are grooved along their ventral surface; the maxillae, which closely resemble the mandibles, fit one into each groove; in this way the two sets of appendages function as a pair of tubes through which the body juices of victims are sucked out. Larvae of the Planipennia are further remarkable for the fact that six of their eight excretory tubes become transformed into silk glands, the silk being emitted through an anal spinneret.

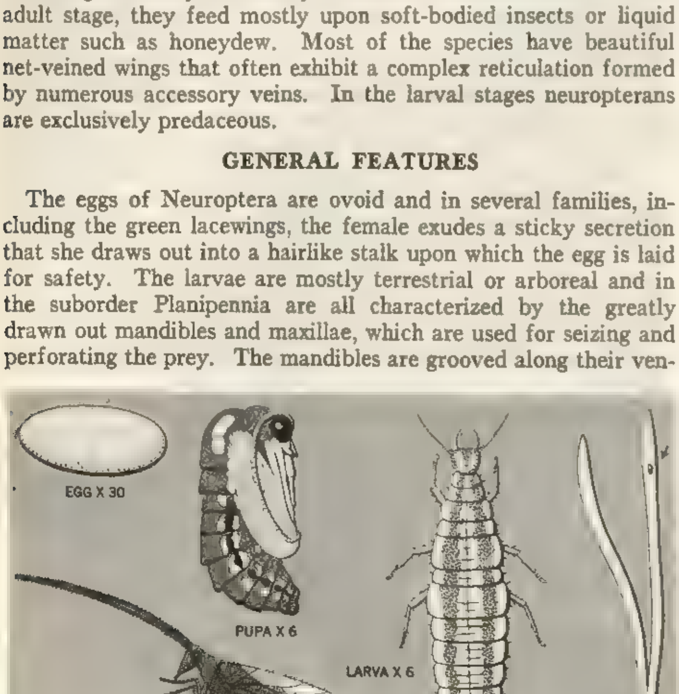

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FIG. 2.—LIFE CYCLE OF THE BROWN LACEWING (HEMEROBIUS STIGMA)

Larvae of all Neuroptera are carnivorous and prey mostly upon other forms of insect life. When mature those of the Planipennia construct silken cocoons and, prior to the emergence of the adult insect, the pupa cuts open the cocoon with its mandibles and, being mobile, often travels some little distance before the imago emerges. Little is definitely known respecting the specific nature of the food of the adults; many are nocturnal in habits and are attracted to lights, while most of the day-flying species are rarely seen on the wing.

Geographical Distribution.—Certain families of Neuroptera are nearly world-wide in their distribution. Chrysopidae, for example, are found in almost all extensive areas of land except New Zealand; Sialidae have an almost world-wide though discontinuous range; while the Raphidiidae are mainly restricted to the northern hemisphere. Several families, on the other hand, are almost confined to Australia, which has a more diverse fauna of Planipennia than any other region of the globe, although the Megaloptera are represented there only by a few species. There are 13 families of Neuroptera in the United States but only 7 in the British Isles.

Geological Distribution.—Megaloptera are evidently an archaic group but their fossil remains, unless very perfect, are difficult to identify. The earliest undoubted remains of this suborder have been found in the Permian rocks of the U.S.S.R. The Planipennia first appear as fossils in Permian beds of the U.S.S.R. and Australia.

Economic Importance.—Neuroptera as a whole are distinctly beneficial to man in their larval stages. Larvae of alder flies and dobson flies form food for trout and other fishes, while those of the Planipennia prey upon many soft-bodied noxious insects. In Europe and North America the most beneficial sorts are the brown lacewings, green lacewings and the dustywings. In Australia larvae of the moth lacewings destroy numbers of chafer beetle grubs in the soil.

RELATIONSHIPS AND CLASSIFICATION

The order may be divided into two suborders, Megaloptera and Planipennia.

Suborder Megaloptera.—This suborder is characterized by veins with little or no tendency to fork at the margins of the wings, the third vein in the wing (radial sector) with few branches; larvae with biting mouth parts; and pupae not enclosed in true cocoons.

This group includes a small number of archaic insects separable into two superfamilies comprising about 200 species throughout the world.

Superfamily Sialoidea, all with aquatic larvae, include the alder flies (*q.v.*; family Sialidae), so called because in England the adults often frequent alders along the banks of streams. Their larvae respire by means of seven or eight pairs of slender, jointed, abdominal gills. The genus *Sialis* is widely distributed with many North American species and two British. Also included are the large dobson flies (*q.v.*), belonging to the family Corydalidae and found in North and South America and in parts of the old world. Smaller members of the same family are often known in America as fish flies (*q.v.*).

Superfamily Raphidiodea or snake flies are distinguished by the elongate prothorax and by the very long ovipositor in the female. They are terrestrial insects whose larvae are found under the bark of trees and feed on scale insects and aphids.

Suborder Planipennia.—This suborder is characterized by veins with evident forking at the margins of the wings, third vein (radial sector) usually with numerous branches; larvae with piercing mouth parts; and pupae enclosed in cocoons.

Included here are most of the Neuroptera. They are nearly all terrestrial insects, only a small number being partially or truly aquatic in their larval stages. Planipennia are divided into

families of which only the most important are mentioned.

Ithonidae or moth lacewings are confined to Australia; they are large, stoutly built, mothlike insects with primitive venation. Their larvae live in the soil where they prey upon those of chafer beetles, to which they bear a close general resemblance.

Hemerobiidae and Chrysopidae, the brown and the green lacewings, are widely distributed and fairly numerous in species. Their larvae roam about vegetation preying upon mites, aphids, thrips and other soft-bodied insects (*see* LACEWING FLY).

Osmylidae have aquatic larvae. They are medium- to large-sized species which differ from the lacewings in certain venational characters. They are widespread in the tropics but are represented in Europe by only one species and are absent from North America.

Sisyridae, which also have aquatic larvae, differ from the Osmylidae in having very few cross veins to the wings, besides being much smaller in size. They are brown or fuscous insects found along the borders of rivers that contain the freshwater sponge upon which their larvae feed and live. Three species of *Sisyra* occur in Great Britain, and this genus, along with *Climacia,* is found in the United States.

Mantispidae or mantis flies (*q.v.*) are easily distinguished by the elongate thorax and the prehensile forelegs, which resemble in form those of the common mantis (*q.v.*) and are likewise used for seizing other insects that serve as their prey. The larvae of the European *Mantispa styriaca* are predacious upon young *Lycosa* spiders and during development they undergo striking changes of form. The family is mainly tropical but occurs in southern Europe and in much of the United States.

Psychopsidae have very broad, rounded wings supported by a stout midrib and with a densely reticulated venation. Many are insects of striking beauty. Their larvae have been found beneath the bark of trees. The family has a wide discontinuous range occurring in South Africa, Tibet, China and Australia.

Nemopteridae differ from all other Neuroptera in having very long threadlike or ribbonlike hind wings. Their larvae occur in caves, on the floors of buildings, among debris, etc., where they prey upon smaller forms of insect life. The family occurs in many of the warmer parts of the world, including southern Europe, but is absent from North America.

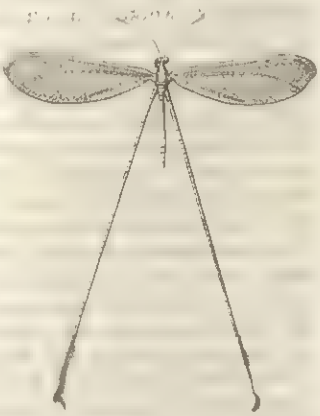

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FIG. 3.—NEMOPISTHA IMPERATRIX (NEMOPTERIDAE)

Myrmeliontidae or ant lion (*q.v.*) flies bear a general resemblance to dragonflies and have short knobbed antennae. Although most abundant in the warmer parts of the world, about 65 species occur in the United States, several occur in Europe, one being found as far north as Sweden, but none are found in the British Isles. Their larvae, called ant lions or doodlebugs, live on the ground, where some make pitlike snares for entrapping their prey, while others hide away under stones or debris.

Ascalaphidae are closely related to the preceding family but can be distinguished easily by their much longer antennae as well as by differences in venation. Their larvae either hide away on the ground or live concealed on the bark of trees. They are chiefly tropical insects, only a few species occurring in southern Europe and North America.

Coniopterygidae or mealywings (*q.v.*), number about 70 species and are the smallest and most aberrant of all Neuroptera. They are covered with a white powdery secretion, their wings have comparatively few veins and the hind wings are much reduced in size. Their larvae roam about plants, preying upon aphids, scale insects and mites. Many species are found in the United States but only a few species are found in Great Britain.

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(A. D. I.; F. M. CR.)

NEUROSES are psychological disorders which arise from a person's unsuccessful attempt to deal with inner conflicts and stressful life situations. They are adaptive in that they aim at the resolution of opposing forces within the personality through the discharge of accumulated inner tension and anxiety. The anxiety may be experienced directly or manifested in the form of bodily discomfort, phobias, obsessional thoughts, compulsive acts, mild depression, altered states of consciousness or physical complaints in the absence of organic and structural pathology. The neuroses represent attempts to obtain partial gratification for impulses and drives in a manner which was more or less successful in an earlier period of development. The disorders are benign disturbances within the personality and are to be differentiated from psychoses (*q.v.*) in that total disorganization and loss of contact with reality do not occur.

Although recognizable neurotic syndromes have been described since the Hippocratic period, the tendency for many centuries was to consider the illness a result of demonic possession or willful simulation. With the development of scientific medicine based on pathology, the 19th century considered neuroses as a primary functional disorder of the central nervous system. The French neurologist Jean Martin Charcot (*q.v.*) laid the foundations for a psychological understanding of neuroses through the use of hypnotic techniques for the treatment of hysterical disorders. The psychological approach was further developed by Sigmund Freud (*q.v.*), who demonstrated the effect of unconscious forces within the mind, the symbolic meaning of neurotic symptoms, the significant etiological agents in childhood experience, the importance of unacceptable repressed sexual and aggressive drives and a technique of treatment based on psychological principles. The modern psychiatric outlook is largely based on the discoveries of Freudian psychoanalysis.

Freud divided the neuroses into two major categories, the actual neuroses and the psychoneuroses. Although not universally accepted, this division is useful in understanding and classification. The actual neuroses include symptomatic disorders which are primarily reactions to acute stressful situations and arise as a result of excessive stimulation originating either environmentally or internally.

Symptoms are simply the discharge of accumulated tension rather than an attempt at the resolution of psychological conflict. The traumatic neuroses—such as the "shell shock" of World War I, the combat fatigue of World War II or the emotional disorders following civilian disaster—are essentially neuroses of this type. The symptoms are an attempt to deal with catastrophic external events of such magnitude that the personality has no recourse but the immediate dissipation of the accumulated tension. These reactions are short-lived and usually disappear with the removal of the stressful situation.

The actual neuroses also include reactions to endogenous stresses, that is, stimuli which arise within the organism. If a weakened personality becomes flooded by sexual or aggressive excitation, a paniclike state may result. When a state of overstimulation and insufficient motor discharge becomes chronic, diffuse symptoms such as general fatigue, tension, dizziness, insomnia, pressures and pain in the head, neck and back occur. This general state of exhaustion and bodily preoccupation is characteristic of neurasthenia and hypochondriasis.

These actual neurotic reactions may in turn become converted into psychoneurotic reactions in which the symptomatic response

carries a more elaborate psychological content. The reaction in the psychoneurotic condition is a result of the meaning of the stimulus rather than its magnitude. An objectively insignificant stress may produce a psychoneurotic reaction in a person who is particularly vulnerable because of his inability to handle such frustrations. To illustrate, in wartime a traumatic neurosis may develop following prolonged and threatening bombardment during combat. A psychoneurosis may intervene when under similar conditions the death of a comrade arouses intolerable feelings of guilt in a soldier for whom the event recapitulates a childhood jealousy of an older brother. Since Freud first distinguished the two neuroses, clinical experience has demonstrated that most actual or traumatic neuroses are frequently elaborated into psychoneuroses.

CAUSATION

Evaluation of Factors.—Modern psychiatry considers many factors in the causation of the neuroses. Although in a particular patient one factor may be more important than others, all must be evaluated in attempting to understand the origins of neuroses. Since these factors fall into a complementary series, it is unlikely that a single linear relation between specific cause and end result will be found.

Socio-Economic and Cultural Factors.—These may be causative in the development of neuroses because of the presence of conflicting and opposing values within a society. A person may strive toward the gratification of ends, such as "belongingness" and competitiveness, which are essentially contradictory. The satisfaction of one value may make it impossible to satisfy the other. A group of neo-Freudian psychiatrists have tended to relate the findings of psychoanalysis to the social sciences in order to elucidate the mutual interactions between culture and disturbances in personality. Among these, Erich Fromm and Karen Horney (*q.v.*) have considered neurotic conflict to be primarily the result of reactions to social institutions.

One type of social organization or ethnic group may encourage neurotic responses either by its own nature or by its mode of relating to a larger group. Attitudes toward class position, urbanization, sharp transitions in prevailing social codes, and prejudicial attitudes toward minority groups affect the development and content of neuroses. It is well established that social position affects to a large extent the type of treatment a neurotic patient will seek for his illness.

Constitution.—Although psychiatry does not deny the significance of heredity, this factor is not credited with the overwhelming importance attached to it prior to the 20th century. A therapeutically oriented psychiatry is inclined to minimize hereditary influences and to deal more with experiential factors subject to observation and change.

Parental Attitudes and Early Childhood Experiences.—These are considered to play a critical role in the development of faulty patterns of neurotic interaction. The experiences of the child in the family setting determine to a large extent the subsequent personality development.

An attitude of love, acceptance and security in the family tends to foster healthy behaviour patterns. Inconsistency, rejection and deprivation tend to create areas of vulnerability which may become sensitized in later life.

Oedipus Situation.—The parental attitudes and the constitutional predispositions converge at the time of the development of the Oedipus complex (*see* PSYCHOANALYSIS) to create the basic personality pattern with which the person handles situations of stress subsequently. At the ages of three to five, the child begins to develop a close, positive bond with the parent of the opposite sex and to resent and feel jealousy toward the parent of the same sex. If the previous relationships with the parents have been relatively nontraumatic, and if the parental attitudes during this stage, called by Freud the Oedipus situation, are not excessively prohibitive or stimulating, this phase of development is passed through harmoniously. Should trauma occur, regressive techniques which have been found useful in handling stress in early phases of development are again used and may become a consistent mode of handling emotional difficulties in the future. The early attempt to resolve the problems of the Oedipal situation by regression is called the infantile neurosis, and it is a forerunner of similar reactions which occur during the adult neurosis.

Following the resolution of the Oedipus complex the character structure becomes consolidated as a habitual mode of relating to situations in later life.

Precipitating Stress.—Should living provide no major frustrations, the character defenses prove adequate for adaptation and the person may then remain free of a symptomatic neurosis unless a precipitating stressful event occurs.

Interrelations.—The five causative factors are related to one another dialectically; that is, in order for a symptomatic neurosis to occur, one factor may be quite significant while another may not. Thus, socio-cultural factors may be of minimal importance but the parental influences may be markedly traumatic, or the resolution of the Oedipus complex may have left only minor psychological scarring while the precipitating event may present a major and insurmountable frustration.

Psychopathology of Neurotic Conflict.—The causative factors in neuroses were described above in a primarily chronological manner. The shifts in forces as they occur in the development of the adult neurosis can be understood as a retracing of a similar sequence.

The precipitating event is the actual life stress with which the person has difficulty in coping. It may be either a temptation or frustration, and the stress itself may penetrate consciousness only dimly. Following a period of unsuccessful attempts at adaptation through fantasy or action, a regression to earlier adaptive pattern occurs. The patterns, which resemble the infantile neurosis, were a source of gratification in early life and are thus called into play to help the person adjust to the immediate stress.

Such regressive maneuvers consume great energy, since the struggles are worked out on an unconscious level. Much effort is expended in keeping the nature of the conflict removed from awareness, because the original wishes and impulses which make up the content of the primary conflict were and continue to be highly unacceptable to the self. The apparently irrational quality of the adult neurosis thus is due to the fact that the mechanisms used to handle psychological stress, though appropriate to the unique childhood situation, are not suitable for adult life. The extent of the neurotic disability is determined by the amount of energy expended in keeping repressed and inactive the impulses which strive toward fulfillment.

The symptom itself is a symbolically expressed compromise of the conflict between unacceptable impulses and prohibitive restraints, permitting partial expression for both opposing forces.

Neurosis, Normality and Psychosis.—The distinction between normal and neurotic expression is not so great as is commonly believed. It must be realized that all persons share similar childhood experiences, and the repression of primitive impulses by the ego is a universal phenomenon in human development. Thus there is a potentiality for a neurotic reaction in most so-called normal persons, and it is likely to arise when the environment presents to the person a stress which stimulates his unique vulnerability.

In most instances, however, such neurotic reactions are not clinically significant, because they are either socially acceptable, psychologically rationalized as idiosyncrasies, or transient in appearance so that they appear as trivial occurrences such as dreams, errors or slips in speech.

The differentiation between neuroses and psychoses is more meaningful, though here too it is frequently difficult to make a rigid and meticulous distinction. For legal, social and therapeutic purposes, many psychiatrists feel a distinction is justified. In the psychoses the degree of social disorganization and loss of contact with reality is of major proportions. In contrast to the neuroses, the inner assessment of external reality in the psychoses is greatly impaired, and reality is imbued with attributes which are projections of inner experiences. The neurotic, unlike the psychotic,

does not form delusions or hallucinations, nor does he engage in forms of thinking which are bizarre and grossly illogical. The distinction is greatest in the area of social adaptiveness. The neurotic is often able to continue to function within the social unit, and others may remain unaware of the extent of his suffering.

The psychotic, on the other hand, is much more obviously a misfit, a threat to himself or to others, and markedly dissimilar in attitude and action to those around him. This does not imply that the criteria for diagnosis are social and cultural, although it is frequently stated that a particular reaction which appears in one social group as extreme deviance may be positively sanctioned and accepted in another. Though cultural relativity must be taken into account, the differentiation between neuroses and psychoses is ultimately made on the basis of the inner psychological attitudes and behaviour.

TYPES OF PSYCHONEUROTIC DISORDERS

Most classifications of neurotic disorders have been inadequate because of the multiplicity of causal factors, the general overlapping of clinical syndromes and the changing historical aspect of the neurotic illness. Whereas in the 19th century massive hysteria involving major bodily dysfunction was a common type of psychiatric illness, by the middle of the 20th century it had largely disappeared as a clinical entity, and most neurotic illness appeared to be based on disorders in character structures and personality types. Though a tendency to classify on the basis of predominant symptom complexes remained, symptomatic manifestations were found to be secondary to defects in total personality development.

In 1952 a standard nomenclature was adopted by the American Psychiatric association. Neurotic disorders and personality disorders were differentiated largely on the basis of clinical clustering rather than on the basis of etiological antecedents.

In the standard nomenclature the psychoneurotic disorders are classified as follows: (1) anxiety reaction, (2) phobic reaction, (3) dissociative reaction, (4) conversion reaction, (5) obessive-compulsive reaction and (6) depressive reaction.

Anxiety Reaction.—Anxiety is a diffuse fear which is not restricted to definite situations or objects. It is subjectively experienced as dread, apprehension or tension and may arise in any situation in which the integrity of the personality is threatened. The anxiety is not controlled by any specific psychological defense mechanism as in other neurotic reactions. Anxiety frequently arises when there is a failure of repression of forbidden sexual impulses or aggressive urges, usually in association with major life adjustments related to shifts in vocational, interpersonal, sexual or marital adaptations. The patient is in a constant or periodic state of apprehensive expectancy. Since defense mechanisms are not brought into play to handle the anxiety, it can be considered the simplest type of neurosis from a structural point of view.

The tension is frequently expressed in the form of insomnia, outbursts of irritability, agitation, palpitations of the heart and fears of death or "insanity." These patients are frequently fatigued as a result of the excessive effort they must expend in managing the distressing fear. Occasionally the anxiety is expressed in a more acute form and results in physiological concomitants such as nausea, diarrhea, urinary frequency, suffocating sensations, dilated pupils, perspiration and hyperventilation.

Phobic Reaction (Anxiety Hysteria).—A phobic reaction resembles an anxiety reaction in that the discomfort experienced by the patient is also fear. In this condition, however, the fear is of a definite external situation. The anxiety of phobic patients has become detached from a specific inner idea, object or situation and is displaced to a symbolic idea or external situation in the form of a specific neurotic fear. The patient cannot avoid experiencing acute discomfort if he is exposed to the external situation which he fears, even though he is consciously aware that no actual danger exists. The fear actually is derived from unconscious sources, such as forbidden impulses and wishes of a sexual and aggressive nature; and is displaced to an object which is symbolic of the fulfillment of the threatening wish. The commonly observed forms of phobic reactions include fear of venereal disease, fear of small enclosed places (claustrophobia), fear of high places (acrophobia) and fear of open places (agoraphobia).

The phobic patient can control his anxiety if he avoids the phobic object or situation. If he were to carry out a phobic activity it would unconsciously mean to him that he was performing the forbidden activity and gratifying the forbidden wish. The anxiety and suffering serve as a form of self-punishment for the unconscious tendencies and impulses.

Dissociative Reaction.—At times a person may handle his anxiety in such a manner as to obliterate certain functions of the personality, such as consciousness or memory. Though this is essentially a neurotic disturbance, the extent of the dissociation occasionally may reach psychotic proportions.

One of the commonest of the dissociative reactions is amnesia. Dissociative amnesia is a blotting out of awareness of highly unpleasant memories. These are experiences involving great terror, as in military combat, or experiences which have aroused great shame, guilt or loss of self-esteem.

Amnesic patients frequently accept their loss of memory indifferently and casually, indicating that a valuable protective function is performed by the reaction.

Dissociative reactions also are characterized by disturbances of consciousness such as dream states, stupor, coma and sleepwalking. Such phenomena are usually preceded by strong emotional experiences and represent the wishful reliving of an unacceptable fantasy in a dramatic and colourful manner.

In the dissociative fugue there is a temporary loss of personal identity, and actions are performed which in the patient's normal state would be firmly prohibited by the conscience. The patient may protect himself against punishment by assuming a false identity, later developing an amnesia for the experience when he returns to his usual self.

Although there appears to be a conscious deliberate element in the patient's behaviour, the dissociative reactions are actually motivated and set in action by parts of the mind that do not involve conscious volition.

Conversion Reaction.—In the conversion reactions anxiety, instead of being consciously experienced either diffusely as in the anxiety reactions or displaced as in the phobias, is "converted" into symptoms involving organs or parts of the body innervated by either the sensory or motor nerves. The symptoms serve to prevent or lessen conscious anxiety, and usually are symbolic of the underlying mental conflict. Such hysterical symptoms represent an attempt to resolve a conflict symbolically. Thus, an essentially mental content is converted into a somatic expression. To illustrate, the wish of a female patient to withhold medication from her dying father and thus hasten his death is converted into a hysterical paralysis of an arm; this partially serves to carry out the wish and also to punish the patient for entertaining the wish. The form of the conversion symptom may be determined by a somatic symptom which is contiguous to the conflictual situation. In the above example, the symptom began when the woman's arm fell asleep while she watched over her father in his illness.

Persons with a hysterical type of personality are prone to self-display and dramatic behaviour. Many are adept at ruling others directly by bids for sympathy or attention or indirectly by frightening others or by appearing pitiful and appealing. Egocentricity, predilection for fantasy and daydreaming, emotional liability and suggestibility are predominant character traits.

The physical symptoms may be either sensory or motor. Among common sensory symptoms are pain, anesthesia, numbness and such disturbances of the special senses as blindness or deafness. The symptoms are found to have a specific symbolic relation to psychologic conflict, and they differ from organic disturbances by revealing absence of neurological findings upon physical examination. The motor disturbances—common among them paralyses, tics, tremors, inability to speak (aphonia) and writer's cramp—also occur without demonstrable physiological or anatomical change.

The patient with a hysterical conversion reaction may utilize the symptom to provide himself with secondary gratifications. The secondary gain is the material, emotional and social advantage

contributed by the symptom. The presence of the symptom permits a self-justifiable escape from anxiety-provoking life situations. The symptom also provides dependent satisfactions of a regressive nature as a result of the sympathy with which the sick are frequently treated.

The successful conversion reaction, like the dissociative reaction, is accompanied by a marked absence of anxiety or conscious concern. Though the disability may mobilize concern in others, the patient may appear tranquil and content. *See* also HYSTERIA.

Obsessive-Compulsive Reaction.—In this reaction the anxiety is associated with the presence in consciousness of unpleasant and morbid thoughts or repetitive impulses to perform apparently meaningless and ritualistic acts. Although the patient may regard his ideas and behaviour as unreasonable, he is unable to control them. Either the obsessive thought or the compulsive ceremonial may arise singly or both may appear in sequence. The patient regularly repudiates the distressing thoughts, which are often highly repugnant and concerned with violently aggressive or sexually perverse impulses. However, the more he struggles to dispel his thoughts, the more insistently do they intrude. Great fear may be associated with such ruminations, and a ritualistic act frequently serves as an attempt at mastery of the fear. Although patients may fear that they are likely to act out the disturbing impulses, an obsessively neurotic patient almost never carries out the thought against which his conscience rebels so strongly.

Occasionally the preoccupations may be with absurd trivialities or circular speculations on abstruse religious or philosophical issues.

The personality of obsessive-compulsive patients is characterized by inflexibility, constant doubt, vacillation and adherence to excessive standards of morality. They tend to be overconscientious and inhibited in the expression of pleasure and in the capacity for relaxation. A tendency toward checking and rechecking of the simplest acts contributes toward lack of productivity and the consumption of much energy in unprofitable and wasteful labour.

The recurrent thought may be the direct expression of a primitive impulse or it may represent a substitute or concealment for it. A further attempt to handle the guilt and anxiety associated with the impulse is provided by the compulsive act. Should the act be obstructed in some manner, the patient will experience anxiety directly. Although most compulsive rituals are rather simple—such as persistent handwashing, counting, touching or the repetition of stereotyped words or phrases—occasionally elaborately formalized and time-consuming ceremonials are necessitated. The compulsive acts are similar to the magical expiatory rituals of nonliterate societies and similarly attempt to deal with potentially threatening situations.

The predominant psychological mechanisms utilized by the compulsive patient are undoing and isolation. The compulsive act is an attempt at undoing, since the action essentially nullifies any harm the patient feels he may cause by his wishes. The mechanism has originated in early childhood and is related to the child's propensity for utilizing magical fantasies and superstitions to master disorganizing traumatic states within the developing ego. Isolation is observed in the separation of the obsessive wish from any emotional content aside from anxiety. The wish is reacted to as if it were alien to the total personality.

Depressive Reaction.—A psychotic depression is a major disturbance involving the entire personality and disrupting contact between the patient's self and external reality. The neurotic depressive reaction is a less malignant condition, which may be precipitated by the loss of a valued person, object or idea. The emotional state is characterized by melancholy, brooding, hopelessness and an attitude of self-criticism and self-depreciation. Psychological processes, such as thought, and physical activity are retarded. There is a lack of initiative, curtailed concentration and preoccupation with feelings of guilt for past failures which are exaggerated beyond their just proportions.

Commonly, the depressive reaction follows the loss through abandonment or death of someone to whom the patient was closely attached, and in this regard it resembles a normal reaction of grief; the difference resides in the prolongation and severity of the depressive reaction and the appearance of guilt and self-accusations. A neurotic reaction results when the lost or abandoned person is regarded ambivalently, that is, when intense feelings of both love and hate are experienced toward the other person, and the hatred is felt to be unacceptable and thus repressed. In depression, since guilt prevents the outward expression of rage, the hatred is turned on the self, accounting for the feelings of unworthiness and occasional thoughts of self-destruction.

Depressive feelings may arise in situations of helplessness, frustration and great loss of self-esteem. In persons who are habitually inhibited in the expression of aggressive impulses, a depressive reaction may intervene if an external situation mobilizes the expression of such forbidden impulses. In contrast to the compulsive person, who handles his guilt by rituals of expiation, the melancholic attempts to handle his guilt by turning his hostility against his own person. The more malignant symptoms which accompany psychotic depressions, such as suicide attempts, profound stupor and physical debility, are absent.

Character Neuroses.—A large group of personality disturbances in which the defect is expressed primarily in the character rather than in symptoms are described as character neuroses or neurotic characters. The patient may not suffer from any of the usual psychological symptoms such as anxiety, depression, obsessions or compulsions, but instead may manifest generalized pathological patterns of action or behaviour.

The inner psychological problems are expressed in interaction with the environment rather than in symptom formation.

TREATMENT

The treatment of the neuroses takes two main forms: it is directed either toward the alleviation of environmental pressures or toward effecting changes within the person which allow him to cope with his external and internal conflicts more suitably.

In the acute traumatic neuroses environmental manipulation is the most desirable treatment. Temporary removal from the scene of battle during combat is effective for many in whom the neurosis was primarily a reaction to a stress of overwhelming magnitude.

Treatment directed toward the individual may be either somatic or psychological. Somatic treatment is essentially symptomatic in that no attempt is made to eradicate the roots of the psychoneurotic condition. Therapy is directed toward ameliorating the discomfort associated with the symptoms through the use of sedation, postural relaxation or pharmacological tranquilizing agents. The symptoms frequently recur when somatic treatment stops.

Psychotherapy is an attempt to deal with the patient through psychological means either through the use of reassurance and suggestion or through the provision of insight and understanding of the conflicts. In both forms of psychotherapy the essential vehicle is the communicative potential of the doctor-patient relationship. Psychoanalysis is the most thorough form of insight psychotherapy, and various modifications of psychoanalytic techniques and principles are commonly used in the treatment of the neuroses.

See also DEFENSE MECHANISMS; EGO; PERSONALITY; PSYCHIATRY; PSYCHOANALYSIS; PSYCHOLOGY, ABNORMAL; PSYCHOTHERAPY.

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NEUROSES, EXPERIMENTAL are complex behavioural disturbances in animals, primarily emotional in character, produced experimentally by behavioural methods as opposed to direct assault on the nervous system by drugs, poisons, brain lesions or other physical or chemical agents.

Historical Background.—The first experimental neuroses were discovered by accident. During the normal course of his research on conditioned salivation reflexes in dogs, Ivan Petrovich Pavlov and his co-workers occasionally noted that the general behaviour of an experimental subject might change radically. A

previously manageable and co-operative dog would become unmanageable and unco-operative. Changes in behaviour were dramatic and included frequent vocalizations, restlessness or inactivity, avoidance of the experimental situation and everything associated with it, insomnia or somnolence and loss of appetite. Also noted were physiological symptoms including changes in heart rate, breathing rate and changes in the frequency of micturition and defecation; the nature of the symptom varied with the individual dog.

The following description of the onset of an experimental neurosis illustrates the profound changes in behaviour that typically occurred. In the experiment reported, the dog was being trained to salivate when a luminous circle was projected onto a screen (directly in front of the animal) and not to salivate when an ellipse was shown. This training was accomplished by giving the dog a small quantity of food whenever the circle appeared but withholding the food whenever the ellipse was presented. Eventually, the animal learned to salivate when the circle was presented and not to salivate when the ellipse was shown. After this differentiation had been established, the shape of the ellipse was approximated by stages to that of the circle by changing the ratios of the semiaxes until the ratio 9:8 was reached. At this point the differences between the circle and ellipse were so minimal that the ability of the animal to tell the difference between them practically disappeared; *i.e.*, the animal's discriminating ability became severely taxed. The animal's behaviour soon changed drastically. Pavlov wrote:

> After three weeks of work upon this differentiation [*i.e.*, ellipse 9:8 versus circle] not only did the discrimination fail to improve, but it became considerably worse, and finally disappeared altogether. At the same time the behavior of the animal underwent an abrupt change. The hitherto quiet dog began to squeal in its stand, kept wriggling about, tore off with its teeth the apparatus for mechanical stimulation of the skin, and bit through the tubes connecting the animal's room with the observer, a behavior which never happened before. On being taken into the experimental room the dog now barked violently, which was also contrary to its usual custom; in short it presented all the symptoms of a condition of acute neurosis. On testing the cruder differentiations they also were found to be destroyed, even the one with the ratio of the semi-axes 2:1. (*Conditioned Reflexes*, p. 291, Oxford University Press, London, 1927.)

In addition to difficult discriminations Pavlov found that sudden changes in the experimental procedure or the use of painful stimuli might also cause similar behavioural disturbances.

Pavlov's choice of the term neurosis was unfortunate. As pointed out by H. S. Liddell, F. A. Beach and others, the term implies that behavioural disturbances in other animals are analogous to behavioural or psychic disorders in man. Although a few investigators believe that such is the case, most are unwilling to make such an assumption. The consensus is that much more compelling evidence is needed to establish the hypothesis that human neuroses are fundamentally the same as those of other animals; a position that such is the case is more an act of faith than anything else. In human beings, the distinctive character of neurotic symptoms is related to a relatively high level of ability to think, introspect and imagine. Nevertheless, most investigators note that the types of stress that tend to induce abnormal behaviour in other animals, and the types of therapy that tend to be beneficial for them, often show instructive resemblances to stimuli that induce corresponding changes in people.

Pavlov's subsequent descriptions of behavioural disorders in other dogs, together with an enumeration of some of the variables that affected such responses, established the first meaning of the term experimental neurosis—its historical or classical meaning. For Pavlov, an experimental neurosis was said to exist when previously learned conditioned reactions were disrupted and the animal became more or less useless as an experimental subject unless given a vacation or unless other steps were taken (*e.g.*, injections of bromide had a beneficial effect on some dogs).

Once a neurosis had occurred the animal's disturbances were not confined to the laboratory but might also be observed in his pen and in his relations with humans or with other animals. Also, once established, a neurosis might last a week, a month or even years in the absence of remedial treatment.

Pavlov identified two types of neuroses, inhibitory and excitatory, distinguished from each other in terms of the performance of the animal in the conditioning situation. A failure to respond to the conditioned stimulus altogether (as in the case reported above) identified an inhibitory neurosis. Conversely, a tendency to respond to any change in the environment—that is, to respond at the slightest provocation—identified an excitatory neurosis. Pavlov found that some dogs tended to exhibit inhibitory reactions, while others developed excitatory neuroses. Such findings led him to develop a nervous system typology to which dogs were assigned depending on their symptoms.

Since Pavlov's classic studies, the meaning of the term experimental neurosis has changed greatly. It has been applied, both as a descriptive and as an explanatory concept, to widely divergent forms of behaviour (possibly sharing some common elements, however) observed in a great many species (*e.g.*, sound-induced convulsive seizures in rats and aggressive resistiveness in the pig). Such an extension in meaning has been an almost inevitable consequence of the great world-wide interest in behavioural disturbances that followed Pavlov's pioneering studies, and the hundreds of research studies that resulted. Because of this extension in meaning, however, the term has acquired an omnibus character, and the establishment of defining criteria acceptable to most workers in this area has not been possible. Accordingly, the term experimental neurosis has tended to fall into disuse in favour of purely behavioural descriptions of less complex experimentally produced changes in emotional (and other forms of) behaviour.

In effect, researchers have tended to analyze experimental neuroses into simpler, more conceptually manageable component parts, and to study these parts intensively in the laboratory. Experimental techniques uniquely suited for producing select symptoms at will have been developed, and factors influencing rather limited but well-defined behavioural disorders continue to be investigated in a variety of disciplines. Studies of conditioned emotional responses of the fear or anxiety variety, conditioned avoidance responses, conditioned reactions to punishment, conditioned conflict behaviour, conditioned physiological reactions and studies of body damage resulting from psychophysiological stress have largely replaced the broader study of experimental neurosis.

Nevertheless, as pointed out by R. W. Russell and Liddell, the term experimental neurosis is important because of its historical significance and because later observations of experimentally produced behavioural abnormalities in animals may be referred to the systematic writings of Pavlov on this subject. Also, a number of investigators have continued Pavlov's classical methods for studying experimental neuroses in animals.

Extensions of Pavlov's Work.—W. H. Gantt, at the Johns Hopkins university, and Liddell, at Cornell university, continued and extended Pavlov's work in the United States. They and their co-workers, after about 1930, worked to verify Pavlov's findings and to investigate further the variables that influence classically defined experimental neuroses and associated conditioning phenomena in a variety of mammals.

Gantt thoroughly investigated the visceral and autonomic conditioned reactions (primarily heart rate, respiration, sexual functions) that accompany motor or salivary conditioned responses in dogs. He studied these reactions—their onset, course and duration—for periods ranging from 5 to 14 years in dogs. One important finding was that heart rate is a much more sensitive indicator of conditioning effects than overt emotional reactions or conditioned motor or secretory responses. Not only were conditioned increases in heart rate established sooner, but also they continued to occur in many subjects long after overt emotional, salivary or motor components had been extinguished (in one case, even after an 18-month vacation from the experimental regimen).

Another important finding was that neurotic symptoms not previously observed might occur several years after the original behavioural trauma. Gantt reported spontaneous sexual erections in a dog, for example, both in the sound-proof enclosure in which the dog was placed for conditioning or observation and at the country retreat where the animals were taken for periods of rest and vacation. This symptom (as well as very frequent urination)

became most pronounced about two years after the main experimentation had been completed, and frequently appeared whenever an event reminiscent of the early conditioning procedure occurred (*e.g.*, the appearance of Gantt at the country retreat).

Liddell extended Pavlovian conditioning methods to other mammals. He and his co-workers studied experimental neuroses in the goat, sheep, rabbit and pig as well as in the dog, but the sheep was his standard experimental subject. After preliminary attempts to establish conditioned salivation in sheep and goats, he abandoned this procedure in favour of the defensive leg-flexion conditioned reflex.

In this procedure a signal, usually a sound or light, is turned on for a few seconds before the onset of a momentary mild shock to a foreleg of the animal. The signal and shock are terminated together. Eventually, leg-flexion, which initially occurs only at the moment that the shock is given, begins to occur at the moment the signal is turned on. At this point the animal is said to have acquired a conditioned leg-flexion reflex.

Liddell has emphasized the mildness of the shock, which, he indicates, is barely perceptible to the human hand. Although the animal starts slightly when the shock is delivered, it soon quiets down. Using this procedure Liddell has produced marked behavioural deviations in his subjects. The animals develop highly stereotyped responses which vary widely from somnolence and immobility to hypersensitivity and overactivity, both in and out of the experimental situation. Such sheep will occasionally lose their gregarious tendencies and stray away from the main flock. In at least one case this tendency caused the death of an animal, which, separated from the main flock, fell victim to maurading dogs.

The relative nonsignificance of the level of shock used by Liddell is illustrated by control experiments in which sheep were subjected to the same procedures known to produce abnormal behaviour in this species, with the difference that the conditioned stimulus or signal was omitted. Under these conditions the sheep did not become neurotic. That is, if the sheep were spared from having to listen to or see the conditioned stimulus (sound or light) they did not become behaviourally disturbed by the shock, even after hundreds of trials.

This does not mean that the animal would not eventually become neurotic, however, if shocks were given indefinitely. More than anything else, Liddell's findings demonstrate that very specific conditioned stimuli (*e.g.*, a tone) result more readily in neuroses when paired with mild shock than do very diffuse conditioned stimuli (*e.g.*, features of the experimental room, the time of day, persons present during conditioning). If a neurosis were established to such a diffuse conditioned stimulus, however, it undoubtedly would be much more pervasive and much more difficult to remedy. This expectation is in line with other research which has shown that emotional behaviour conditioned to a diffuse, ambiguous stimulus situation lasts longer and is harder to eradicate than are behavioural disorders conditioned to a clearly defined conditioned stimulus.

Liddell emphasized the temporal relations between the various phases of the conditioning procedure in the production of experimental neuroses. Two types of reproducible abnormal responses that are dependent upon the duration of the interval between trials have been observed in sheep and goats. The first is a forced extensor rigidity of the foreleg to which the shock electrodes are taped; this symptom occurs when a regimen of ten conditioning trials each day, separated by two minutes each, is employed. The second type is an increase in the number of leg flexions, beginning with the onset of the conditioned stimulus and continuing until the shock is delivered; this symptom is seen when the same number of daily trials is given (*i.e.*, ten) but the interval between trials is extended to seven minutes. The first case was likened by Liddell to Pavlov's inhibitory neurosis, the latter to Pavlov's excitatory neurosis.

Other Approaches.—N. R. F. Maier, B. W. Lichtenstein and J. H. Masserman among others, produced atypical responses in rats, cats, dogs and monkeys using conditioning methods other than those of Pavlov.

Maier trained rats to jump across a space to one of two distinctive stimulus cards in order to receive a food reward. If the animal jumped to the correct card, the card fell over and the animal landed on a platform where a piece of food was found. A jump to the incorrect card resulted in a bump on the nose (the incorrect card was locked in place) and a fall into a net below. The correct card was changed from right to left, at random, to prevent the animal from learning to jump always to one side.

The animals readily learned to jump to the correct card. Then the procedure was changed so that the previously correct card was locked in place during 50% of the trials, randomly determined. With this change in procedure a jump to the card previously designated correct resulted in a bump to the nose and a fall into the net on half the trials. After a few trials with the changed procedure, the animals showed great hesitancy before jumping, and eventually stopped jumping altogether.

Maier then forced the animals to jump by directing a jet of air at them, or by applying an electric current to the stand. Under these conditions the animals soon developed abnormal jumping responses, punctuated by stereotypy, and some animals showed violent running fits (after leaping to the floor instead of jumping to a card), or convulsive seizures.

Maier argued that the seizures of his rats were caused by the conflict engendered in them when forced to make a choice in the unsolvable choice situation. Although conflict may play a role, C. T. Morgan, F. W. Finger and J. Wolpe are unconvinced of the necessity of a conflict formulation. Morgan, for example, produced similar convulsions in rats by exposing them to the sound frequencies produced by a hissing air stream, in the absence of any conflict.

Lichtenstein and Masserman produced feeding inhibitions in dogs, cats and monkeys. The procedure involves shocking or blowing a stream of air at the animal or exposing it to a so-called psychologically traumatic stimulus at the moment food is taken. A psychologically traumatic stimulus is a fear-arousing but physically innocuous stimulus. Monkeys, for example, seem afraid of toy snakes. When a feeding inhibition is established, the animal refuses to eat in the experimental situation, even though he should be intensely hungry. The animal may also refuse food in its home cage.

The most striking result of Lichtenstein's experiments was the alleviation of the learned feeding inhibition in dogs by prefrontal lobotomy. The inhibition was reconditioned after the operation and alleviated again by a second posterior cut. Finally, the response was again conditioned and alleviated once more after a third sectioning of the forebrain.

Masserman emphasized the role of motivational conflicts, or conflicts among basic needs of the animal, as causative factors in the development of experimental neuroses. His dynamic formulations reflect his psychoanalytic orientation and are couched in terms to make them applicable to human as well as to animal behaviour disorders. The need for a conflict formulation, however, is not established. Wolpe showed that the same sort of behavioural disorders reported by Masserman may be produced by shocking cats or directing air at them, even though these disagreeable events are never associated with eating or food getting. Perhaps the most instructive outcome of Masserman's work is his determination of therapeutic procedures which appear to have beneficial effects in people and other animals. This, of course, should not be taken as prima facie evidence that the dynamics underlying the observed changes in behaviour are identical.

Theories About Causes.—Many theories attempt to explain experimental neurosis. Perhaps the most frequently quoted are those of Pavlov, Gantt and Liddell.

Pavlov believed that behavioural disturbances in both man and animal are caused by a conflict between cortical processes of excitation and inhibition which, under normal conditions, are kept in balance. His theory can be understood best perhaps, in the terms of a conditioning experiment.

In the circle-ellipse experiment noted above the cells of the salivary gland presumably were stimulated (ultimately) by cortical brain cells whenever the circle was presented; this stimulation de-

fined a cortical excitatory process. Secretion of saliva presumably was inhibited whenever the ellipse was presented; this defined a cortical inhibitory process. When the stimulation entering the central nervous system from the circle and the ellipse became so similar that both excitatory and inhibitory processes tended to be aroused simultaneously (*e.g.*, when the semiaxes of the ellipse were in the ratio of 9:8), the pronounced conflict between these processes became too much for the animal's nervous system, and experimental neurosis resulted.

Cortical conflicts might occur also, Pavlov believed, if either excitatory or inhibitory processes became overstrained. Excitatory overstraining might occur if conditioned stimuli of greater intensity than normal were introduced during a conditioning experiment; inhibitory overstraining, if the animal were forced to wait longer than usual for a reinforcement—*e.g.*, food during salivation experiments. (A reinforcement is an object or event that elicits an unlearned response or reflex; *see* ANIMAL BEHAVIOUR.)

Gantt enunciated two principles that he considers fundamental for understanding the causes of experimental neurosis—principles evolved from his intensive, long-term study of individual dogs. The first he terms schizokinesis and the second autokinesis.

Schizokinesis refers essentially to the animal's propensity to overreact, autonomically, during the process of acquiring adjustive reactions (*e.g.*, conditioned responses). Thus, Gantt considers as pathological the persistence of conditioned heart-rate responses long after overt conditioned reactions have disappeared. He suggests that other autonomic effects associated with conditioning (such as increased stomach acidity and the release of adrenalin by the adrenal medulla) may disturb the normal functioning of the organism and pave the way for later behavioural pathology.

The term autokinesis refers to another organismic propensity which further contributes to the formation of behavioural disorders. This is the tendency for earlier traces of long-past incidents to undergo dynamic change in the nervous system (to ferment, as it were) and eventually make their presence known as new symptoms which may appear years after the original disturbance. Unlike schizokinesis, however, autokinesis may also work in favour of the organism. Gantt suggests that autokinesis may be responsible for long-term effects of therapeutic efforts which may not be visible in the short run.

Liddell's theory emphasizes the strains and stresses of the conditioning situation itself as instrumental in causing experimental neurosis. He was greatly impressed by the resistance of his animals to Pavlovian conditioning. He sees the whole conditioning procedure as stressful, constantly taxing the nervous system of the animal, forcing it to maintain a state of readiness or vigilance. This state has been compared to what H. Selye termed the alarm reaction, the first stage of the organism's physiological response to stress. The restriction imposed on the animal by the chamber and restraining harness used during conditioning, and the animal's self-imposed restriction in attending and responding to the monotonous and regular conditioned signals, inevitably followed by relatively inconsequential amounts of shock or food, are the sources of its neurosis, according to Liddell. He suggests that the conditioned signal triggers innate, tense, preparatory reactions in the animal (*i.e.*, vigilance) which, in the animal's natural environment, prepares it for fight or flight. Moreover, the effects of repeatedly triggering the vigilance reaction (day after day and month after month) generally tend to be cumulative.

Gantt's and Liddell's theories point up the reality and primacy of autonomic conditioning, and the effects of monotonous provocations, respectively, in the development of abnormal animal behaviour. The degree to which these findings may be generalized to man, however, remains an open question, which further research should settle.

Many other theories have been proposed to explain experimental neuroses, both as classically defined by Pavlov and as defined by some of the later workers. Notwithstanding the extant theories, most workers in the area of emotional behaviour agree that a better understanding of the more elemental emotional reactions of animals (*e.g.*, conditioned "fear," conditioned avoidance behaviour, conditioned punishment reactions) must precede a better understanding of a phenomenon as complex as experimental neurosis, however defined. An adequate theory should also assign due weight to genetic constitutional factors, innate behavioural tendencies, and to the tendency to misconnect causes and events (*i.e.*, to learn "superstitions"). Happily, the investigation of such simpler emotional reactions and the role played by genetic and other variables in disturbed emotional behaviour is being vigorously pursued in many laboratories.

See also CONDITIONING; EMOTION; NEUROSES; PSYCHOLOGY, EXPERIMENTAL.

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NEUSIEDLER LAKE (NEUSIEDLERSEE; Hungarian FERTŐ), situated in Burgenland (east Austria) and northwest Hungary, is slightly saline, very shallow (2–10 ft. deep), and its level and size (about 125 sq.mi.) vary with climatic fluctuations. In 1742, 1811, 1865 and 1871 it almost completely disappeared. Its origin is not completely established, but it was formed during the Pleistocene probably as the result of tectonic subsidence which brought its present bed below groundwater level. Neolithic and Bronze Age finds do not indicate *Pfahlbauten* (pile dwellings) but a smaller size lake in prehistoric times. A canal (dug 1873–95) links its southern part with the Répce, a Danube tributary, and drains or adds water according to the seasons. A protected area since 1935, the heavy growth of reeds around its banks constitutes a noted bird sanctuary sheltering about 250 species. The lake has a beneficial influence on agriculture as a regulator of climate and ground water, and its reed resources, at present inadequately utilized, provide raw materials for cellulose manufacture and various building materials. The lake is fished, mainly for carp, and serves as a recreation area for nearby Vienna. Major places on its shores are Neusiedl, Podersdorf (the main summer resort) and the wine centre of Rust. (K. A. S.)

NEUSS, a town of Germany in the *Land* (state) of North Rhine-Westphalia which after partition of the nation following World War II became part of the Federal Republic of Germany. It is an important traffic centre at the junction of railway lines to Cologne, Viersen, Zevenaar (the Netherlands), Düren and Rheydt. Neuss lies near the west bank of the Rhine, opposite Düsseldorf, with which it is connected by the Erft canal, and its harbour makes it accessible to small ocean-going vessels. Its population (92,916 in 1961) is predominantly Catholic. Neuss was founded as a Roman fortress (the Novaesium of Tacitus); it was later captured by the Franks and was renamed Niusa. The town, which was chartered 1187–90, was unsuccessfully besieged by Charles the Bold (1474–75); it was sacked by Alessandro Farnese in 1586 and passed to Prussia in 1816. Now an important industrial centre its various enterprises include the manufacture of machinery, screws, rivets, chemicals, concrete, rope, ceramics and bricks. Neuss is also an important grain market and food-processing centre.

The Quirinus church (damaged during World War II) is a fine example of the transition from the Round to the Pointed style. The Romanesque Obertor (a massive gatehouse), part of the medieval town fortifications, houses the Clemens-Sels museum, which contains Roman antiquities, medieval pictures and sculptures, numerous documents of local history and a modern section.

The "Neusser Kirmes," a famous Rhineland *Schützenfest* (rifle marksmanship contest) takes place at the end of August.

(I. F.)

NEUSTADT AN DER WEINSTRASSE (formerly NEUSTADT AN DER HAARDT), a town of Germany in the *Land* (state) of Rhineland-Palatinate which after partition of the nation following World War II became part of the Federal Republic of Germany. Pop. (1961) 31,567. It lies 22 km. (14 mi.) W. of Speyer at the junction of railway lines to Worms, Weissenburg and Kaiserslautern. Its convenient location and picturesque setting under the eastern slope of the Haardt mountains at the mouth of the Speyerbach have made it a favourite tourist resort. Neustadt is the centre of the Pfalz wine trade and the famous *Deutsche Weinlesefest* (wine festival) is held annually in October. The training and research institute of viticulture and horticulture is of international repute. The town was chartered in 1275 and its historic buildings include the Casimirianum (the seat of Heidelberg university, 1578–83, now a popular convention hall), the *Stadthaus* (formerly a Jesuit college) and the 14th-century Gothic Abbey church (Stiftskirch). Apart from the wine trade, economic activities include food processing and the manufacture of metal products, textiles, paper and concrete.

NEUSTRELITZ, a town of Germany which after partition of the nation following World War II became part of Neubrandenburg *Bezirk* (district) in the German Democratic Republic. Pop. (1961) 27,663. It is situated on the Zierker See, 107 km. (67 mi.) N. of Berlin by road. Extensive agricultural land surrounds the town, which was severely damaged in the last days of World War II. A junction on the Berlin-Stralsund railway, economic activities include foodstuffs, wood and engineering manufactures. Neustrelitz was incorporated in 1736 and until 1918 it was the residence of the grand dukes of Mecklenburg-Strelitz.

NEUSTRIA, in the Merovingian period of French history, was the western Frankish kingdom as opposed to Austrasia (*q.v.*), the eastern kingdom. The term appears in the chronicle of the pseudo-Fredegarius (mid-7th century). While Austrasia, by derivation, was the land in the east, Neustria was the "new" (Fr. *neuf;* German *neu*) land; *i.e.*, the whole area colonized by the Franks since their settlement in the north and northeast of Gaul. A similar distinction was made in the Lombard kingdom in northern Italy, where the names "Austria" (= Austrasia) and "Neustria" denoted the territory to the east and to the west, respectively, of the Adda river. In Frankish history the 7th century was marked by rivalry between Austrasia and Neustria, whose king often also ruled over Burgundy. The victory of Pepin of Herstal, mayor of the palace in Austrasia, over the Neustrians at Tertry in 687 assured the ultimate ascendancy of Austrasia.

In the later Merovingian period the names Neustria and Francia were used interchangeably by Neustrian writers to designate the kingdom of which they were subjects, thus betraying their conviction that Neustria formed the heart and core of the Frankish lands. Later the name Neustria came to denote a much smaller area, the territory between the Seine and the Loire; and when, in the middle of the 9th century, the Bretons gained control of the districts of Nantes and Rennes, the name Neustria was used to denote a still more restricted area. Indeed, in the 11th and 12th centuries certain writers used "Neustria" synonymously with "Normandy." In the same way the name "Austrasia," superseded in its former location by "Lotharingia" under the Carolingians (*see* LORRAINE), was sometimes later used to denote the land originally settled by the Hessian Franks (*Chatti*); *i.e.*, the valley of the Main river, still later called Franconia.

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NEUTRALISM. In the two decades following World War II this term came to mean the policy of nonalignment with major allied systems as pursued by India, Burma, the United Arab Republic, Yugoslavia and most of the new Asian and African states. These countries refused to align themselves with the Communist bloc led by the Soviet Union or with the western bloc led by the United States, but they were not "isolationist"; as members of the United Nations they took an active interest in international problems.

A similar policy, known as the avoidance of "entangling alliances" or as "isolationism," was advocated for the United States by Presidents Washington and Jefferson and pursued during the European wars between France and Great Britain after the French Revolution, and for a century after the peace of 1815. President Wilson sought to depart from this policy after the United States entered World War I but the senate's rejection of the League of Nations and of the alliance with France and Great Britain against Germany resulted in a continuance of the neutralist policy until World War II.

After World War II the United States not only abandoned this policy itself by creating the North Atlantic Treaty organization and other alliances against Communism but also criticized other states for pursuing a neutralist policy. It was sometimes suggested in congress that economic assistance should not be given to neutralist countries but only to American allies. This attitude, however, began to change in 1956 as the power situation between the great blocs was becoming more evenly balanced, as the practical difficulties of the neutralist states became more obvious, as the Soviet Union began to give economic aid to these states and as it became apparent that unless the west continued to give them aid, the neutralist states would become wholly dependent upon the Communist bloc.

Neutralism and Neutrality.—Neutralism is often confused with neutrality (*q.v.*) but the two terms have distinct meanings. Neutralism refers to the foreign policy of a state in time of peace while neutrality is a term of international law referring to the rules that states are obliged to follow during a legal state of war in which they are not belligerents. Their neutral status implies strict impartiality and abstention from any assistance to either belligerent and the enjoyment of rights of maritime trade with all belligerents subject to the danger of belligerent capture and condemnation of neutral ships for carriage of contraband, breach of blockade or unneutral service. During the 19th century the United States not only pursued a policy of neutralism but it also carefully observed the obligations and demanded the rights of neutrality during wars between other states.

Neutralist states have justified their position not only for practical reasons but also in principle on the ground that everyone should be presumed innocent until proven guilty. In accord with this principle they have declined to assume in advance that the United States, the Soviet Union or any other country is intending to embark upon an aggressive action or other violation of the charter before an incident arises and, therefore, have refused to enter alliances or collective defense arrangements directed against particular states. They have also declined to assume that the ideology or the political or economic system with which a nation conducts its domestic affairs violates its international obligations; they assert that this attitude accords with the United Nations charter provision that forbids intervention in matters essentially within the domestic jurisdiction of any state. It would therefore seem that a policy of neutralism is entirely in accord with the obligations of UN members but neutrality in the conventional sense is forbidden if the UN functions, as it is supposed to, in determining the innocent and guilty party in hostilities. (Q. W.)

NEUTRALITY. As understood at the beginning of the 20th century, when it held an honoured place among the situations regulated by international law, neutrality could be defined as the legal position of third states which, in a war between two others or groups of others, chose to remain apart from the conflict, but in doing so had certain rights and duties that had to be respected by the belligerents and observed toward them. War was then a legal procedure over the initiation of which the unorganized community of nations exercised no control. When a state found its rights violated or its just claims denied, it might have recourse to force to vindicate them. States not directly involved in the conflict thereupon declared their neutrality and adopted a position of impartiality toward the belligerents.

Historical Background.—It was one thing for the neutral state not to take sides between the belligerent governments and quite another to be willing to abandon its trade with the citizens of the belligerent countries. Early in the 18th century, Holland

Sweden and other maritime countries felt that they should have the right to continue their normal trade relations with the countries at war, and they resisted the restrictions that the belligerents sought to impose upon them. By the time of Vattel's treatise on the law of nations in 1758 the rights of neutrals were defined along general lines, but new situations were constantly arising to create controversies. The United States had scarcely won its independence when it found in 1793 that both Great Britain and France were violating its rights as a neutral, capturing its vessels on grounds of alleged breach of blockade and carriage of contraband. The situation led to hostilities with France in 1798 and became so acute in 1812 that the United States, harried by the "paper blockades" of both belligerents, declared war against Great Britain as the worst offender. Paradoxically enough, when the United States was at war in 1861–65 it extended the scope of the existing rules of blockade and contraband (*qq.v.*), and in the famous case of the "Alabama" held Great Britain to account for allowing the construction of a Confederate cruiser in its neutral ports. (For a statement on neutrality stemming from the Crimean War *see* PARIS, DECLARATION OF.)

At the end of the Napoleonic Wars the great powers that were represented at the Congress of Vienna agreed upon the principle of the perpetual neutrality of Switzerland and thereafter Switzerland successfully maintained its neutrality. In 1839 the great powers of Europe also recognized Belgium as a perpetually neutral state and bound themselves to intervene if either party to a war violated that neutrality. During the Franco-German War of 1870–71 the neutrality of Belgium was reaffirmed by treaties concluded by France, Prussia and Great Britain.

1907: New Conditions and New Rules.—The opening of the 20th century found the conflict between belligerent and neutral interests even more acute than a century earlier. Nations still retained the right to go to war at will, but with the advance of science the instruments of war had become more destructive and the commerce of neutrals far more extensive, with resulting conflicts of interest. The second Hague conference of 1907 sought to compromise the conflicting interests, adopting two separate conventions, one dealing with the rights and duties of neutral states in war on land, the second dealing with the rights and duties of neutral states in naval war. The adoption of the first convention offered little difficulty, since the principle of the inviolability of neutral territory was already well established; but the second was complicated by questions of naval power, the size of merchant marines, colonial possessions and other factors bearing upon the success of naval warfare. The outstanding controversies were concerned with the scope of contraband and the effectiveness of blockade. The United States, anticipating the status of a neutral, sought to have the rules drafted as much as possible in favour of neutral commerce; Great Britain, anticipating involvement in a war, pressed for restrictions upon commerce in the interest of the effectiveness of naval power. Lists of contraband were drawn up, but it was difficult to determine what should be done with articles that were susceptible of use in war as well as for purposes of peace. Belligerents must not blockade neutral ports; but what if goods ostensibly destined to a neutral port were to be transshipped to a neighbouring belligerent country? Could neutral vessels be destroyed when captured for carriage of contraband or breach of blockade under circumstances when they could not be taken into a belligerent port for adjudication? These and numerous other questions were left unsettled by the convention and were taken up a year later at the London Naval conference; but the compromises there reached, embodied in the Declaration of London, had not yet been ratified when war broke out in 1914.

Breakdown of Neutrality.—Elaborate as were the provisions of the agreements adopted at The Hague in 1907 they proved unequal to the strain put upon them when war broke out in 1914. Germany's violation of the neutrality of Belgium at the opening of the war proved to be a forecast of what was to come. Great Britain pressed hard upon the neutral rights of the United States by diverting vessels for search in port, requisitioning them and extending the rules of blockade and contraband. Germany pressed even harder with submarine attacks upon passenger ships. The sinking of the "Lusitania" in 1915, followed by the renewal of submarine warfare against merchant ships in 1917, finally led the United States to declare war. Before that, however, on Oct. 16, 1916, President Wilson, harassed by both belligerents, had come to the conclusion that it was time to put an end to the right to make war. The "business of neutrality," he said, was over. No nation must henceforth be permitted to set in motion forces so destructive to the normal commerce of peaceful nations. War by its very nature put the neutral state in a position where it must either abandon its neutral rights or fight to maintain them.

Such was the intent of the covenant of the League of Nations. The members of the League undertook to act collectively to protect one another. A state that resorted to war in disregard of its pledges of pacific settlement was held to have committed an act of war against all other members of the League, which were pledged to discontinue trade and financial relations with it. Neutrality was now at an end. An individual state might still have recourse to force, but the collective action taken against it, in whatever form, would not be "war" in the old technical sense. The council of the League explicitly declared in 1920 that, "The idea of neutrality of members of the League of Nations is not compatible with the other principle that all the members of the League will have to act in common to cause their covenants to be respected."

Under these circumstances it is of interest to note that Geneva was chosen as the permanent seat of the League because of Switzerland's neutrality. The League council in 1920 recognized Switzerland's permanently neutral status and agreed that no military force would be required of it in the event of a breach of the covenant (*see* SWITZERLAND: *History*).

Neutrality Revived.—The United States, the former champion of neutral rights, refused to ratify the treaty of Versailles, which embodied the covenant of the League of Nations. What then would be its rights as a neutral in the event of collective action by the League? If it insisted upon trading with a state against which the sanctions of art. 16 of the covenant were being applied, the sanctions could not be effective. Advocates of the League argued that there was a moral obligation upon the United States to forego claiming its neutral rights under such circumstances. The moral obligation was held to have been given legal force by the provisions of the Pact of Paris of 1928 (*see* KELLOGG PACT), which condemned recourse to war and renounced it as an instrument of national policy. But the implied exception of the right of self-defense left the situation somewhat uncertain; and under the circumstances the American republics, meeting in Havana in 1928, felt it desirable to adopt a formal convention on maritime neutrality, based largely upon the Hague convention of 1907, with an exception in favour of states having obligations previously undertaken. War between Bolivia and Paraguay raised issues as to the applicability of the convention, with the result that the Argentine antiwar treaty of 1933 made provision that, in case of noncompliance by a state with the obligations of nonaggression and pacific settlement, the contracting parties would "adopt in their character as neutrals a common and solidary attitude," thus reinstating neutrality if the League of Nations should fail to act.

Neutrality on the Eve of World War II.—As the clouds of war grew darker with the attack by Japan upon China in 1931 and the attack by Italy upon Ethiopia in 1935 the debate among jurists became more acute. The leading European jurists, and many American jurists also, looked upon neutrality as fundamentally immoral because it represented a refusal to distinguish between right and wrong in the conduct of states; other American jurists found it impractical to make the distinction and advocated policies of restriction upon traditional neutral rights. The U.S. congress responded to the appeal that the country must not be drawn into a war by the commercial interests of its citizens seeking the profits of neutral trade with the belligerents, as was said to have been the case in World War I. A law of 1935 made it illegal to export arms, ammunition or implements of war from any place in the United States to any port of the belligerent states or to any neutral port for transshipment to a belligerent country; and a later section made it unlawful for American citizens to travel as

passengers on vessels of a belligerent nation (except at their own risk), thus preventing loss of American lives by another "Lusitania" disaster. A year later, in 1936, a second law made it illegal to make any loan or extend any credit to a belligerent, thus depriving bankers and munitions makers of any business interest in the outcome of the war. Again, in 1937, a "cash-and-carry" plan was put into effect; it provided that certain articles and materials, as determined by the president, were to be paid for before leaving the United States and were to be transported in the vessels of some other country. The president was to determine when a state of war existed and issue a proclamation to that effect. All three laws clearly indicated that no discrimination would be made between the possible belligerents on ground of acts of aggression in violation of the Kellogg pact.

Neutrality During World War II.—When war broke out in 1939 there was a temporary revival of the traditional law of neutrality. The League of Nations found it impossible to put into effect the provisions of the covenant under the circumstances of such a bold challenge to its authority. The smaller European powers were permitted to remain neutral for a time, but only while the Axis powers were gathering their forces.

In the western hemisphere the United States took the lead in proclaiming its neutrality, going so far as to announce that it was "on terms of friendship and amity with the contending powers," no distinction being made between them in line with the implications of the Kellogg pact. Following the lead of the United States the American republics, in accordance with decisions taken at the conferences held in 1936 and 1938, met at Panama on Sept. 23, 1939, and issued a general declaration of neutrality, setting forth certain standards they proposed to follow and creating an Inter-American Neutrality committee to formulate recommendations with respect to problems that might arise. At the same time the Declaration of Panama was issued; it proclaimed that "as a measure of continental self-protection" the American republics were entitled to have the waters adjacent to the American continents free from the commission of hostile acts by the belligerents. A "zone of security" was marked off, defining the area from which belligerent operations were to be excluded. No measures of enforcement were provided in the declaration, but the use of the term "self-protection" indicated that a violation of the declaration would not be taken lightly. Great Britain protested against this extension of neutral rights, which, it insisted, required its specific assent to become binding. In like manner the German government held that the zone of security could not be regarded as in force until accepted. Within three months of the issuance of the declaration the German battleship "Graf Spee," damaged in an engagement with three British cruisers, took refuge in the harbour of Montevideo. Having exhausted its permissible stay the vessel left the harbour and by prearrangement with a German merchant ship was scuttled at a point within the river claimed by Uruguay to be within its territorial waters.

On the continent of Europe one violation of neutrality succeeded another. On Feb. 17, 1940, a British destroyer pursued the German transport "Altmark" into Norwegian territorial waters and rescued from its decks hundreds of officers and men belonging to various British merchant ships captured and sunk by German warships. Norway protested, but two months later the country as a whole was occupied by German troops. The occupation of Denmark by Germany and that of Greece by Italy followed. On May 10, the German government, alleging that it was in possession of evidence that the Allies were about to attack through Belgium, the Netherlands and Luxembourg, invaded these three neutral states without warning. On its part Great Britain occupied Iceland in order to forestall a German invasion of the island. Yugoslavia, refusing to depart from its position of neutrality, was occupied by the Axis armies on April 6, 1941.

Endless controversies developed over the scope of contraband goods, whether absolute or conditional, and the effectiveness of blockade. Goods such as rubber, which had never been classified as contraband in earlier wars, were now found to have great value for military purposes, making the lists of the Declaration of London meaningless. The earlier doctrine of the "ultimate destination" of cargoes left the neutral free to sell its goods in the open market of a neutral state. But what if a neutral state adjacent to Germany should transship the goods to the enemy state? Would not that constitute an indirect violation of the blockaded enemy ports? Even a guarantee from the neutral state that the goods would be consumed in the country still left the neutral state a larger portion of its own domestic produce to transship to Germany. So argued Great Britain on both points. The meeting of foreign ministers of the American republics at Panama in 1939 protested the placing of foodstuffs and clothing intended for civilian populations on lists of contraband, but to no avail. New circumstances had arisen and war, said both belligerents, was not what it used to be.

The United States, as the leading neutral, yielded on most points; or rather, with the experience of World War I behind it, the dominant opinion in congress was that it was better to abandon the "freedom of the seas" than to risk a conflict in the interest of the commerce of its individual citizens. But its sympathy with the Allied powers grew stronger with each new incident. In July, 1940, a meeting of foreign ministers of the American republics was held at Havana at which, in anticipation of a possible victory of Germany, a system of regional defense was adopted, accompanied by a convention providing for the provisional administration of European colonies and possessions in the Americas, clearly indicating the realization that a victory of Germany would be a danger to the western hemisphere.

More directly contrary to its status of neutrality were the negotiations of the United States with Great Britain by which 50 destroyers, described as "out-of-date," were exchanged for the lease of naval bases on British islands in the Caribbean. The fact that Germany chose to overlook the transaction rather than risk an open break with the United States did not make the act any the less a violation of neutral duty, and the allegation of self-defense was without justification except in anticipation of a German victory.

But the exchange of destroyers for naval bases was a minor violation of neutrality compared with the passage of the Lend-Lease act on March 11, 1941, by which congress authorized the president to lease, lend or otherwise dispose of defense articles to the government of any country whose defense the president deemed vital to the defense of the United States. This act was justified on the ground that Germany had violated the Kellogg pact, thus permitting other parties such as the United States to discriminate against it. Neutrality was now at an end except to the extent of a formal declaration to that effect. Two months later the "Robin Moor," a neutral U.S. vessel, was sunk by a German submarine on the high seas, the passengers and crew being left afloat in small lifeboats. The president, in describing the act to congress, branded the sinking of the "Robin Moor" as "the act of an international outlaw."

Neutrality ended for the United States with the Japanese attack at Pearl Harbor on Dec. 7, 1941. A month or more later the foreign ministers of the American republics met at Rio de Janeiro, and, after reaffirming their pledge that an act of aggression against one of them would be considered as an act of aggression against all, recommended the breaking of diplomatic relations with the Axis powers. A number of them promptly declared war, but even for the rest neutrality was over. For other states, previously neutral, the status ceased to have any technical meaning.

Effect of the Charter of the United Nations.—The underlying assumption of the charter of the United Nations, as had been that of the covenant of the League of Nations, was that the old right of individual states to have recourse to armed force was, except in case of individual or collective self-defense, the prerogative of the collective group acting through the Security council looking to the suppression of acts of aggression and the maintenance of the general peace. Such collective action as might be decided upon by the Security council would not be "war" in the technical sense, so that states not participating in the measures taken would not be "neutral" in the traditional sense. While there is no obligation, except by special agreement, for every member to take part in military measures of enforcement, there is the

obligation of affording mutual assistance in carrying out the measures decided upon by the Security council, which would preclude any claim of the traditional neutral rights.

But what if a conflict of ideologies and military policies between the leading members of the United Nations should reach the point where the system of collective security might prove to be unworkable? What then would be the attitude of third states that could not risk taking sides between the two powerful contenders, now become more powerful with the discovery of a weapon of devastating power? A new position of "neutralism" developed, not one of claiming rights as against the two possible belligerents, but a position of remaining as completely aloof as possible from the impending conflict, which might at any time pass from that of a cold war to a fighting one over which it was clear that the Security council could exercise no control (*see* NEUTRALISM). A war in violation of the provisions of the charter could not be expected to keep within the traditional laws of war. The atomic bomb had eliminated the old distinctions between combatants and noncombatants, making the risk of participating even in discussions of the Security council too great for the defenseless nation. Specific application of the new status of neutrality was given by the Declaration of the 14-nation conference at Geneva in 1962 by which Laos was recognized as a neutral state and on its part pledged itself to remain neutral. Meanwhile Switzerland, while not a member of the United Nations, retained its old status as a neutral under the covenant of the League of Nations, and Austria, on becoming a member of the United Nations, was recognized as having a similar status. *See* WAR; INTERNATIONAL LAW, PUBLIC; UNITED NATIONS. *See* also references under "Neutrality" in the Index.

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NEUTRALIZATION is a setting of limitations upon the belligerent capacities of a sovereign state, which thereupon becomes bound not to do or to suffer certain things, such as the building of fortifications or the presence or passage of armed forces in a defined area. This area is usually smaller than the whole territory of the state, but a similar situation may be created in respect of a whole state, when that state undertakes not to take part in wars except in self-defense. The resulting situation is in this case commonly called perpetual neutrality. For instance, when Austria's status was regulated by the state treaty of 1955, Austria unilaterally and voluntarily declared by a separate instrument that it would be perpetually neutral, defend its neutrality, join no military alliances and allow no foreign bases on Austrian territory. The state treaty prohibited Austria from possessing atomic and similar weapons. Neutralization agreements affect other states, if and so far as these assume obligations in the event of a breach of the agreement or if they undertake themselves to abstain from certain actions.

A state is not, of course, bound by a neutralization agreement which it has not signed, and therefore the only way to ensure complete immunity from attack is by a universally signed convention. In practice, considerations of geography and comparative power determine what signatures are necessary to make a particular agreement effective.

Neutralization, which is the outcome of agreement, is to be distinguished from neutrality (*q.v.*), which is an attitude adopted by a state at will, in face of a particular situation, and for no specifically prescribed period—as, for instance, with Sweden or the Republic of Ireland during World War II, these states choosing to remain outside the contest.

Among islands, Corfu was neutralized upon its cession to Greece in 1863, Spitsbergen (Svalbard) and Ahvenanmaa (the Aland Islands) were neutralized in 1920 and 1921 respectively. Norway undertook in 1920, by a convention signed by eight other states, not to build a naval base in Spitsbergen or to use it for any military purposes. Russia, which acquired Ahvenanmaa from Sweden in 1809, agreed in 1856, upon the insistence of Sweden and other powers, not to fortify the islands or to maintain any military or naval establishment in them. After World War I Finland, to which the islands then passed, gave a similar pledge in a convention signed in 1921 in company with nine other states (excluding the U.S.S.R.); this promise was repeated in 1947 in the peace treaty with Finland.

Instruments declaring the neutrality of whole states were signed in respect of Switzerland in 1815, of Belgium in 1839, of Luxembourg in 1867 and of the Vatican city-state in 1929 (the last was signed only by the Holy See and Italy). Switzerland continued to maintain its neutrality, but Belgium abandoned that attitude after World War I and Luxembourg after World War II.

(P. J. A. C.)

NEUTRON, a particle in the atomic nucleus which has no electrical charge. The discovery of the neutron played an important part in opening the way for the utilization of nuclear energy. Fission of the atomic nuclei of various isotopes of uranium, plutonium, etc., it was learned, could be induced by bombarding them with the neutral particles. In this process, additional neutrons are released, making possible the so-called chain reaction. This is the principle of the fission bomb developed during World War II. Also, the released energy has been harnessed for industrial use by controlling the reaction so as to prevent it from going substantially beyond the point where the chain reaction is self-sustaining.

The neutron and the proton are now considered to be the basic building materials of which all atomic nuclei are composed. The neutron has a mass slightly greater than that of the proton.

History.—Following publication in 1911 of his concept of the atom as a structure built around a nucleus, Lord Rutherford conducted experimental studies of the atomic disintegration of light elements. In 1920, in a lecture to the Royal Society, he offered laboratory proof that the long-range particle emitted by nitrogen under bombardment with alpha rays is the proton, which is the nucleus of the hydrogen atom and part of the nucleus of all other atoms. The proton is the simplest of all nuclei, and carries a positive electrical charge.

With the discovery of this first nuclear reaction, Rutherford's nuclear hypothesis was further validated. He then offered still another hypothesis. The observed reactions of the proton, he said, were consistent with the supposition that it was linked with another, still undiscovered constituent in the nucleus—a particle that was electrically neutral.

In 1932, Sir James Chadwick demonstrated that the radiation created when beryllium is bombarded by alpha particles consists of a stream of nuclear particles carrying no electrical charge. Rutherford's hypothetical particle, now an established fact, was named the neutron. Earlier, Frédéric Joliot and Mme. Irène Joliot-Curie in Paris had investigated this penetrating radiation emitted by beryllium when bombarded by alpha particles. They found that the radiation which had previously been interpreted by W. Bothe and H. Becker as a gamma radiation (*see* RADIOACTIVITY), was capable of propelling hydrogen nuclei (protons) with very high speed. Chadwick, after a thorough experimental investigation of all the properties of the new radiation, came to the conclusion that it must consist of neutral particles of a mass nearly equal to that of the proton. The major argument in this conclusion was the speed given by the newly discovered particle to various atomic nuclei in collisions. The assumption of a massive particle rather than a gamma ray brought order into the experimental observations.

It was soon found that neutrons, because of their lack of electric charge, are particularly effective in causing nuclear transformations (*see* ATOM; NUCLEUS). In 1934 Enrico Fermi and his collaborators showed that nearly every element in the periodic table may undergo a nuclear transformation when bombarded by neutrons. In many cases, radioactive isotopes of the elements are formed in this way (*see* ISOTOPE: *Radioactive Isotopes*). Slow neutrons were found particularly useful in producing these transformations.

Fermi found that uranium was among the elements in which neutron bombardment induced transformations. This element was investigated in greater detail by Lise Meitner and Otto Hahn in Berlin in subsequent years. Their results were difficult to interpret, until late in 1938 Hahn and F. Strassmann found that at least one of the radioactive elements formed by bombardment of uranium was an isotope of barium. This was immediately interpreted by Otto Frisch and Meitner (also two weeks later and independently, by Hahn and Strassmann themselves) as indicating that the uranium nucleus had been split into two massive fragments, a process later called fission. The important technical developments resulting from this discovery will be described in a later section of this article.

Properties of Free Neutrons.—It is appropriate to discuss the properties of the neutron by comparing them with those of its counterpart in the atomic nucleus, the proton.

The neutron, as already mentioned, has no electric charge, whereas the proton has one positive elementary charge (1.6×10^{-19} coulombs). This causes great differences in the passage of the two particles through matter: a fast-moving proton ejects electrons from atoms which it encounters, and thereby produces heavy ionization along its path with consequent loss of energy. Because of this, the track of a proton can easily be observed in a cloud chamber. The neutron, having no electric charge, cannot produce ions but can only make direct collisions with atomic nuclei. Its track, therefore, cannot be observed, but the presence of neutrons can be deduced from the visible tracks in a cloud chamber of charged recoil nuclei which have been set in motion by neutron impact. (See *Detection of Neutrons*, below.)

Another consequence of the absence of ionization is that neutrons do not lose energy so long as they do not collide with atomic nuclei. Since such collisions are very rare, a neutron travels far through matter before losing its speed. Protons, on the other hand, travel only very short distances because they lose their energy by ionization. For instance, a proton with a velocity of 3×10^9 cm./sec., which is the order of magnitude of the velocities common in nuclear physics, will travel about 0.005 cm. in a material such as iron or copper. A neutron of the same velocity will travel about 5 cm. before it makes its first collision with a nucleus, and since it loses only a fraction of its energy in each collision, it will continue to travel for 10 to 100 times this distance before it is finally captured by a nucleus. Neutrons are, therefore, very penetrating.

Mass.—The mass of the neutron is very nearly the same as that of the proton. In the physical scale of atomic weights (in which the isotope C^{12} has a mass of exactly 12), the mass of the neutron is 1.00867. On the same scale, the mass of the hydrogen atom is 1.00797 and that of the proton 1.00728. The neutron is, therefore, slightly heavier than the proton and even slightly heavier than the hydrogen atom (proton plus electron).

The fact has two important consequences. First of all it makes the neutron unstable and subject to beta disintegration (*see* below).

The second consequence is that the neutron cannot be considered as a proton and an electron bound together in some way. Therefore, the neutron and the proton have to be regarded as fundamental particles which are closely related to each other in a manner the details of which were still unknown as of the mid-1960s, although by that time much was known of the forces between them. The view then gaining currency was that protons and neutrons were simply two different charge states of the same entity called the nucleon.

Spin, Magnetic Moment and Statistics.—Just like the more familiar fundamental particles, the electron and the proton, the neutron has a "spin"; *i.e.*, it has properties which are analogous to those of a spinning top. The value of the spin (angular momentum) is $\frac{1}{2}(h/2\pi)$, where h is Planck's constant, just as for proton and electron. It also shares with proton and electron the property of obeying Fermi-Dirac statistics, which makes it impossible for two neutrons in an atom to be in the same quantum state. The value of the spin and the fact that neutrons obey Fermi-Dirac statistics are further arguments against the interpretation of the neutron as a combination of electron and proton.

The neutron has a magnetic moment whose direction is opposite to that of its spin, as if a negative electric charge were revolving in the rotation of the spinning top. The value of the magnetic moment has been measured with great accuracy and is 1.9135 nuclear magnetons. This is defined in terms of the mass M of the proton as $eh/4\pi Mc$. The proton has a positive magnetic moment (as if a positive charge were revolving) whose value is 2.7928 nuclear magnetons. The magnetic moment of the electron is negative and is almost one Bohr magneton (about 1,840 nuclear magnetons).

Beta Decay.—According to the theory of radioactive beta decay (*see* RADIOACTIVITY), the process taking place is $n \rightarrow p + \beta^- + \bar{\nu}$, indicating the formation of a proton p, negative electron β^- and antineutrino $\bar{\nu}$, respectively. This fundamental process was first observed for free neutrons in 1949. A. H. Snell and collaborators at Oak Ridge, Tenn., detected the simultaneous occurrence of a proton and an electron coming from the decay of neutrons in a high intensity beam issuing from the nuclear reactor (see *Nuclear Energy*, below). In 1950 John M. Robson at Chalk River in Canada observed the decay of the neutron and also measured the energy spectrum of the decay electrons. In a sensitive mass spectrometer he identified the heavy particles as protons. The negative particles in coincidence with the protons were detected in a beta ray spectrometer which measured the electron energy. The observed maximum energy of the decay electrons gives a value for the mass of the neutron which compares very well with the more accurate measurements (*see* above) made from observations on numerous nuclear transmutations in which all the masses and energies, except the neutron's mass, are known.

Free neutrons decay according to the usual laws of radioactive decay. Robson deduced a value for the half life of the neutron of 10.2 min., in excellent agreement with the value estimated from theory; in the 1960s the value was given as 12 min.

Wave Properties.—Quantum mechanics postulates that every particle exhibits wave properties with a characteristic wave length $\lambda = h/mv$, where λ is the wave length, h is Planck's constant, and mv is the momentum of the particle. Neutrons are no exception and the existence of this property gave rise to an active field of research in neutron optics. Experimental methods for obtaining monochromatic neutrons, or neutrons of a single momentum, and ways of measuring their diffraction by crystals were devised, much as X-rays were used to study crystals. Because neutrons are strongly scattered by lighter nuclei, as mentioned below, they help to disclose the part taken by light atoms in crystal lattices where X-rays are affected scarcely at all. Promising results are found in the study of magnetic substances. As the neutron has a magnetic moment but no electric charge, passage of a neutron beam through strongly magnetized iron causes the neutrons to show polarization effects not exhibited by other particle waves. A slow neutron of kinetic energy 0.13 electron volts has a particle wave length of 1×10^{-8} cm. (1 Å). Neutrons that, as a result of collisions, have come into equilibrium with their surroundings are called thermal neutrons. Their average energy is about 0.025 electron volts, hence, their particle wave lengths are about 5 Å. The marked resonance absorption of slow neutrons appears to be closely linked with this wave nature of the neutron and its likelihood of being captured for appreciable lengths of time within the potential barrier of a nucleus.

Neutrons as Building Blocks of Nuclei.—According to present theory, all nuclei are composed of neutrons and protons. The theory replaced the older one, now completely discarded, that protons and electrons were the building stones of the nucleus. Even before the discovery of the neutron, this older theory had encountered grave difficulties. For example, according to quantum mechanics, electrons cannot be compressed into such a small space as the inside of a nucleus. Additional arguments arise from the spin and the statistics of atomic nuclei, and the peculiar phenomena connected with beta radioactivity.

The proton-neutron hypothesis has met with considerable success, however, and has been used to explain a number of fundamental properties of atomic nuclei. It is well established that protons

and neutrons inside the nucleus can be considered to conform to the laws of quantum mechanics.

According to the proton-neutron hypothesis the atomic number Z (charge) of a nucleus is equal to the number of protons contained in it. The mass number A, *i.e.*, the integer nearest to the atomic mass, is the sum of the numbers of protons and neutrons since each of these particles contributes about one atomic mass unit. The isotopes of a given element, therefore, all contain the same number of protons but varying numbers of neutrons; for instance, whereas any isotope of the element carbon contains 6 protons, the most abundant isotope C^{12} contains in addition 6 neutrons, while the less abundant stable isotope C^{13} contains 7 neutrons, the radioactive isotope C^{14} contains 8 neutrons and C^{11} contains only 5 neutrons.

Perhaps the most important information about a nucleus is provided by its exact weight. From it the binding energy of the nucleus can be deduced, with the help of Einstein's relation, $E = mc^2$. For instance, the helium nucleus has a mass of 4.00288. Since its atomic number is 2 and its mass number 4, it contains 2 neutrons and 2 protons; the combined weight of these 4 particles is 4.03300. The difference between this and the weight of the helium nucleus represents the binding energy with which the 4 particles are held together in the nucleus. The energy represented by this mass difference is tremendous. The formation of 4 g. of helium from 2 g. of hydrogen and 2 g. of neutrons would release as much energy as the burning of about 100 tons of coal if such a process of fusion could be brought about.

A binding of this tremendous strength cannot be the result of electric forces; moreover, no such forces act on neutrons anyway, because of the absence of electric charge. Gravitational forces are even more inadequate to account for the strong binding. A new force must therefore be assumed, which is known as nuclear force. The exact character of nuclear forces was only partially known as of the mid-1960s; however, it was known that they act only over very short distances, having a range of about 3×10^{-13} cm. and being negligible outside this range. The exploration of nuclear forces is the prime objective of nuclear physics. The scattering of neutrons of various velocities by protons has given fundamental information about nuclear forces.

Neutron-neutron and proton-proton forces are found to be about equal within the nucleus, and there is a strong tendency for equal numbers of neutrons and protons to form the lighter atoms. In the heavier atoms, the number of neutrons exceeds that of protons. For example, uranium-238 has 92 protons and 146 neutrons; uranium-235 has the same number of protons but only 143 neutrons. The separation energy of a neutron, or the energy that must be supplied to extract a neutron from a nucleus, ranges from 5 to 13 Mev (million electron volts) except for some of the lighter elements to be mentioned below.

Neutron Production.—Since the neutron is not stable and is readily captured by a nucleus (see *Properties of Free Neutrons*, above, and *Nuclear Reactions Produced by Neutrons*, below), few neutrons are found in nature in the free state, *i.e.*, outside of atomic nuclei. Therefore, if an experimenter wishes to work with neutrons, he must produce them by means of nuclear reactions. These reactions fall into three types: (1) reactions initiated by an energetic charged particle, such as the nucleus of light or heavy hydrogen or helium, commonly called proton, deuteron and alpha particle, respectively; (2) reactions initiated by gamma rays (electro-magnetic radiation); (3) nuclear fission.

Reactions Produced by Charged Particles.—This type of reaction was historically the first method to produce neutrons and, until 1942, the only way to produce them in quantity. It is still the most versatile method, being capable of producing neutrons of specified kinetic energy. Chadwick, in his first experiments, obtained neutrons by bombarding beryllium or boron with alpha particles, according to the nuclear equation $He^4 + Be^9 \rightarrow C^{12} + n^1 + Q$ where Q, the increase in kinetic energy, is in this case 5.76 Mev. With the growing prevalence of high-energy accelerators, neutrons were mostly produced by bombarding various atomic nuclei with deuterons and sometimes with protons, accelerated in a cyclotron or some similar device. This has the advantage that the number of particles obtainable is very much greater than the number of alpha particles emitted by available amounts of radioactive material, and neutrons of much higher energies than those from natural sources are available. This has led to a great expansion in the nuclear particles being studied (*see* PARTICLES, ELEMENTARY). Particular nuclear reactions useful for the production of neutrons will be discussed below.

One of the prime considerations for choosing a particular nuclear reaction for the production of neutrons is the yield. This depends sensitively on the kinetic energy of the bombarding particle, and on the nature of the bombarding particle as well as that of the target nucleus. The bombardment of beryllium with deuterons gives in general a higher yield than any other combination of nuclei. However, even for this reaction, the yield is very small and changes rapidly with the energy of the deuterons: at 1 Mev deuteron energy, it is about 1 neutron for 100,000 deuterons; at 10 Mev, about 1 in 1,000, and further increase of the deuteron energy, to 40 Mev is expected to increase the yield to about 1 in 100. The yields are so small because the deuteron loses kinetic energy continuously by ionizing the atoms of beryllium through which it passes, and in general it will have lost all its energy before it has had a chance to hit a beryllium nucleus and disintegrate it. A cyclotron may give a current of deuterons of about 100 microamperes; if the deuteron energy is 10 Mev, this will produce about 10^{12} neutrons per second.

The yield from the bombardment of beryllium with alpha particles is about 1 neutron for 4,000 alpha particles (if the alpha particles comes from radon). One curie of radon (*i.e.*, the amount which is in radioactive equilibrium with 1 g. of radium), intimately mixed with beryllium will give about 10,000,000 neutrons per second. An average cyclotron is thus equivalent in neutron production to about 100,000 curies, *i.e.*, to the radioactive rays from 100 kg. of radium.

At very low energy the yield decreases rapidly. The reason is that the incident particle (deuteron or alpha particle) cannot come close to the beryllium nucleus because there is a strong electrostatic repulsion between them, and there is not sufficient kinetic energy to overcome this repulsion. For instance, the yield for deuterons of 500,000 ev (electron volts) on beryllium is only 1 neutron per 2,000,000 deuterons, and at 250,000 ev it is immeasurably small.

Neutrons can also be produced by deuteron bombardment of other light nuclei such as deuterium, lithium, boron, nitrogen, etc. The yields are usually smaller by a factor of between two and ten than the yields from beryllium at the same energy.

In any nuclear reaction energy is either released or absorbed. When neutrons are produced from deuterons, there is normally an energy release because the proton is not very strongly bound to the neutron in the deuteron and can be bound more strongly to the target nucleus. For instance, with a beryllium target, the energy release is 4 Mev; with a deuterium target, 3 Mev. Higher energy releases are obtained from lithium or boron targets, namely 15 and 13 Mev, respectively. These targets can, therefore, be used to produce very high energy neutrons from deuterons of quite low kinetic energy, which can be accelerated by apparatus of only moderate size and cost. Still higher energy neutrons can be obtained by deuteron bombardment of tritium, the hydrogen isotope of mass 3, with an energy release of 18 Mev; this reaction is also useful because of its high yield at deuteron energies of a few hundred thousand volts.

An important problem in experiments on fast neutrons is the obtaining of neutrons of a well-defined energy (monochromatic neutrons). In general, a nuclear reaction will give neutrons of many different energies because the residual nucleus (which remains after emission of the neutron) can be left in several different energy states. Thus, the deuteron bombardment of boron gives, besides the fast neutron group with 13 Mev energy release, at least 3 other groups with energy releases of 9, 6 and 4 Mev, respectively; the reaction with lithium gives neutrons of all energies below the maximum, and that with beryllium also gives many energy groups.

On the other hand, the reaction between two deuterons is satis-

factory because in this case the residual nucleus (helium 3) does not have any excited states. The deuteron-deuteron reaction $H^2(d,n)He^3 + 3.28$ Mev has, therefore, been an important reaction for producing monochromatic neutrons. The reaction between tritium and the deuteron also fulfils this criterion and at the same time gives very high energy neutrons according to the reaction $H^3(d,n)He^4 + 17.6$ Mev, where H^3 stands for tritium and d for deuteron.

Neutrons can also be produced by bombarding a nucleus with protons. In this case energy is always absorbed and the reaction, therefore, begins to take place only above a certain kinetic energy of the proton, the threshold energy. Measurement of this threshold energy is valuable in making accurate comparisons between the masses of atomic nuclei and has given an accurate value of the mass of the neutron. The reaction between lithium 7 and a proton $Li^7(p,n)Be^7 - 1.65$ Mev gives monochromatic neutrons with high yield, and is valuable for the accurate study of neutrons of moderately low kinetic energy, so long as the energy of the incident protons is not too high.

Neutron Production by Gamma Rays.—Neutrons can be released from nuclei by gamma rays, *i.e.*, by electromagnetic radiation of extremely short wave length. The energy of one quantum of gamma radiation, $h\nu$, must be greater than the energy with which the neutron is bound to the rest of the nucleus. In most nuclei this separation energy is about 8 Mev; notable exceptions are beryllium $Be^9(\gamma,n)Be^8 - 1.67$ Mev and deuterium $H^2(\gamma,n)H^1 - 2.23$ Mev for which the separation energies are 1.67 and 2.23 Mev, respectively.

The yield of neutrons is very small, even for gamma rays of high energy. Average yields are about 1 neutron for 1,000 gamma rays if sufficient material is provided to absorb the gamma rays (this requires a thickness of several centimetres of iron or about a metre of beryllium); in thin layers, the yield is proportionally less. The efficiency of gamma rays in producing neutrons usually rises with increasing gamma-ray energy and reaches a maximum at a gamma-ray energy of about 15 to 20 Mev per quantum.

Neutron Production by Fission.—In the fission of uranium and other heavy nuclei, neutrons are emitted. This is the basis of the nuclear chain reaction which is the most economical means of producing large quantities of neutrons.

The fission of uranium can be induced by neutrons; in each fission one neutron is absorbed whereas more than one neutron is emitted. Each of the emitted neutrons can in turn produce fission in another uranium nucleus provided (1) the neutrons are not absorbed by other nuclei, and (2) a sufficient amount of uranium is used to prevent escape of the neutrons. In this way a nuclear chain reaction is obtained in which neutrons are continuously produced by fission and in turn cause fission in other nuclei.

There is virtually no limit to the number of neutrons that can be produced in this way. The only practical limitation comes from the considerable amount of energy released in fission which must be dissipated. If 100,000 kw. can be dissipated or used in production of useful power, more than 10^{18} neutrons per second are produced; one such reactor thus gives a neutron production equivalent to the output of 1,000,000 cyclotrons. However, for experimental purposes it is necessary to remember that the neutrons will be distributed over a larger area, making their density per unit area not much greater than that from a cyclotron, and the neutrons also will be of lower energy, in general, than those from a cyclotron. In addition, in working with larger numbers of neutrons, the health hazards must be considered. But despite these shortcomings, intense beams of neutrons from nuclear reactors are commonly used for experiments.

Nuclear Reactions Produced by Neutrons.—The most important physical property of neutrons is the absence of electric charge. This enables them to approach an atomic nucleus without being repelled by its positive charge. Therefore, a neutron can enter an atomic nucleus no matter whether it is fast or slow. On the other hand, a charged nuclear particle like a proton or deuteron can enter a nucleus only when it has a sufficiently high velocity to overcome the electric repulsion; hence the usefulness of a charged particle for producing nuclear reactions is exhausted after it has been slowed down. Accordingly, the yield of nuclear reactions produced by a charged nuclear particle is only of the order of 1 in 1,000 or less (see *Reactions Produced by Charged Particles*, above); on the other hand, the yield of nuclear reactions from very slow neutrons is nearly 100%; almost every neutron which is produced will ultimately be captured by a nucleus and will produce some nuclear reaction.

Several types of reaction between neutrons and atomic nuclei will be discussed below. Which of these reactions takes place in any given collision between neutron and nucleus is a matter of chance; the probability of any given type of reaction depends on the particular nucleus with which the neutron collides, and on the velocity of the neutron. Some reactions, notably the capture of neutrons with the emission of gamma radiation, are enhanced by reducing the velocity of the neutrons while others can be initiated only by fast neutrons.

Scattering of Neutrons.—The simplest process which may occur when a neutron hits an atomic nucleus is scattering, *i.e.*, a change of the direction in which the neutron moves. This scattering may be elastic like the collision between two billiard balls; in this case, the kinetic energies of the neutron and the nucleus after the collision add up to the kinetic energy of the neutron before the collision; or the scattering may be inelastic, *i.e.*, kinetic energy may be lost and transformed into internal energy of the bombarded nucleus.

At relatively low neutron energy, elastic scattering takes place in collisions between neutrons and protons, although neutron capture to create deuterons also occurs. A neutron of nearly any energy may give rise to resonant capture, with radiation of gamma rays and consequent loss of kinetic energy of the neutron. Above about 0.1 Mev, inelastic scattering becomes rapidly more important and predominates over elastic scattering when fast neutrons collide with heavy nuclei. In the majority of cases, a very large fraction of the kinetic energy is lost in inelastic collisions, so that the neutrons emerge after the collisions with an average kinetic energy of about one-quarter of their initial energy or less. The remainder of the energy has been transformed into excitation energy of the nucleus and usually appears afterward in the form of gamma rays.

At very high neutron energies, above 100 Mev, new fission processes begin, resulting in the production of "stars" in photographic emulsions. This is the experimental region in which many of the so-called strange particles originate. In the mid-1960s these particles were still the object of detailed study.

Collisions between neutrons and atomic nuclei are, of course, relatively rare because of the very small size of the atomic nucleus. This size can be determined from the frequency of collisions with fast neutrons. The frequency of collisions is commonly measured in terms of the effective cross section, *i.e.*, the target area which the nucleus appears to present to the neutron. If the cross section is σ, a thin slab of material, of thickness t and containing N nuclei per unit volume, will scatter (or absorb) a fraction

$$f = N\sigma t$$

of the neutrons incident upon it. The cross section σ is conveniently determined by measuring the fraction, $1\text{-}f$, of neutrons which penetrate the slab without being deflected.

The cross sections of nuclei for collisions with fast neutrons are all of the order 10^{-24} sq.cm. This corresponds to a radius of the nucleus of about 10^{-12} cm., which confirms the result obtained from other experiments. A unit of area 10^{-24} sq.cm. has become commonly known as a "barn." Neutron scattering experiments further confirm that the volumes of nuclei are roughly proportional to the number of particles contained in them, *i.e.*, to the atomic weight. The most important deviation from this rule is that the lightest nuclei tend to present a relatively greater cross section to neutrons of moderate energy (a few million electron volts). In solid materials neutrons travel on the average about 2 to 10 cm. between collisions.

For the theory of nuclear forces, the scattering of neutrons by protons is particularly important. The effective cross section of the proton for slow neutrons is unusually large, namely about

20×10^{-24} sq.cm., whereas that of the nuclei of such elements as aluminum, silicon, etc., is only about 2×10^{-24} sq.cm. The large cross section of the proton has been explained in terms of a resonance effect. At higher neutron energy, the proton cross section decreases but it is still 3×10^{-24} sq.cm. for neutrons of 2 Mev and falls in line with heavier nuclei only at extremely high neutron energy.

Whether the scattering is elastic or inelastic, some kinetic energy will be transferred from the neutron to the nucleus. The scattering is connected with a slowing of the neutron, which will be discussed in more detail under *Neutron Diffusion*, below.

Nuclear Reactions Leading to the Emission of Charged Particles.—In many cases the collision between a neutron and a nucleus leads to a true nuclear reaction in which a nuclear particle other than a neutron is emitted. These reactions are the inverse of the reactions in which neutrons are produced by an incident-charged particle. The likelihood of a nuclear reaction is dependent to an important degree on the time a neutron spends in the neighbourhood of the target nucleus, as expressed by the $1/v$ relationship, which shows the probability of such events to vary inversely with the velocity of the neutron.

Many reactions have been observed in which a proton or an alpha particle is emitted when a nucleus is bombarded by a neutron. These are designated as (n,p) and (n,α) reactions respectively. Reactions in which a proton is produced in general absorb energy and can, therefore, be caused only by neutrons of considerable kinetic energy. There are some exceptions, the most important being the reaction $n + N^{14} \rightarrow p + C^{14}$ which releases an energy of 0.6 Mev; this reaction is caused with considerable probability by very slow neutrons, and occurs in the atmosphere where neutrons of cosmic ray origin form radioactive C^{14} from atmospheric nitrogen. Archaeological dating by the activity of C^{14} in organic remains is based on the assumption of a constant supply of C^{14}, of half-life 5,600 years, and its uniform distribution in the carbon of living matter.

The reactions in which alpha particles are emitted often release energy. The most important ones of this type are the reactions of neutrons with lithium-6 and with boron-10; the cross section for these reactions is extremely great, especially for slow neutrons: 4,000 barns for $B^{10}(n,\alpha)Li^7$; 10,900 barns for $Li^6(n,\alpha)H^3$.

Many neutron-induced nuclear reactions lead to the formation of a radioactive nucleus, which subsequently emits a beta ray (electron). An example is the nucleus C^{14} mentioned above. It can be shown from general arguments about nuclear stability that all reactions caused by a neutron in which a proton is emitted lead to a radioactive nucleus. If an alpha particle is emitted in the reaction, the resulting nucleus may or may not be radioactive; for instance, in the cases mentioned above, the reaction between neutrons and lithium-6 leads to the important radioactive isotope of hydrogen of mass 3, whereas the reaction with boron-10 gives the stable nucleus lithium-7.

Reactions Leading to the Emission of Several Neutrons.—When a neutron of very high energy (more than 10 Mev) hits a nucleus, 2 or more neutrons are frequently emitted from the nucleus. In the case of heavy nuclei and of neutrons of sufficiently high energy, theory shows that this $(n,2n)$ reaction is the most likely process to occur. If two neutrons are emitted, the bombarded nucleus loses one unit of weight; this results frequently in a radioactive nucleus which emits positrons (positive electrons). Reactions of this type are often useful because they provide specific detectors for neutrons of high energy.

Capture of Neutrons.—Neutrons colliding with an atomic nucleus may simply be captured and incorporated into the nucleus, the energy of binding and the kinetic energy of the neutron being transformed into the energy of one or several gamma rays in an (n,γ) reaction. In many instances, neutron capture leads to the formation of a radioactive nucleus which subsequently emits beta rays as in C^{14}; this makes the capture easily observable and makes it possible to use this process for the detection of neutrons. The probability of capture varies greatly; it is generally greater for slow than for fast neutrons, and greater for heavy than for light nuclei. For fast neutrons and light nuclei the capture probability is immeasurably small, but for heavy nuclei about 1 collision in 20 to 200 leads to capture. The capture cross section for most nuclei for slow neutrons is less than 10 barns. Notable exceptions are found in the cases of boron, cadmium and gadolinium, with cross sections of 430, 2,100 and 22,000 barns, respectively. For slow neutrons and light nuclei, scattering still predominates over capture, *e.g.*, in ordinary hydrogen in the ratio 200 to 1, and in heavy hydrogen or carbon even more strongly.

Accordingly, neutrons have very different lifetimes in different substances, the lifetime being the average time from the production of the neutron until it is captured (or causes a nuclear reaction). In solid boron, this time is about 1×10^{-7} sec., in most solids of high atomic weight about 1×10^{-4} sec., in such special substances as graphite it becomes more than 1×10^{-2}, while in gases it ranges from about $\frac{1}{10}$ sec. for air to many seconds in pure heavy hydrogen. Even the longest of these times is short compared with the half life (10.2 min.) of the neutron as a radioactive particle.

The capture of slow neutrons shows the interesting phenomenon of resonance. For each nucleus there exist certain characteristic values of the kinetic energy of the neutron which make the capture of the neutron very likely. For instance, cadmium absorbs very strongly all neutrons less than 0.4 ev, indium absorbs neutrons of 1.4, 4 and 9 ev., gold those of 5 ev., whereas iodine has resonances at about 20, 30 and 40 ev and some at higher energies. The resonances are very sharp; *e.g.,* indium absorbs strongly only neutrons between 1.2 and 1.7 ev, and its capture cross section at 1.44 ev is nearly 1,000 times as large as that at 2.5 ev. To study these neutron resonance levels, special devices, known as velocity selectors, have been built which measure the time of flight of the neutron from its source to a detector. Studies of resonances give important information on the structure of nuclei; in fact, the resonance effects in the capture of slow neutrons gave rise to the modern theory of the compound nucleus, first developed by Niels Bohr, which forms the basis for the general understanding of reactions involving heavy nuclei.

Fission.—Neutrons can produce fission in heavy nuclei, especially in uranium, thorium and plutonium. Fission consists in the splitting of the heavy nucleus into two parts of approximately equal weight. This is possible because the mass energy in the heavy nucleus is considerably greater than the sum of the mass energies in the two nuclei of medium weight which are produced by fission. The difference in mass energy is released in kinetic energy of the fragments; it is approximately 200 Mev per fission. In a 1,000,000 kw. power plant approximately 1 kg. of uranium must undergo fission per day.

The use of fission for practical purposes is based on the fact that neutrons are emitted in the fission process and that more than one neutron is emitted per fission. As was pointed out in *Neutron Production by Fission*, above, this process is the most suitable one for the practical production of neutrons in large quantities. For example, in the Arco reactor (Idaho) and the Dido reactor at Harwell, Eng., a neutron flux density in excess of 10^{14} per sq.cm. per second was obtained.

Detection of Neutrons.—One of the most important problems in neutron experiments is the detection of the neutrons. Since the neutron produces no direct ionization, it can be detected only through its interactions with other nuclei. Four types of effects may be used for the detection of neutrons, viz.:

(1) The recoil of a nucleus with which a neutron has collided; (2) the emission of charged particles in a nuclear reaction produced by a neutron; (3) the production of a radioactive nucleus by any nuclear reaction caused by the neutron (this reaction may be simple capture), and (4) the production of "stars" in photographic emulsions by high-energy neutrons, a special case of (2).

The first effect will occur only with fast neutrons and can, therefore, be used only to detect these neutrons; on the other hand, it has the advantage that it permits the determination of the energy of the neutron. The second and third effects can be used for the detection of slow as well as fast neutrons; different nuclear reactions are used in the two cases. The fourth effect has been used to study energetic nuclear reactions, the production of mesons and the "strange" particles.

Fast Neutron Detectors.—*Recoil Detectors.*—In an elastic collision between a neutron of mass m and a nucleus of mass M the latter receives the kinetic energy

$$E' = \frac{4mM}{(M+m)^2} E \cos^2 \theta$$

where E is the kinetic energy of the neutron before the collision and θ is the angle between the direction of motion of the incident neutron and the recoil nucleus. For ease of observation, a large kinetic energy of the recoil nucleus is usually desirable; therefore, protons are preferred because their mass M is practically equal to that of the neutron. If the recoil proton goes in the same direction as the incident neutron it will receive the entire kinetic energy of the latter, as shown above, since $\cos^2 \theta = 1$ and $m = M$.

Protons are also preferred because the probability of their collision with a neutron is particularly large and can be calculated with accuracy on theoretical ground. Furthermore, the recoil protons produced by neutrons of a given energy E are distributed uniformly in kinetic energy from 0 to E, which simplifies the determination of the energy of neutrons.

The most important types of proton recoil detectors are cloud chambers filled with hydrogen or a gaseous hydrogen compound, photographic emulsions, ionization chambers with linear pulse amplifiers, and organic scintillators. The cloud chamber or emulsion is then exposed to neutrons coming from a definite direction and the direction as well as the length of the proton tracks are observed. From the length of the track the energy of the proton can be deduced. In an ionization chamber the energy is measured by the number of ions formed (by a single proton). The ionization chamber can be filled with hydrogen or provided with a layer of paraffin or some other solid material containing hydrogen. For the observation of large numbers of neutrons and determination of their energy, the ionization chamber is a satisfactory instrument.

The efficiency of neutron counters is usually low because of the small probability of collision between neutrons and nuclei. However, thick plastic organic scintillation counters may detect as many as 50% of incident neutrons. These counters produce an output of light that is proportional to the energy of the recoil particles. A proton recoil counter containing a thick layer of paraffin in an ionization chamber is the most efficient counter known for fast neutrons. If the neutron energy is E Mev, the counter will give about $2E$ pulses for every 10,000 neutrons incident upon it. Thin paraffin layers, of course, give even smaller efficiency but are more convenient for measuring the neutron energy. "Thick" and "thin" are to be understood in comparison with the range of the recoil protons. "Long counters" for recording high-energy neutrons rely upon the passage of the particles through a region containing paraffin as a moderator, in which the neutrons are slowed to the $1/v$-law range and then detected in boron trifluoride gas.

Deuterons and alpha particles have also been used successfully for the observation of neutrons by the recoil method. The recoil of still heavier nuclei, such as carbon, appears mainly as a disturbing effect when compounds such as paraffin are used in a recoil detector.

Nuclear Reactions.—The $B^{10}(n,\alpha)Li^7$ reaction of neutrons with boron-10, giving alpha particles, can be used for the detection of fast neutrons. An unsatisfactory feature of this detector is that the reaction is produced with much higher probability by slow neutrons than by fast ones.

Fission is a very convenient means of detecting neutrons, because it gives rise to very large pulses of ionization which can easily be distinguished from any disturbing effect. It is usually desirable that the detector respond only to fast neutrons (above 1 Mev); this can be accomplished by using uranium-238 or thorium, rather than uranium-235 or plutonium.

Radioactivity.—Many nuclear reactions produced by neutrons lead to radioactive nuclei. These can be observed after the end of the irradiation with neutrons, a fact which is often an advantage. For the detection of fast neutrons, reactions are preferable which can be produced only by fast neutrons. The reaction $n + Al^{27} = Mg^{27} + p$ is a good example; Mg^{27} is a radioactive nucleus emitting beta rays with a lifetime of about 10 min. The reaction can be produced only by neutrons of more than 2 Mev kinetic energy and increases in probability with increasing neutron energy. Similar threshold detectors can be obtained by using magnesium, silicon, phosphorus, etc.

Of particular interest are threshold detectors sensitive to neutrons of extremely high energy. Such detectors are provided by nuclear reactions in which one neutron enters the nucleus and two neutrons are ejected. A useful reaction of this $(n,2n)$ type occurs with copper, leading to the formation of the radioactive nucleus Cu^{62} of 10 min. half life; it occurs with neutrons of more than about 11 Mev energy. For still higher neutron energy carbon is a good detector; a reaction of the same type leads to the formation of C^{11}, a radioactive nucleus of 20 min. half life. The minimum neutron energy required in this case is about 20 Mev.

Detectors for Slow Neutrons.—The recoil type detector is not usable in this case, which leaves only two types:

Nuclear Reactions.—The most generally useful detector of slow neutrons is based on the (n,α) reaction $n + B^{10} = Li^7 + He^4$. This reaction has an extremely high probability for slow neutrons (cross section, 4,000 barns). The alpha particles have an energy of about 1.5 Mev and are easily observed. The most commonly used detector consists of an ionization chamber filled with boron trifluoride gas; the ionization pulses are detected with the help of a linear amplifier. Moderate size chambers of this type (about 10 cm. long) at atmospheric pressure will detect about 10% of the neutrons of thermal velocity (2 km. per second) incident upon them. Increase in the pressure and size, and enrichment of the boron trifluoride by boron-10, will increase the efficiency. The detection of slow neutrons is much more efficient than the detection of fast ones.

Boron can also be used in the form of thin foils of boron metal or boron carbide, the alpha particles being detected in some neutral gas.

Fission is a very convenient means of detecting slow neutrons because of the large pulses of ionization from the fission fragments. Uranium-235, uranium-233 or plutonium must be used because only these nuclei undergo fission when bombarded with slow neutrons.

Radioactivity.—There are many ways of observing slow neutrons by using the formation of radioactive nuclei. The most useful type of nuclear reaction for this purpose is the simple capture of neutrons (with emission of gamma rays), which is generally much more probable for slow neutrons than for fast ones and thus provides a specific detector for slow neutrons. As has been mentioned before, neutron capture leads often, although not always, to the formation of a radioactive nucleus. Indium foils have been found especially useful as detectors of slow neutrons, but also silver, gold, rhodium, bromine, iodine and other substances have been used successfully. The radioactivity is observed promptly after the irradiation by neutrons.

By making use of the resonance capture of neutrons, detectors of this type can be selected so as to indicate slow neutrons of fairly definite velocities. For example, the number of thermal neutrons (very slow, with energies less than 0.4 ev) can be measured by utilizing the fact that cadmium absorbs these neutrons very strongly while it is transparent for neutrons of higher energies. If the resultant radioactivity is measured, for instance, in an indium foil with and without a surrounding shield of cadmium, the difference will indicate the number of thermal neutrons incident upon the foil. On the other hand, the radioactivity observed with the foil shielded by cadmium is almost entirely the result of neutrons whose kinetic energy corresponds to a resonance in the indium nucleus (see *Capture of Neutrons*, above). Thus, the properties of neutrons of various energies can be observed by using detectors with different resonance energies.

Neutron Diffusion.—*Thermal Neutrons.*—Neutrons cannot be accelerated—they must be accepted with whatever energy they have upon formation—but they can be retarded. This can be done by permitting the neutrons to collide with nuclei; in each collision some kinetic energy is transferred from the neutron to the

nucleus according to the equation given above. If this process is continued for a sufficient number of collisions, the velocity of the neutrons will be reduced until they come into equilibrium with the thermal motion of the atoms with which they collide.

In this manner so-called thermal neutrons are produced. The thermal neutrons have a velocity distribution similar to that of molecules in a gas; their mean energy at room temperature is about 0.025 ev. The thermal neutrons continue to make collisions with atomic nuclei, but since they are now in thermal equilibrium, these collisions no longer slow the neutrons down, there being equally many collisions in which the neutron gains and in which it loses energy. Ultimately, the neutron will be captured by a nucleus.

The production of slow neutrons, and of thermal neutrons in particular, is important from the scientific as well as from the practical point of view. The investigation of thermal neutrons has yielded most of the information about the radioactive nuclei formed by neutron capture. The investigation of neutrons of somewhat higher energy showed the existence of resonance levels in nuclei and thus laid the foundation for the modern theory of the compound nucleus (see *Capture of Neutrons*, above). For nuclear reactors in which natural uranium is used, slow neutrons are important in order that the fission of uranium-235 may predominate over the capture of neutrons in uranium-238. Whatever the purpose of the slowing down, it is important that not many neutrons are lost by capture during the process.

The most commonly used moderator for the slowing of neutrons is hydrogen in the form of paraffin or of water. Hydrogen has the advantage that the neutron loses a large fraction of its energy in each collision (see *Fast Neutron Detectors*, above) and that the effective cross section is large. Neutrons of an initial energy of 2 Mev become thermal at an average distance of about 10 cm. from the source, in paraffin or water. This corresponds to about 18 collisions per neutron with protons. However, a paraffin block of at least 50 cm. radius is required to prevent a sizable fraction of the neutrons from escaping. If the neutrons are emitted from the source with higher kinetic energy, larger amounts of paraffin are needed to slow them down and vice versa.

For nuclear reactors or piles, hydrogen-containing substances are not suitable because protons capture neutrons with considerable probability. In this case, either heavy water or graphite is commonly used. The energy transfer in a collision is in this case much less than in the case of protons, and the effective cross sections are also smaller. Therefore, much larger amounts of material are required to slow the neutrons down to thermal energy; this is one of the reasons for the large size of graphite-moderated reactors. Heavy-water reactors are much more compact, and ordinary water can be used if slightly enriched uranium is present. On the other hand, there is practically no capture in either graphite or heavy water until the neutrons have been slowed to thermal energy, and even at thermal energy they will make hundreds of collisions before being captured.

The mathematical treatment of neutron diffusion is usually done in two stages; namely, first the slowing down to thermal energy and then the diffusion of the thermal neutrons. The second stage can be treated according to the ordinary methods of diffusion theory, using the diffusion equation

$$\tfrac{1}{3}\, lv\nabla^2 n - \frac{n}{\tau} + q = 0$$

where n is the density of neutrons (number per cubic centimetre), q the strength of the neutron source (number produced per cubic centimetre per second), l is the mean free path of the neutrons between two collisions, v their mean velocity and τ their mean lifetime, that is, the mean time which elapses before they are captured.

The mathematical treatment of the first stage, the slowing process, is quite difficult because the mean free path of the neutron changes with its velocity. A very useful although not exact concept in this theory is the age of the neutron, defined as one-sixth of the mean square distance traveled by the neutrons from the source to the point at which their energy drops below a certain arbitrary energy, E. The age η can be calculated as a function of E from experimental data, and the density of neutrons of energy E at the distance r from the source in a homogeneous medium is given approximately by

$$n(\eta,r) = (4\pi\eta)^{-3/2} \exp^{-r^2/4\eta}$$

Nuclear Energy.—Neutrons supplied the key for the release of nuclear energy. Fission of uranium can be caused by neutrons, and in each fission a certain number of neutrons, ν, are released. For uranium-235, for example, ν, has the value 2.5. This is the basis of the nuclear chain reaction in which each of the neutrons produced in fission is again available to react with a uranium nucleus and can cause another fission.

Conditions are simplest in the rare isotope uranium-235, or in plutonium-239. These substances can be made to undergo fission by neutrons of any velocity; in fact, slow neutrons are most effective. In a large mass of uranium-235, every neutron which has been released in a fission may in turn cause fission. Since the number of neutrons released in each fission is about 2.5, the total number of neutrons will increase in this process. The increase is rapid because very little time elapses between the production of a neutron and its fissioning of another nucleus. With large amounts of uranium-235 or plutonium, therefore, the result is a veritable avalanche of neutrons and an explosive release of fission energy. This is the principle of the fission bomb.

If the amount of uranium-235 is reduced, a fraction of the neutrons produced in it will escape. If the amount of uranium is made small enough, so that only one neutron out of every ν neutrons produced will stay in the uranium, whereas the remaining $\nu - 1$ escape, the reaction will cease to lead to a multiplication of the number of neutrons but will merely be self-sustaining. This is the principle of the power reactors, which in the 1960s were operating in numerous power plants as well as in ocean vessels and submarines. It is ordinarily desirable to keep the amount of the expensive material, uranium-235 or plutonium, to a minimum. This is accomplished both in the controlled reactor and in the bomb by surrounding the active material with a reflector, *i.e.*, any substance which can scatter neutrons back to the active material, and thus minimize the number of escaping neutrons. Conditions are somewhat more complicated if ordinary uranium is used instead of the separated isotope 235. In this case the abundant isotope of uranium, 238, undergoes fission only when bombarded by fast neutrons, whereas slower neutrons are simply captured, leading to the formation of uranium-239. In this capture the incident neutron disappears and no new neutron is emitted. Only the rare isotope uranium-235, which comprises about 0.7% of natural uranium, undergoes fission with slow neutrons, and thus can keep the chain reaction going. But in general the fission in 235 is much weaker than the capture in 238; only for neutrons of very low velocity, less than 1 ev, is the ratio reversed. Since it is not possible to avoid nuclear collisions and thus keep the neutrons at very high energies (at which they could produce fission in 238), it is necessary to slow them down completely, *i.e.*, to energies less than 1 ev, so that they can cause fission in 235 with high probability.

On the basis of these considerations atomic energy reactors are designed to include a moderator, usually graphite or heavy water (see *Neutron Diffusion*, above), which serves to slow the neutrons down to thermal energies. The neutrons produced by fission have kinetic energies of several million electron volts; they are then permitted to diffuse in the moderator and come back as thermal neutrons to the uranium. Then some of them will cause fission in 235 and thus produce new neutrons to sustain the chain reaction. Other neutrons returning to the uranium will be captured in 238 and produce uranium-239. This is a radioactive nucleus which decays successively by β emission into neptunium and then into plutonium-239. The plutonium can be separated chemically from the uranium and can be used in its turn for nuclear energy production. The production of plutonium in a chain-reacting pile is the first instance in which one chemical element has been transmuted into another in large quantities by man. Plutonium is fissionable by slow neutrons. In the so-called breeder reactor,

plutonium is created from uranium-238 as the reactor generates power from the fission of uranium-235. Thus the very operation of producing power also can be used to produce new fissionable fuel.

These reactors are very useful for the production of neutrons in large quantity. By letting the emerging neutrons diffuse through large additional amounts of moderator, it is possible to obtain thermal neutrons which are almost entirely free of fast neutrons. A great variety of radioactive nuclei, useful as tracers in biology, chemistry and for industrial research, may be produced by introducing samples into nuclear reactors where they are exposed to intense flux of neutrons and become radioactive by neutron capture.

See also references under "Neutron" in the Index.

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NEUVE CHAPELLE, BATTLE OF (1915), the first British offensive against the Germans after the advent of trench warfare on the western front in World War I (*q.v.*). After the French offensive in Champagne during the winter of 1914–15 had failed, the British commander in chief, Field Marshal Sir John French, planned an offensive in the Pas-de-Calais area with the initial object of seizing the village of Neuve Chapelle and the hope of piercing the German defenses and capturing Lille. Two British divisions (7th and 8th) and two Indian (Lahore and Meerut), under the command of Gen. Sir Douglas Haig, were involved. On March 10, 1915, after a 35-minute bombardment, the attack began on a narrow front. Some initial success was achieved and the troops entered the village. The Germans then counterattacked successfully while the British ran out of gun ammunition. When, late on March 12, the offensive was stopped, an advance of about 2,000 yd. on a front of 1,000 yd. had been made. British casualties were about 11,600 and German casualties were about the same. Useful lessons were learned, including the necessity for much heavier artillery bombardments in trench warfare, and the futility of launching infantry against uncut barbed wire. (C. N. B.)

NEUWIED, a town of Germany, *Land* (state) of Rhineland-Palatinate, which after partition of the nation following World War II became part of the Federal Republic of Germany, is situated on the right bank of the Rhine near the Wied stream, 17 km. (10 mi.) N.W. of Coblenz by road. Pop. (1961) 26,359. The town incorporates the ancient village of Heddesdorf, and buildings include the 18th-century baroque château of the Prince of Wied, churches of several denominations and 17th- and 18th-century houses. The former Moravian school (1756–1910) was attended by 2,720 British boys. Neuwied is on the Frankfurt am Main-Cologne railway, and is a highway junction. There are quays for passengers and freight. The town has a handsome dike wall and a steel road bridge across the Rhine. Industries include iron and steel production, engineering, and the manufacture of veneer, paper, chemicals, and pumice building materials made from the local volcanic sand. Neuwied was founded as a refuge for victims of religious intolerance by Count Frederick of Wied in 1653, and in the 18th century became a flourishing commercial and craftsmen's town. Roman *castra* were excavated at Heddesdorf and at Niederbieber nearby. (A. MT.)

NEVA, a river of Leningrad *oblast* in the Russian Soviet Federated Socialist Republic of the U.S.S.R., is the outlet for Lake Ladoga (*q.v.*) and flows into the head of the Gulf of Finland by way of a delta. The river is only 74 km. (46 mi.) long, but its drainage basin covers about 109,000 sq.mi., and includes lakes Ladoga, Onega and Ilmen and the Svir and Volkhov rivers. Its average annual discharge is 89,699 cu.ft. per second. Its banks are low and although its lower course is enclosed in stone embankments the spring floods are occasionally troublesome to the city of Leningrad; the highest recorded, in 1924, reached 16½ ft. Freeze-up begins about mid-November and is complete by the beginning of December. The thaw comes in the second half of April. The Neva is historically one of the most important rivers in Russia. In Kievan times it was the northern end of the "water road" via the Volkhov and Dnieper to the Black sea and Byzantium. Later the Swedes established two fortresses, Noteborg (Petrokrepost) at the Ladoga outlet and Nyenschanz (Nienshants) at the confluence of the Okhta, a small right-bank tributary, within present-day Leningrad. Peter I (the Great), after capturing these in 1703 founded St. Petersburg on the delta and made it his capital. As Leningrad, it is the second town and first port of the U.S.S.R. The Neva is navigable by ocean-going ships and forms part of the White sea–Baltic waterway (*q.v.*) and the Volga–Baltic waterway. (R. A. F.)

NEVADA, popularly known as the "Sagebrush state," or the "Silver state," is one of the far western states of the U.S., admitted to the union on Oct. 31, 1864, as the 36th state. It is bounded north by Oregon and Idaho, east by Utah and Arizona, south and west by California. The Colorado river, separating it in part from Arizona, is the only natural boundary the state possesses, the others being arbitrary lines of geodetic measurement. Nevada ranks seventh among the states in size, having an area of 109,788 sq.mi., 752 sq.mi. of which are water surface. Its extreme length north and south is 483 mi., and its extreme width east and west is 320 mi. Its name, a Spanish word meaning "snow clad" was originally applied to the snow-capped Sierra Nevada on the Pacific slope. The capital is Carson City. The state motto is "All for Our Country." The state flower is the sagebrush, the state tree the single-leaf piñon. The state flag is of solid cobalt blue, with, in the upper left quarter, crossed sprays of sagebrush surmounted by a scroll bearing the words "Battle Born" and by a single silver star.

PHYSICAL GEOGRAPHY

Physical Features.—With the exception of its northeast and southeast corners, the state (between approximately latitude 35° and 42° N. and longitude 114° 2′ and 120° W.) lies wholly within the Great Basin, the floor of which is really a vast tableland between 4,000 and 5,000 ft. above the sea. This plateau, however, is not a plain, but contains many buttes, mesas and isolated mountain ranges, the latter running generally in a north–south direction and rising 1,000 to 7,000 ft. above the level of the plain. These ranges are from 5 to 20 mi. wide at their bases, and the valleys between are of about the same width. The total area of the valleys is about equal to that of mountainous land.

In the northeast an unnamed range of highlands, broken and ill-defined, with a general east–west trend, forms the water parting between tributaries of the Humboldt river in the Great Basin region and those rivers that flow to the Snake river in Idaho and Oregon and from there via the Columbia to the Pacific ocean. The drainage area of the Snake amounts to about 5,000 sq.mi., the Owyhee, Little Owyhee and Bruneau rivers and Salmon Falls creek being the principal streams. In the southeast corner is the third drainage system. There the Virgin river from Utah, after crossing the northwest corner of Arizona, enters the state and flows southwest for 60 mi. until it joins the Colorado river. The latter stream flows for 150 mi. along the southeastern boundary toward the Gulf of California.

The Colorado leaves Nevada at an altitude of only 470 ft. above sea level, the lowest point in the state. The mean elevation of the state is 5,500 ft. and, with the exception of the dip to the Colorado in the southeast, all of it lies above the 2,000-ft. line.

The Sierra Nevada, which forms the western rim of the basin, sends into the state a single lofty spur, the Washoe mountains. At the foot of this range there is, relatively speaking, a depression, with an altitude of about 3,850 ft. above the sea, which receives the drainage of the eastern slopes of the Sierra and what little drainage there is in the northern half of Nevada. From this depression eastward the general level of the plateau rises to an elevation of 6,000 ft. near the eastern borders of the state.

The mountain ranges also increase in height and importance as far as the East Humboldt range, a lofty mass about 60 mi. W. of the Utah boundary. This range is the water parting for nearly all the westward-flowing streams of the state, and is by far the steepest and most rugged within Nevada, a number of its peaks attaining a height of more than 8,000 ft. On its eastern slope the waters soon disappear within the bed of narrow canyons, but break out again at the foot in ice-cold springs that form the source of the Ruby and Franklin lakes; on its western side the descent is more gentle, and the waters form the south fork of the Humboldt river. The two highest mountain peaks in the state are Boundary peak of the White mountains in Esmeralda county (13,145 ft.) and Wheeler peak of the Snake range in White Pine county (13,061 ft.).

The Humboldt is the most important of the basin streams. Rising in the northeast it flows in a tortuous channel in a general southwesterly direction for 290 mi. and drains 7,000 or 8,000 sq.mi. It empties into Humboldt lake, the overflow from which goes into the so-called Carson sink. At no part of its course is the Humboldt a large river, and near its mouth its waters are subalkaline. The Truckee, Carson and Walker rivers flow with more vigour, receiving their waters from the eastern slopes of the Sierra Nevada and discharging them into alkaline lakes. Of these lakes Pyramid is the largest, being about 30 mi. long and 4 to 13 mi. wide. Walker lake is 33 mi. long but only six or seven miles in width. These larger lakes always contain water, varying only in area and depth, but the smaller lakes usually evaporate in the course of the summer. The latter are formed by waters that fall on barren mountainsides and rush down in torrents, forming in the valleys shallow bodies of water yellow with mud held in suspension.

Climate.—The skies of Nevada are clear nearly every day in the year. The mean annual precipitation varies from 3 in. in the southwest (Esmeralda county) to 12 in. in the east (White Pine county), and varies also according to altitude. Snow rarely lies on the ground in the valleys. Prevailing winds are from the south, southwest and west.

Soil.—There are three general types of soil in Nevada. Gray desert soils are found in the arid low country and on the low slopes going up into the mountains. The mountains, generally arid or semiarid, have various mountain varieties of soils. Alluvial soils are found along the rivers.

Vegetation.—Except for the alkali flats no portion of the desert is devoid of vegetation, even in the driest seasons. In the Washoe mountains there is a heavy growth of conifers extending down into the valleys, but in many places these mountains have been almost deforested to provide timber for the mines. In other places these areas have been incorporated into national forests, in the endeavour to protect and foster the growth of timber and vegetation so as to regulate the drainage of the state. On all but the lowest ranges of the basin the piñon and juniper are found, but these rarely grow to a height of more than 15 ft., on the principal ranges above 6,800 ft. is the stunted mountain mahogany (*Cerocarpus* species). But except for these infrequent wooded areas, the mountains are even more bare than the valleys, because their shrubs are dwarfed from exposure. The valleys are covered with typical desert shrubs, greasewood, creosote bushes and sagebrush, and with bunch grass, which is valuable for grazing. The three-dented leaf sagebrush (*Artemisia tridentata*) is the commonest of the many species of sagebrush, growing sometimes to a height of ten feet with a silvery green leaf and yellow flower stalk. The creosote bush (*Covillea tridentata*), typical of the vegetation of the southern part of the state, has conspicuous yellow flowers. About 30 species of cacti are found in Nevada, and a number of yuccas, most conspicuous of which is the Joshua tree (*Yucca brevifolia*), which may reach a height of 40 ft.

Animal Life.—Deer are very common in Nevada, along with certain predatory animals such as the coyote, badger and bobcat. Among the rodents, several varieties of jack rabbits and many types of ground squirrels and desert mice and rats are prevalent in the desert country. The magpie and western varieties of sparrows are common, while the golden eagle is found sparingly in the state.

Parks and Recreation.—Nevada has many scenic attractions, many of them, such as the Death Valley National monument (115,240 ac. in Nevada) and the Black Rock desert, in the desert country. The Lehman caves, a limestone cavern, is 68 mi. S.E. of Ely and the Jarbridge canyon is in northern Elko county. The Valley of Fire, 50 mi. N.E. of Las Vegas, has thousands of prehistoric Indian drawings and fragments of petrified forest intermixed with red sandstone. Cathedral gorge in Lincoln county has been called a Bryce canyon in miniature. Hoover dam is 30 mi. from Las Vegas. Lake Mead, created by the dam and one of the largest man-made lakes in the world, provides year-round fishing and water sports. Walker and Pyramid lakes (remnants of the prehistoric Lahontan lake) are scenic and sporting attractions. Lake Tahoe lies across the California-Nevada boundary and its beaches attract many sports enthusiasts.

The state also has several excellent winter sports areas, largely in the Sierra Nevada. Reno is the central point for the ski country of the Sierras, but other ski resorts are found in the Ruby mountains near Elko, the Ward mountains near Ely and the Charleston park area 35 mi. N.W. of Las Vegas.

HISTORY

The first recorded person of European descent to enter the limits of Nevada was Francisco Garcés of the Order of St. Francis, who set out from Sonora in 1775 and passed through what is now the extreme southern corner of the state on his way to California. Half a century later trappers of the Hudson's Bay company led by Peter Skene Ogden entered Nevada from the north and discovered the Humboldt river. In 1827 Jedediah Smith, an American trader from St. Louis, crossed the state from west to east on his return from California after the first recorded journey from the Mississippi to the Pacific by the central route. In 1833 Capt. Benjamin Bonneville's men were on the Humboldt, and during 1843–45 John C. Frémont made a series of explorations in the region.

The first recorded emigrant train to California crossed the state in 1841.

Territorial Period.—By the treaty of Guadalupe Hidalgo, negotiated in 1848 at the close of the war with Mexico, Nevada became U.S. territory. It was then a part of California known as the Washoe country and so remained until 1850, when most of the present state was included in the newly organized territory of Utah (*q.v.*). One of the first settlements was made in 1849 by Mormons at Genoa in the valley of the Carson river. There in 1851 the earliest recorded public meeting in the state was held to frame a government for the settlers since the seat of the territorial government of Utah was considered too remote to afford protection to life and property. But the Utah authorities intervened, and in 1854 the Utah legislature created the county of Carson to include all settlements in western Utah.

In 1858 Carson City (*q.v.*) was laid out, and in the following year the people of Carson county chose delegates to a constitutional convention which met at Genoa and drafted a constitution. It was adopted by vote of the people, but this attempt to create a new state government proved abortive, and it was not until the mineral wealth of the Washoe country became generally known that congress took action.

In 1861 the territory of Utah was divided at 39° W. of Washington, D.C., and the western portion was called Nevada. The Comstock lode, one of the richest deposits of precious metal known in the world, was discovered in 1859, and Nevada ceased to be merely a highway for gold seekers on the way to California and became a stopping place. Virginia City became the most famous of all the mining camps of the far west (*see* VIRGINIA CITY).

Statehood.—An attempt to win statehood in 1863 was defeated, but in 1864 when it became evident that two more votes might be needed in the U.S. senate to propose the 13th amendment, party leaders at Washington urged the people of Nevada to adopt a constitution and enter the union as a patriotic duty. The third constitutional convention met at Carson City and drew up a constitution which was duly ratified and in October of that year, Pres. Abraham Lincoln proclaimed the new state. The eastern bound-

ary was pushed eastward to its present location on the 37th meridian west of Washington, D.C., in 1866; the southern boundary also was fixed in that year.

Nevada territory had been loyal to the union throughout the American Civil War. In spite of its scanty population, in 1861 it furnished a company of troops that was joined to a California regiment. In 1863 the territory raised six companies of infantry and six of cavalry (about 1,000 men), which saw no actual service against the Confederates but were useful in subduing hostile Indians.

The history of the state for many years after its organization was largely a history of its mines. From 1864 to 1868 there was a general reaction in the industry caused by unwarranted speculation and inflated values. After 1868 there came a period of consolidation, of more systematic workings, and of deeper development. In 1873 came the discovery of the "big bonanza" by John Mackay, James Fair, William O'Brien and James C. Flood, who became the four "bonanza kings" of Nevada. In 1873, $21,000,000 was taken from the Comstock and production increased until a maximum of $36,000,000 was reached in 1878. The Sutro tunnel intersected the lode in the latter year and drained the mines. But the richer workings soon proved below the tunnel level and the shafts were sent deeper. In 1882 an immense flow of hot water was struck which flooded the principal mines up to the Sutro tunnel level. The miners were forced to return to the upper levels and work the lower-grade ores. Production decreased, and with the end in sight the market slumped. Also, the national government had abandoned its artificial maintenance of the price of silver.

The period of depression lasted until about 1900 when the discovery of a new mineral belt in southern Nevada brought renewed prosperity. Tonopah, 60 mi. from the railroad, became the new Mecca. Fast upon the heels of the Tonopah discovery came that at Goldfield (*q.v.*). A railway was completed to the new camps in 1904, and Tonopah proved to be one of the largest and steadiest producing districts of the state. Copper ores of vast extent were discovered at Ely at about the same time, and the Nevada Northern railway was completed to this camp in 1907.

The depression immediately before 1900 turned attention to the agricultural and livestock possibilities of the state. Accessibility of markets through improved rail and highway transportation facilities aided in the expansion of the livestock industry. The river valleys under irrigation proved most fertile, and these were soon settled by large-scale ranchers. On the river bottoms the ranchers raised their hay and controlled a still larger acreage of the upland grazing ground. Private irrigation systems were supplemented by federal undertakings, the most notable being the Truckee-Carson project. The prosperity of many beautiful valley towns came to be founded on the permanent basis of agriculture rather than the uncertain one of mining.

Until the silver agitation of the 1890s Nevada was safely Republican. The state's politics in the early period were highly corrupt, and many rich mine owners were accused of buying their seats in the United States senate. For four state elections the Silver party of Nevada swept the state. After the issue subsided the old parties came into control.

After the legalization of gambling in 1931 and the reduction to six weeks of the residence requirement for divorce, Nevada became a marriage, divorce and resort centre. The principal resort areas are Las Vegas, Reno (*qq.v.*) and Lake Tahoe. Las Vegas attracts most of its tourists from the Los Angeles area, and it is famous for its resort hotels and gambling casinos. Reno draws many pleasure seekers from the San Francisco bay area. The gambling tax is second only to the sales tax in revenue from taxation for the state. Nevada's liberal divorce laws attract people from all parts of the country; because of the no-waiting period for marriages, however, many more weddings than divorces are performed in the state.

In the post-World War II years, Yucca Flats near Las Vegas became a primary atomic testing ground. Another atomic test site was developed near Fallon. The introduction of Bonneville hydroelectric power and construction of a pipeline to bring natural gas into northwestern Nevada promoted industrial development.

GOVERNMENT

Nevada is governed under its original constitution, adopted in 1864 and since amended in important respects. The usual method of amendment is the passage of a proposal by a majority of both houses of two consecutive legislatures followed by popular approval at a general election. In the 1958 election, for the first time in the history of the state, an amendment proposed by initiative petition was passed by the people.

Executive.—The principal executive officers of the state are the governor, lieutenant governor, secretary of state, attorney general, controller and treasurer, all elected for four-year terms. The governor possesses a limited pardoning power in that he must have the support of two other members of the Pardons and Parole board (the three justices of the supreme court and the attorney general). Reorganization of the executive department by the legislature in 1963 merged 16 formerly separate agencies and established a new department of administration, a department of commerce and a combined department of health and welfare including supervision of child and youth services and institutions. The state park system was placed in the department of conservation and natural resources.

Legislative.—The legislature, composed of a senate and assembly, meets in regular session in January of odd-numbered years. There is no constitutional limit on the length of a regular or special session, but salaries of legislators cease after 60 and 20 days, respectively. The constitution requires the number of assemblymen (apportioned according to population, with each county having at least one) shall not be less than twice nor more than three times the number of senators (each county having one). With the overwhelming majority of the population of the state concentrated in two counties (Clark and Washoe), the rural areas have been traditionally over-represented in the legislature. Senators are elected for four years, approximately one-half the membership retiring every two years; the entire assembly is elected biennially. Nevada joined in the Populist movement for more direct control of the government by the people in adopting the referendum in 1904 and initiative and recall in 1912.

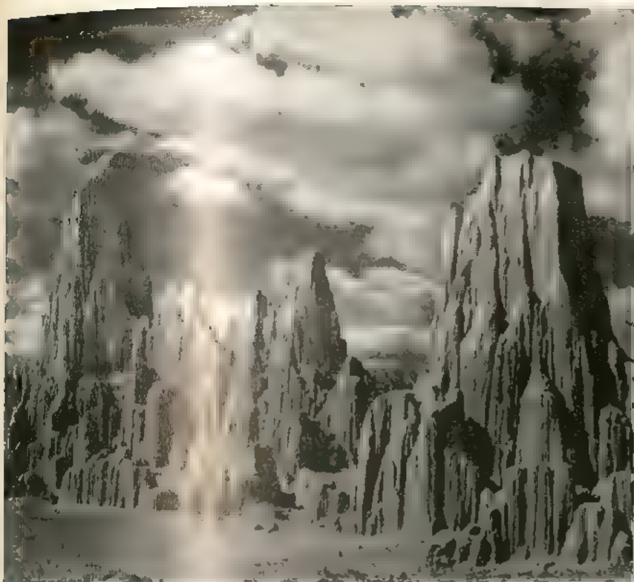
Judiciary.—The supreme court consists of a chief justice and two associate justices elected for six-year staggered terms. The number of district courts and judges (elected for four-year terms) is determined by the legislature. The great number of divorce cases made it necessary to expand the number of district judges who sit in Las Vegas and Reno. Each township has a justice of the peace who is elected for a two-year term.

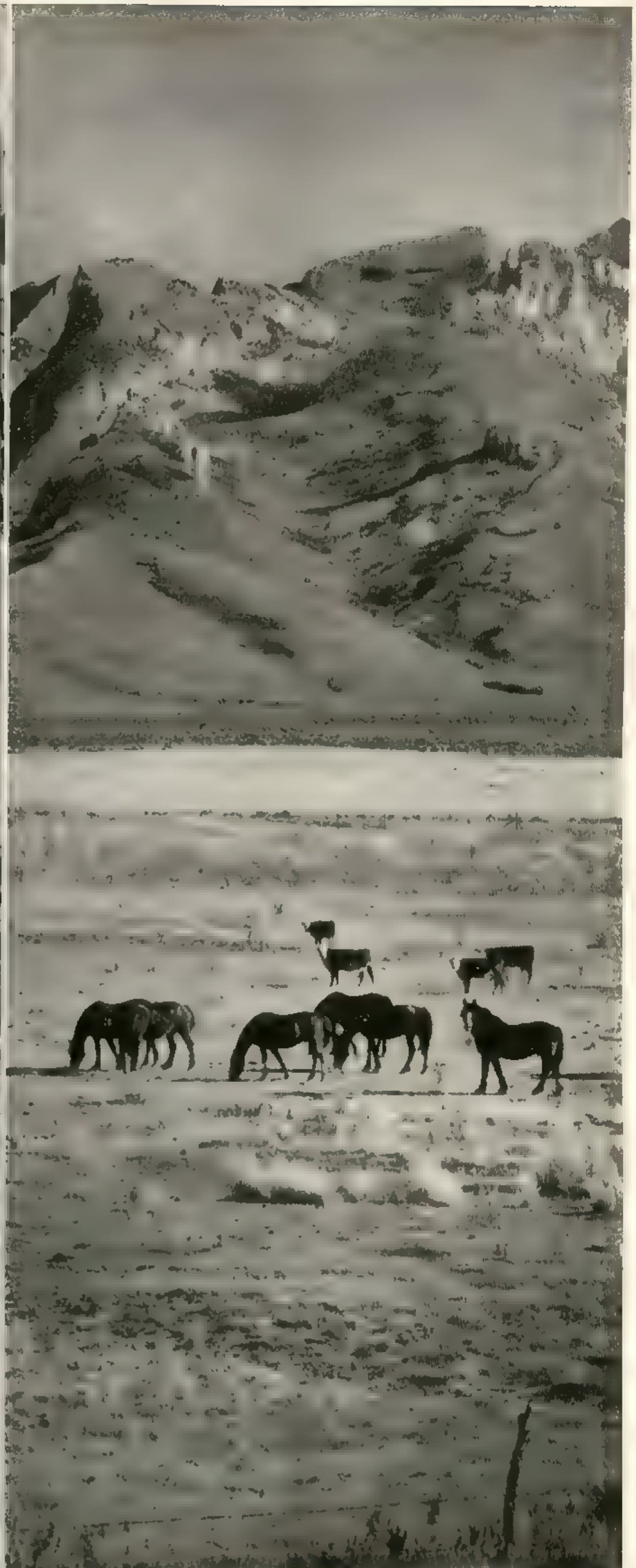
Finance.—The state legislature authorizes all expenditures, and in turn fixes a tax levy which is intended to produce revenue enough to meet these expenditures. The supervision of the assessment and collection of taxes is in the hands of the Nevada tax commission, consisting of the governor, acting as chairman, and six commissioners appointed by him. The director of the budget prepares the annual state budget and exercises control of departmental spending. The director and the state board of examiners scrutinize every expenditure item. The post audit function is performed by the legislative auditor responsible to the legislature and the legislative counsel bureau.

The major sources of tax income to the state are general sales tax, gambling tax, motor fuel taxes, motor vehicle licence taxes, cigarette tax and liquor tax. Almost all of the property tax is turned over to local units—schools, cities and counties. For the property tax there is a constitutional limit of $5 on each $100 valuation. Also, the state indebtedness cannot exceed 1% of the total assessed valuation of property in the state.

POPULATION

The population of Nevada in 1860 was 6,857; in 1880 it was 62,266 (as a result of the ore discoveries); in 1910, 81,875; in 1940, 110,247; in 1950, 160,083; and in 1960, 285,278. This last figure represented an increase of 78.2% over the 1950 population. The population per square mile in 1960 was 2.6, as compared with 1.5 in 1950 and 49.6 for the U.S. in 1960. Of the 1960 population, 200,704 or 70.4%, lived in incorporated places of 2,500 or more as compared with 52.5% in 1950 and 39.3% in 1940.





PHOTOGRAPHS, (TOP LEFT, TOP RIGHT) JOSEF MUENCH, (CENTRE LEFT) A. DEVANEY, (BOTTOM LEFT) DEANE DICKASON FROM EWING GALLOWAY

SCENES IN NEVADA

Top left: An erosion in Cathedral Gorge State park. Wind and rain have eroded the chalky clay into Gothiclike formations

Right: Horses and cattle grazing on pastures leading to the western slopes of the Ruby mountains. At the highest point the mountains rise nearly 7,000 ft. above the range lands

Centre left: "Broncho-busting" at Reno. During the annual rodeo all persons in the city are required to wear western dress

Bottom left: The state capitol. Carson City is the smallest capital city in the U.S.

PHOTOGRAPHS, (TOP LEFT, TOP RIGHT) JOSEF MUENCH, (BOTTOM) EWING GALLOWAY

MINING AND MOUNTAINS IN NEVADA

Top left: The Kennecott open-pit copper mine at Ruth is more than a mile in diameter and 1,000 ft. deep. Copper leads in value among the state's mineral products

Top right: Lake Tahoe, with the Sierra Nevadas in the background. The lake, ringed by high Sierra peaks, is blue-green in colour because of its great depth, at one point, 1,776 ft.

Bottom: Virginia City, one of the famous mining camps of the old west, was a boom town during the exploitation of the Comstock lode, one of the richest deposits of silver ever recorded

*Nevada: Places of 5,000 or More Population (1960 census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	285,278	160,083	110,247	77,407	42,335
Carson City	5,163	3,082	2,478	1,685	2,100
Elko	6,298	5,393	4,094	2,173	—
Henderson	12,525	3,643	—	—	—
Las Vegas	64,405	24,624	8,422	2,304	—
North Las Vegas	18,422	3,875	—	—	—
Reno	51,470	32,497	21,317	12,016	4,500
Sparks	16,618	8,203	5,318	3,238	—

*Populations are reported as constituted at date of each census. Note: Dash indicates place did not exist during reported census, or data not available.

The state has two standard metropolitan statistical areas, which are Las Vegas and Reno. These areas had a total population of 211,759 or 74.2% of the total population of the state in 1960.

The number of occupied dwelling units (or households) in 1960 was 102,694, as compared with 56,515 in 1950. The average population per household had declined from 3.09 in 1940 to 3.05 in 1950 and to 3.02 in 1960.

The population of the state was distributed by colour and nativity in 1960 as follows: 88.1% native white; 4.3% foreign-born white; and 7.6% nonwhite, mainly Indians. There were 106.7 males per 100 females in the native white population and 116.7 in the foreign-born. Six and four tenths per cent of the population was 65 years old or over; 63.0% of the population 14 years old and over was in the labour force. Of the total number of employed males, 6.1% was engaged in agriculture, 3.7% in mining, 12.4% in construction, 8.0% in manufacturing, 6.1% in transportation and 16.8% in wholesale and retail trade.

There are 14 Indian reservations, in addition to several Indian colonies, in the state. The two dominant tribes are Paiute and Shoshone (*qq.v.*).

EDUCATION

The state board of education is composed of eight lay members. Six of these are elected—one from each of the six educational supervision districts of the state—and two members are appointed by the elected members. The board appoints a superintendent of public instruction who is the executive head of the state department of education. The superintendent has no fixed term, serving at the pleasure of the board. The school districts are coextensive with the counties, and the districts receive substantial grants from the state treasury, with the amount based on the number of pupils attending school in a particular district. School attendance is compulsory for children between the ages of 7 and 17.

The only institution of higher learning in the state is the University of Nevada, with the main branch situated in Reno and a southern division at Las Vegas. (The university was originally established at Elko in 1874 but was moved to a 60-ac. Reno campus in 1886.) The university is divided into the following colleges: agriculture, arts and sciences, business administration, education, engineering, mining engineering and a school of nursing, in addition to a graduate division. The extension division carries on an ambitious program of taking classes to various parts of the state.

The governing body of the university is a nine-man board of regents, with three members elected from Washoe county, three from Clark county and three from the 15 small-population counties. The board members serve four-year terms.

HEALTH, WELFARE AND CORRECTIONS

A state orphans' home is located at Carson City, a state hospital for mental diseases at Sparks and a home for male juvenile delinquents at Elko. The state penitentiary is at Carson City. The department of health and welfare is one of the most important in the state from the standpoint of expenditures of funds.

THE ECONOMY

Agriculture.—Nevada is the most arid state of the United States because the high Sierra Nevada interrupts the moisture-laden clouds from the Pacific. East of these mountains, the valleys, however rich their soils, are covered with sagebrush and appear like monotonous desert wastes, except where some stream annually overflows its banks to create natural meadows, or where the land has been cleared of sagebrush and artificially watered. Agriculture is dependent almost entirely upon irrigation.

Principal crops in Nevada are hay, barley, wheat, oats and corn. In the southern part of the state, hay and forage, wheat, tomato plants and barley are the principal crops, with berries, apples and other orchard fruits growing on both irrigated and unirrigated lands.

In this arid region livestock are a far more important source of farm income than are crops. Approximately 65% of the agricultural income of the state is derived from grazing sources, and in 14 of the 17 counties livestock raising and farming dominate over any other industry (with the exception of gambling in Washoe and Clark counties). The average sized ranch in mid-20th century was 3,428 ac., with the larger ranching operations found in Elko, Humboldt and Pershing counties in the north and in Eureka, Lander and White Pine counties in the central and eastern sections. Many Basque sheepherders have settled in White Pine and Humboldt counties.

Mining.—Nevada metal production reached a peak in 1917, when gold, silver, copper, lead and zinc were produced to the value of $54,424,580. The years 1918–21 were years of swift decline, the production in 1919 being less than half that of 1918, and that of 1921 only half that of 1919. There was an upward turn in 1923 and a steady rise from then through 1929. Then the depression of 1929 caused a sharp decline.

Gold and silver were first to recover from the depression because of the revaluation of the gold dollar and the passage of the Silver Purchase act in 1934. The production of both metals declined sharply, however, during World War II and continued relatively low. The production of copper was stimulated by defense needs during World War II and, after a brief post-war decline, far exceeded the 1917 level.

In the early post-World War II years, Nevada continued to be an outstanding producer of magnesite, manganese ore, diatomite, mercury, perlite, sulfur ore, fluorite, tungsten, antimony and gypsum. In the late 1950s the reduction of the federal government's price-support program and foreign competition resulted in a sharp drop in production which, however, remained above all pre-war highs.

Manufacturing.—Manufacturing is limited in scope and production. Leading industries in the state include lumber and wood products; stone, glass and clay products; chemicals, insecticides and allied products; gypsum board; and titanium sponge.

Transportation and Communication.—Nevada is crossed east and west by three main lines of railway, the Southern Pacific and the Western Pacific in the northern part and the Union Pacific system in the southern part. Branch lines connect the more important mining towns with these lines. Railway mileage in the state reached a peak in 1915 when it amounted to 2,332 mi.; by the early 1960s it had decreased to about 1,500 mi. There are about 4,500 mi. of road in the designated state highway system, mostly paved. Several airlines operate in the state. There are more than 20 radio and television stations, the majority being in the Reno and Las Vegas areas.

See also references under "Nevada" in the Index.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures are summarized annually in the *Britannica Book of the Year*, American edition.

(E. C. D. M.; J. E. SPR.; D. W. DS.)

NEVAI, ALISHIR (1441–1501), Turkish poet and scholar, is the greatest representative of Chagatai Turkish literature. He was born in 1441 into an Uygur family in Herat, where his father

was a member of the court chancellery. The king of Khorasan took him under his protection and thus he met the leading poets and scholars of the day. Under Husain Bayqara, his school friend, who succeeded to the throne of Herat, Nevai held a number of offices, but the latter part of his life he devoted to poetry and scholarship. His poetry includes four *divans* (collections) belonging to different phases of his life, and five romances on conventional themes, inspired by the *Khamsa* of Nizami (*q.v.*). His main prose works are: *Muhakemet-ul-lugateyn*, a comparison of the Persian and Turkish languages; *Mecalis-un-nefais*, the first collection of biographical articles on Turkish poets; and *Mizan-ul-evzan*, a treatise on Turkish poetic art. His mastery of the eastern Turkish language both in poetry and prose was such that classical Chagatai came to be known as "the language of Nevai."

See A. Bombaci, *Storia della litteratura turca* (1956). (F. I.)

NEVERS, a town of central France, capital of the *département* of Nièvre, is situated 232 km. (144 mi.) S.S.E. of Paris by road on the right bank of the Loire river at the confluence of the Nièvre river. Pop. (1962) 38,716. In its historical development from the Roman Noviodunum through the middle ages into modern times as a district centre rooted in the life of the surrounding agricultural countryside, and enlarged by some modern development of manufacturing, Nevers is a typical French provincial town. It has been the seat of a bishopric since the 5th century, and was the capital of the duchy of Nivernais (*q.v.*). The cathedral of St. Cyr combines a Romanesque church and a later Gothic church. The church of St. Étienne is pure Romanesque. The palace of the counts (later dukes) of Nevers, now occupied by the law courts and an important ceramic museum, dates from the 15th and 16th centuries and is one of the great buildings of central France. The chapel of the St. Gildard convent contains the body of Saint Bernadette (*q.v.*) Soubirous, the visionary of Lourdes, who lived at Nevers from 1860 to 1879.

Nevers was formerly an important river port on the Loire. Its industries are chiefly concerned with engineering, including rolling stock and aircraft manufacture. (Ar. E. S.)

NEVILLE (Nevill), the name of an English baronial family which came to play an important part in 15th-century politics. Several branches of the family existed in the century following the Norman conquest, but their origin and interrelationship still remain uncertain on many points. The family of Neville of Essex, the first to become prominent, descended from Alan (de) Neville (d. 1178), a younger son of Geoffrey Neville, whose father, Gilbert, was a Lincolnshire landholder at the time of the Domesday survey (1086). Alan's grandson, Hugh Neville (d. 1234), emerged as a leading adviser and confidant of King John, whom he supported in the negotiations over Magna Carta. His kinsman, Ralph Neville, bishop of Chichester, was chancellor of England from 1226 to 1238. A later Hugh Neville (d. *c.* 1335) of Essex was summoned to parliament as a baron in 1311, but the male line of this branch came to an end with the death of his son, John, 2nd lord, in 1358, his estates having been sold to his comrade-in-arms, William de Bohun, earl of Northampton.

A more brilliant destiny awaited the Nevilles of Raby in the county of Durham. This branch of the family stemmed from the marriage of Isabel Neville, the heiress of a line descended from Gilbert (d. *c.* 1169), an elder son of the Geoffrey Neville mentioned above, to Robert FitzMaldred (d. 1242–48), a north country landowner whose grandfather had received a grant of the lordship of Staindrop in Durham from Henry I. Robert's son, Geoffrey (d. *c.* 1242), retained the paternal arms but usually employed his mother's surname, which became hereditary in later generations. By this time the Nevilles had already acquired their distinctive connection with Yorkshire and with Durham, where they had castles at Raby and Brancepeth, but as yet they were still barons of modest estate. Geoffrey's son, Robert (d. 1282) was a strong royalist in the baronial wars; his son, Robert (d. 1271), acquired by marriage the estates of the FitzRanulf family in north Yorkshire, including the lordship of Middleham; and his grandson, Ranulf (d. 1331) was summoned to parliament as a baron in 1295. Ranulf's eldest son, Robert Neville, sometimes known as "the Peacock of the North" was slain by the Douglases in a border fray in 1319, and the estates passed to his younger brother, Ralph (d. 1367), 2nd lord, who was active as warden of the marches, served in the Scottish wars, and was a commander at the English victory at Neville's Cross in Oct. 1346.

Ralph was succeeded by his son, John (d. 1388), as 3rd lord Neville of Raby. A supporter of the powerful John of Gaunt, duke of Lancaster, whose retainer he became in 1370, Neville served on the Scottish marches and in the French war, leading an unsuccessful expedition to Brittany in 1372, and in the same year he became steward of the king's household. This association with English reverses abroad and unpopular Lancastrian policies at home made him a target of criticism in the Good parliament of 1376. But he escaped lightly, the fines imposed on him being remitted by the parliament of 1377, and he was able to devote his considerable fortune to the building of Raby castle and the erection of the great Neville screen in Durham cathedral, where he was buried in 1388.

His association with the house of Lancaster was renewed by his son, Ralph Neville (d. 1425), 4th lord, who secured the hand of Joan Beaufort, daughter of John of Gaunt, as his second wife. This marriage proved of decisive importance in the advance of Neville fortunes, especially when Gaunt's son, Henry of Lancaster, usurped the throne as Henry IV in 1399. Ralph Neville was created earl of Westmorland in 1397, and enjoyed a flow of royal favour; and his wife's connection with the king, and Ralph's own vigorous loyalty, brought the earl and countess wealth, influence and social prestige, which in turn made possible an unparalleled series of brilliant marriages for their many children. The eldest son of this marriage, Richard Neville, was matched with Alice Montagu, heiress of Thomas, earl of Salisbury, and his parents successfully carried through a vast transfer of land whereby Raby Sheriff Hutton and Middleham, with the larger part of the ancestral family estates, were settled upon him and his heirs, to the disinheritance of Ralph's children by his first marriage (*see* Westmorland, Earls of). Heiresses were likewise secured for three younger sons, George, William and Edward, who became, in right of their wives, Lords Latimer, Fauconberg and Abergavenny. The fifth son, Robert Neville (d. 1457) was appointed bishop of Salisbury in 1427, and translated in 1438 to the great palatine see of Durham. Nor were their sisters less fortunate: Richard, duke of York, John, duke of Norfolk, Humphrey, duke of Buckingham and Henry, earl of Northumberland, each married a daughter of Ralph Neville and Joan Beaufort. By 1450 the peers in parliament included five of Ralph's sons, five sons-in-law, and several grandsons. When one of these last, Richard Neville (d. 1471), eldest son of Salisbury, obtained the earldom of Warwick by marriage to the Beauchamp heiress, the Neville connection had become immensely influential, and its support for the Yorkist cause proved decisive in establishing that dynasty on the throne.

Under Edward IV Neville power reached its apogee. Richard, earl of Warwick, was the king's principal adviser, his brother George Neville (d. 1476), was archbishop of York and chancellor and with another brother, John Neville, Marquess Montagu, and his uncle, William Neville, Baron Fauconberg and now also earl of Kent, as the king's chief commanders, the Nevilles virtually ruled England in Edward's early years. But the wayward ambition of Warwick the Kingmaker (*see* Warwick, Richard Neville, Earl of) brought about their downfall. Warwick and Montagu were killed at the battle of Barnet in 1471; George Neville lost his influence; and William Neville had died without heirs in 1463. Although Warwick's daughter, Anne, married Richard, duke of Gloucester, and became queen of England when he usurped the throne as Richard III, the greatest days of the Nevilles were now over. They were themselves the chief victims of the Wars of the Roses in which they played so large a part. The senior line of the family, the earls of Westmorland, survived until 1601. The Nevilles, Lords Latimer, became extinct in the direct male line in 1577. The Nevilles of Abergavenny have continued into modern times; George Neville (d. 1785), 17th lord, was created earl in 1784, and William Neville (d. 1915), 5th earl, was made marquess of Abergavenny in 1876. The present marquess is John Henry Guy (1914–).

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(C. D. R.)

NEVILLE'S CROSS, BATTLE OF. This battle, fought on Oct. 17, 1346, followed the invasion of England by the Scots under David II in an attempt to help the French by distracting Edward III from the siege of Calais. David encamped at Bearpark outside Durham. But the forces of northern England had been assembled nearby by William de la Zouche, archbishop of York, and the lords Percy, Neville, Umfraville and Mowbray. A disastrous dawn foray by Sir William Douglas brought the whole English army upon the Scottish encampment. Both sides were then arrayed in three divisions. When the Scots abstained from launching an attack, a body of English archers advanced to gall them into action. Neglecting the chance to disperse the archers by a cavalry charge, David ordered an advance that brought his first two divisions to awkward positions. Some hours of hard fighting ensued, the survivors of the first division under the earl of Moray falling back upon the second division commanded by David. The third Scottish division under Robert the Steward (afterward Robert II) and the earl of March took to flight. The remaining Scots concentrated around their wounded king who was eventually captured by John Coupland. The heavy Scots losses enabled the English to reoccupy most of southern Scotland and pursue the French war.

See J. H. Ramsay, *Genesis of Lancaster*, vol. i (1913); C. Oman, *History of the Art of War in the Middle Ages*, vol. ii, 2nd ed. (1924); A. H. Burne, *More Battlefields of England* (1952). (R. G. NI.)

NEVIN, ETHELBERT WOODBRIDGE (1862–1901), U.S. composer of light songs and piano pieces. Born at Edgeworth, Pa., on Nov. 25, 1862, he studied in Boston, New York and Germany; in Berlin he was a pupil of Karl Klindworth and Hans von Bülow. He first appeared as a pianist in Pittsburgh (1886) and later gave concerts in Boston, Chicago, New York and other U.S. cities. His early songs on English and German texts were influenced by Schubert and Schumann. His later pieces were in a lighter style. They include "The Rosary" (1898) and "Mighty lak' a Rose" (1900), which achieved great popularity. His best-known piano piece was "Narcissus" (1891) from the *Water Scenes*. He died at New Haven, Conn., on Feb. 17, 1901.

His brother ARTHUR FINLEY NEVIN (1871–1943) was a pupil in Berlin of Klindworth and of E. Humperdinck and became a conductor at Memphis, Tenn. He did research work on the folk music of the Blackfoot Indians of Montana (1903–04) and used this music in his opera *Poia* (Berlin, 1910). His other works include the one-act opera *A Daughter of the Forest* (1918), orchestral suites, cantatas and chamber works.

See J. T. Howard, *Ethelbert Nevin* (1935); A. F. Nevin, "Two Summers Among the Blackfoot Indians of Montana" in *The Musical Quarterly* (April 1916). (N. SY.)

NEVIS, an island of the Lesser Antilles in the Caribbean sea, forms with the islands of St. Kitts and Anguilla the British colony of St. Kitts-Nevis. Area 36 sq.mi. (93 sq.km.). Pop. (1960) 12,762. Nevis lies at latitude 17° 14′ N. and longitude 62° 33′ W. and is separated from St. Kitts by a two-mile-wide channel. An almost circular volcanic island, it is conical in appearance, rising gradually to a height of 3,596 ft. (1,096 m.) at Nevis peak. Charlestown (pop. [1960] 2,850), the chief town and port, lies on the southwest coast; it was the birthplace of Alexander Hamilton (*q.v.*). Sea-island cotton is the main crop, supplemented by sugar cane. Discovered by Columbus in 1493, Nevis was first colonized by the English in 1628, and subsequently enjoyed great prosperity. It was attacked by the French and Spanish on several occasions, being finally restored to Britain in 1783.

NEVSEHIR, capital of an *il* (province) of the same name in interior Anatolia, Turkey, located to the south of Kizil Irmak river 45 mi. (72 km.) N. of Nigde. Pop. (1960) 17,662. It lies on the slopes of a dry valley formed by a tributary of the Kizil Irmak and is characterized by stone houses built of hard volcanic tuff.

NEVSEHIR IL (area 2,172 sq.mi.; pop. [1960] 187,398) occupies the central part of the Anatolian plateau. Its eastern section is noted for its curious, densely dissected landscape caused by intense erosion, with earth pyramids, cones, pillars and old rock dwellings, especially around Goreme and Urgup. The climate is dry continental with extremely severe winters. Chief economic activities are cereal and grape cultivation, and stock raising.

(N. TU.; S. ER.; E. TU.)

NEVUS: *see* SKIN, DISEASES OF.

NEWARK, DAVID LESLIE, LORD (1601–1682), Scottish general who commanded the royalist forces during the third phase of the English Civil War, was the fifth son of Patrick Leslie of Pitcairly, Fifeshire, commendator of Lindores, and Lady Jean Stuart, daughter of the earl of Orkney. He began his military career on the continent, returning to Scotland in 1640. He was major general under Alexander Leslie, earl of Leven, at the battle of Marston Moor (1644) and was then sent into the northwestern counties and besieged and took Carlisle. When, after the battle of Kilsyth, Scotland was at the mercy of the marquess of Montrose and his army, Leslie was recalled from England in 1645, and made lieutenant general of horse. He surprised and routed Montrose at Philiphaugh near Selkirk on Sept. 13, 1645. He was then declared lieutenant general of the forces. After a short period of service in England he returned to Scotland, and reduced several of the Highland clans.

In 1650 Leslie was sent against Montrose, whom he defeated and captured. He had earlier declined to join in the Engagement on behalf of Charles I, but he now agreed to support Charles II and was appointed to the chief command of the new army levied on Charles's behalf. The result, though disastrous, abundantly demonstrated Leslie's capacity as a soldier, for Oliver Cromwell proved no match for him until his movements were interfered with and his army reduced to indiscipline by the representatives of the Kirk party that accompanied his headquarters (*see* CIVIL WAR, ENGLISH). After his defeat at the battle of Dunbar (Sept. 3, 1650) Leslie fought a stubborn defensive campaign up to the crossing of the Forth by Cromwell, and then accompanied Charles to Worcester, where he was lieutenant general under the king. On the defeat of the royal army (Sept. 3, 1651) Leslie was committed to the Tower of London, where he remained till the Restoration in 1660. In 1661 he was created Lord Newark, and received a pension of £500 per annum. He died in 1682.

NEWARK, a city and port of entry in northeastern New Jersey, U.S., is located on the west bank of the Passaic river and Newark bay, 8 mi. W. of lower Manhattan (New York city); the seat of Essex county, Newark, which is part of the New York-Northeastern New Jersey standard consolidated area, had a population (1960) of 405,220. The Newark standard metropolitan statistical area, which includes Essex, Morris and Union counties, had a population of 1,689,420. The city, which has 13 mi. of waterfront, is generally level but rises gradually from the Passaic river westward.

History.—Newark was founded in 1666 by Puritans who migrated from Connecticut under the leadership of Capt. Robert Treat. The settlement was established on land purchased from the Hackensack Indians for arms, ammunition, hoes, clothing, uniforms and liquor. The purchase included almost all of what is now Essex county and part of Union county. It was first named Pesayak Towne and later New Milford after Milford, Conn., from which some of the original settlers had come. The name was changed to Newark in honour of their pastor, Rev. Abraham Pierson (1608–1678), who came from Newark-on-Trent, Eng. Newark was chartered as a township in 1693 and incorporated as a city in 1836. For more than a century after its founding, Newark remained a quiet village of about 1,200 persons; then it experienced a sudden manufacturing and population expansion. Moses Combs, a local shoe cobbler, is credited with giving the industrial beginning to the town by starting its first shoe factory. Newark soon became a centre for leather tanning and shoe manufacture, and its industries included quarries, mills and iron foundries, as well as stagecoach and jewelry manufacturing. Its leading inventors were Seth Boyden, who developed the processes for making patent leather (1818) and malleable cast iron (1826); Rev. Hannibal Goodwin, who in 1887 patented a flexible film for motion pic-

tures and Edward Weston, who invented electrical measuring instruments.

Between 1850 and 1920 the city underwent rapid growth and expansion, its population increasing from 38,894 in 1850 to 414,524 in 1920. Between 1920 and 1930 the rate of increase fell off, and the next decade saw a slight drop in population (2.8%). This decline was mainly attributed to problems of urban blight that have plagued industrial centres and the resulting flight to the suburbs. During the 1940s, partially because of World War II, this tide was temporarily reversed and in the mid-1950s Newark experienced the beginnings of rejuvenation, with large-scale construction projects designed to stem urban blight. By 1960, however, the city's population had declined by nearly 8%, while its suburban population increased more than 24%. (For comparative population figures *see* table in NEW JERSEY: *Population.*) The proportion of Negroes increased from 17% in 1950 to over 50% in the 1960s. In July 1967 the National Guard helped to restore order after four days of looting and rioting in the Negro district.

Government.—Effective July 1, 1954, Newark had abandoned the commission form of government established in 1917 and adopted a charter form of the mayor-council type. Executive power is exercised by the mayor, administrative power is vested in an appointed business administrator and legislative power is exercised by the council.

Transportation, Commerce and Industry.—Newark has long been a centre for highway, rail, sea and air transportation and a major east coast distributing point for many of the nation's leading products. Both the Newark airport and the Port of Newark are operated by the Port of New York authority (*see* NEW YORK [CITY]: *Commerce and Industry*) as part of the great New York industrial and transportation complex.

The airport, one of the pioneer U.S. airports, was established in 1928 on a 2,200-ac. site three miles from the city's centre. Until the completion of La Guardia field in 1939, it was the principal air passenger terminal for New York city. The Port of Newark, started by the city in 1914 and later leased and operated by the Port of New York authority, has terminal and industrial facilities which make it one of the most efficient ports in the U.S.

Newark has long been noted for industrial diversification and concentration; its products include electrical equipment, chemicals, paints, malt liquors, bread products, processed meats, machinery, leather goods and jewelry. It is also a financial, retail, wholesale and insurance centre with a number of life, fire and casualty companies having their home offices in the city.

Education.—Located in Newark are the state-supported Newark College of Engineering (1881); Newark State college (public teachers, 1960); the Newark campus of Rutgers–the State university (*see* NEW JERSEY: *Education*); and a coeducational branch campus of Seton Hall university (Roman Catholic, 1856).

Parks and Recreation.—Near the centre of town is Military park used as a drill ground in colonial times and preserved as an oasis among the department stores and large office buildings. In the park is an imposing bronze group of figures, "The Wars of America," by Gutzon Borglum. To the north is Washington park, flanked by the public library, the Newark museum and several Rutgers university buildings. Branch Brook, a county park, is noted for one of the finest displays of Japanese cherry trees in the eastern United States. In front of the county courthouse, designed by Cass Gilbert, is Borglum's seated statue of Abraham Lincoln. Among churches of historic interest are Trinity Episcopal cathedral (1746), used as a hospital during the American Revolution; House of Prayer with its two-century-old stone rectory; and Old First Presbyterian church (1791). (S. N. W.)

NEWARK, a city of central Ohio, U.S., 33 mi. E. by N. of Columbus is the seat of Licking county. In pre-Columbian times the area was a cultural centre for the Mound Builders (*q.v.*). This is attested to by extensive, well-preserved earthworks to be seen in Moundbuilders and Octagon State parks. When first seen by Newark's settlers, these mounds were covered by dense forests containing trees more than 500 years old. The basic reason for the importance of this region to the Stone Age aborigines was the outcroppings of flint in the hills as at Flint Ridge State park nearby.

From its founding in 1801 by migrants from the middle Atlantic states, who settled at the forks of the Licking river, Newark was the trading centre for a prosperous agricultural region. Named for Newark, N.J., the home of an early settler, Newark was platted in 1802, incorporated in 1826 and chartered as a city in 1860. In 1825 the Ohio canal system was initiated at Licking Summit, 4 mi. S. of town and for a time the canal contributed greatly to the city's prosperity. The first railroad reached Newark in 1852, and by 1880 the population had grown to about 10,000, largely the result of industrial expansion. In mid-20th century leading industries included glass fabrication, aluminum processing, truck axles and transmissions, lawn mowers, corrugated boxes and other containers, plastics and petroleum products.

In Granville, 6 mi. E. of Newark, is Denison university (Baptist, 1831), a coeducational college. Buckeye lake is 10 mi. S. For comparative population figures *see* table in OHIO: *Population.* (W. T. U.)

NEWARK-ON-TRENT, a market town and municipal borough in the Newark parliamentary division of Nottinghamshire, Eng., 23 mi. N.E. of Nottingham. Pop. (1961) 24,651. It lies on the navigable arm of the Trent river and at the crossing of the Fosse way with the Great North road. Though Roman coins and pottery have been found nearby, there is no evidence of its having been a Roman settlement. Niweweorce ("the new work") was an important town in Saxon times. In 1055 Newark belonged to Lady Godiva who granted it to the monastery of Stow near Lincoln and it remained in the hands of the bishops of Lincoln until 1549, when it was incorporated.

A castle, probably wooden, and a bridge over the Trent were built by Bishop Alexander between 1123 and 1135, the castle being replaced by a stone building about 1173 by Geoffrey Plantagenet. Of this castle, where King John died in 1216, only the gatehouse and west tower stand; the other parts are remains of the rebuilding of about 1280. During the Civil War the castle was garrisoned for Charles I; it was besieged three times and Newark siege coins were minted there. On its surrender in 1646 a large part of it was destroyed by Cromwell. The cathedral-like parish church of St. Mary Magdalene is one of the finest in the country, its tower and spire being 246 ft. high. The crypt and four piers at the transept crossing are Norman; the lower part of the tower is Early English, the upper part and spire are Decorated; the nave dates from 1384–93 and the chancel from 1489. It contains one of the largest 14th-century brasses in the country and a fine 16th-century oak screen. An interesting monument in the town is the Beaumond cross (possibly 15th century) and among old brick buildings are the grammar and song school (founded in 1529), part of which contains the museum, and the 18th-century town hall in the marketplace.

The varied trades of Newark, which is the centre of an agricultural district, consist principally of brewing, malting, the quarrying of limestone and gypsum, the manufacture of ball and roller bearings, plaster and bricks, agricultural implements and beet sugar.

NEW BEDFORD, an industrial port of Massachusetts, U.S., 56 mi. S. of Boston at the mouth of the Acushnet river near Buzzards bay, is a port of entry and one of the seats of Bristol county. Pop. (1960) 102,477; standard metropolitan statistical area (New Bedford city and Acushnet, Dartmouth and Fairhaven towns in Bristol county; Marion and Mattapoisett towns in Plymouth county), 143,176. (For comparative population figures *see* table in MASSACHUSETTS: *Population.*)

Settled in 1652 by colonists from Plymouth who were joined in 1665 by Quakers from Rhode Island, there was no village on the site until 1760, at which time it was part of Dartmouth.

Bedford, as it was then known, assumed importance in 1765 when Joseph Rotch, a Nantucket merchant, built wharves and warehouses and expanded the village's infant whaling industry; in 1787 Bedford was set off from Dartmouth and incorporated as a town; it was chartered as a city in 1847. Fairhaven was separated in 1812. Originally named Bedford by Joseph Russell, one of the founders, in honour of his family's estates in England, it was later

changed to New Bedford to distinguish it from Bedford in Middlesex county. During the American Revolution the use of the harbour by American privateers led to an attack on Sept. 5, 1778, by the British under Earl Grey in which 70 ships were burned and the village almost completely destroyed by fire.

By 1820 New Bedford was the leading whaling port of the world, reaching its peak in 1857 with the registry of 329 whaling ships. From 1767 when the "Dartmouth," later one of the Boston Tea Party ships, slid down the ways, New Bedford was also an important shipbuilding centre. With the shifting of whale hunting grounds after 1791 from off Virginia and the Carolinas to the Pacific and after 1848 the arctic waters, the whaling industry began to decline. This decline was accelerated in 1859 by the discovery in Pennsylvania of petroleum, which displaced whale oil as an illuminant in oil lamps and as a lubricant for machinery.

The manufacture of fine cotton fabrics replaced whaling as the chief economic activity. From the founding of the first cotton mill in 1847 to the 1920s New Bedford was a leading textile centre. With the movement of the weaving industry to the southeast after the 1920s, apparel manufacturers moved into the vacated New Bedford mills and constituted the leading economic activity. There was, however, a trend toward diversification of industry with the manufacture of electrical equipment being the most notable development, although a wide variety of products including rubber goods, screws and bolts, twist drills, copper and brass goods and electrical machinery were manufactured.

The port business consisted of coal and petroleum products although over 75,000,000 lb. of fish were landed annually. New Bedford is in the heart of the southern New England resort area.

Local landmarks include Ft. Rodman built during the American Civil War on Clark's Point to guard the harbour, the Bourne Whaling museum and the Seamen's Bethel on Johnny Cake hill made famous in Herman Melville's *Moby Dick.* (I. T. S.)

NEW BERN, a city and port of entry in eastern North Carolina, U.S., is on the Neuse river at the mouth of the Trent, about 110 mi. S.S.E. of Raleigh; the seat of Craven county. Founded in 1710 by about 400 Swiss and Germans under the leadership of Christopher von Graffenried, of Bern, Switz., the settlement was nearly wiped out by Tuscarora Indian uprisings between 1711 and 1713. The town, however, the second to be established in North Carolina under the lords proprietors, was repopulated and incorporated in 1723.

North Carolina's first printing press (1749) and first tax-supported school (1764) were established there under royal government. The provincial assembly began meeting in New Bern in 1737 and the city's status as colonial capital of North Carolina was assured by the erection of a costly governor's house by Gov. William Tryon in 1767–70. The main building of "Tryon's Palace" burned in 1798, but was restored, along with its two wings, and opened to visitors in 1959. In 1774 the first provincial congress in North Carolina in opposition to the English was convened at New Bern to elect delegates to the first continental congress. After the American Revolution, despite the fact that the assembly met in various other towns, New Bern remained the legal capital of North Carolina until the seat of government was moved to Raleigh in 1794.

As in the Revolution, the city suffered little damage during the American Civil War, having been captured early (March 14, 1862) by Federal troops. A yellow fever epidemic in 1864, however, took 1,300 lives in the area.

Prior to the American Revolution New Bern was one of the leading seaports of North Carolina, trading with New England and the West Indies through Pamlico sound at the mouth of the Neuse, 30 mi. to the east. After the American Revolution, shipbuilding became important and timber and rope were produced. Exports consisted mostly of tobacco, lumber and naval stores.

In the 20th century New Bern, connected by a 12-ft. channel with the Atlantic Intracoastal waterway (*q.v.*) and state-developed deepwater port at Morehead City, became the commercial centre for nearby summer resorts, the large marine corps air station at Cherry Point and farmlands which produce corn, tobacco, soybeans, pulpwood and cotton. Manufactures include lumber products, boats, processed foods, clothing and chemicals.

Noteworthy among the city's older buildings are the Stanly house, now the public library (1780), Attmore house (1790), Presbyterian church (1822) and Christ church, with its communion service presented by George II in 1752.

For comparative population figures *see* table in NORTH CAROLINA: *Population.* (A. T. D.)

NEWBOLT, SIR HENRY JOHN (1862–1938), English author and poet, best known for his patriotic and nautical verse, was born at Bilston, Staffordshire, on June 6, 1862. He was educated at Clifton college and Corpus Christi college, Oxford, was called to the bar at Lincoln's Inn in 1887 and practised law until 1899. His first book was a novel, but it was the appearance of his ballads, *Admirals All* (1897), which included the stirring "Drake's Drum," that created his literary reputation. These were followed by other volumes collected in *Poems New and Old* (1912; rev. edition 1919) in which he extended his range to nostalgic and contemplative poems and affirmed his admiration for traditional English values. He edited the *Monthly Review* from 1900 to 1904 and published several novels including *The Old Country* (1906) and *The New June* (1909). During World War I he was comptroller of wireless and cables, and was later commissioned to complete the official naval history of the war. He also edited various anthologies of verse which reveal his catholic and progressive taste in poetry. He was knighted in 1915, appointed a companion of honour in 1922, and died in London on April 19, 1938.

NEW BRIGHTON, residential community of New York city, U.S., is located on the northeast shore of Staten Island (borough of Richmond) at the junction of Kill Van Kull and upper New York bay, about 6 mi. S.W. of Manhattan. New Brighton had its beginnings in the New Brighton association, founded in 1834 under the leadership of Thomas E. Davis who purchased extensive property in that area.

In 1836 New Brighton was described by the association as a community that "combines advantages, which, it is believed, are unrivalled in this country. Added to its proximity to the great commercial mart of the western hemisphere it possesses a beauty of location, extent of prospect and salubrity of climate that will in vain be sought elsewhere."

In 1866 New Brighton was incorporated as a village enabling the residents to provide themselves with more urban facilities. Horse cars were introduced to connect New Brighton with other villages on the island, the first sewers and street lights appeared, and more and better schools were built. In the latter part of the 19th century New Brighton became one of the most fashionable summer resorts in the east. Only a few of the stately mansions remain as a link with this period when the wealthy patronized the hotels and villas of this area. After 1898 New Brighton was a part of New York city.

Among the points of interest in New Brighton are the Neville house, said to have been built in 1770 and one of the best-preserved colonial houses on Staten Island; the Sailors' Snug Harbor, a home for retired seamen, opened in 1833; and Silver Lake park (207 ac.) which surrounds Silver Lake reservoir. (D. L. D.)

NEW BRITAIN, the largest island of the Bismarck archipelago (*q.v.*), situated to the north of the "tail" of New Guinea. With the adjacent islands, it forms a district of the Trust Territory of New Guinea (*q.v.*), administered by Australia. Pop. (1954) 91,748. Area (including adjacent islands) 14,100 sq.mi.

The island is arc shaped and about 300 mi. long with an average width of 50 mi. It is rugged and mountainous, several peaks exceeding 7,000 ft. and plains are restricted to the coasts. The Whiteman range in the south trends east-west, but farther east the Nakanai mountains extend in a southwest-northeast direction, and in the Gazelle peninsula in the north the Baining mountains have north-south alignment. The mountains are composed of massive limestones, shales and sandstones, with a number of volcanic cones. There are three areas of active volcanism: at the western extremity of the island southeast of Borgen bay; on the Nakanai coast southeast of Open bay where the Father (Mt. Ulawun) and the South Son (Mt. Bamus) both exceed 7,000 ft.; and in the northeast of the Gazelle peninsula near Rabaul, where

the Matupi and Vulcan cones constitute a hazard to the development of the town. An eruption in 1937 killed 263 people. Volcanic activity is, however, responsible for the rich soil in parts of the Gazelle peninsula, the most economically advanced part of New Guinea.

New Britain has an equatorial type of climate, with heavy rainfall owing to the mountains and to a position athwart both prevailing winds, the northwest monsoon (December–March) and the southeast trades (May–October).

The island is divided into four areas: Rabaul and Kokopo, both on the Gazelle peninsula, Talasea on the Willaumez peninsula on the northwest of the island, and Gasmata on the south coast. The most populous area is the Gazelle peninsula where the Tolai people have made greater advances than any other Melanesian peoples. The chief town of the island and administrative centre of the district is Rabaul, an important port of the southwest Pacific, on the northeast shore of Blanche bay. There is a small community of Chinese traders there, and most of the larger settlements have at least one Chinese trader and storekeeper. Rabaul was formerly capital of the Territory of New Guinea, but after the volcanic eruption of 1937 the capital was moved to Lae on the main island.

Only a small proportion of the island is cultivated, but it has the largest area under plantation crops in New Guinea. Most of the plantations are on the Gazelle peninsula coasts. Copra is the principal product and output from native groves has been increasing. The cultivation of other commercial crops, including cacao, has developed further in the Gazelle peninsula than in other parts of the territory. A feature of this development was the success of native co-operative societies with their own driers and fermentaries, a success likely to continue owing to the acute shortage of labour for the plantations, such labour being recruited from the Sepik area of New Guinea 500 mi. away. A variety of crops is grown on village garden land for local consumption but in the more primitive interior a system of shifting cultivation is practised, involving a rotation of plots, only used at long intervals.

New Britain was discovered and named in 1700 by William Dampier, but not explored until late in the 19th century. As Neu Pommern (later New Pomerania) it became part of the German protectorate in 1884, and after World War I was mandated to Australia. It was taken by the Japanese in Jan. 1942 and during 1943–45 Rabaul was severely damaged by U.S. air attacks. The island was re-occupied by Australia in 1945. *See* also Pacific Islands.

NEW BRITAIN, a city in central Connecticut, U.S., conterminous with New Britain town, about 10 mi. S.W. of Hartford, is known as the "hardware city." Pop. (1960) 82,201; standard metropolitan statistical area (New Britain city and Berlin, Plainville and Southington towns in Hartford county), 129,397. (For comparative population figures *see* table in Connecticut: *Population.*) New Britain's predominant nationalities of foreign-born are Polish, Italian, Irish, Swedish, German and English.

Formerly known as the Great Swamp, New Britain came into being in 1754. The township of New Britain was incorporated in 1850 and the city received its first charter in 1870. The township and the city were consolidated by act of the state legislature in 1905.

New Britain and the surrounding area long has been the scene of industrial and manufacturing enterprises. Metalworking began there in the 18th century. Berlin, now a suburb, was the home of the brothers Edward and William Pattison who in 1740 turned out the first tinware made in North America and generally have been credited with inaugurating the tradition of the Yankee pedlar. Berlin also was the home of Simeon North, contemporary of Eli Whitney and a pioneer in the use of interchangeable parts in the manufacture of small arms. Principal modern products include building hardware, household appliances, builders' tools, ball bearings, automatic machines and heating equipment.

An ecclesiastical society, the forerunner of the First Church of Christ Congregational, was organized there in 1760. By 1850, churches for three other Protestant denominations, Baptist, Methodist and Episcopal, had been organized. The first Roman Catholic parish was organized in 1884. A distinguished son, Elihu Burritt (*q.v.*), who was born in New Britain in 1810 and later was known as the "learned blacksmith," gained an international reputation for his efforts in behalf of international peace and brotherhood.

Central Connecticut State college was chartered as New Britain State Normal school, the first in the state, in 1849 and the first instruction was given in 1850, the same year in which a high school was established in the town. The normal school became a four-year college and was renamed Teachers College of Connecticut in 1933; the present name was adopted in 1959. The college offers advanced placement in some subjects and in 1961 inaugurated new programs leading to bachelor's and master's degrees. (A. J. M.)

NEW BRUNSWICK, one of the four original Canadian provinces of the confederation in 1867, lies on the Atlantic coast between 44° 37′ and 48° 3′ N. and 63° 46′ and 69° 3′ W. Roughly square in shape, it measures about 160 mi. in width and 193 mi. from north to south, and has a total area of 28,354 sq.mi. The province has a coast line of approximately 600 mi. along Chaleur bay in the north, the Gulf of St. Lawrence and Northumberland strait in the east and the Bay of Fundy in the south. The province of Quebec forms the northwest boundary, and the state of Maine the international border on the west. In the southeast, New Brunswick adjoins the province of Nova Scotia in the 17-mi.-wide isthmus of Chignecto. The interior is rolling and of moderate altitude, and is well drained by many rivers and streams of great importance to the early settlement and exploitation of the area. Of these, the St. John is the largest, flowing the full length of the province from north to south and navigable for 88 mi. as far as Fredericton (*q.v.*), the capital. The coast line offers a number of harbours, of which Saint John is the most notable. Being ice free throughout the year, it is one of Canada's most important winter ports. Approximately 80% of the province is forested. Cleared agricultural land is largely confined to coastal areas and the major river valleys, particularly the St. John valley; fishing is an active industry around the coasts. The major manufacturing industries are based on these primary resources, with the production of forest products being by far most important to the province's economy.

Physical Geography.—*Geology and Physiography.*—New Brunswick is an extension of the system of uplands and highlands of the Appalachian region which sweeps up the eastern flank of North America. Paralleling the Bay of Fundy in the south are the southern highlands, underlain by the oldest rocks in the province (pre-Cambrian granites). Extending from the southwest to the northeast of the province are the central highlands, a broad band of igneous and metamorphic rocks culminating in Mt. Carleton, elevation 2,690 ft., the highest point in New Brunswick. Associated with the central highlands in the northeast (Bathurst-Newcastle area) are large bodies of valuable base metal ores. To the northwest are the northern uplands, an undulating area underlain by folded Paleozoic sedimentary rocks. To the east is an extensive lowland, developed on flat carboniferous sandstones. Associated with it are the coal seams in the Chipman-Minto area and the natural gas in the vicinity of Moncton.

With the exception of the St. John and St. Croix, nearly all the major river valleys follow the southwest to northeast physiographic trend. Of these the more important are the Restigouche and Nipisiguit flowing into Chaleur bay, the Miramichi flowing into the Gulf of St. Lawrence and the upper section of the Petitcodiac flowing into the head of the Bay of Fundy. Many of the rivers have shallow tidal estuaries. The exceptionally high tides of the Bay of Fundy (over 50 ft.) occasion the peculiar phenomena of the reversing falls at the mouth of the St. John and the tidal bore which rushes up the Petitcodiac river.

Climate.—Like the other Canadian maritime provinces, New Brunswick has a climate characteristic of inland rather than maritime regions. This is especially true in the upper St. John valley and interior areas more directly connected with the continental land mass. The prevailing westerly winds bring with them the weather systems passing from the continent to the North Atlantic. At Saint John, average summer and winter temperatures differ by as much as 42° F. (January 19°, July 61°), while in the interior

variations are even more extreme. Summer highs in excess of 90° F. are occasionally recorded in the interior valleys, while readings of 30° below zero have been observed in the highland areas. Precipitation is normally ample and well distributed throughout the year (the annual average is approximately 40 in. at most stations with 3 to 4 in. monthly). About half falls in the form of snow. The average length of the frost-free season varies from 165 days at Saint John on the coast to 115 days in the upper St. John valley and to fewer than 90 days at higher interior elevations.

Vegetation.—Over four-fifths of New Brunswick was forested in the 1960s (about 14,000,000 ac.). Exploited since the early days of settlement, the forests were largely secondary growth in the second half of the 20th century. About two-thirds were conifers or needle-leaved trees in the following order of importance: spruce (three species), balsam fir, pine (three species), cedar, hemlock and tamarack (larch). The other third comprised hardwood or broadleaved species including birch, maple, beech and poplar, with smaller quantities of elm, ash, oak, basswood and butternut. Typically, the hardwood species grow on the ridge tops while the conifers are found in the valley bottoms and on the lower slopes. There are large areas of peat bog in the poorly drained coastal areas in the northeast of the province, especially in Gloucester county, including Miscou and Shippigan islands, where the extraction of peat moss is an important industry. Along the estuaries of the rivers flowing into the head of the Bay of Fundy are large areas of tidal marshlands developed on the vast accumulation of silts washed in and deposited by the tides. Originally covered with broadleaf and other salt marsh grasses, they have been reclaimed for agricultural use.

Animal Life.—The abundant wildlife of New Brunswick attracts many sportsmen to the province. Deer are especially common, and moose, once almost exterminated, were increased through the enforcement of stringent game laws. In addition there are a large number of fur-bearing animals including the bear, raccoon, marten, otter, lynx, beaver, muskrat, woodchuck, rabbit and red squirrel. The porcupine and skunk are also common. There are over 200 species of birds of which the grouse, duck and Hungarian partridge are the most popular for game. The St. John, Restigouche and Miramichi rivers have a wide reputation as the habitat of the Atlantic salmon, and trout are fished in nearly all the brooks and streams.

History.—Before 1784 New Brunswick formed part, first of the French province of Acadia, second, of the British province of Nova Scotia. The first settlement within its borders was made in 1604 by Pierre de Guast, sieur de Monts, with whom was Samuel de Champlain. Their colony at the mouth of the St. Croix river was soon abandoned, but throughout the French regime the district was frequented by bands of fur traders. In 1762 the first English settlement was made at Maugerville, on the St. John river, and in 1764 a body of Scottish farmers and labourers took up land along the Miramichi.

Scattered French settlers located themselves on the mainland side of the Bay of Fundy. They numbered about 4,500 at the time of the expulsion of their kindred across the bay, and their numbers were increased by about 500 of these as refugees.

After the American Revolution the great influx of loyalists into the valley of the St. John led to the separation of New Brunswick from Nova Scotia in 1784. The close of the Napoleonic Wars in 1815 brought a constant influx of immigration from Great Britain. The province had 74,000 inhabitants by 1824.

New Brunswick shared with Nova Scotia, in the middle period (1815–67), the prosperous development that arose from lumbering, shipbuilding and the fisheries and (until 1849) from the preference of the British market for colonial timber and the effect of the Navigation acts in giving the maritime provinces the West Indian trade denied the United States. This occasioned a relative neglect of agriculture and led many immigrants to prefer settlement in Upper Canada.

The landmarks in the provincial history include the long diplomatic struggle between Britain and the United States over the delimitation of the boundary according to the cryptic terms of the treaty of 1783 which ended in the compromise of the Webster-Ashburton treaty of 1842 (*see* also MAINE: *History*). Provincial history turned also on the question of responsible government, granted after its adoption in Canada (1841–49), and then on reciprocity of trade with the United States (1854). The 1864 plan of confederation for British North America, urged by Canada as a remedy for deadlock and by Great Britain after the warning of the American Civil War, found little favour in the province but in 1866 was voted by the legislature as a reaction from the Fenian raids.

The 1867 union with Canada led to marked improvement in the economic welfare of the province. The Intercolonial railway, promised under the terms of confederation, ran through the east side of New Brunswick and connected Halifax with Montreal in 1867. Other provincial rail lines, including the Saint John to Montreal connection by way of northern Maine, were completed shortly after. However, the introduction of the steamship and the exhaustion of the white pine timber led to the demise of the traditional wood, wind and water economy of the province. Protective tariffs and the concentration of population and industry in central Canada made competition difficult and led to the closing of many local industries. The opening of the Canadian west after 1900 and employment attractions in the rapidly expanding industries of central Canada and the United States started an emigration from New Brunswick which still continues. Various federal government assistance programs—including grants, subsidies and railway freight subventions—proved only moderately successful. In the second half of the 20th century, with the more efficient use of timber resources (chiefly for pulp and paper), the development of local electric-power supplies and the discovery of new mineral deposits, the prospects for economic development seemed more promising.

Incorporated Places of 5,000 or More Population

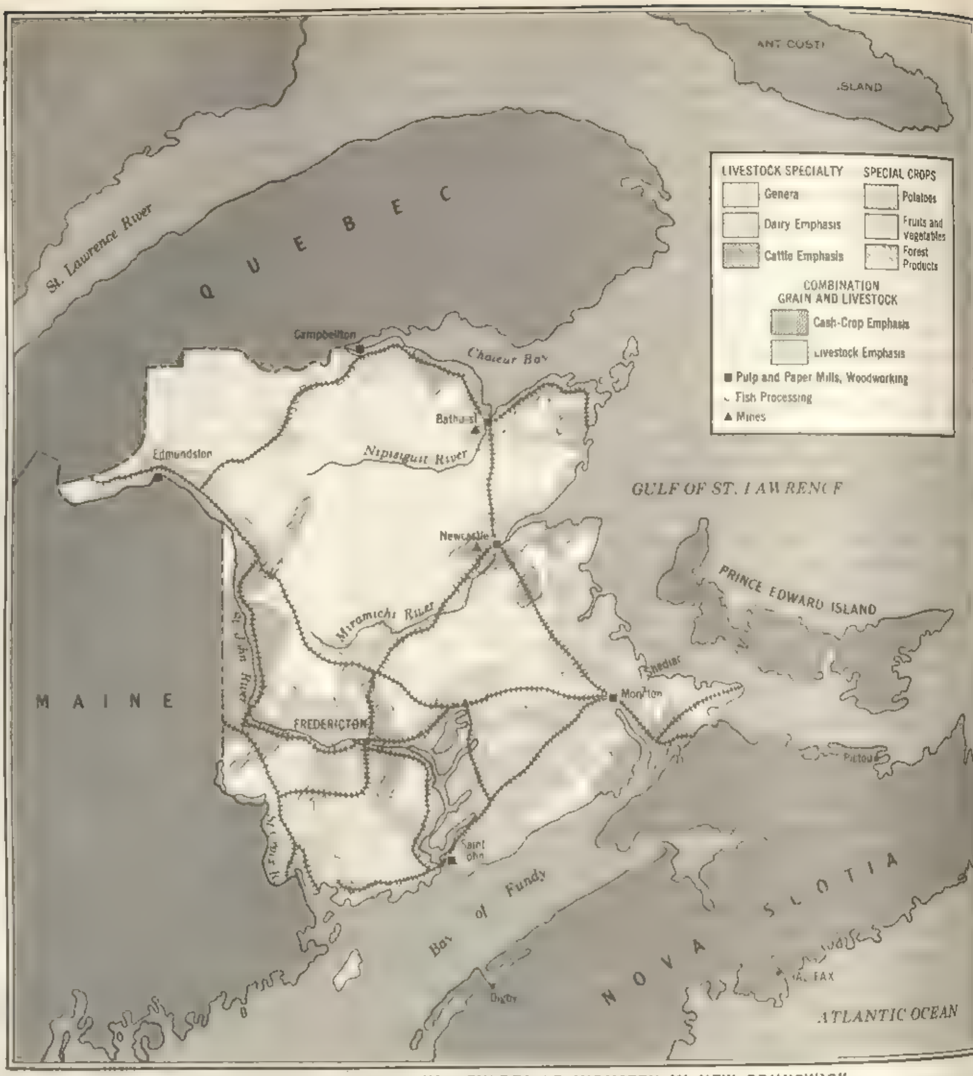
Place	Population				
	1961	1956	1951	1941	1921
Total province	597,936	554,616	515,697	457,401	387,876
Bathurst	5,494	5,267	4,453	3,554	3,327
Campbellton	9,873	8,389	7,754	6,748	5,570
Chatham	7,109	6,332	5,223	4,082	4,506
Dalhousie	5,856	5,468	4,939	4,508	1,958
Edmundston	12,791	11,997	10,753	7,096	4,035
Fredericton	19,683	18,303	16,018	10,062	8,114
Lancaster*	13,848	12,371	—	—	—
Moncton	43,840	36,003	27,334	22,763	17,488
Newcastle	5,236	4,670	4,248	3,781	3,507
Oromocto	12,170	661	—	—	—
Saint John	55,153	52,491	50,779	51,741	47,166

*Previously known as Lancaster Parish.
Note: Populations reflect data as each place was constituted at date of each census. A dash (—) indicates place did not exist during reported census, or data not available.

Population.—The population of New Brunswick grew slowly after 1900 despite the high birth rate; because of heavy emigration, it passed 500,000 only in 1951. In 1961 the population was 597,936, of which the majority were either Anglo-Saxon or French in origin. About 40% of the total were living in the larger cities and towns, of which the cities of Saint John and Lancaster had a combined population of 96,001; Moncton had 43,840; Fredericton, 19,683; and Edmundston 12,791. Other important centres were Campbellton, Dalhousie, Bathurst, Chatham, Newcastle, Woodstock, and St. Stephen. Fredericton replaced Saint John as the provincial capital in 1785 and became a city in 1845 at the command of Queen Victoria. On a broad terrace at the head of tidewater on the St. John river, it has enjoyed a certain importance as a lumber and railroad centre. Persons of French origin made up an increasingly larger proportion of the total population. Descended from the early Acadian settlers and the French Canadians from Quebec who later joined them, they settled chiefly in the upper St. John valley and along the northern and eastern shores. The English-speaking population originates from the Loyalists of 1783 and the large numbers of immigrants who arrived from Britain in the first half of the 19th century. The religious affiliations of the population are, roughly, Roman Catholic, 50%; Baptist, 18%; United Church of Canada, 14%; Anglican, 12%; Presbyterian, 3%; and other, 3%.

Government and Public Finance.—Since 1891 the provin-

cial government has been a one-chamber legislature with 52 elected members representing the province's 15 counties and 2 of its cities. It is headed by the lieutenant governor, who is appointed by the federal government and acts on the advice of the executive council. The executive council is chosen from the legislative assembly and consists of the premier and the heads of departments. In 1960 New Brunswick was represented in the parliament at Ottawa by ten senators appointed for life and by ten members elected to the house of commons for a period not exceeding five years. The counties are organized as municipalities with the parish as the unit of representation in the county councils. In addition there were 6 cities (Saint John, Moncton, Fredericton, Lancaster, Edmundston and Campbellton), 20 incorporated towns and 1 incorporated village in 1960. The sources of revenue collected for provincial purposes embrace various licences, permits, fines, penalties, sales taxes and royalties, augmented by federal government subsidies, health grants, certain equalization and development payments and various tax-sharing agreements.



AGRICULTURAL REGIONS AND CENTRES OF INDUSTRY IN NEW BRUNSWICK

Education.—Public-school education dates from the act of 1871 and is compulsory and free. The system of regional high schools developed after World War II greatly improved the educational facilities, especially in the rural areas. In addition the major centres have institutions which provide vocational training. Degree-granting universities with enrollments over 1,000 after mid-20th century were the University of New Brunswick at Fredericton and Mount Allison university at Sackville; others, with smaller enrollments, were St. Joseph's university, St. Joseph; University St. Louis, Edmundston; Université du Sacre Coeur, Bathurst-Quest; St. Thomas college, Chatham. There is a provincial teacher's college in Fredericton.

Agriculture.—Until about 1900, New Brunswick agriculture was largely a subsistence operation. Mixed farming was carried on with cash income derived from winter lumbering operations or from fishing in the coastal areas. With the opening of the Canadian west in the early 1900s, beef, mutton and grain products could be imported more cheaply than they could be raised locally and maritime agriculture became depressed. Moreover, the enormous expansion of industry in central Canada and the United States provided job opportunities away from home. The result was a large decrease in farm population, in farm production and in improved farm acreage. Agriculture has been increasingly confined to the more favoured areas. About one-third of the farm income is derived from potatoes, a cash crop concentrated in the upper St. John valley. Dairying is important in most areas. More than half of the total cropland (about 600,000 ac.) is normally in hay, with a large additional acreage in pasture. Apples, small fruits and vegetables are grown commercially in the lower St. John valley, and blueberries are a source of income in Charlotte county. Attempts were made after World War II to increase the numbers of sheep and beef cattle in the province and more attention was given to farm wood-lot management.

Forestry.—New Brunswick's forests still provided in the second half of the 20th century the largest source of income in the province (approximately $175,000,000 in the typical year of 1958, for example). Most of this income was produced by pulp and paper mills at Campbellton, Dalhousie, Bathurst, Newcastle, Saint John, St. George and Edmundston; the balance was accounted for in lumber (approximately 200,000,000 bd.ft. annually) and other wood products. New Brunswick had more than 1,000 industrial establishments in the 1960s, of which more than half were based on the use of wood. The province owns nearly half of New Brunswick's forest land and disposes of cutting rights in the form of timber licences and stumpage permits. Over half of the remaining acreage is in farm wood lots and other small holdings from which pulpwood and saw logs are sold to the highest bidder. The balance of the privately owned land is held mainly by operators of forest industries. Growth rates are rapid and compare favourably with other parts of Canada.

Mining.—Large deposits of base metal ores (lead, zinc, copper, silver, pyrite) were discovered in the Bathurst area in the early 1950s and later in the Newcastle area. Construction of Canada's first lead-zinc smelter east of Manitoba began near Bathurst in 1962. A large deposit of manganese ore in the Woodstock area and the oil shales in Albert county also were investigated. Soft bituminous coal, mined for many years in the Chipman-Minto area, was chiefly used in the production of electricity. Gypsum, the second important mineral mined, was used principally for the production of cement at Havelock near Saint John. Small quantities of oil and gas are extracted in the Moncton area, and there is a small tungsten production at Burnt Hill.

Fishing.—Of the more than 30 commercial species of fish

caught in New Brunswick coastal waters, four varieties normally account for over 80% of the total value of the catch (lobsters and sardines are most important, followed by cod and herring). Most of the lobsters were taken from the northern and eastern shores, the sardines from the western Bay of Fundy. With federal government assistance, fishing methods and processing facilities were greatly modernized after World War II, and in the ten years after 1945 the value of the industry almost doubled ($13,000,000, 1945, compared with $23,000,000 in 1956). There were approximately 11,000 fishermen and over 100 fish processing plants by the 1960s.

Power.—The development of New Brunswick's electrical facilities proceeded rapidly after World War II reaching a total installed capacity of more than 300,000 h.p. hydroelectric turbine capacity and 300,000 kw. thermalelectric generating capacity by the early 1960s. The 102,000 kw. Beechwood hydroelectric unit on the upper St. John river was completed in 1958. Steam units were at various points in the province while the hydroelectric installations were on the St. John and its tributaries (Grand Falls, Tinker Falls, Tobique Narrows, Beechwood and Edmundston), the St. Croix, Musquash and Nipisiguit rivers. The possible use of tidal power in Passamaquoddy bay, where a U.S. tidal power project was started in the 1930s (and abandoned in 1937) was again under international investigation in the 1960s (*see* also FUNDY, BAY OF; TIDAL POWER).

Industries.—Although the value of New Brunswick's manufacturing industries increased from $66,000,000 in 1939 to over $300,000,000 by the 1960s, it had consistently declined in relation to the national total (from 7.8% to less than 2%). Manufacturing traditionally has been based on the natural resources of the province, particularly wood. Pulp and paper accounted for about one third the total value in the 1950s and 1960s while other wood products, food, shipbuilding, fish products and textiles followed in that order.

Communications.—New Brunswick is serviced by both the Canadian National and Canadian Pacific railways. The main C.N.R. passenger line from Halifax to Montreal (the old Intercolonial completed in 1876) services communities on the northern and eastern shores, while the main C.N.R. freight lines pass diagonally across the province from Edmundston to Moncton. Other C.N.R. lines connect Saint John and Moncton and serve the lower St. John valley. The main C.P.R. "short line" from Montreal to Saint John via the state of Maine was completed in 1890; branch lines connect with Fredericton, Edmundston and St. Andrews. The C.P.R. operates a ferry service between Saint John and Digby, N.S., as does the C.N.R. between Cape Tormentine and Port Borden, P.E.I. In the 1960s New Brunswick had over 13,000 mi. of roads, of which about 3,000 mi. were improved. Trans-Canada Air Lines service was established on a regular basis from Montreal to Moncton in 1940, and later, direct communications commenced between Halifax and Sydney, N.S., and Moncton, and between Fredericton and Montreal. The Maritime Central Airways began flying in 1941, with flights between Saint John and Charlottetown, P.E.I., via Moncton, and later branched into Nova Scotia and to the Magdalen Islands.

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NEW BRUNSWICK, a city of New Jersey, U.S., is on the Raritan river, 30 mi. S.W. of New York city and 60 mi. N.E. of Philadelphia, Pa.; the seat of Middlesex county. The site was settled in 1681 by a party from Long Island, led by John Inian who established a ferry across the river in 1686. Known originally as Prigmore's swamp, the settlement was called Inian's Ferry in 1713 and finally, about 1724, was named New Brunswick in honour of King George I, who was also the duke of Brunswick. It received a charter from George II in 1730, about the time a number of Dutch settlers from Albany began arriving. Its location at the head of navigation of the Raritan meant that during the colonial period New Brunswick was an important port for the shipment of agricultural products from northwestern New Jersey. During the American Revolution, George Washington and his troops, retreating from New York, occupied the town for about a week in 1776, but had to evacuate at the approach of the British under Sir William Howe who remained there about seven months. Washington again occupied the city after the battle of Monmouth in 1778 and it was there that he issued orders for the march south that culminated in the victory at Yorktown. During this time, small privateers sailed from the city's docks at night to prey upon British ships operating in the waters adjacent to Manhattan. After the war New Brunswick continued to grow and was incorporated as a city in 1784.

In 1834 the city became the eastern terminus of the Delaware and Raritan canal which quickly declined, but continued nominal operations until 1933. The Camden and Amboy (later the Pennsylvania) railroad crossed the Raritan to New Brunswick in 1838 and by mid-century the city was producing wallpaper, rubber products, machinery, shoes and hosiery. In 1896 Robert W. and James W. Johnson established a firm to produce gauze, adhesive tape and surgical dressings. Other manufactures include pharmaceuticals, chemicals, clothing and leather goods.

New Brunswick is the seat of Rutgers—the State university (*see* NEW JERSEY: *Education*), founded as Queen's college in 1766, which became the state university of New Jersey in 1945. New Brunswick Theological seminary, a school of the Reformed Church of America and the oldest theological school in the U.S., founded in 1784, has been in New Brunswick since 1810. Joyce Kilmer, the World War I soldier-poet, was born in New Brunswick. The national headquarters of the Boy Scouts of America is also there.

For comparative population figures for New Brunswick (part of the New York-Northeastern New Jersey standard consolidated area) *see* table in NEW JERSEY: *Population*. (E. R. D.)

NEWBURGH, a royal and small burgh of Fife, Scot., on the Firth of Tay, 11 mi. E.S.E. of Perth by road. Pop. (1961) 2,321. It is the headquarters of the Tay salmon fisheries and other industries are the manufacture of linoleum and of waterproof fabrics. Whinstone (road metal) is exported to England from the harbour. About 1 mi. S.W. of the town stand the remains of a monolith called Macduff's cross where the murderer of Macbeth was reputedly granted rights and sanctuary. A short way east of Newburgh are the ruins of Lindores abbey, a Benedictine establishment founded in the 12th century by David, earl of Huntingdon, brother of William the Lion.

The ruined Denmylne (Denmill) castle, slightly farther east, belonged to the Balfours. At Blackearnside, a forest of alders east of the village, Sir William Wallace defeated Aymer de Valence, earl of Pembroke, in 1298. A Pictish fort with a triple line of earthworks is at Clachard Craig.

NEWBURGH, a city of Orange county in southeastern New York, U.S., lies on the west bank of the Hudson river, opposite Beacon, about 60 mi. N. of New York city and 85 mi. S. of Albany. Temporarily settled in 1709 by German refugees from the Rhenish Palatinate, Newburgh was permanently founded by Scottish and English settlers in 1752 and named after Newburgh, Scot. During the American Revolution, it became prominent as a key command post of the strategic Hudson valley. As Washington's headquarters after 1782, it was there that the general wrote his letter of May 27, 1782, rebuking Col. Lewis Nicola for the suggestion that he assume the title of king; made his reply to the "Newburgh Addresses" calling for action by the army to force congress to redress its grievances; and dissolved his armies in 1783. The headquarters building, a Dutch farmhouse built by Jonathan Hasbrouck in 1750, is now a state museum.

Prospering as a river port and for a while as the terminus of important turnpikes to the west, the city shared in the Hudson river whaling boom and other seafaring activity of the 19th century, but eventually its economy became based on manufacturing and, for a while, the city served as the seat of Orange county. It also became the hub of an agricultural region dominated by dairying and fruit growing.

Newburgh's varied industries include the manufacture of textiles, fabrics and leather goods. Stewart air force base, an installation of the North American air defense command, is located a

few miles to the west. Newburgh was incorporated as a village in 1800 and was chartered as a city in 1865. In 1916 it adopted a manager-council form of government. For comparative population figures *see* table in NEW YORK: *Population.* (D. H. K.)

NEWBURN, an urban district of Northumberland, Eng., forming part of the southern boundary of Northumberland and the western boundary of Newcastle upon Tyne. Pop. (1961) 27,879. In 1204 the name was Niewburg. The Anglo-Scottish battle of Newburn (1640) was fought there and parts of Hadrian's wall are in the district. The church of St. Michael and All Angels dates back to *c.* 1190 with later additions. Newburn is a residential and industrial district and its industries include coal mining, engineering (springs, axles, valves), glass, building materials and cordage. It has a large industrial estate with others projected in the 1960s. Woolsington airport lies 3 mi. N. (C. A. Wo.)

NEWBURY, a market town and municipal borough of Berkshire, Eng., lies 17 mi. W.S.W. of Reading by road on the river Kennet and the Kennet and Avon canal. Pop. (1961) 20,386. Its modernized shops and open-air markets attract an extensive rural shopping population. It is situated at the intersection of the London-Bath and Midlands-south coast trunk roads; an east-west relief road was opened in 1959. The council chamber and magistrates' court and the corn exchange (now used for public entertainment) are in the marketplace.

First inhabited in Mesolithic times, much evidence of Roman occupation has been found. At the time of the Domesday survey there were two mills and the manor was held by Ernulf de Hesding. The manor subsequently passed to the crown and was held by Elizabeth I before her accession. Newbury castle was besieged and captured by Stephen in 1152, and traces of it remained until the 17th century. St. Nicolas parish church is an early 16th-century Perpendicular building on an older site, and was built largely through the munificence of John Winchcombe or Smallwood (Jack of Newbury), an eminent clothier, a part of whose house in Northbrook street still remains. South of the river, in Wharf street, is the Jacobean cloth hall, now the borough museum. Adjoining is an old granary, a long and picturesque two-story galleried building. East of this is the site of the castle.

A charter of incorporation was granted by Elizabeth I in 1596, and revocations and renewals were made by Charles I, Charles II and James II. King John also granted a charter by which the profits of a fair supported almshouses. Borough boundaries were extended in 1878 and 1934. The grammar school was built in 1885, but had its origin in 1466. The town has the right of presentation of boys and girls to the educational foundation of Christ's hospital. Shaw house, a notable Elizabethan mansion associated with the second battle of Newbury and occupied by Oliver Cromwell, is now a secondary school. The suburb of Speenhamland, formerly an important posting station on the Bath road, gave its name to the so-called Speenhamland system of parish relief for unemployment in 1795. Sandleford priory, site of an Augustinian priory (*c.* 1200), is now a school. A racecourse, east of the town, was opened in 1905. The principal industries are marine and light engineering, flour milling, woodworking and the manufacture of light aircraft.

Battles of Newbury (1643 and 1644).—These two important battles occurred during the Civil War. The first took place on Sept. 20, 1643, in the Wash common and Enborne area, when the royalists sought to bar the path of the parliamentary forces under the earl of Essex, returning to their base at Reading after raising the siege of Gloucester. Six thousand men fell in this battle, among them the earls of Carnarvon and Sunderland and Viscount Falkland, a memorial to whom was erected on the site in 1878. In the second battle at Shaw and Donnington, on Oct. 27, 1644, the situation was reversed and a large parliamentary army failed to prevent the royalists from relieving 14th-century Donnington castle, ruins of which remain. *See* CIVIL WAR, ENGLISH. (G. E. Wl.)

NEWBURYPORT, a city of northeastern Massachusetts, U.S., at the mouth of the Merrimack river, 37 mi. N.N.E. of Boston, is one of the seats of Essex county.

Newbury, including the site of Newburyport, was settled in 1635 under the leadership of Rev. Thomas Parker (1595–1677) who had lived in Newbury, Eng. While the western portion of the town was primarily interested in farming, Newburyport's location at the mouth of the river drew merchants, tradesmen and seafarers. This division of interests led to the incorporation of Newburyport as a separate town in 1764. Fishing, whaling, shipbuilding and subsidiary industries brought wealth and fame to the town in the years before the American Revolution. During the war business was virtually destroyed and the shipowners temporarily turned to privateering. By 1790 shipbuilding had recovered and retail trade boomed, but the Jefferson embargo of 1807–08 against all foreign trade, a disastrous fire in 1811 and the War of 1812 brought the end of Newburyport's pre-eminence as a commercial port, although during the clipper ship era of the 1840s Newburyport built a number of those famous ships.

Incorporated as a city in 1851, Newburyport turned to the manufacture of textiles and shoes, along with its traditional products, rum and fine silver. In the second half of the 20th century the electronics and electrical machinery industries were the largest sources of employment. Newburyport contains the birthplace of William Lloyd Garrison (*q.v.*), American antislavery leader, and many of the stately federal-style houses built by early shipowners and their captains.

For comparative population figures *see* table in MASSACHUSETTS: *Population.* (L. G. BA.)

NEW CALEDONIA (NOUVELLE-CALÉDONIE), an island and French overseas territory in the Pacific, lies about 800 mi. E. of Australia. Besides the main island (area, with neighbouring small islands, 8,548 sq.mi.), the territory includes the Loyalty Islands (*q.v.*). Encircled by a great coral reef, New Caledonia is about 250 mi. long and 30 mi. wide. The east coast, which is steep, is composed of ancient Primary (Paleozoic) rocks, and on the west coast, more broken, there are some Secondary (Mesozoic) and Tertiary (Cenozoic) formations. Metamorphic rocks include gneisses, schists and serpentines. All the southeastern area consists of peridotites, which also occur in the north and northeast. The mineral resources include nickel, chrome, cobalt, iron, copper, gold and manganese. A chain of mountains in the interior reaches 5,413 ft. in Mt. Panié and 5,361 ft. in Mt. Humboldt. The climate is subtropical with mean monthly temperatures ranging from about 17° to 32° C. (63° to 90° F.). The rainfall is highest during December–March; on the east coast, which is subject to the trade winds, it is about 80 in. annually and on the west less than 40 in. Four-fifths of the plant species are endemic. There are forests along the east coast and in some valleys, and the west coast has savannas, the *niaouli,* or cajeput tree (*Melaleuca leucadendron*), and Araucaria (*q.v.*) are characteristic. The natural fauna is sparse except for fish.

Capt. James Cook discovered and named the island in 1774, and in 1843 a French Roman Catholic mission was established. New Caledonia was annexed by France in 1853, Nouméa being founded the following year. The island served for a number of years as a penal colony, but free settlers were attracted later. In 1878 abuses of the concessions led to a native revolt. New Caledonia became a French overseas territory in 1946.

The population of the main island in 1963 was estimated at 84,000, of whom 32,000 were Europeans and 42,500 Melanesians. Brought in as a labour force, there are also natives of the Wallis Islands and New Hebrides, Indonesians and Vietnamese. Nouméa, the capital, had 35,300 people. The governor is assisted by a *conseil du gouvernement* elected by the territorial assembly, which is elected by universal suffrage. There are about 50 medical centres, a hospital, two secondary schools and about 250 primary schools. The monetary unit is the franc C.F.P., equivalent to 0.055 fr.

Besides subsistence crops (yams, sweet potatoes, taro, manioc, maize), coconut palms (3,000 tons of copra annually) and coffee (1,800 tons) are cultivated. There is extensive stock breeding with about 100,000 cattle and 20,000 goats. Nickel is mined and accounts for four-fifths of the value of exports, being shipped as ore, smelted metal or castings. Electric power is provided by the Yaté dam and hydroelectric plant, completed in 1959. Nouméa is the port and industrial centre, with blast furnaces for nickel ore, a meat-preserving works and timber mills. The island has

about 1,770 mi. of roads and a weekly air link with France via Australia and another with the United States via Tahiti; ships from France also call occasionally.

See also Pacific Islands.

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NEWCASTLE, DUKES OF. Within the space of a century there were four successive creations of dukes of Newcastle in the British peerage. William Cavendish (*see* below), nephew of the 1st earl of Devonshire, was raised to the dignity of duke of Newcastle upon Tyne in 1665. His son and successor, Henry (1630–91), died leaving daughters only; one of these daughters married John Holles (1662–1711), earl of Clare, who was created duke of Newcastle in 1694. This duke died also without male issue, leaving his estates to his sister's son, Thomas Pelham (*see* below), who, with other dignities, had the title of duke of Newcastle upon Tyne conferred on him in 1715, and a second and similar ducal title (that of Newcastle-under-Lyme) in 1756. The first dukedom became extinct at his death, but the second title was granted him with remainder to Henry Fiennes Clinton, earl of Lincoln, at once his nephew and nephew-in-law. From that time the dukedom has remained in the Clinton family.

William Cavendish (*c.* 1593–1676), duke of Newcastle, only surviving son of Sir Charles Cavendish and of Catherine, daughter of Cuthbert, Lord Ogle, was born *c.* 1593 and educated at St. John's college, Cambridge. On the occasion of the creation of Prince Henry as prince of Wales in 1610 he was made a knight of the Bath. He traveled with Sir Henry Wotton, then ambassador to the duke of Savoy, and on his return married his first wife, Elizabeth, daughter of William Basset of Blore, Staffordshire, and widow of Henry Howard, third son of the earl of Suffolk. His fortune was immense, and several times he entertained James I and Charles I with great magnificence at Welbeck abbey and Bolsover castle. In 1620 he was created Viscount Mansfield; in 1628, earl of Newcastle; and in 1629 the barony of Ogle was restored to his mother, this title, together with an estate of £3,000 per annum, descending to him. He was made governor of the prince of Wales in 1638 and in 1639 a privy councilor. When the Bishops' War broke out he assisted the king with a loan of £10,000 and a troop of volunteer horse. He was implicated in the army plot in 1641 and in consequence withdrew for a time from the court. He was sent by Charles on Jan. 11, 1642, to seize Hull, but was refused admittance. When the king declared open war, Newcastle was given the command of the four northern counties; he advanced into Yorkshire in Nov. 1642, raised the siege of York and compelled Lord Fairfax to retire. Subsequently his plans were checked by Sir Thomas Fairfax' recapture of Leeds in Jan. 1643, and he retired to York. He escorted the queen, who returned from abroad in February, to York and thence to Oxford, and subsequently captured Wakefield, Rotherham and Sheffield, but his successes were once more ravished from him by the Fairfaxes, whom he subsequently defeated at Adwalton moor on June 30, obtaining possession of all Yorkshire except Hull and Wressel castle. He might then have joined the king against the earl of Essex, but continued his campaign in the north, advancing into Lincolnshire to attack the eastern association, and taking Gainsborough and Lincoln.

Thence he returned to besiege Hull, and the force which he had left in Lincolnshire was defeated at Winceby by Oliver Cromwell on Oct. 11, 1643, which caused the loss of the whole county. On Oct. 27, 1643, he was created marquess. Next year his position was further threatened by the advance of the Scots. He retreated to York, where the three armies of the Scots, Lord Fairfax and the earl of Manchester surrounded him. Prince Rupert raised the siege on July 1, but the next day threw away his success by engaging the three armies in battle, contrary to Newcastle's desire, at Marston moor. After this disaster Newcastle announced his intention of abandoning the cause and quitting England. He sailed from Scarborough accompanied by a considerable following, including his two sons and his brother, resided at Hamburg from July 1644 to Feb. 1645 and in April moved to Paris. There he married as his second wife Margaret, daughter of Sir Thomas Lucas of St. John's, Colchester. He left in 1648 for Rotterdam to join the prince of Wales in command of the navy, which had revolted, and finally settled at Antwerp. In April 1650 he was appointed a member of Charles II's privy council, and in opposition to Edward Hyde, earl of Clarendon, advocated the agreement with the Scots. In Antwerp he established a famous riding school, exercised "the art of manage" and published his first work on horsemanship, *Méthode et invention nouvelle de dresser les Chevaux* (1658; translated as *A General System of Horsemanship*, 1743).

At the Restoration Newcastle returned to England and regained the greater part of his estates, though burdened with debts, his wife estimating his total losses in the war at £941,303. He was reinstated in the offices he had filled under Charles I; was invested in 1661 with the Garter; and was advanced to a dukedom on March 16, 1665. He retired, however, from public life. Newcastle established a racecourse near Welbeck and published *A New Method and Extraordinary Invention to Dress Horses and Work Them According to Nature . . .* (1667). He also wrote several comedies and with Sir John Dryden's assistance translated Molière's *L'Étourdi* as *Sir Martin Mar-All* (1688). He was the patron of Ben Jonson, James Shirley, Sir William Davenant, John Dryden, Thomas Shadwell and Richard Flecknoe, and of Thomas Hobbes, Pierre Gassendi and René Descartes. Newcastle died at Welbeck on Dec. 25, 1676, and was buried in Westminster abbey. By his first wife he had ten children, of whom one son, Henry, survived him and became 2nd duke of Newcastle. Henry died in 1691 and the title then became extinct.

Margaret (*c.* 1623–73), the 1st duke's second wife, had been maid of honour to Henrietta Maria. The duchess cultivated literary composition with exuberant fervour, and kept a bevy of maids of honour obliged to be ready at all hours "to register her Grace's conceptions." Among many high-flown philosophical works she published two of real merit: her *Nature's Picture Drawn by Fancie's Pencil to the Life*, which includes an autobiography (1656), and *The Life of William Cavendish, Duke of Newcastle*, of which the best edition is that by C. H. Firth (rev. ed., 1906).

Thomas Pelham Holles (1693–1768), duke of Newcastle, was the elder son of Thomas, 1st Lord Pelham, by his second wife, Lady Grace Holles, younger sister of John Holles, duke of Newcastle upon Tyne. Both the families of Pelham and Holles had amassed large fortunes and estates during the 16th and 17th centuries by consistently good marriages and careful attention to their interests. Thomas Pelham Holles inherited the wealth of his mother's family in 1711, and the following year he succeeded his father. When he came of age in 1714 he was, in consequence, one of the greatest landowners in the kingdom. The whole of his influence he threw into securing the succession of George I and the triumph of the Whigs. He was rewarded with the earldom of Clare, and in 1715 he became marquess of Clare and duke of Newcastle upon Tyne. He extended his Whig family connections by marrying Lady Henrietta Godolphin, daughter of Lord Godolphin and granddaughter of the duke of Marlborough. He became lord chamberlain in 1717 and was sworn of the privy council; and the next year, at the age of only 25, he was created a knight of the Garter.

If his inherited possession and wealth gained him early pre-eminence among the Whig families who governed Hanoverian England, it was his long retention of ministerial office which won him most of the personal power and influence which he so much desired. Robert Walpole made him secretary of state in 1724, and he held this important office for 30 years. He survived the fall of Walpole in 1742, gained even greater power when his brother Henry Pelham became prime minister in 1743, and on Henry's death in March 1754 Newcastle became prime minister, serving until Nov. 1756. He was then created duke of Newcastle-under-Lyme. He resumed the premiership in July 1757, and it was in this ministry that William Pitt (afterward earl of Chatham) earned so great a reputation as an efficient, inspiring and brilliant national leader in the Seven Years' War. Newcastle was replaced in May 1762 by Lord Bute, favourite of the young king George III, who

proceeded to make the peace of Paris in 1763. The last five years of Newcastle's life were spent mainly in opposition, though for a few months in 1765 he became lord privy seal. He died in London on Nov. 17, 1768.

The two ruling passions of Newcastle's life were devotion to the Hanoverian succession and the cause of the Whigs, and a love of personal power, influence and the "game of politics" for its own sake. So long as party organization in country or parliament hardly existed, the only means of giving a government cohesion and stability were the systematic management of elections and the distribution of patronage to secure parliamentary support for a ministry. Newcastle won a unique reputation for inexhaustible patience and skill in the arts of managing elections by borough-mongering and influence and of securing a ministerial majority in the commons by distributing posts, sinecures, pensions and all forms of patronage. The extent to which his personal wealth brought him such power has often been greatly exaggerated. What brought him power was his long and unbroken tenure of ministerial office, which put at his disposal the rich resources of the crown. He used these resources not for his own pecuniary profit, for he spent much of his own wealth on similar ends, but for making himself an almost indispensable manager in all the ministries of these years. Jealous of his own dignity and position, and of much abler rivals such as Chatham, fussy and disturbing in his incessant intrigues, he lacked the intellect and the will to shape policy. Although so active in political life for about 50 years, he remained always the political manager rather than the statesman. Ridiculed as "hubble-bubble," distrusted and thought more sinister than he was, this kindly and generous man performed a role in Whig politics which was distasteful to abler men yet was inevitable in the structure of politics of his time.

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NEWCASTLE, a city and port of New South Wales, Austr., lies on the southern shore of the estuary of the Hunter river, 104 mi. N.N.E. of Sydney by rail. Pop. (1961) 208,630. The town is built at the foot of, and up, a steeply rising hill which backs the harbour, with a well-developed suburban area of more than 80 sq.mi. Its average annual temperature is 22°–12° C. (73°–54° F.) and its average annual rainfall is 45 in. With a large and fertile hinterland (Hunter valley, northern tablelands and Liverpool plains) and abundant coal resources locally, Newcastle was early a notable centre for the export of coal and primary produce. Its possession of fuel, water, food supply, a good commercial position and access to raw materials, has steadily attracted manufacturing industries and it has become one of the leading industrial areas in the southern hemisphere. Its iron and steel industries, established in 1915 by the Broken Hill Proprietary Company Ltd., have expanded to proportions rivalling its coal trade. The coal produced on the Newcastle-Cessnock field (over 10,000,000 tons a year) represents 46% and the iron and steel output (more than 1,600,000 tons) represents 40% of Australia's total annual production. The establishment near Newcastle since 1950 of a large-scale rayon yarn and cord factory and of cotton mills and a wool processing plant were indicative of textile manufacture's becoming its third major industrial development. Newcastle's industries may be generally classified as metallurgical and metalworking; construction engineering and shipbuilding; coke and chemical; textile manufacture; the making of fertilizer, cement, firebrick and pottery; and woodworking. There are also flour and food product industries These are conducted in Newcastle itself or in one of the numerous centres within easy reach of the port.

The harbour (comprising North harbour, the Basin and Port Waratah) has ample accommodation, is well-sheltered and has modern installation for handling cargo and especially for loading coal and bulk wheat. The entrance is by a channel (500–450 yd. wide; average depth 26 ft. to a rock bottom) between breakwaters. Breaking of the rock bar across the entrance was undertaken in 1962 with a view to increasing the depth to 36 ft. Its three miles of wharfage can be extended and it has a floating dock with a lifting capacity of 15,000 tons. Newcastle is the third port of Australia and the second port of New South Wales in respect of trade, with overseas exports amounting to £A40,000,000 and imports to £A10,000,000 a year. Its exports (more than 4,700,000 tons annually) are coal, coke, tar, etc.; frozen meat; butter, eggs; timber; pig iron, steel rails and plates, etc.; and fertilizers. They exceed the imports, which are more than 2,600,000 tons annually About 9,000,000 tons of shipping, of which about half are "overseas" vessels (*i.e.*, other than interstate or coastwise), use the port annually. Newcastle has railway and highway connections to the south with Sydney and to the rich dairy pastures of the north coast, and across the Hunter valley with the wheat, wool and cattle hinterland of the northwest. (W. Bs.)

NEWCASTLE, an urban district and seaside resort of County Down, N.Ire., lies 31 mi. S. of Belfast by road. Pop. (1961) 3,722. Situated on the shore of Dundrum bay at the foot of Slieve Donard (2,796 ft.), the highest Mourne peak, and possessing a famous championship golf course, Newcastle is a popular seaside resort and a centre for exploring the Mourne mountains (*q.v.*). Two miles from Newcastle is Tollymore Forest park, a 1,200-ac. government forestry estate, including 135 species of trees, open to the public as a park and caravan (trailer) site. Light engineering products are made in Newcastle. The "new castle" from which the town takes its name was a Magenis (MacGinnis) stronghold, no longer standing, built in 1588 to replace an older structure. (Hu. S.)

NEW CASTLE, a city of eastern Indiana, U.S., located about 40 mi. N.E. of Indianapolis, is the seat of Henry county. It is the trade centre of an extensive agricultural area which produces livestock, poultry, wheat, corn and tomatoes. Founded in 1819 it was incorporated in 1839.

In 1900 a decade of expansion began when automobile and piano manufacturing, as well as other industries were started there. During this same period the commercial growing of roses gave New Castle the name "rose city." In the second half of the 20th century manufactures included automobile parts, steel products, pianos and children's clothing.

In 1955 New Castle was the scene of a bitter strike at the automobile parts plants. Rioting at the strike-bound plants led to calling out the Indiana national guard and for a short time the city was under martial law.

The historical novel *Raintree County* (1948), by Ross Lockridge, Jr., had New Castle and Henry county for its fictional setting.

For comparative population figures *see* table in INDIANA: *Population*. (H. L. HE.)

NEW CASTLE, a city of western Pennsylvania, U.S., is about 45 mi. N.N.W. of Pittsburgh and 20 mi. S.E. of Youngstown, Ohio, at the point where the Shenango and Mahoning rivers meet to form the Beaver, and is the seat of Lawrence county. Located in the foothills of the Allegheny mountains near the Ohio plain, the city commands a strategic industrial location. Deposits of coal, limestone and fire clay found in the area give it a natural base for manufacturing. Originally a Delaware Indian town and trading centre, it was settled about 1798 by John Stewart who set up a furnace for making pig iron and named the area after Newcastle upon Tyne, the English industrial city. Laid out in 1802, New Castle was incorporated as a borough in 1825 and as a city in 1869. Manufactures include vitrified china, pottery, steel and steel products, brass and bronze castings, cement, firebrick, chemicals and rolling mill machinery. For comparative population figures *see* table in PENNSYLVANIA: *Population*. (C. C. G.)

NEWCASTLE-UNDER-LYME, a market town, municipal and parliamentary borough of Staffordshire, Eng., bounded on three sides by the city of Stoke-on-Trent. Pop. (1961) 75,688. It takes its name from the "new castle" erected *c.* 1144 by the earl of Chester, the feudal overlord in the reign of Stephen, for the greater protection of his fief lying under *i.e.*, near what was the Roman *Limes Britannicus* (Hadrian's wall or the border between the provinces of Flavia Caesariensis, on the east, and Britannia Secunda, on the west). The derivation of the place-name is also attributed to the proximity of the former Lyme forest. The castle served as a bastion during the long war against Wales. The fort

fication, being low-lying, became obsolete in Tudor times, and fell into decay. The town received its first royal charter of incorporation from Henry II in 1173, and the liberties and privileges were confirmed and extended by succeeding monarchs down to James II. In 1267 the borough and manor were granted by Henry III to his youngest son, Edmund Crouchback, and ever since then it has formed part of the duchy of Lancaster. The borough has sent representatives to parliament at least since 1354.

The parish church of St. Giles, the fourth or fifth on the same site, was rebuilt, with the exception of the tower, by Sir Gilbert Scott (1876). The University College of North Staffordshire, founded in 1949, became the University of Keele in 1962. In 1932 the borough was enlarged by the inclusion of Wolstanton (with a fine old church), Clayton and part of Keele. Chesterton (the site of a Roman camp), Knutton and Silverdale also lies within the borough. Industries of Newcastle-under-Lyme include collieries, brick and tile works, a cotton mill, a uniform-clothing factory and light engineering. (H. G. Ss.)

NEWCASTLE UPON TYNE, a city and county, parliamentary borough and port, and the county town of Northumberland, Eng., stands on the river Tyne, 8 mi. from its mouth and 274 mi. N. of London by road. Pop. (1961) 269,389. It is the metropolis of the shipbuilding and industrial area of Tyneside and the principal shopping and marketing centre of the northeast of England.

Five principal bridges over the Tyne link Newcastle and Gateshead: Tyne bridge (1928), taking traffic to the Great North road; the electrically operated Swing bridge (1865–76; one of the greatest engineering achievements of its time) on the site of the Roman and medieval bridges; the High Level bridge (1844–49), over which the railway crosses to Gateshead with road and foot traffic at the lower level, a fine piece of engineering and town planning by Robert Stephenson; and the King Edward VII (1906) and Redheugh (1871) bridges.

Municipal and commercial offices, the main shopping streets and principal places of entertainment in the city are concentrated in the square mile between the Tyne and the Town Moor, and after 1963 a new civic and university centre was constructed for the northern half of this area. The central parts of the city were also refashioned with tall residential blocks, new road systems and shopping and educational precincts. Broad and dignified thoroughfares were laid out by Richard Grainger (1798–1861) and John Dobson (1787–1865) in place of the open ground and unplanned streets which had occupied the space within the city walls. Grey street is perhaps their masterpiece as an example both of dignified urban architecture and bold town planning. Along the river banks to east and west lies the former crowded heart of the city—now largely taken over by business premises—and the remains of the grimly dark and crowded Victorian slums; Scotswood, Elswick and Byker being the most notorious. On the higher ground are pleasanter suburbs, Jesmond, the oldest, and Gosforth to the north, Walker and Heaton to the east, Denton, Fenham and Kenton to west and northwest. There is much new building at Longbenton, Killingworth (a projected New Town), Newburn and Westerhope in Northumberland. Ponteland has developed as a dormitory town. There are 706 ac. of parks as well as the Town Moor (927 ac.).

History.—Newcastle was the site of a Roman station called Pons Aelii. It is possible that a pre-Roman settlement existed there and references to a place called ad Murum ("at the Wall"), and Monkchester (associated with a monastery sacked by the Danes) have been claimed as relating to it. The modern community and its name derive from the Norman castle, built in 1080 by Robert, eldest son of William the Conqueror, and replaced (1172–77) by the impressive stone keep still standing. The keep is a fine example of late Norman architecture and contains a beautiful chapel. The castle dominates the river crossings and the railway and provides a focal point for the old city. The adjoining Black gate was originally the castle gatehouse and contains a small local museum. The best remaining portion of the town walls lies between Westgate road and Gallowgate, near the important remains of the medieval Black Friars' priory. Fragments of Hadrian's wall are visible along the West road and Denton bank. The guildhall, rebuilt 1655–56, stands in the Sandhill, the old city centre.

The diocese of Newcastle, covering Northumberland, Berwick and parts of Cumberland and Durham, was instituted in 1882. The church of St. Nicholas, adopted as the cathedral, is mainly 14th century in date, though there is documentary evidence of a church on that site as early as 1123. The tower and steeple, added in the 15th century, are splendid examples of early Perpendicular. The spire is the finest known work in the style termed "Scottish Crown." St. John's church disputes with St. Andrew's the honour of being the city's oldest church; St. Andrew's was damaged during the Civil War when Newcastle was twice besieged and occupied by the Scots (1644) and Charles I was held prisoner by them in 1646 prior to being handed over to the parliamentary commissioners. St. Mary's, designed by A. W. N. Pugin, completed in 1844, is the cathedral of the Roman Catholic diocese of Hexham and Newcastle.

Administration.—Newcastle upon Tyne is a borough by prescription and had already obtained its own written constitutions before the reign of Henry II. One of its most important charters of incorporation was that of King John, granted in 1216, and the government of the town was thereafter in the hands of local traders and manufacturers, under their elected mayor. Privileges and immunities by royal grant followed rapidly, and in 1400 Henry IV created Newcastle a county separate from Northumberland. Since then it has had its own sheriff and court of quarter sessions, and until 1881 its own assize. Newcastle was represented in parliament by two members from 1283; in 1918 the borough was divided into four single-member constituencies. The ancient constitution of the town, codified by charters of 1600 and 1604, was reformed in 1835, and county borough status was granted in 1888. The town became a city in 1882, and the mayor was given the title of lord mayor in 1906. There have been several extensions of the borough boundaries: notably in 1298 (when the lordship of Pandon was included) and the incorporation in 1835 of Westgate, Elswick, Jesmond, Heaton and Byker. There were further extensions in 1904 and 1935.

Education and Culture.—Of the independent schools in the city, the most famous are the Royal Grammar school, since 1907 occupying premises at Jesmond, which was founded by Thomas Horsley in the time of Henry VIII and incorporated by Queen Elizabeth I in 1600, and Dame Allan's school, since 1935 established at Fenham, which was endowed in 1705. The Municipal College of Commerce and Rutherford College of Technology provide both full and part-time further education. University education is provided by the University of Newcastle (1963), formerly King's college which was founded in 1937 by the merging of Armstrong college and the University of Durham college of medicine. The former was opened in 1871 as a branch of the University of Durham and was the first university college to establish a department of mining. The latter, founded as the Newcastle School of Medicine and Surgery in 1834, was incorporated in Durham university in 1852.

An important collection of Roman inscribed stones and archaeological discoveries is displayed by the Museum of Antiquities of the university and the Society of Antiquaries. The Municipal Museum of Science and Industry is devoted to the development and history of engineering, electrical engineering, mining, shipbuilding, transport and other industries, with special reference to those of Tyneside. The Hancock museum, named after the John Hancock collection of British birds, houses the collections of the Natural History Society of Northumberland, Durham and Newcastle, founded in 1829. Permanent collections of paintings are kept by the Laing municipal art gallery and the Hatton gallery of Newcastle university. The public library has an extensive local history collection which includes local newspapers from the early 18th century, and a fine series of works by Thomas Bewick the wood engraver. Collections of manuscripts and records are maintained by the city archives. The Literary and Philosophical society, founded in 1793, has a library, reading and lecture room. The People's theatre, one of the oldest amateur dramatic societies

(1911) in the country, opened (1962) a new theatre and arts centre. There are also two professional theatres.

Industry and Transport.—Coal is Tyneside's most important natural resource. Mining has continued since the 13th century, though coal exports were less important than wool until the 16th century. London then became dependent on "sea-coal" from Newcastle, and the sarcasm "carrying coals to Newcastle" was coined to convey the essence of an unnecessary journey. Industry and commerce expanded rapidly after the foundation of banking houses from 1755, and the Tyne became a centre for glassmaking, salt and chemical industries, and oil and soap manufacturing. Tyneside's achievements in shipbuilding are famous and its yards contain one of the largest ship repairing centres of the world. The Tyne itself has been navigated since Roman times.

The conservancy of the river was originally vested in Newcastle corporation, but in 1850 control passed to the Tyne Improvement commission. The commissioners accelerated development by dredging above and below the town and improving dock facilities. The corporation quay, almost 1½ mi. long, accommodates even the largest vessels. Exports include iron and steel products, machinery and electrical equipment, coal and coke, and chemicals; imports include wheat and foodstuffs, Scandinavian timber and paper. Much of England's passenger traffic with Scandinavia and the Baltic passes through the ports of Newcastle and North Shields (near the estuary mouth).

Newcastle is an important centre for rail communications with London, northwest England and Scotland. The municipal airport was opened at Woolsington, 6 mi. N.W., in 1935. (Mi. G. C.)

NEW CHURCH (Church of the New Jerusalem, commonly called Swedenborgians) rests unequivocally on the theology of Emanuel Swedenborg (*q.v.*), who himself initiated no organization. His readers in England, however, shortly after his death (1772) felt obliged to do so by their conviction that Jesus Christ in his "Divine Human" (a specifically New Church concept) is the only God in whom is the Trinity, that man's salvation rests less in faith than in his resisting evils as sin against God, and that the second advent was not in person but in the revelation of the spiritual sense of the divine Word. A small group, championed by John Clowes, rector of St. John's, Manchester, advised against the formation of a separate church; but the majority, led by Robert Hindmarsh, prevailed. In 1788 the first building for New Church worship was opened in Great East Cheap, London, rapidly followed by others. In 1789 a conference met in the London church; and, apart from 1794–1806 and 1809–14, the consequent General Conference of the New Church has since met annually. A parallel General Convention of the New Jerusalem in the U.S.A. was founded in the United States in 1817; differences of interpretation within Convention led in 1897 to the formation of the General Church of the New Jerusalem.

Worship, almost invariably liturgical, is addressed directly to Jesus Christ; there is no trace of tri-personalism. Preaching of the Scriptures is usually doctrinal, always practical. Emphasis is on the "inspired" books of the Bible—*i.e.*, 29 books of the Old Testament and 5 of the New, all of which have the "spiritual sense." Baptism and the Lord's Supper are the two sacraments of the church. Marriage is most holy and, when true, continues in heaven. To the established Christian festivals New Church day (June 19) is added.

Candidates for the ministry, apart from those trained in Africa for service there, normally pass through a full-time four-year course in one of the two American colleges (of Convention at Cambridge, Mass., and of the General Church at Bryn Athyn, Pa.) or that in London before being ordained.

The three main organizations all have extensive mission interests; African missions especially are strong. New Church societies, generally allied with one of these three, are small but widespread. Australia has its own conference, closely allied to that in Britain. The New Church groups in continental Europe are nearly all assisted from the U.S. The British Conference and the U.S. Convention annually appoint a general council which, with a ministerial council, is the controlling authority. The General Church is episcopalian. Conference has some 4,500 adherents in 57 societies and several groups in Great Britain; Convention has about 5,000 in the United States, the General Church about 2,000. Membership in the isolated societies and in the various mission fields greatly increases these totals.

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(C. H. Pa.)

NEWCOMB, SIMON (1835–1909), was the greatest American astronomer of the 19th century, although in depth and originality of mathematical invention he was excelled by George W. Hill, his associate for 15 years. Newcomb was born in Wallace, N.S., on March 12, 1835. His father, an itinerant country schoolteacher, records that he taught Simon to count at the age of four, and that before he was five his son was spending several hours a day making calculations in addition and multiplication; before he was seven he had finished the arithmetic book, including the extraction of cube roots.

Newcomb had little or no formal education. At the age of 16 he was apprenticed to a quack herb doctor in Salisbury, N.B. After two or three years he ran away to join his father, widowed in the meantime, in the United States, settling in Maryland as a country schoolteacher. In the libraries at Washington, D.C., he found the first ample opportunity to indulge his intellectual curiosity. After avidly exploring many technical fields he concluded that his principal talent lay in mathematics. He was especially attracted to the *American Ephemeris and Nautical Almanac*, an annual handbook for astronomers, containing predicted positions of the principal celestial objects and other astronomical phenomena. Of this work he says, "Its preparation seemed to me to embody the highest intellectual power to which man had ever attained." He thereupon applied for employment in the American Nautical Almanac office, then at Cambridge, Mass., and became a computer there in 1857. He also enrolled in the Lawrence scientific school of Harvard university, receiving a degree in 1858. In 1861 he applied for and received a commission in the corps of professors of mathematics in the United States navy and was assigned to the United States Naval observatory at Washington, where he worked for more than ten years determining positions of celestial objects with the meridian instruments and for two years with the new 26-in. refractor.

In 1877 Newcomb was put in charge of the American Nautical Almanac office, then in Washington, where almost at once he commenced the great work that he had had in his mind for some years and which was to occupy the greater part of his time for the rest of his life: the calculation of the motions of the bodies in the solar system. Reaching the compulsory retiring age for captains in 1897, he later received the then unusual distinction of retirement with the rank of rear admiral. He died in Washington on July 11, 1909, and was buried in Arlington National cemetery.

In 1884 he had obtained the additional appointment of professor of mathematics and astronomy (which he held until 1893) at the Johns Hopkins university, Baltimore, Md., continuing, however, to live in Washington. For many years he was editor of the *American Journal of Mathematics*. He was one of the founders of the American Astronomical society and its first president (1899–1905). Newcomb received honorary degrees from ten European and seven American universities and was a member of 45 foreign societies. He was awarded the gold medal of the Royal Astronomical society (1874), the Huygens gold medal of the Holland Society of Science (1878), the Copley medal of the Royal society (1890), the Bruce gold medal of the Astronomical Society of the Pacific (1898), the Schubert prize of the Imperial Academy of Sciences, St. Petersburg (1897) and the Sylvester prize of the Johns Hopkins university (1901). He was elected a member of the National Academy of Sciences in 1869, serving as home secretary, 1881–83; vice president 1883–89; and foreign secretary 1903 until his death.

His most important work appeared in the *Astronomical Papers Prepared for the Use of the American Ephemeris and Nautical Almanac*, a series of memoirs that he founded in 1879 with the object of "a systematic determination of the constants of astro-

omy from the best existing data, a reinvestigation of the theories of the celestial motions, and the preparation of tables, formulae, and precepts for the construction of ephemerides, and for other applications of the same results." Of 37 articles filling up approximately 4,500 quarto pages in the first nine volumes, he was sole or principal author of 25. Among them were his tables of the sun, Mercury, Venus, Mars, Uranus and Neptune, and Hill's tables of Jupiter and Saturn, which were in use throughout most of the world for calculating daily positions of the objects from 1901 to 1959, and even afterward for the sun, Mercury, Venus and Mars. This series of *Papers* is remarkable for its sustained high quality. Hardly anything in them has proved to be incorrect, and at mid-20th century they were still worthy of the attention of any student of celestial motions.

Possibly Newcomb's most far-reaching contribution was his inauguration, jointly with A. M. W. Downing, then superintendent of the British Nautical Almanac office, of a world-wide unified system of astronomical constants, which was later to lead to the outstandingly successful scheme of international collaboration among the principal almanac makers of the world that survived two world wars with increasing vigour. Newcomb and Downing were impressed by the "confusion which pervaded the whole system of exact astronomy, arising from the diversity of the fundamental data made use of by the astronomers of foreign countries and various institutions in their work" (Newcomb, *Reminiscences of an Astronomer*). A conference of the directors of the national ephemerides of the United States, Great Britain, France and Germany, was held in Paris in May 1896. It resolved that beginning with 1901 a certain set of constants, substantially Newcomb's, should be used by all the ephemerides. The decision even included some work of Newcomb's that was not to be finished for several years. Although Newcomb was attacked by some astronomers at home for decisions in their opinion premature, time has proved the wisdom of his course. A similar conference, held at Paris in 1950, decided unanimously that the system of constants adopted in 1896 was still preferable to any other for practical use.

Newcomb wrote a number of books, including *Popular Astronomy* (1878), *The Stars* (1901), *Astronomy for Everybody* (1902) and *Compendium of Spherical Astronomy* (1906), some of which have been translated into as many as seven foreign languages. He also wrote on finance and economics and published some fiction. An autobiography, *Reminiscences of an Astronomer*, was published in 1903. A bibliography of his life and works (541 titles) is given by R. C. Archibald, in *Memoirs of the National Academy of Sciences*, xvii, pp. 19–69 (1924). (G. M. Ce.)

NEWCOMEN, THOMAS (1663–1729), English engineer and the inventor of the "atmospheric engine" (the first practical steam engine for pumping water out of mines), was born in Dartmouth, Devon, in 1663. His business as an ironmonger at Dartmouth brought him into contact with the Cornish tin mines, where he became aware of the high cost of using horses to raise water from the mines. With his assistant John Calley (or Cawley), a plumber, he therefore experimented for over ten years with a steam pump. It differed fundamentally from the steam pump of Thomas Savery, who in 1698 had obtained a master patent for raising water by fire. As Newcomen could not patent his engine, he entered into partnership with Savery. The first recorded Newcomen engine was erected near Dudley castle, Staffordshire, in 1712. (For a working description of the device, *see* STEAM.) Newcomen invented the internal condensing jet for obtaining a vacuum in the cylinder and the automatic valve gear; by using steam at atmospheric pressure he kept within the working limits of his materials. Newcomen died in London on Aug. 5, 1729.

See H. W. Dickinson, *A Short History of the Steam Engine*, 2nd ed. (1963). (Ar. S.)

NEW DEAL. The expression "New Deal" came into use to describe the political policies and activities of the administration of Pres. Franklin D. Roosevelt. It was first used by him in his speech accepting the Democratic nomination for president on July 2, 1932. It had been written into the speech by his adviser and collaborator, Raymond Moley, who was the chief of what came to be known as the "brains trust." When it was first used by the candidate it was not intended to describe his philosophy or policies. But the press took it up, just as it had earlier taken up the New Nationalism or the Square Deal of Pres. Theodore Roosevelt and the New Freedom of Pres. Woodrow Wilson.

The term was applied later to a series of proposals, policies and legislation sponsored by President Roosevelt in his first campaign in 1932, in the period between the election in 1932 and his inauguration in 1933, and enacted into law in the Hundred Days' congress of that year. Since the Roosevelt policies shifted abruptly in 1935, it has been said by some historians of the period that there originated in that year a second New Deal.

While the many policies and plans sponsored by President Roosevelt from 1932 to 1935 can hardly be said to belong to any specific political or economic philosophy, most of them tended to emphasize the subordination of private interests to collective interests through the increased power and authority of the federal government. Agricultural subsidies, high taxes and deficit spending brought about a much greater equality in wealth and income than had hitherto existed. In some of the legislation that Roosevelt sponsored there is evidence of economic planning on a national and regional scale through the federal authority.

Since the earlier New Deal was designed primarily for agricultural recovery and for co-operation within industries to promote economic recovery, and since the Roosevelt financial and monetary policies were designed to raise domestic prices, the trend was nationalistic-intranational rather than international. This Roosevelt made clear in his famous "bomb-shell" message, which terminated the World Economic conference in London, July 1933.

Among the major policies enacted into law early in his administration at the instance of President Roosevelt were the Agricultural Adjustment act, the National Industrial Recovery act, the creation of the Tennessee Valley authority, two pieces of legislation regulating the issuance and sale of securities, and a broad reform of the nation's banking structure. The agricultural as well as the industrial planning reforms were later declared invalid by the supreme court. No substitute for the industrial planning reforms was proposed, although a bill greatly increasing the authority of the federal government in industrial relations and strengthening the organizing power of the unions was passed and approved by the president in 1935. This came to be known as the Wagner act, after its sponsor, Sen. Robert F. Wagner of New York. As a substitute for the invalid Agricultural Adjustment act, the president sponsored and congress enacted soil conservation legislation.

With enactment of the Wagner act and the Social Security act in 1935, the emphasis of the Roosevelt policies turned from recovery and agrarian reform to measures designed to favour labour and other urban groups. Thus began the so-called second New Deal, which continued until the crisis in Europe in 1939 brought about the rearming of the U.S. United States entry into World War II in 1941 substantially brought an end to further domestic reform under Roosevelt. He remarked as the U.S. entered the war that "Dr. New Deal" was to be supplanted by "Dr. Win the War."

The lasting effects of the Roosevelt reforms upon the economy and social structure of the United States were the acceptance as national policies of a great increase in the size and authority of the federal government with a consequent diminution of state and local powers; the projection of government authority into private business; large federal subsidies for agriculture, small business, urban housing and shipping; social insurance and old-age and unemployment assistance; high taxes and, with the exception of a few years, deficit financing; great public hydro-power projects; and the government-encouraged progressive growth of unionized labour. Following World War II, the Truman administration largely followed the policies of the prewar Roosevelt administration under the name "Fair Deal." *See* also UNITED STATES (OF AMERICA): *History;* and references under "New Deal" in the Index.

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planning in the New Deal; E. E. Robinson, *The Roosevelt Leadership, 1933–1945* (1955) is unsympathetic but factual and has the best of all critical bibliographies on the period; Basil Rauch, *The History of the New Deal* (1944) is brief but objective; Ernest K. Lindley, *The Roosevelt Revolution* (1933) and *Half Way With Roosevelt* (1936) are perceptive, sympathetic journalism; Dixon Wechter, *Age of the Great Depression* (1948) is an interesting social history; Broadus Mitchell, *Depression Decade* (1947) is an economic study. Personal accounts by participants are Raymond Moley, *After Seven Years* (1939); J. M. Blum, *From the Morgenthau Diaries* (1939); Frances Perkins, *The Roosevelt I Knew* (1946); Rexford G. Tugwell, *The Democratic Roosevelt* (1957). *Public Papers and Addresses of Franklin D. Roosevelt*, 13 vol. (1938–1950) ed. by Samuel I. Rosenman with comments by Roosevelt. (RD. M.)

NEW DELHI: *see* DELHI.

NEW ENGLAND, the six most northeasterly states of the United States—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut—received its name from Capt. John Smith, who explored its shores in 1614 for some London merchants.

Along its entire length the coastline of New England is indented with harbours, large and small. Of New England seaports Boston early became the most important. Eastward from the coast stretches a broad continental shelf which rises in places near enough to the surface to make grounds favourable for fishing. About 80 species of edible fish live in these waters, made cold by the Labrador current. The most important of these are haddock, redfish, flounder, cod, whiting, pollack and hake. Inland from the coast stretches an uneven hill country that rises into rugged, forest-covered mountains. These, beginning in Maine at the Canadian border, extend into the White mountains of New Hampshire (seen and reported by Smith in 1614) and into the Green mountains, the giant ridge that runs north and south the length of Vermont. The Berkshire hills in western Massachusetts and the Litchfield hills in northwestern Connecticut form the southernmost extension in New England of this geologically ancient system. The last of the ice caps of the Glacial Age covered all of New England save for a very narrow band on Cape Cod. The receding ice left soil filled with stones and dotted in many places by great boulders. Glacial action, in overdeepening old valleys and in depositing moraines or drifts, created over the entire area a profusion of large and small lakes. The largest of these, Lake Champlain, lying in the broad lowland between the Adirondack mountains and the Green mountains, separates the states of Vermont and New York. Of the innumerable streams that flow from the mountains across the rolling lowlands the Connecticut river is the largest and most important. This stream, while navigable in its lower reaches, provides access north of Massachusetts only to a region of little economic importance. In the 17th century the first settlers of New England found iron in bogs, and their successors in the 18th and 19th centuries mined small veins of copper and iron in the ancient rocks of the uplands. But granite, marble and clay comprise the only important mineral resources of the 20th century.

This article deals with the influence of New England, as a section, on U.S. history. Additional historical details and chronology will be found in the separate articles on individual states and in UNITED STATES (OF AMERICA): *History*. *See* also articles on various cities and biographies of persons cited.

Settlement.—The first attempt to settle New England, that of France in 1604 at the mouth of the St. Croix river, the boundary between Maine and New Brunswick, proved abortive. The leaders took the colony to Nova Scotia in the spring of 1605. In 1613 an armed force of Englishmen captured a second French colony at Mt. Desert on the coast of Maine.

In 1620 a company of Separatists, who had found Holland an undesirable refuge from persecution, migrated, with the aid of some London merchants, across the Atlantic to found an English beachhead at Plymouth in New England. Ten years later the Massachusetts Bay company, chartered to trade and to colonize in a designated portion of New England, established what its Puritan sponsors and members looked upon as a new Zion in the American wilderness. Bringing the charter to Massachusetts, John Winthrop turned the management of a trading company into the government of a colony. Persecution by the English government of the growing Puritan party caused some 20,000 persons to cross to Massachusetts between 1630 and 1640. In the new world the Puritans laid out villages whose centre of life was the parish church. Following the precedent set by the Pilgrims the government of the church became congregational. A systematic allotment of land reinforced the close social structure of the Puritan villages (*see* LAND SYSTEM [U.S.]).

Other Puritans from England founded New Haven colony in 1638. Some of the Massachusetts Puritans, dissatisfied with the government of that colony, moved westward to found three towns on the Connecticut river—Hartford, Wethersfield and Windsor. In 1662 New Haven, the Connecticut river towns and another settlement at Saybrook united to make the colony of Connecticut. Roger Williams, pastor of the church at Salem, opposed the religious intolerance of the Massachusetts magistrates and even questioned the right of the English crown to grant territory in America that had not first been purchased from its Indian owners. Williams, circumventing a decree of banishment, led followers in the spring of 1636 to Narragansett bay, where he founded Providence.

North of the Merrimack river Capt. John Mason received a grant from the crown and sent settlers to the mouth of the Piscataqua (Portsmouth). His plans for an aristocratic domain modeled on the medieval county palatine (*q.v.*) as well as his appointment as governor general of all New England came to naught with his death in 1635. His settlers came under the rule of the Massachusetts Bay company until organized as a royal province (New Hampshire) in 1679. Farther northeast another royal proprietor, Sir Ferdinando Gorges, planned to colonize. Ultimately his enterprise failed in competition with Massachusetts settlers. His heirs sold their claims to Massachusetts in 1677 and the region, under the name of the district of Maine, remained a part of Massachusetts until erected into an independent state in 1820. In the latter half of the 18th century settlers moved into the region north of Massachusetts and west of the Connecticut river and occupied land under grants from New Hampshire. But the province of New York claimed the region. In 1764 an Order in Council adjudged the country between Lake Champlain and the Connecticut river to be part of New York but without prejudice to the grants from New Hampshire. The status of the region remained in dispute and unsettled until 1790 when New York state relinquished its claim. Congress admitted Vermont to the union in 1791.

Colonial New England.—New England was founded by religious refugees who were strongly influenced by the teachings of John Calvin. In America circumstances compelled them to set up a separate (Congregational) church. They were uncompromising Sabbatarians. They opposed the theatre as immoral. They replaced the ritual of the Church of England with a plain service in a plain meetinghouse. The centre of the service was the sermon and extemporaneous prayer. Puritan prudential ethics sanctified work, insisting that faithful attention to the secular calling was, in itself, worship of God. Discouraging idleness and luxury, and glorifying saving, Puritan ethics served admirably the needs of frontier communities where the work to be done was prodigious and the hands to perform it few.

Many of the leaders of the Puritans were university men, particularly from Cambridge. As a consequence New England Puritans held learning in high esteem and insisted on an educated clergy. Massachusetts required each town to provide education for its children. To train men for service in church and state Harvard college was founded in 1636 and Yale college in 1701. Sometimes local pastors prepared boys for admission to these institutions by teaching them Latin and Greek. Grammar schools (Boston Public Latin school and Hopkins Grammar schools in New Haven and Hartford) arose to perform more effectively the same function.

From their beginnings the New England colonies (like the other mainland colonies) enjoyed representative government. The towns managed their affairs through the direct democracy of the town meeting. The Fundamental Orders of Connecticut, a kind of 17th century constitution of the three river towns—Hartford, Windsor and Wethersfield—proclaimed the principle that government must rest on the consent of the governed and that liberty im-

plied liberty under law. Roger Williams' Rhode Island from its beginning in 1636 guaranteed religious freedom. The charters granted to Connecticut and Rhode Island by Charles II after the Restoration were surprising documents for the 17th century in that they provided not only for representative government but for the election of the provincial governor within the colony. Save for the reserved power of the crown to disallow acts passed by their assemblies these corporate colonies were virtually tiny independent republics. In this characteristic they differed in the 18th century from Massachusetts, which had lost its charter in 1684 and had become a royal colony.

The End of Colonial Status.—In the 18th century as the frontiers of New England pushed westward and northward the greater part of the population lived by agriculture. Husbandmen cleared fields high on the slopes of hills and mountains to take advantage of the fertility of the rich mold under the primeval forest. It was the day of the self-sufficient farm. The land on which the family lived provided materials for practically all its needs—timber for house and barn (often one continuous building in northern New England), fuel, food, wool and flax for cloth, leather for harness and shoes. Primitive roads and the almost complete absence of bridges made transportation and communication difficult. Self-sufficiency was an adjustment to isolation. But colonial New England enjoyed three advantages that led to special economic developments. Shipbuilding flourished in many harbours at the mouths of rivers. On these streams logs from the forest in the interior could be floated to the yards. The making of ships began with the founding of the Massachusetts Bay colony when Winthrop's "Blessing of the Bay" was launched in 1631. New England ships found a ready sale because the English Navigation acts admitted colonial-built vessels to the status of English ships in the monopoly of the carrying trade of the expanding empire. Many boats were constructed for the fisheries, which from the beginning of settlement remained an important part of New England's economy, providing food for the colonials and an important item of external trade. Good harbours and available ships stimulated the growth of the sea trade. Merchants in Boston and other coast towns ventured in commerce with England and with the British and French colonies in the West Indies.

New Englanders, like other colonials, resented the increasing enforcement after 1763, when New France fell, of the principles of mercantilism on which British imperial policy was based. They looked upon a succession of parliamentary acts as denials of their traditional rights as Englishmen.

The American Revolution broke out in 1775 when New England minutemen engaged, at Lexington and Concord, in armed conflict with a detachment of British regulars sent from Boston to destroy military stores being gathered by the colonial militia.

New England played its chief part in the American Revolution during the years 1765–1775 in defining issues and precipitating hostilities. In the continental congress the New England colonies early supported the independence movement in 1776. After the evacuation of Boston by the British army on March 17, 1776, New England saw only minor military actions, but Connecticut became a major source of supply for Washington's army. After 1775 the irreconcilable temper of New England people convinced the British military leaders in America that attempts at conciliation or subjugation had a better chance of success elsewhere. Tories, while important as economic and social leaders, did not constitute a large percentage of the New England population. Many of them fled to Nova Scotia, New Brunswick and England when the British army left Boston. The revolt against the mother country brought less civil war between rebels and Tories in New England than occurred farther south. Control of the governments of the newly independent states fell into the hands of conservatives who assumed the political offices and the economic and social leadership vacated by the fugitive loyalists.

New England in the New Nation.—The period of disorganization which followed the cessation of hostilities brought suffering to many communities. The disruption of the old courses of commerce within the British empire, no longer supplemented by privateering and wartime trade with other countries, caused a lack of specie. The departure of British armies, which had purchased supplies in the colonies, contributed to the same deficiency. Farmers who had gone into debt in the development of their holdings found themselves facing difficulties when interest payments and taxes were due. Distress led to a demand, most successful in Rhode Island, to print paper money whose depreciation would assist the debtor and work to the disadvantage of the creditor. In the western counties of Massachusetts and New Hampshire opposition to the tax collector and to court action against debtors was terminated by a show of force and belated remedial measures.

Although New England leaders played prominent parts in the Constitutional Convention, actual ratification proved a difficult matter in Massachusetts and New Hampshire. Rhode Island rejected the instrument until after the new federal government was organized. The creditor and mercantile sections of the population supported the stronger national government provided in the constitution in the hope that the national credit would be established and a national currency created that would have stability. Supporters of the constitution hoped that a national tariff might be used to persuade reluctant European governments to open their home and colonial ports to American trade. For nearly a decade after the inauguration of the new government under Washington the superior organization of the dominant commercial interests committed New England as a whole to the Federalist party. But Jefferson, representing the common man and the agrarian interests, had sufficient success in organizing anti-Federalist elements to carry several representative districts in the election of 1800.

The basis of New England's prosperity in the Federalist period seems to have lain in the application of Yankee energy and resourcefulness to the exploitation of the peculiar advantages of New England in foreign trade. Its ships, restricted in their enterprises in the older fields under the control of the British crown, turned to the Mediterranean and to the Pacific and Indian oceans. In 1786 Samuel Shaw established in Canton the first American mercantile house in China. In 1787 the "Grand Turk" brought to Salem the first of the many oriental cargoes which made that port famous. In 1787–90 Capt. Robert Gray's "Columbia" carried the flag of the new republic around the world for the first time and laid the foundations not only for the U.S. claim to Oregon but also to the very profitable trade with the northwest coast. There, furs were obtained which could be exchanged in China for silks and tea. Salem became for a time the tea market of North America and Europe and the third city in the union.

The Napoleonic Wars shattered this prosperity. Jefferson's embargo, continued in milder form under Madison, struck a heavy blow at New England commercial interests. The War of 1812, strongly opposed in New England, brought opportunities for privateering and the profits of blockade-running. But commercial interests suffered. The disaster of the war plus concern that westward expansion of the nation, made possible by the purchase of Louisiana, would seriously reduce the relative political power of New England led to a secession movement. This came to climax in the Hartford convention which formulated demands for drastic changes in the constitution. News of the signing of a peace treaty coming immediately after the convention adjourned made the New England effort abortive.

The sea trade revived after the war. In the 1840s New England shipyards created the clipper ships, in their day the fastest sailing vessels afloat. By reducing materially the sailing time to the orient, they brought large profits to their owners. In the 1830s and 1840s a large New England whaling fleet, mostly out of New Bedford and Nantucket, pursued their profitable prey in all the oceans.

Manufacturing using the machines of the Industrial Revolution began in New England near the end of the 18th century. The disaster of the embargo and the interruption of trade caused by the War of 1812 caused a shift of New England capital from commerce to manufacturing. Dams across the numerous rivers provided power. Textiles, shoes, clocks, hardware and articles of wood entered the market in increasing amounts. Itinerant Yankee pedlars distributed "Yankee notions" in the middle states and the south and as far west as the Mississippi. The rapid expansion of

the agricultural regions of the south and west from 1815 to 1850 brought into the eastern market cheaper cotton as well as cheaper foodstuffs. The former stimulated more textile activity; the latter drove the less well-situated farmers to abandon their farms and migrate to the west. In fact New England contributed greatly to westward expansion as migrants from New England moved early to the old northwest and later to Iowa, Kansas and Oregon. Through these pioneers on new frontiers New England continued to exert the peculiar influence of its Puritan traditions.

The growth of manufacturing bound New England to the nation because of the need for cotton and for an expanding market. Sectionalism gave way to a strong nationalism. Beginning with the tariff of 1816 New England supported protection but after 1833 the strong opposition of the agrarian south prevented the maintenance of a strong protective policy. New England was a pioneer in railroad experimentation. One of the first railroads in the U.S. was built in 1826 to carry granite blocks from the Quincy quarries to tidewater. In the 1840s short lines were built connecting Boston with Providence, Lowell, Portsmouth, Springfield, New Haven and New York. The railroad brought to an end the period of self-sufficiency in New England farming. Husbandmen raised crops to sell in the growing industrial towns. But location excluded New England from the competition in canal, highway and railroad building for access to the west which engrossed the attention of the states to the south. Although in 1850 Massachusetts ranked third to New York and Pennsylvania in railroad mileage these railroads failed to secure connections with the great productive areas of the Mississippi valley, so that Boston, as a port of export, fell behind its rivals. Yet New England had its own expansion. Its northern and eastern regions—Vermont, New Hampshire and Maine—were losing their frontier character. The northern boundary, long subject to dispute even to the extent of an armed clash in 1839 known as the Aroostook War, was finally determined by the Webster-Ashburton treaty in 1842. By that arrangement a large area in northern Maine came under the permanent jurisdiction of that state. The victory for New England claims stimulated the sentiment of nationalism. During the Civil War, New England, where antislavery sentiment was very strong, stoutly supported the cause of the Union.

The war brought to an end a phase of New England life. New England commerce had suffered severely. The whaling fleet was broken up by Confederate raiders, and its monopoly of the illuminating-oil market was destroyed by the introduction of kerosene and gas. By the change from wooden to iron and then steel ships and by the rising costs of operation under the U.S. flag, all the natural advantages in construction and operation of ships which New England formerly possessed were lost.

New England in a Changing America.—Between 1855, and the subsequent development of the Bessemer process for making cheap steel, and U.S. entry into World War I the country underwent its Industrial Revolution. By the end of that period the region east of the Mississippi and north of the Ohio and Potomac rivers had become thoroughly industrialized. New England, where industrialization had gotten under way early in the 19th century, kept its place in the forefront of the economic advance. Throughout the period it was a high income area. New England cities burgeoned as did those throughout the entire industrialized area. The need for labour brought a social change that has been called the "conquest of New England by the immigrant." The Irish came first to help build the railroads, to work in the mills and to transform Yankee Boston into something approaching an Irish city. Italians, Poles, Swedes, Czechs, Slovaks, Ukrainians, Lithuanians, Magyars and French Canadians combined to bring about in New England a veritable ethnic revolution. The newcomers added colour, character and a cosmopolitanism to the communities of the region. In the great variety of manufacturing enterprises they acquired the skills that enabled New England to hold fast to an old tradition. One of the most important assets of the region in the 19th century (and continuing into the second half of the 20th) was the existence of a numerous and highly skilled labour force.

In the 20th century, and particularly after World War I, New England's economic position was seriously disturbed by the impact of new trends in several fields. The demand for both granite and marble from the Maine coast and the Green mountains of Vermont declined with the extensive use of cement and steel in construction. Lumber for the building trade, which reached its peak in the 1860s, when 60 schooners came down the Penobscot river from Bangor, was displaced by lumber from Oregon and Washington or by other materials. Most timber by mid-20th century fell into the class of pulp for paper mills and had to compete with Canadian and southern products. In the second half of the 20th century Aroostook county, Me., the Connecticut valley and the area adjacent to Plymouth and Cape Cod remained the only sections where extensive agricultural operations were still profitable. There, potatoes, tobacco, onions and cranberries are raised for export. Forests moved in to take over land no longer profitable for crops. The result was the paradox that in one of the most highly industrialized regions in the world 77% of the land area is occupied by forests. Though important national and state forests exist, most of the wooded country is privately owned.

After World War I some New England textile industries moved to the south where they would be nearer to raw materials and also in a lower wage area. The danger that communities, such as Manchester, N.H., which had primarily depended upon textiles would become ghost towns was averted by the development of new and diversified industries. The existence in and near New England of important markets was a prime factor in attracting industry. The council of economic advisers reporting to the president in 1951 described that market in *The New England Economy:* "The northeastern part of the country is the most densely populated. Its inhabitants have higher than average personal incomes and conduct more than their proportionate share of manufacturing and much other business activity. The New England and Middle states alone contain 26.4 percent of the nation's population and receive almost one-third of the nation's income." The characteristics of New England industry and its relative position in the national economy are suggested by W. Storrs Lee's summary of Connecticut enterprises. "The state still produces more than half the nation's hats, firearms, fabricated brass products, ball bearings, typewriters, springs and counting devices; only one other state exceeds her productivity in machine tools, cutlery, needles, pins, hooks and eyes, snaps and zippers; it ranks first in the production of aircraft engines, firearms, felt hats, non-ferrous metal products, silverware, clocks, hardware, insulated wire and cable, office and store machines, and mechanical transmission." (*Yankees of Connecticut*, p. 230, Henry Holt & Co., Inc., New York, 1957.) As industrialization spread over much of the United States, New England lost its former pre-eminence. Its rate of growth became slower than that of newer industrial areas. But in an absolute sense progress continues. Diversification has gone beyond manufacturing. If the pre-Civil War merchant marine that sailed from New England's ports has disappeared, the region contains in Hartford, Conn., the "insurance capital" of the nation. New England's mountains, lakes, rivers and seashore are not only available for the enjoyment of the people of the region but attract a sufficient number from beyond its borders to make the tourist business a major industry.

Cultural Influences.—The first settlers of New England had a deep interest in religion and in education. In Jonathan Edwards New England produced one of the chief theologians and philosophers of the English-speaking world in the 18th century. From Edwards, among other origins, stemmed the evangelical impetus that gave power not only to early 19th-century Congregationalism but to the other Protestant denominations that had become important in New England. At the same time Unitarianism under the leadership of William Ellery Channing softened the harsh rigidities of the old Calvinism by stressing the humanism and the emphasis on reason of the Enlightenment. Transcendentalism as expressed by Emerson, Phillips Brooks and Horace Bushnell replaced the distant God of Calvin with an immanent deity abiding in the hearts of men. The concept of an immanent deity became central to the theology of the social gospel, important in New England churches at the turn of the 20th century. After the middle

of the 19th century, however, the Protestant monopoly of New England religion rapidly disappeared. Beginning with the Irish, the immigrants brought Catholicism to the region and to the nation. By the middle of the 20th century Catholics made up a large percentage of the population of the three southern states of New England.

After the founding of Harvard and Yale the interest of New Englanders in higher education expressed itself in the establishment of Brown (1764), Dartmouth (1770), Williams (1791), Amherst (1825), Massachusetts Institute of Technology (1861), Bowdoin (1794) and Smith (1871), to mention only the more famous of the institutions which appeared. In the 20th century all were independent institutions. Only in the middle years of that century did the state universities begin to reach a stature that could be said even to approach that of many of such institutions west of the Appalachians. In the 19th and 20th centuries New England became a centre for privately endowed preparatory schools. But Horace Mann of Massachusetts and Henry Barnard of Connecticut were the two most important pioneers in bringing about the American public school system supported by taxation and with trained teachers in the classrooms. In New England the Catholics created and supported their own school system from kindergarten through college.

In the first half of the 19th century evangelical Protestantism stimulated the development of many humanitarian and reform movements in the nation and particularly in New England. Dorothea Dix of Massachusetts pioneered in the reform of the treatment of the mentally ill. Lyman Beecher of Connecticut was an initiator of the temperance movement. William Lloyd Garrison of Massachusetts led a militant abolitionism. Elihu Burritt of Connecticut founded an international peace society. Beginning at Williams college early in the 19th century a missionary movement to foreign lands and to the American frontier carried outward from New England not only religion but education and medicine.

In two villages, Concord and Cambridge in Massachusetts, appeared the most important groups in the first flowering of American letters. Emerson, Thoreau, Hawthorne, Longfellow, Holmes and Lowell created an enduring literature. Outside the region Irving and Cooper preceded them and Whitman followed. Only Poe and Melville among the major figures were their contemporaries. After the Civil War the solitary Emily Dickinson of Amherst wrote the poetry that gave her rank among the best. Henry James fled New England at the height of the Industrial Revolution to become an expatriate in England but one who in his writings could not escape the fascination of the American theme. Meanwhile his brother William, borrowing an idea from the logician Charles Peirce, formulated at Cambridge the American philosophy of pragmatism. In the 20th century Eugene O'Neill of Provincetown and New London brought American drama to eminence.

New England in the 20th Century.—For roughly two centuries—from the landing of the Pilgrims in 1620 to the Hartford convention in 1814—New England was a peculiar and self-conscious region whose leaders in the latter year gave serious thought to the possibility of setting up their own independent nation. In the century from the War of 1812 to World War I, New England, accepting the role of a small region in a nation of continental size, led the way in the creation of industrial America, produced a literature that ranked with that of contemporary England and exported thousands of its people to the territories and the states beyond the Appalachian mountains. These migrants carried with them from their rocky eastern hills the New England ethics and regard for things of the mind. After World War I the forces making for standardization in a dynamic civilization rubbed away, for the most part, the angularities that had so long given New England its distinctive character. But uniformity did not triumph completely. The New England past was prologue in the mid-20th century to a present in which, in a new age, a traditional spirit of enterprise carried on in the face of continuing disadvantages.

In manufacturing, no giant mass-production industries took form. Limited supplies of power and lack of local raw materials suggested to New England enterprisers that they concentrate, like their counterparts in Switzerland, on products of small bulk and of high quality and value. In an age of relative decline on the part of railroads New England built arterial highways east and west across Connecticut and Massachusetts that connected with others running north and northeast in New Hampshire and Maine. The new highway network increased the mobility of goods and persons within the area and, by being joined with the highway system of New York state, maintained for New England effective contact with the rest of the nation. If transoceanic airways and seaways bypassed New England, the busy life of the region brought about a considerable airborne and seaborne commerce. Suburbs pushed out from the major coastal cities until the "long street" from Boston to New York and beyond became almost a literal reality. If the growth of suburbia threatened parent cities with decay at the centre, New Haven's thoroughgoing destruction of obsolete downtown commercial structures and its creation of a modern city centre demonstrated community readiness to face realities and determination to keep in the van of 20th-century progress. The fact that the many-times-elected mayor who led the community effort was of Irish extraction suggests that the new Yankee who appeared after the conquest of New England by the immigrant possessed an enterprise and vision equaling that of the early 19th-century Yankees who built Lowell, Mass., and Manchester, N.H.

In the arts the Boston symphony orchestra achieved a position second to none. Its Berkshire Summer festival became a national cultural event. In the same period Yale established the first school of music of graduate level in the United States. In architecture New England, while cherishing the tradition of 18th century Georgian expressed in carefully guarded old houses and churches, welcomed the new philosophies and new forms of modern architecture. The theatre and chapel at the Massachusetts Institute of Technology and the hockey rink at Yale expressed freedom and creativity. A concentration of institutions of higher learning within its small area made New England in the 20th century an intellectual centre unequaled in the nation. Thornton Wilder's *Our Town* summed up the region: the play's theme is universal, but "Our Town" remains a New England village.

See also references under "New England" in the Index.

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(R. H. Ga.)

NEW ENGLAND PRIMER, the "Little Bible of New England," was a famous children's schoolbook published sometime before 1690 by Benjamin Harris (fl. 1673–1716), who, in Sept. 1690, published the quickly suppressed first issue of the first newspaper printed in the colonies, *Publick Occurrences Both Forreign and Domestick*. The catechism contained woodcuts illustrating the alphabet, crude couplets and moral texts, including the child's prayer "Now I Lay Me Down to Sleep." Frequently revised, it was an important children's textbook for more than a century.

NEW FOREST, one of the most densely wooded regions of England, lies in southwest Hampshire between Southampton water, the Solent and the Avon river. Agriculture is important on the coastal fringes. Inland the infertile, sandy or gravelly soil supports only woodlands or broad heaths grazed by the ponies and cattle of the "commoners," small farmers holding ancient grazing rights. This region of unique scenic beauty, administered under special acts of parliament, serves many of the recreational purposes of a national park.

The New forest, mentioned in Domesday Book, was a hunting ground of the West Saxon kings, but derives its name from being placed under forest laws by William the Conqueror in 1079. It has been reduced since Norman times, but its legal "perambulation" is still 130 sq.mi. Of this, 30 sq.mi. are privately owned, while 100 sq.mi. are controlled by the Forestry commission. The

45 sq.mi. of crown woodlands form a valued reserve of timber. The main centres are Lyndhurst; Fawley; Lymington (*q.v.*), a yachting port and Georgian town beside the Solent; New Milton; and Ringwood, a market town in the Avon valley. Beaulieu village on the estuary of the Beaulieu river has ruins of Beaulieu abbey, founded by King John for Cistercians. Many of Lord Nelson's wooden battleships, built of New Forest oak, were launched from the slipway that may still be seen at Buckler's Hard. (H. L. En.)

NEWFOUNDLAND is the tenth province of Canada, having entered the confederation on April 1, 1949. It comprises two main areas, the Island of Newfoundland and the Coast of Labrador, a total area of 156,185 sq.mi. The Island of Newfoundland, roughly triangular in shape, is separated from the Canadian mainland by the narrow Strait of Belle Isle on the northwest, the broad Gulf of St. Lawrence on the west and the 68-mi.-wide Cabot strait on the southwest. The island has an area of 42,734 sq.mi., of which 625 sq.mi. is fresh water. The Coast of Labrador extends northward from the Strait of Belle Isle to Hudson strait and inland to include the area draining eastward. Consequently, the Labrador-Quebec boundary follows the irregular and twisting drainage divide. The Coast of Labrador has an area of 112,826 sq.mi. (of which 10,195 sq.mi. is fresh water), considerably larger than that of the island.

The population of Newfoundland in 1961 was 457,853, of which only 13,534 lived in Labrador. St. John's, on the island, is the largest city and the capital of the province. Historically, the Newfoundland economy has been based essentially on the codfishery, but in the 20th century forest and mineral industries have become increasingly important. The fishing industry itself has changed in character, with greater mechanization and new methods.

This article deals with various aspects of the Island of Newfoundland and with the political history of the province, including the Coast of Labrador.

For the physical geography, natural resources, etc., of the Coast of Labrador *see* Labrador-Ungava.

PHYSICAL GEOGRAPHY

The Island of Newfoundland is considered to lie within the Appalachian physiographic province, related in structure to the whole eastern seaboard of North America (*q.v.*). The great diversity of rock types which have undergone metamorphism and faulting are complex in structure. Nevertheless, there is a marked northeast-southwest alignment of the rock formations which conforms with the trend throughout the Appalachian system. Rocks of Pre-Cambrian Age constitute the Long Range mountains which parallel the west coast, parts of the interior and the southern part of the island, including the Avalon peninsula, joined to the island by a narrow isthmus, at the extreme east. Much of the central portion of Newfoundland is made up of Paleozoic sediments, chiefly Ordovician in age, and intrusives of Acadian (Middle Cambrian) Age.

The island may be regarded as a rugged plateau sloping eastward from the Long Range mountains. The surface exhibits signs of glaciation such as numerous lake basins, ice-sculptured valleys, rounded rock knobs and glacial deposits in typical forms. Reaching a common level of about 2,200 ft., the tablelike summits of the Long Range mountains represent the remnants of an ancient peneplain that has undergone periods of uplift and erosion. Other peneplain surfaces at lower elevations have been recognized. Certain peaks in the Long Range mountains rise above the high peneplain level to elevations of more than 3,000 ft. The Humber is the only major river that crosses the range to reach the west coast. Notable among the eastward-flowing rivers are the Exploits, the Gander and the Terra Nova. In the interior of the island are several long, narrow lakes, the largest of which are the Grand, Red Indian, Gander and Deer lakes. The greatly indented coastline of the island is estimated to be more than 6,000 mi. long. Numerous embayments separated by peninsulas constitute the jagged east and south coasts, in contrast to the relatively straight west coast.

Climate.—In spite of the maritime location of Newfoundland, the climate is essentially continental in character. Air masses which cross Newfoundland come predominantly from the west, bringing the continental influence. Nevertheless, the cold Labrador current that flows southward along the east coast of Newfoundland affects the climate to a certain degree. A cooling effect of the sea in summer prevents especially high temperatures and postpones the warmest weather until August. In winter the presence of the sea moderates the temperature, preventing the very cold readings of mid-continental areas. The mean temperatures in January range from 15° to 25° F. (about −9° to −4° C.), and in July from 50° to 60° F. (10° to about 15° C.). Precipitation is highest, about 50 in., in the southeastern part of the island and decreases northward to about 40 in. at the Strait of Belle Isle. Snowfall ranges from approximately 80 in. along the south coast to more than 120 in. in the northern half of the island. In winter the east and west coasts are icebound for periods of time ranging from five months in the north to one month in the south. Only the south coast is ice-free throughout the winter. Fog occurs frequently along the east coast, especially during the summer months. In fact, the Grand Banks, where the cold Labrador current (*q.v.*) meets the warm Gulf stream, are noted as one of the foggiest areas of the world.

POPULATION AND PRODUCTION CENTRES OF NEWFOUNDLAND

Plant and Animal Life.—Newfoundland lies within the boreal forest region in which coniferous trees predominate. Balsam fir, white spruce, black spruce, white birch and yellow birch are among the most common trees. No more than one-half of the total land surface is forested, while the remainder is mostly rock, barren and bog. The main forest areas lie within the watersheds of the principal rivers. On the barren lands and bogs vegetation is in the form of mosses, lichens, stunted trees, grasses and certain flowering plants.

The island is well endowed with wildlife and fresh-water fish. The chief fur-bearing animals are beaver, muskrat, fox, lynx and otter. Game animals include caribou, moose, black bear and hare. Evidence points to the fact that the numbers of certain game animals are decreasing. Trout and salmon are abundant in the riv

Extracting iron ore with electric drills at Wabana mine, under the ocean floor near Bell Island

Landing a catch on a trawler on the Great Bank of Newfoundland, part of the Grand Banks

Hilltop church in Torbay, a fishing and farming village north of St. John's

Bowater's pulp and paper mill, Corner Brook, one of the largest such mills in the world

SCENES OF NEWFOUNDLAND

BY COURTESY OF (TOP LEFT, CENTRE LEFT, BOTTOM) NATIONAL FILM BOARD OF CANADA; PHOTOGRAPH, (TOP RIGHT) GILES FROM BLACK STAR

NEWFOUNDLAND

View at the harbour of St. John's, capital and largest city of the province

Drying codfish on platforms at Bonavista, village at the end of Cape Bonavista, Bonavista bay

Church street, Fortune, western end of Burin peninsula near the French islands of St. Pierre and Miquelon

Iron miners leaving the shaft, Dominion Steel and Coal company mines, Bell Island

Falls on the Lomond river, Bonne bay, on the Gulf of St. Lawrence

ST. JOHN'S AND VIEWS OF ISLAND OF NEWFOUNDLAND

and lakes of Newfoundland and attract sport fishermen from distant cities.

HISTORY

Investigation of the subject of transatlantic navigation suggests that Newfoundland and the Grand Banks fishing ground were well known by fishermen before John Cabot made his voyage in 1497. Cabot gave emphatic advertisement to the wealth of the western waters, an advertisement reinforced by the Portuguese explorer Gaspar Côrte-Real in 1501. By the first quarter of the 16th century, French, Basque, English and Portuguese adventurers were fishing regularly off Newfoundland. (*See* also LABRADOR-UNGAVA.)

The island occupied a vital place in the scientific and military activity of the 16th century; it was associated with the search for the northwest passage, and it was of great strategic importance in the Anglo-Spanish maritime contest. In 1583 Sir Humphrey Gilbert formally annexed Newfoundland for England, and in the course of the next 30 years attempts were made to colonize the island. In 1610 the London and Bristol company established a colony, led by John Guy, at Cupids, on Conception bay. Colonization was attempted also in the Avalon peninsula by Sir William Vaughan, Lord Falkland and Sir George Calvert, later Lord Baltimore. The Baltimore colony at Ferryland promised well, until its proprietors procured the patent for Maryland in 1632. In 1637 all Newfoundland, including the Baltimore holdings, was transferred to Sir David Kirke and his associates. Although the Kirke family seems to have retained possession until the 1670s, efforts at permanent settlement were at an end; 17th century economic theory and practice far preferred the codfisheries to established colonies.

Mercantilism.—Throughout the 16th century the codfisheries attracted great annual expeditions from maritime Europe. In England, these reached the position of supreme national importance. Poole, Bristol, Exeter, Teignmouth and the other western ports became the centres of English enterprise, thus establishing in the Newfoundland trade a dominance that endured for more than two centuries. The cod were shipped overseas, the best fish going to the Mediterranean, the least valuable to the slave plantations in the West Indies. Marketing was done by large merchant vessels which brought to Newfoundland the all-essential salt; in the late autumn they returned to England with wine or oil, or with the more precious bullion from abroad.

In the eyes of the 17th- and 18th-century theorist, these transactions had a double value. First, they made England the beneficiary of the profitable export trade in dried cod. Second, the western fisheries were a great nursery of hardy seamen. It is not surprising, therefore, that the fisheries were regarded as being of fundamental importance to England's security and prosperity. It was manifestly contrary to national policy to permit permanent settlement or to allow the fishermen to winter in Newfoundland. It was equally in the interests of the western merchants to discourage settlement. Accordingly, they adroitly identified their private interests with the widely accepted mercantilist theories, and argued that possession of the fisheries was synonymous with maritime supremacy.

Intensification of maritime rivalry probably forced the issue. In 1662 the French established themselves at Placentia; in 1665 the Dutch burned St. John's, even at that early date a centre of English trade. Beginning with 1696, the French made concerted attempts to conquer Newfoundland with attacks on English establishments in 1697, 1705 and 1708. By the terms of the treaty of Utrecht (1713), the French recognized English sovereignty over Newfoundland, although they retained valuable fishing privileges between Cape Bonavista and Point Riche. These concessions graphically indicate the high value set on the fisheries by both French and English. The ultimate settlement of these claims was postponed for nearly two centuries. During the Seven Years' War (1756–63) Newfoundland again became a centre of conflict, St. John's being lost and retaken by the English in 1762. During the American and French Revolutionary wars, the island's coasts were ravaged again.

The subordination of Newfoundland's social and political development to the codfisheries was complete. After the failure of the early colonization schemes, authority was chaotically exercised by the fishermen themselves, under the title of "fishing admirals." In 1729 an officer of the Royal Navy, Capt. Henry Osborne, was appointed governor. His tenure was seasonal, as was that of his successors until 1817. The naval governors wholeheartedly sought to aid the overseas fisheries as auxiliary to national policy. In 1791 a civil court was instituted and in 1792 a supreme court. In this way the earliest attempt was made to introduce an element of constructive order into Newfoundland affairs.

The population of the island was almost entirely seasonal, the fishermen returning each autumn to England; as late as 1683–84 there were only 120 permanent residents on the island. Throughout the 18th century their numbers increased from 3,400 in 1754 to more than 12,000 in 1774. The newcomers were drawn increasingly from Ireland to provide inexpensive labour for the codfisheries. Food and supplies were brought in from New England. The great prosperity enjoyed by the fisheries in the late 18th century probably accounted for the steady increase in population, which by 1804 reached 20,000. The peak year was 1814–15, when more than 11,000 immigrants arrived in St. John's from southern Ireland.

The operation of the shore fisheries was left chiefly to these newcomers. The prosperous deep-sea fishermen became resident merchants, buying dried cod, fish oil and sealskins for speculation abroad. Their headquarters was St. John's, which became a distributing and financial centre as well as a fishing station. By the end of the 18th century, therefore, the hold of the old system on Newfoundland life was weakening.

Representative and Responsible Government.—As early as 1802 the governor, Lord Gambier, proposed that a form of representative government be granted the colony of Newfoundland. The leading advocates of self-government in the island were William Carson, a politically inclined Scottish physician, and Patrick Morris, an Irish-born merchant. In 1832 representative institutions were established with a bicameral legislature, the lower house of which was elected on a broad franchise. From an early period discord developed between the two houses. The legislative councilors were residents of St. John's and representative of the economically dominant merchants; the assembly was a much more popular body. The discord between the houses led to a temporary suspension of the constitution and amalgamation of the two houses. From 1848 onward, attempts were made for complete responsible government. In 1855 full legislative responsibility was admitted, on the analogy that what had been recognized in Nova Scotia and Canada could not be withheld in Newfoundland.

Economic and Social Development.—Increasing economic maturity underlaid the constitutional changes. The early 19th century was characterized by the growth of the inshore fisheries, as distinct from the bank fisheries. The war years, especially from 1800 to 1815, drastically curtailed the deep-sea fisheries. During the Napoleonic war years the Newfoundlanders established virtual control over the Mediterranean market for dried cod and about 1814 they established an important new market in Brazil. Peace brought a disastrous fall in the price of dried fish, occasioning a prostration in business that lasted until 1819. Thereafter, until the middle of the 19th century, the export of cod remained remarkably constant.

An important adjunct to economic prosperity was the seal fishery. From the middle of the 18th century, the people of the northern bays took a few seals annually by means of nets. Somewhat later, small boats were employed. These ships sailed each spring for "the ice," in order to intercept the great herds of seal on their migrations. In 1831 and 1844 phenomenal catches were made, 686,830 and 685,530 respectively. The industry gave employment to a large number of men and brought handsome returns to the capitalists who directed it. In 1857, 13,600 men shipped for the ice; the catch was valued at $1,700,000. After the middle of the century, sealing declined.

Throughout this period, concerted efforts were made to broaden

the economic basis of island life. Under the direction of Sir John Harvey in the 1840s, agricultural societies were formed in an effort to put farming on a rational and extensive basis. The success of these efforts may be judged by the progressive increase of land under cultivation: 1836, 11,062 ac.; 1845, 29,656 ac.; 1855, 41,108 ac. The majority of such holdings were small, usually being worked as auxiliary to the all-absorbing fisheries. Nevertheless, they did impart a degree of self-sufficiency and permanency to island life. The first geological survey of Newfoundland was begun in 1839 by J. B. Jukes, with the aim of developing mineral resources.

The social development of the colony kept pace with the economic. The merchant class, Newfoundlander by birth and outlook, with the rise of the enterprising Irish shopkeeper, began to lose its exclusively Anglican caste. The outport merchants, with the increasing importance of the seal fishery, played a more decisive role in business life. St. John's was transformed gradually into a commercial centre and colonial capital. In 1800 the population of the city was about 3,000, living along two narrow paths that straggled on the north side of the harbour. A series of disastrous fires in 1816, 1817 and 1819 largely destroyed the ancient malodorous fishing town and made possible a degree of planning. In 1846 another fire hastened this process and opened the way for such improvements as a general water-supply system, the St. John's Water company being incorporated in 1846. In this period, some of the most conspicuous landmarks of St. John's took form. In 1841 the cornerstone of the Roman Catholic cathedral was laid and in 1855 the church was consecrated. In 1843 the building of the Anglican cathedral was begun.

The Newfoundland churches owe their modern organization to the early 19th century. In 1856 the Roman Catholic diocese of St. John's was established. Catholic worship had been conducted regularly as early as 1623 in the Baltimore colony; a prefecture was created in 1784 and a vicariate in 1796. The Anglican diocese of Newfoundland was created in 1839. Provision for Anglican worship was made as early as 1583, and the first Anglican minister reached the island in 1610. The consecration of Bishop Edward Field in 1844 introduced the modern period in church extension and education. Methodism was introduced into Newfoundland in 1764, establishing itself strongly in the northern outposts. In 1855 the Methodist churches joined the Eastern British-American conference, thus breaking the administrative connection with England. The entrance of the Methodist Church into the United Church of Canada was effected in 1925. Organized Presbyterianism dated from 1842. The other chief religious bodies, Salvation Army, Adventists and Pentecostals, came into being later.

The Age of Local Enterprise.—The quarter century 1870–95 was one of general prosperity, attributable to the progressive broadening of economic life through farming and mining and also to the stimulus of railway building. An additional reason was the high price the increasing exports of dried codfish commanded. In an era of general price decline, the price level of dried fish remained almost stationary. Thus the fisherman had the absolute advantage of a high selling price and the relative advantage of greater purchasing power. Moreover, the capitalistic enterprises of the period were locally managed and financed. The intrusion of alien direction and control following 1895 may be regarded as closing one period in Newfoundland history.

The search for economic self-sufficiency was initiated as early as the 1860s. The rapid increase in population (1857, 124,288; 1869, 146,536; 1874, 161,374) gave a note of urgency to these investigations. In 1862 two committees of the legislature examined the fisheries and agriculture, and in 1864 the geological survey of the island was reinstated. Also in this year a copper mine was opened at Tilt Cove on Notre Dame bay. The mine operated almost continuously until 1918 and produced 1,492,000 tons of ore. A number of smaller copper deposits were discovered around Notre Dame bay in succeeding years. Among the producing mines were those at Baie Verte, Betts Cove, Little Bay and Roberts Arm.

Railway construction became the great end of national policy. In 1875 Sir Sandford Fleming, the engineer of the Canadian Pacific, surveyed a practicable route from St. John's to St. Georges bay. In 1880 a joint committee of the legislature recommended the building of a railway northward, as the best means of making accessible the mining and agricultural regions of Notre Dame bay and Exploits valley. In 1881 a company was incorporated and construction begun. The company was aided by government subsidies of $180,000 per annum for 35 years, and a land grant of 5,000 ac. for each completed mile. At the same time, new enterprises were initiated at St. John's. In 1882 a ropewalk was established for the manufacture of fishing gear, netting, cordage and cables, thus freeing Newfoundland from its dependence on foreign sources for these indispensable supplies. Between 1882 and 1884 a large dry dock was constructed. Other industries developed locally included foundries, machine shops and engineering works, all associated with the railway or with shipping.

In the early 1890s two disasters altered completely the pattern of Newfoundland growth. In 1892 three-quarters of St. John's was devastated by fire. The damage to property was computed at $20,000,000, of which less than one-quarter was covered by insurance. In Dec. 1894 the two leading banks, the Commercial and the Union, failed, while the Government Savings bank was compelled to suspend payment. The notes of these banks, the normal currency of the island, became valueless, business stagnated and workingmen were dismissed. As the Union bank was under obligation to provide the half-yearly interest (about $225,000) on the public debt, the crisis assumed serious proportions. A loan from the United Kingdom serving for immediate relief, Newfoundland sought permanent solution by union with Canada. The insistence of the Canadian government on certain debt settlements caused the negotiations to break down early in 1895. Left to their own devices, Newfoundland public men, directed by Sir Robert Bond, succeeded in raising loans in Montreal, New York and London, thus staving off the danger of complete financial collapse.

The bank failures brought to an end a distinct era in Newfoundland history. Local enterprise had been overwhelmed by disaster. The Canadian banks entered the island and their notes replaced the local Newfoundland dollar. Alien direction invaded the business life of the island.

The Era of Foreign Investment.—For the first 30 years of the 20th century, Newfoundland development followed a consistent pattern. Foreign enterprise increasingly sought to exploit the island's natural resources. World War I intensified this process. The liquidation of long-standing differences with France and the United States was a feature of this period.

As early as the 1890s, foreign investment was attracted to railway construction and mining. Sir Robert Reid of Montreal, a Scottish-Canadian promoter, had become influential in pushing the construction of the transinsular railway. The financial disaster of 1894–95 induced the government in 1899 to transfer to Reid virtually all the island's communications; railway, shipping lines and telegraph, as well as the St. John's dry dock and extensive timber and mining rights. Strong protest produced an amendment of the contract in 1901, whereby the more objectionable monopolistic features were surrendered at the price of about $2,500,000. Construction was pushed vigorously; in 1893 the railway reached Norris Arm on the Exploits; in 1897, Port aux Basques. Fast steamships were put in service between this point and Sydney, N.S. The profitable operation of these enterprises proved increasingly difficult, until finally in 1923 the government assumed their operation.

In 1895 the exploitation by a Canadian company of the iron deposits on Bell Island commenced and in 1905 the Anglo-Newfoundland Development company was constituted for the manufacture of newsprint. The company was originated by Lord Northcliffe, who wished to make his chain of newspapers independent of foreign countries for supplies of newsprint. The location of the original plant was at Grand Falls, where the company received power rights on the Exploits river and timber limits amounting to 2,000 sq.mi. The first paper was produced in 190[illegible]. For export purposes the company installed docks and sheds at Bo[illegible]

wood, which was connected with Grand Falls by private railway. The company expanded greatly. In 1923 it acquired the pulp mill of the Albert Reed company at Bishop's Falls. In carrying out surveys, officials of the company discovered outcroppings of copper-lead-zinc ore near Buchans but it was not until 1925 that these deposits were made profitably exploitable. The American Smelting and Refining company undertook development under agreement with the Anglo-Newfoundland Development company, and mining operations were begun in 1927.

The participation of Newfoundland in World War I was distinctive. The large seafaring population enlisted in the Royal Naval reserve, an institution of long standing on the island. In all, over 1,500 men served at sea in all parts of the world. In Aug. 1914 the government determined to raise a small land force, ultimately known as the Royal Newfoundland regiment. This unit fought in Egypt, the Dardanelles and France. At the battle of Beaumont Hamel, in the Somme (June 30, 1916), it lost virtually its entire complement of 700 men. The regiment was immediately brought up to strength and served with distinction during the later phases of the war. In 1917 a forestry corps was recruited from among Newfoundland woodmen. A noncombat unit, it was employed in timber cutting in Scotland. Outside these purely Newfoundland formations there was extensive enlistment in the British forces.

In the era following World War I came the exploitation of the timber resources of the west coast. Between 1923 and 1925 the Newfoundland Power and Paper company built a paper mill at Corner Brook and a hydroelectric plant at Deer Lake. Costs of construction were more than double the original estimates and the company decided to sell its interests to the International Paper company in 1928. Bowaters Newfoundland corporation acquired the plants in 1937 and greatly expanded the production facilities.

Labrador Coast Award.—This decision was rendered in 1927 by the judicial committee of the imperial privy council of Great Britain following litigation between Newfoundland and Canada over ownership of the ill-defined area of Labrador. The waters off the Labrador coasts were worked by French and English fishermen, the former from Canada, the latter from Newfoundland. With the cession of Canada to Britain in 1763 by the treaty of Paris, disputes over the title to Labrador were referred to British tribunals. These were concerned primarily with the coastal areas, since until the late 19th century there was no economic attraction except fishing.

Between 1763 and 1825, four adjustments were made, the sum of which gave the Newfoundland colony jurisdiction over the Atlantic face of Labrador and Canada the north shore of the Gulf of St. Lawrence. In 1888 the exact location of the inland boundary was first disputed. The decision of the judicial committee in 1927 was in favour of Newfoundland, asserting that "the Coast of Labrador" included the hinterland to the watershed of the rivers draining eastward to the Atlantic. The award endowed Newfoundland with a continental dependency of 110,000 sq.mi., embracing among other assets the basin of the Hamilton river, and stretching from the Gulf of St. Lawrence to Cape Chidley.

Commission of Government.—In 1931 Newfoundland began to experience the effects of the world depression. These were intensified by the heavy service charges on the Newfoundland debt. Throughout the 1920s, the program of railway consolidation and highway construction, along with increased aid to education, raised the national debt from $43,000,000 to $101,000,000. Moreover, the budgets had not been balanced after 1920, the annual deficits amounting to an average of $2,000,000. The deficits were met by loans, which, of course, added to the general indebtedness. The onset of the depression, therefore, found Newfoundland in a dangerous position. Unfortunately, Newfoundland's best customers for newsprint, minerals and dried cod were themselves seriously affected. Employment declined in Canada and the United States, forcing home scores of seasonal workers. In 1931 a loan for $8,000,000 received no tenders. Upon request, a financial adviser for the government was dispatched from the United Kingdom. In 1932 loans were successfully raised from the Canadian banks and from local subscriptions. Drastic cuts were made in expenditures and taxes steeply increased. During 1933, however, no improvement was visible, and additional loans were sought from governments of Canada and the United Kingdom. At this time application was made for the appointment of a royal commission to inquire into Newfoundland affairs.

In February a royal commission was appointed. It consisted of three members, a Newfoundlander, a Canadian and a representative from the United Kingdom. The terms of reference stressed the examination of Newfoundland's financial situation and prospects. The royal commission met throughout the summer of 1933, gathering information on Newfoundland life. A report of these investigations, along with certain recommendations, was published in the autumn of 1933.

The report was a comprehensive document, containing an extensive survey of Newfoundland's existing condition and past history. The ills of the dominion were set down to the functionings of a perverted parliamentary system which had been exploited for party and personal gain. As a solution the royal commission recommended the temporary suspension of government responsible to the people. It recommended, also, that the government of the United Kingdom assist Newfoundland financially until such time as the dominion became self-supporting. Other recommendations concerned the rehabilitation of the fisheries, the revision of the educational system and so on. The constitutional proposals were startling since they envisaged the establishment of a unique body, the commission of government, which should exercise both legislative and executive functions.

The commission of government took office in Feb. 1934 and governed Newfoundland until union with Canada in March 1949. It was composed of six appointed members, three Newfoundlanders and three from the United Kingdom, under the chairmanship of the governor. The commission encountered a number of difficulties, virtually all of which proceeded from the low prices commanded by the island's primary products in the world market. The commission gave assistance to the fishing industry by creating a fisheries board, which made substantial progress in improving standards of production and methods of marketing. Aid was also given in building more modern fishing vessels. Other undertakings that enjoyed the commission's support were farming and land settlement, the former through education and cash bonuses, the latter by means of the land settlement board, later the department of rural reconstruction. Transportation was improved: the main line of the railway was restored to predepression standards, several new coastal steamers were put in service and a number of local roads were laid out. Expenditures were substantially increased in education and in health. The means of implementing these reforms came from improved finances. The commission simplified and reduced the customs duties (the traditional staple income of Newfoundland), and by thus encouraging imports secured substantial increases in revenue. It was also assisted by grants-in-aid from the United Kingdom to cover ordinary expenditures, and loans from the Colonial Development fund for capital outlays. In terms of rehabilitation and reform, the record of the commission of government was impressive.

World War II.—The outbreak of war in Sept. 1939 found Newfoundland without fixed defenses of any kind, and without even a garrison. A local defense force, the Newfoundland regiment, was immediately raised, and troops were recruited also for overseas service. The latter formed part of the British army, not, as in World War I, a separate Newfoundland unit. The island provided the personnel of two heavy artillery regiments, one of which later became a field artillery regiment. They served in north Africa, Italy and western Europe. A total of 2,327 Newfoundlanders joined these units. A Newfoundland overseas forestry battalion, a civilian organization, was likewise raised, with a strength of about 1,500 men. Individual Newfoundlanders, both men and women, enlisted in the Canadian as well as in the British forces. Total enlistments were about 10,000.

The military collapse in western Europe in the summer of 1940 precipitated a crisis in Newfoundland. The security of the island was vital not only to Newfoundlanders themselves but to all North America. In June 1940 Canadian troops undertook the ground protection of Gander airport and the Botwood seaplane

base. Two months later Canada assumed wide responsibilities for the defense of Newfoundland, both on the ground and in the air. The Canadian navy constructed and maintained a large base at St. John's. The United States also had a stake in the defense of Newfoundland. In virtue of the "base agreement" with Britain, the United States secured leases on three areas, where it established bases. Newfoundland served as an important point of departure for aircraft and surface convoys throughout the war.

World War II had a profound effect on the island economy. Newfoundland products were in steady demand at high prices. Jobs were easy to secure. War prosperity extended even into remote areas, drawing young men and women into employment elsewhere, principally in construction work at military bases. As early as 1941, the commission of government reported a surplus of revenue over expenditure, the first since 1919. As a result of this and of successive surpluses, the commission was able to extend to the United Kingdom an interest-free loan of $12,000,000. By March 1948 a cumulative surplus of $30,000,000, including the British loan, was built up.

Confederation With Canada.—The ending of the war raised the subject of constitutional status. In Dec. 1945 the government of the United Kingdom announced that a national convention would be elected to secure a representative view of what Newfoundlanders desired. The convention was elected in June 1946 and began its deliberations in September. Delegations were sent to London to ascertain British views and to Ottawa to sound out Canada on terms of union. A motion to send a similar delegation to Washington, D.C., was decisively defeated. The formal reply of the Canadian government was made in Nov. 1947. Nevertheless, in preparing the ballot, the convention recommended only two choices, continuation of the commission or restoration of responsible government. The government of the United Kingdom, however, insisted on adding to the ballot union with Canada. The first poll, held in June 1948, resulted in stalemate; no one of the choices received an absolute majority: responsible government received 69,400 votes, union with Canada 64,066, commission of government 22,311. A second poll, held on July 22, produced a majority of 78,823 votes in favour of union with Canada against 71,334 for responsible government. Representatives from Newfoundland went to Ottawa to discuss confederation.

The term confederation has an especial historical significance. Twice before, 1869 and 1895, Newfoundland and Canada had negotiated confederation. The first confederation effort was part of the general move to unite the British American colonies. Newfoundland had been represented at the Quebec conference of 1864, which drafted the plan of the original confederation. It was not until 1869, two years after the passage of the British North America act, that a decisive move was made in Newfoundland and then the proposal was rejected. The second attempt to bring about confederation, in 1895, was the direct outcome of economic tensions, culminating in the Newfoundland bank failures of Dec. 1894. Negotiations were begun in April, but broke down on the financial terms Canada was prepared to offer. Although both parties were anxious to make concessions, a gap of $200,000 remained between what Canada could extend and Newfoundland accept. This small sum wrecked the second confederation proposals, leaving among Newfoundlanders a sense of continued resentment.

Confederation discussions in 1948 extended over two months and produced a statement of the terms of union. Basically, these terms were the acceptance of provincial status by Newfoundland and the assumption by Canada of services normally provided for the other provinces, including the payment of stated annual subsidies. As in the instance of the other provinces, Newfoundland was to be represented in the federal parliament, with seven members in the commons, and six in the senate. The terms also provided for the revival of the provincial constitution, suspended during the operations of the special commission of government. In place of the bicameral parliament of responsible government days, however, a single-chamber legislature composed of 28 members was envisaged.

In a different category was the taking over by the federal government of the Newfoundland railway (and shipping services) and the sterling debt. amounting to about $63,000,000. Canada agreed to make special transitional grants for a limited period and to leave to Newfoundland the surpluses amassed during World War II. Finally, Canada agreed to appoint within eight years a royal commission to review Newfoundland's economic position and to make recommendations. These special features of the terms of union were in recognition of Newfoundland's unique position, economically as well as constitutionally.

The eight-year period having elapsed, a royal commission on Newfoundland finances was constituted, and submitted its report in May 1958. The commission recommended that Newfoundland thereafter be granted additional financial assistance of $8,000,000 per annum.

THE PEOPLE AND POPULATION

The population of Newfoundland illustrates the interplay of history and environment. The people are markedly homogeneous, over 90% being of English and Irish origin. Until the beginning of the 19th century the population was small, but thereafter it increased rapidly. The 1951 census placed it at 361,416, of which 7,890 lived in Labrador; the 1961 census set the total at 457,853 of which 13,534 lived in Labrador. Of this total about 98% was native born. Emigration is an established pattern, especially for young persons. Between 1891 and 1961 it is believed that more than 80,000 persons emigrated.

Incorporated Places of 5,000 or More Population (1961 Census)

Place	Population				
	1961	1956	1951	1945	1931
Total province	457,853	415,074	361,416	321,819	263,033
Corner Brook*	25,185	23,225	—	—	—
Gander	5,725	1,289	—	—	—
St. John's	63,633	57,078	52,873	44,603	36,444
Stephenville	6,043	3,762	—	—	—
Wabana	8,026	7,873	6,460	—	—
Windsor	5,505	4,520	3,674	—	—

*Previously known as Corner Brook East, Corner Brook West, Curling and Humbermouth.

Note: Populations reflect data as each place was constituted at date of each census. A dash (—) indicates place did not exist during reported census, or data not available.

The early supremacy of the codfishery determined the location of settlement in the island. Convenience to the inshore grounds or to the more distant banks were decisive factors, as were shelter for boats and space for the stages required for curing fish. Thus the population became widely scattered along the 6,000 mi. of coast. However, the Avalon peninsula was recognized as particularly desirable for settlement in relation to the Grand Banks fishery. To this day more than 40% of the island's population lives on this peninsula and about 20% lives in greater St. John's. During the 20th century population on the west and north coasts of the island increased more rapidly than on the south and southeast coasts. The bulk of the population still lives in about 1,300 small coastal settlements, almost 90% of which have fewer than 500 inhabitants. Strong attempts have been made by the government to encourage the abandonment of small, isolated settlements. Financial assistance has been offered to move family belongings to more suitable locations and in many cases wooden houses have been floated from small islands to mainland settlements. That progress along these lines has been achieved is indicated by census figures. The percentage of the population living in communities of over 1,000 increased from 34% in 1945 to 51% in 1961.

The smallness and scattering of the population have influenced the Newfoundland character. Isolation bred individuality and self-sufficiency, but it also extracted a heavy toll. Customs changed slowly; 16th-century methods of fishing and fish-curing persisted; new ideas were rare and were resented; there was a marked weakness in co-operation, individualism of the most uncompromising sort having been nurtured on long years of near self-subsistence.

The church plays a very important role in the Newfoundland community. Denominationally, the population is divided into three main groups, about one-third Roman Catholic, nearly one-third Anglican and about one-quarter United Church. The

remainder of the population is divided among several other denominations, the largest of which is the Salvation Army. Since one denomination frequently monopolizes an entire community, the church is a potential political force. This factor is tacitly admitted in political and administrative circles where efforts are bent toward maintaining a balance in denominational representation.

Two special characteristics of the islanders merit attention, the imagination and humour displayed in naming their numerous communities, and the marked poetic gifts possessed by many of them. Such place names as Heart's Delight and Heart's Content reflect feelings associated with the area; and indicative of isolation, Come by Chance. Nautical or navigational inspiration appears in Main Topsail (mountain peak), Pushthrough and Little Tickle (a tickle is a very narrow strait). Port aux Basques, Frenchman's Bay and Ireland's Eye recall the various nationalities long ago associated with the island. Poetry appears to be a natural medium of expression and has produced a growing body of published work. E. J. Pratt, a Newfoundlander, ranks among leading Canadian poets (*see* CANADIAN LITERATURE [ENGLISH]).

On a more popular level, sea chanties and folk songs are characteristic of the island. Many of these are traditional, the inheritance of an English or Irish past; others reflect the day-to-day life of the fisherfolk, often told with grotesque exaggerations. One of the most popular of Newfoundland songs is entirely modern, Arthur Scammell's "Squid Jiggin' Ground."

GOVERNMENT AND FINANCE

The provincial government of Newfoundland has jurisdiction over education, crown lands and forests, municipal government, property and civil rights, and other matters assigned to the provinces by the British North America act. The house of assembly consists of 42 members (previously 36) elected for a period of not more than five years. The Liberal party under the leadership of the premier, J. R. Smallwood, was victorious in the first election after confederation in 1949 and in 1962 maintained its majority position for the fifth consecutive time. The Progressive Conservative party functioned as the official opposition.

After confederation the economic policy of the provincial government was one of energetic expansion. On taking office for the first time, Smallwood assumed the portfolio of economic development along with the premiership. Thus he clearly showed his appreciation of the predicament of Newfoundland—considerable potential wealth but small immediate resources and a small and scattered population. The general level of prosperity in Newfoundland has long been lower than that prevailing in the Maritime provinces (New Brunswick, Nova Scotia and Prince Edward Island). It was the declared aim of the provincial government to raise Newfoundland living standards to a level comparable with standards in these sister provinces. The federal government also recognized this lack of comparability of living standards and provided annual transitional grants to strengthen provincial revenue. These grants were reduced from year to year toward their eventual termination in 1962. A permanent annual grant of $8,000,000 to maintain public services at the level achieved in 1958 was recommended by the Royal Commission on Newfoundland Finances.

The two major aspects of economic policy were the further development of natural resources and the encouragement of industrialization. With respect to natural resources the government itself undertook mineral surveys both on the island and in Labrador through the agency of the Newfoundland Labrador corporation. Under an agreement made with the government the British Newfoundland corporation, an Anglo-Canadian syndicate, received mineral, timber and hydroelectric power rights on 50,000 sq.mi. in Labrador and 10,000 sq.mi. on the island. The company agreed to spend large sums of money annually on explorations. Direct investment by the government was involved in the industrialization program. Local industries were aided financially and new industries were established. Also, European interests were offered assistance in establishing industries in Newfoundland. Among the new industries brought into production were cement and gypsum wallboard plants, a shoe factory, a rubber products plant and a cotton textile mill. Some were successful while others were not, but the net result was an expansion of employment opportunities.

EDUCATION

The Newfoundland educational system is denominational in character. The first school was set up at Bonavista in 1726 by the Society for the Propagation of the Gospel, the Church of England missionary organization. Schools for Roman Catholics were supplied by the Benevolent Irish society. The Education act of 1876 formally recognized the denominational principle by accepting Roman Catholic, Anglican and Methodist schools and by dividing the government grant to education on a proportional basis. Successive amendments to the act did not substantially alter this arrangement, the appearance of the Salvation Army, Seventh-Day Adventists and Pentecostals being marked by schools conducted by those bodies on the same basis as those of the older churches. By the 1950s there were also 33 nondenominational schools. All classes of schools are subject to the same regulations, follow the same curriculum and receive provincial grants on the same basis.

In 1925 Memorial University college at St. John's was opened as a permanent memorial to the Newfoundlanders who served in World War I. In the 1925–50 period the university gave courses in the first two years of arts and pure sciences and in the first three years of engineering, provided teacher training and sponsored an active adult education program. In 1950 the college was expanded into Memorial University of Newfoundland with degree-granting authority.

The International Grenfell association carries on important educational and medical work in the northern outports and on the Labrador coast. Commenced in 1892 by Sir Wilfred Grenfell (*q.v.*), the association maintains a number of schools and hospitals and an orphanage.

PRODUCTION

The Newfoundland economy is based largely on primary industries. Certain primary products are manufactured for export, while others are marketed essentially in the raw state. Hydroelectric plants produce the only source of energy available on the island, while coal and petroleum are imported for additional energy and heating requirements. Historically, fishery products have been the mainstay of the economy and until the end of the 19th century provided as much as 90% of the exports. Mining developed gradually during the 20th century and the utilization of forest resources on a large scale did not occur until after World War I. The economy is strongly dependent upon external trade because most of the requirements of the population must be imported, and to balance these imports a high level of exports must be maintained.

Agriculture.—Agriculture in Newfoundland is subsidiary to other primary industries. Production is chiefly for domestic consumption and a large part of the farming activity is carried on by fishermen and forest workers on a part-time basis. The basic reasons for the relatively backward condition of agriculture are the unsuitability of climate and the scarcity of good soils. Although winter temperatures are not so low as they are in the main agricultural areas of Canada, spring arrives late, the growing season is short and there is risk of frost during the growing season. There is no large, continuous area suitable for cultivation; for the most part soil exists in depth only in river valleys or in pockets near the coast, and where it does exist in depth it often suffers from poor natural drainage.

Agriculture is best developed along the west coast near St. George's, in the Humber valley near Corner Brook, and on the Avalon peninsula, especially near St. John's. Dairy farms are found near most of the large towns on the island. Outside these areas, commercial farming is almost nonexistent and agriculture is carried on chiefly in kitchen gardens. In connection with gardening, the numerous part-time farmers generally keep a cow, a few sheep or goats and some chickens. Hay and pasture land constitutes over half of Newfoundland's arable acreage, but addi-

tional feed must be imported. Oats, the principal grain crop, is usually cut green for fodder because grain seldom matures properly, except on the west coast. The most common vegetables grown are potatoes, turnips, cabbages, carrots, parsnips and beets.

Successive governments have attempted to stimulate farming. The commission of government began a land settlement scheme in 1934 to provide employment for families on relief. These settlements, comprising several hundred families established in eight different localities, met with little permanent success. A demonstration farm was established near St. John's, where students were given practical instruction in crop production and livestock raising. A soil survey program was actively pursued with the aim of opening new agricultural land. After World War II a settlement scheme for veterans was undertaken in the upper Humber valley. In the second half of the 20th century the possibility of economically draining the extensive flat bogs of Newfoundland promised a moderate expansion of agriculture. Tests have been conducted on the Avalon peninsula to prove the efficiency of growing large quantities of hay for beef cattle. Expansion may take place also in the growing of blueberries, which are frozen and shipped to the U.S. market in considerable quantity. The government-sponsored rural-electrification program in the 1960s brought electricity to many communities for the first time.

Forestry.—Forests on the island of Newfoundland constitute about 35% of the total area. The major products based on these forest resources are pulp and paper, chiefly newsprint. Forest industries at mid-20th century contributed about 32% of the total Newfoundland income. There are two large pulp and paper mills in the province, which develop their own hydroelectric power near their mill operations. The location of the pulp and paper mills at or near tidewater gives them transportational advantages that make them fully competitive in the world market. Virtually all of their production is exported to foreign countries. A detailed study of the forest industries was made in 1955 by a government-appointed royal commission. The report indicated that there remained on the island and in Labrador sufficient untapped reserves of timber to supply a third pulp and paper mill with a capacity of about 500 tons a day.

The production of lumber is carried on in more than 600 small sawmills scattered throughout the island. Most of the lumber is roughly finished for local consumption. Several other small industries are based on forest resources. Among these are producers of fiberboard, flooring, plywood and furniture.

Mining.—The mineral industries, based on a comparatively few producing mines, accounted for approximately 13% of the Newfoundland income at mid-20th century.

Iron ore is mined at Bell Island. Part of the ore moves to Sydney, N.S., where steel is produced, and the rest is exported. Zinc, lead, copper and small quantities of gold and silver are produced at Buchans. The ore is concentrated at the mine site but is sent to export markets for refining. Most of Canada's fluorspar is mined at St. Lawrence on the Burin peninsula. The fluorspar is shipped to Arvida, Que., for use as a flux in producing aluminum, and to export markets. Copper is mined at Little Bay and an old copper mine at Tilt Cove on the northeast coast has been reopened and brought back into production for the first time in 36 years.

Limestone is actively mined at several places. The quarry at Aguathuna on the west coast ships limestone to Sydney where it is used as a flux in the iron and steel industry. In the vicinity of Corner Brook, limestone is quarried to supply the cement plant. From a quarry at Cobb's Arm in Notre Dame bay limestone is shipped to Botwood and St. John's. Gypsum is mined on the west coast at Flat Bay for the manufacture of wallboard at the Corner Brook plant. There are several mineral prospects on the island, such as the asbestos deposits at Baie Verte, and their development was accelerated in the 1960s.

Development of the immense reserves of iron ore in Labrador began after World War II. A railway line was completed in 1954 from Sept Îles to the ore fields. The Twin Falls power development project to provide power for the Wabush and Carol lakes iron projects began production in 1961 and the first open-pit iron mine was opened at the Carol project in 1962.

Fisheries.—Among the primary industries the fishery has declined in value relative to the others, but still constitutes a major source of income for Newfoundland. The main products are dried salt codfish and frozen filleted fish of various species. Inshore fishing is mainly concentrated along the northeast coast, and codfish is the principal species caught. Bank fishing with larger vessels, chiefly draggers, is carried on from settlements on the northeast and south coasts. By this method of fishing a number of species are obtained, including cod, haddock, halibut, flounder and rosefish.

Lobsters are procured on all coasts of the island, but are most abundant along the west coast. The herring fishery is concentrated in the Bay of Islands-Port au Port bay area on the west coast and in Fortune bay on the south coast. Salmon occurs in all Newfoundland waters and, although not plentiful, it is fished in many areas for a minor source of income.

Various fishery products are processed for market in different ways. Part of the catch of codfish is salted and dried artificially or in the sun, and the rest is fast-frozen in filleting plants. Many of the other species except salmon and herring are also fast-frozen. The salmon is sold fresh-chilled or canned and most of the herring is pickled. The frozen filleted fish is exported to the United States, while the dried salt codfish is shipped to various European and West Indian markets. Because the markets for dried fish appear capable of greater expansion in the near future than the markets for frozen fish, the emphasis in Newfoundland is on the construction of artificial drying plants rather than freezing plants. There is no shortage of fish resources and the industry may expand its production under more modern and efficient methods of catching and processing the fish.

COMMUNICATIONS

Water transportation has long been of utmost importance in linking the hundreds of small Newfoundland settlements. The Canadian National railways' coastal steamship fleet serves the larger trade centres and the isolated communities on all three coasts. Several scheduled shipping services connect St. John's and Corner Brook with various mainland and overseas ports. A daily ferry service across Cabot strait is operated by the Canadian National railways as part of the railway system.

The main line of the narrow gauge railway runs from Channel-Port aux Basques on the west coast, through Corner Brook, Grand Falls, and Gander to St. John's on the east coast. Branch lines connect Lewisporte, Bonavista, Carbonear and Argentia with the main line. The whole system totals a little more than 700 mi. of track. The Trans-Canada highway follows a route similar to that of the railway. Much of the highway is gravel-surfaced, but all will be paved in the final construction stage. The road network of Newfoundland is still rather rudimentary. In the early 1960s there existed only 400 mi. of paved highway on the island. Nevertheless, road construction has been vigorously pursued and most of the larger settlements can be reached by land transportation. Frequent airline service is provided between the mainland and St. John's, Gander and Stephenville and between St. John's, the Burin peninsula and St. Pierre Island.

The Canadian National telegraphs serve nearly all of Newfoundland's scattered settlements, far more than are served by telephone. Several independent telephone companies provide service within the more populated areas. About 75% of the island's population has telephone service available. Newfoundland is the landing place of more than a dozen transatlantic cables.

Radio and television services are provided chiefly by the Canadian Broadcasting corporation. This publicly owned system operates radio stations in St. John's, Gander, Grand Falls and Corner Brook. In co-operation with the United States armed forces the corporation operates television stations at Stephenville and at Goose Bay, Labrador. In addition, there are several privately owned radio and television stations. A satellite-tracking station operated in connection with the U.S. space exploration program was opened near St. John's in 1961.

See also references under "Newfoundland" in the Index.

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(J I. C.; G. TR., C CY.; C. N. F.)

NEW GUINEA, the world's largest island after Greenland, stands on the Sahul shelf, a northward submarine extension of the Australian continent. Its total area is 299,310 sq.mi.; 338,878 sq.mi. excluding islands administratively attached to political units on the island. At its nearest point the island is only 100 mi. from the Australian mainland. Political control of New Guinea was divided between Australia and the Netherlands until 1962, the boundary being the meridian of 141° E., except for a short section in the south along the Fly river.

The western portion of the island, forming the Dutch colony Netherlands New Guinea, had been claimed by the Indonesian republic ever since the latter's creation in 1949. By agreement (Aug. 15, 1962) between the Netherlands and the Indonesian republic, negotiated through the United Nations, administrative authority over this territory, known to the Indonesians as Irian Barat (West Irian), was transferred to Indonesia on May 1, 1963 (see *History: West New Guinea* below). Eastern New Guinea comprises the territory of Papua and the trust territory of New Guinea, both administered by Australia. West New Guinea includes the Schouten Islands, Japen Islands, Raja Ampat Islands and Salawati Island. Papua territory includes the D'Entrecasteaux Islands and the Louisiade archipelago (*qq.v.*) and the Trobriand Islands; New Guinea trust territory includes the Admiralty Islands, New Ireland, New Britain and Bougainville (*qq.v.*) and Buka.

PHYSICAL GEOGRAPHY

Geology.—The geological structure of New Guinea is complex and little known. According to the Dutch geologist R. W. van Bemmelen, the island forms part of a great circum-Australia mountain system, traceable southeastward through the Solomon Islands and New Zealand. Other geologists have detected a similarity with the threefold structure of the Indian subcontinent, in which the central mountain complex of New Guinea resembles the Himalayas, and the Digoel-Fly lowland the Indo-Gangetic plain, while the rigid Deccan plateau finds its counterpart in the Australian continent. Little is known about the pre-Tertiary history of the island. Paleozoic rocks occur in parts of the central mountain system of western New Guinea but large areas are occupied by relatively young rocks overlying a pre-Tertiary basement complex which is exposed in the cores of many of the mountain systems. Van Bemmelen regards the metamorphic rocks of Japen Island in Geelvink bay and of the Cyclop (or Cyclops) mountains as remnants of an old Melanesian continent to the north, sediments from which were deposited in a great geosyncline which occupied much of New Guinea from Silurian to mid-Tertiary times. This long period of subsidence was interrupted by a number of orogenic movements and the intrusion of plutonic rocks. Highly metamorphosed rocks associated with these intrusions occur over large areas of the central mountain complex, in the Owen Stanley range and in the Northern ranges (or Northern Dividing range, including the Van Rees range and the Foja range), but these rocks were already intensely deformed before the plutonic intrusions occurred. The present vigorous relief of much of the central and eastern portions is largely the result of intense orogenic movements which, beginning in the Oligocene, extended into the Pleistocene.

Much of the central portion of the island and the entire eastern "tail" is occupied by a remarkable mountain system. Secondary and Tertiary rocks are folded in an east-west, or east-southeast to west-northwest direction. There is no evidence of overthrust or nappe structures and the main movements appear to have been vertical; folding appears to have been secondary to the raising up of the old pre-Tertiary basement complex. The central mountain system is a great horstlike structure with upturned edges and abrupt step-faulted margins to the north and south, the latter being extremely precipitous. The Northern ranges, which are separated from the central mountain system by a broad depression of Tertiary deposits thickly overlain by alluvium, reveal a somewhat similar structure in which the pre-Tertiary basement is exposed; it is bordered on the north by another east-west depression which reaches the sea on either side of the fault-bounded Cyclop mountains. To the south the Digoel-Fly lowland, regarded by T. W. Edgeworth David as the main axis of the depression, is a low dissected plateau sloping southward from the central mountain system, in which the rivers have cut wide valleys. Farther south the pre-Tertiary basement appears in a number of low hills near Merauke, marking in Van Bemmelen's opinion the margin of the Australian continent.

The eastern "tail" differs from the central mountains in having been much more actively volcanic in the geologically recent past and it still contains a number of active volcanoes. Active volcanism is also present in a chain of islands off the northern coast curving eastward into New Britain and New Ireland. Widespread coral limestones occur in many outlying islands off the northeast coast.

The western peninsula, the Vogelkop or Bird's Head, by contrast consists of lightly folded Tertiary rocks, more strongly folded in the low northern mountains where the pre-Tertiary basement again appears. Along the north coast is a zone of recent volcanism, a continuation of the volcanic arc of the Indonesian island of Halmahera in the Moluccas, which contains the volcano Umsini in the Arfak mountains.

Physiography.—Three major divisions of the island can be distinguished, each containing several structural elements; these are generally topographically continuous from one division to another, although their structural relations are far from clear. The Vogelkop is almost completely cut off from the mainland by the shallow Teloek Beraoe (McCluer gulf); to the north is a mountain complex. An extensive lowland borders the gulf and a narrow neck of mountains connects with the Northern ranges and the Snow mountains in the body of the island. Other isolated mountains appear in the Bombarai peninsula to the south of the gulf. The trend of the northern Vogelkop mountains is continued in the island of Japen in Geelvink bay and isolated mountains along the north coast (Cyclop mountains).

Elsewhere the north coast of the body of the island is bordered by a plain, rising southward to the complex Northern ranges; the ranges east of Sepik river constitute a topographic continuation. South of the Northern ranges lies a great median depression, the so-called Lake plain (Meervlakte), occupied by the Rouffaer and Idenburg rivers, tributaries of the Mamberamo which flows to the north coast; a low sill separates this zone from the similar extensive lowland of the Sepik river. To the south of this median depression is a great mountainous zone about 100 mi. in breadth and still little known. It consists of a series of ranges trending roughly east to west and arranged in echelon formation. These include the Nassau and Orange (Oranje) ranges, forming the Snow mountains, which are continued eastward in the Star (Sterren) and Digoel ranges and, in the Australian-administered territories, in the Hindenburg, Victor Emanuel, Muller and Bismarck ranges. The headstreams of the Digoel river and Fly river have carved great gorges through several ranges, many of which rise above 10,000 ft. Much of the Snow mountains lies above 12,000 ft., and the system rises above the snow line (about 14,500 ft.) in a number of great peaks. Carstensz top (16,535 ft.) is the highest point in the whole of the southwest Pacific; it was climbed in 1937 by the A. H. Colijn expedition which approached from the south. The crest of the system lies on the southern side and there is a series of precipitous drops to the alluvial lowlands of the southern coast. Eastward the foothill zone becomes broader, and in western Papua it is punctuated by a number of ancient volcanic

mountains; one of these extinct volcanoes, Mt. Bosavi (Besavi) rises to 9,500 ft. To the south the Digoel and Fly rivers flood enormous areas during the period from October to April. The Fly river is actively building up its delta.

The tail is marked by a change of trend of the main structural elements. Volcanic activity reappears in a string of islands off the north coast, and is continued through the "Rabaul arc" and into the Bismarck archipelago. Ranges east of the Sepik and in the Huon peninsula, together with the Ramu and Markham valleys, continue the topographic features of the northern portion of the main body. Near Mt. Hagen the central cordillera system becomes narrower and is penetrated by several broad valleys, but it broadens eastward in the Bismarck range of the trust territory, where Mt. Wilhelm (15,400 ft.) also rises above the snow line. The foothill zone to the south reaches the coast at the head of the Gulf of Papua, and to the east the Owen Stanley range (Mt. Albert Edward, 13,100 ft.) takes up most of the tail, but along the Port Moresby coast there are numerous small and swampy coastal plains. About 148° E., the west-northwest to east-southeast direction is resumed, and the transition is marked by further volcanic activity. In 1951 a pelean eruption (*see* VOLCANO) of Mt. Lamington (5,850 ft.) caused much loss of life. Volcanicity continues in the D'Entrecasteaux Islands and in Buka and Bougainville islands.

Climate and Soils.—New Guinea experiences the uniformly hot and humid climate of equatorial regions, but elevation produces a marked lowering of temperature, and the highlands have a much modified climate. Rainfall is heavy, only a small part receiving less than 60 in. annually. On the north coast precipitation is generally about 100 in., but many places receive much more. November–April is the season of the northwest monsoon, which brings heavy rain to all parts and especially to the north coast of New Guinea and the Bismarck archipelago. May–October is the season of the southeast trades, which bring torrential rain to the south coasts of New Britain and New Ireland, and those parts of the main island that stand athwart the winds. In the Merauke district of western New Guinea and in the vicinity of Port Moresby the period of the southeast trades is a dry season; Merauke receives about 60 in. annually and Port Moresby only 40 in., though precipitation increases rapidly to east and west.

Temperatures at lowland stations fluctuate slightly around the 27° C. (80° F.) mark throughout the year; the annual range is seldom more than about 8° C. (15° F.) and is less than the diurnal range. Stations on the northern coasts show a typical equatorial regime with temperature maxima following the equinoxes; temperatures in March or April and in October or November average around 27.8° C. (82° F.) falling to around 26.7° C. (80° F.) in July and January. On the south coast, where there is a pronounced dry season, the annual range is greater; the highest mean monthly temperatures are recorded in December and January, attaining 27.8° C. (82° F.), and the lowest in June and July when they fall to about 25.6° C. (78° F.). The daily range is also greater on the south coast, particularly during the dry season.

Under the continuously high temperature and the heavy, well-distributed rainfall, the soils are badly leached and offer limited opportunities for agriculture. Coastal soils are often too sandy or coralline. The best soils are those of the volcanic areas, the Gazelle peninsula of northeastern New Britain being outstanding.

Vegetation.—The natural vegetation of New Guinea comprises a great wealth of plant species, and much of the island is still botanically unexplored. Vestiges of the eucalyptus vegetation of Australia are found in parts of southern Papua, but Indo-Malayan elements are generally dominant. More than two-thirds of the island is forested. Lowland rain forest occurs widely below 6,000 ft.: it exhibits the typical multistory development of equatorial rain forest, with numerous epiphytes and woody vines. Many of the larger trees have extensive buttress roots, such as the numerous species of *Dipterocarpus*. In areas of defective drainage the rain forest is replaced by swamp forest, and along the coasts and in tidal estuaries mangroves and nipa palms abound. Another common tree of the coastal and riverine swampy tracts where the water is not brackish is the food-supplying sago palm, which covers extensive areas along the Fly, Sepik and Ramu rivers. Above 3,000 ft. the rain forest in some valleys is replaced by a more mixed forest containing various species of the coniferous genera *Podocarpus* and *Araucaria*. Several of the highland valleys are not forested, but carry a grassland vegetation which is probably as much man-made as a product of nature; cutting and clearing of the forest and subsequent burning of the debris greatly encourage the spread of the tough and pernicious spear grass, or kunai. As cutting and burning are widely practised by the indigenous peoples in their system of shifting cultivation, the rain forest has been considerably modified in many areas. In certain areas on the southern margin of the island, where the rainfall is markedly seasonal, grasslands with occasional trees also occur; an extensive tract of such savannalike vegetation extends from the middle Fly toward the western New Guinea border. At about 6,000 ft. the rain forest is replaced by temperate rain forest, in which the trees are thickly encrusted with lichens and festooned with streamers of moss; the forest floor consists of a layer of moss and decayed vegetation many feet thick. At about 11,000 ft. a specialized alpine forest with stunted conifers, tree ferns and shrubs replaces the temperate rain forest, the limit of tree growth being at about 12,000 ft.

Animal Life.—The fauna of New Guinea shows strong Australian affinities, particularly among the mammals; of more than 100 species, all are marsupials except the echidna or spiny anteater (a primitive egg-laying mammal also found in Australia) and the bats and introduced rodents. The New Guinea environment, however, has greatly encouraged the development of arboreal forms; the tree kangaroo is the largest indigenous mammal. The birds include many representatives of the principal Australian families, but there are also numerous species from the Malayan region, and many remarkable endemic species. Perhaps the best known are the birds of paradise, whose brilliant and colourful plumage made them much sought after in former times. Their capture and export, however, is now rigorously prohibited. (D. W. F.)

ANTHROPOLOGY

New Guinea is a region of considerable racial and cultural diversity. Before 1939 some research was carried out in wide-

NEW GUINEA AND ADMINISTRATIVELY RELATED AREAS

separated areas along the coasts and the Fly and Sepik rivers, and on some of the adjacent islands: the Bismarck and Louisiade archipelagoes, and the Trobriand and D'Entrecasteaux islands. After 1948, a number of intensive studies were made, especially in the central highlands, where the population exceeds 500,000 and where the cultures differ from those of the Sepik to the north of these highlands and of the Fly and Strickland rivers to the southwest.

Racial Types.—The view that the inhabitants of New Guinea must be closely related to the Negroes of Africa, because of their dark skin and eyes, frizzly hair and long heads, is no longer valid. In general, they have a distinctive serological pattern which excludes affinity with African Negroes, as well as with Indonesians, Polynesians, Mongolians and Caucasians. The eastern extremity of New Guinea may be equated with Melanesia. Ethnic links with Australian aborigines are unlikely. The natives are not predominantly dolichocephalic; medium and short skulls occur and also light skins. Stature is short, about 5 ft. for highlanders and slightly taller for coastal natives. Pygmoid groups (usually called Negrito) occur sporadically; they differ serologically from the majority of the New Guinea people and also from other world groups so far examined. (*See* PAPUAN; NEGRITOS.) The population is probably the result of migrations and mixture, but whence and when they came is unknown.

Cultural Characteristics.—The languages spoken may be divided into two groups: Melanesian and the so-called Papuan or non-Melanesian. Those falling within the first category are found in many of the eastern island clusters, in the Schouten Islands northeast of Wewak, in the Markham valley, and in some villages along the northern coast. Papuan types are many; they differ from Melanesian in vocabulary and grammar, and the number of linguistic stocks is unknown.

Despite the great diversity of cultural patterns in New Guinea, the economic, social and political organization is basically similar throughout the island and has much in common with that in Melanesia to the east. Chieftainship is rare and leadership is often based on age and achievement. Widespread systems of ceremonial exchange occur; initiation ceremonies are elaborate and are, in many areas, associated with ceremonial clubhouses for men.

Except for a few unfavourably situated communities, the economy is one of subsistence horticulture and pig keeping. Sweet potatoes are the staple on the highlands; elsewhere taros, yams and bananas are important. Among the Abelam of the Sepik district very large yams are grown, decorated at harvest, and distributed in competitive exchanges by the men. In general, rights over land are vested in kin groups. The leader usually decides when bush is to be cleared and allocates plots among dependents who may lend sections to other kin, affines and friends. The elementary family is an economic unit, but in situations demanding more labour, such as clearing, fencing, housebuilding and canoe construction, neighbours and kin co-operate. Underlying such assistance is the principle of reciprocity.

Natural resources differ considerably and a good deal of local specialization has developed. Much of the trade is conducted through the institution of the "ceremonial partnership" or "trade friendship" in which two men enter into a compact to exchange necessaries and gifts and extend mutual hospitality and protection. The people of Karkar Island, north of Madang, obtain vegetables from the mainland in return for fish; the Motu near Port Moresby used to journey west to the Gulf of Papua to exchange pots for sago; the Wogeo of the Schouten Islands export their nets and Canarium almonds to the mainland for tobacco, utensils, shells, plumes and cosmetics. The Tubetube (Engineer group) is poor in all resources except clay deposits; the inhabitants trade their pots for what they need, and act as middlemen over a wide area. Shells of different kinds function as stores of wealth and to some extent as exchange media in restricted contexts. Such valuables, along with pigs and food, constitute wealth, but only confer prestige when distributed to others; *e.g.*, at feasts, rites, in marriage payments and ceremonial exchange. A classic example of the last, described by B. K. Malinowski, is the *kula* of the Massim, linking island communities in a circuit of exchange in which red shell necklaces are handed on from partner to partner in a clockwise direction in return for white armlets. Long overseas voyages for this purpose are made and opportunity is taken to trade in food and artifacts, many of which are of very fine workmanship. It is impossible to do justice here to the richness of New Guinea art, particularly in the Gulf of Papua, the Sepik district and the Bismarck archipelago, but notable are the carvings, masks and superbly painted façades of the Abelam clubhouses, the fretted prow-boards of the Trobriands, and the delicately incised lime gourds, spatulas, daggers and shields of the Massim and Sepik. Apart from the production of polished greenstone blades, the highlands are relatively poor in the graphic and plastic arts but are noted for the glowing headdresses of bird-of-paradise plumes worn by the men on ceremonial occasions.

Social Organization.—Villages are usually small with populations ranging from 50 to 300, but larger groupings of 500 to 1,000 occur in the Sepik area. The settlement pattern varies: houses may cluster in a compact group and are sometimes palisaded (eastern highlands), or encircle or line a ceremonial ground (Trobriands and the Iatmul on the Sepik river). In the central and western highlands the homestead pattern prevails. Whatever the distribution of huts, it is common for close kin (usually connected unilineally) to build near one another. Sometimes a hamlet, village or neighbourhood consists only of the male members of a clan or lineage with their wives and children; sometimes it is composed of a number of clans or clan sections, and members of the community are linked by cognatic and affinal ties.

In much of the Bismarck archipelago and Massim area, descent and inheritance are matrilineal, but on the mainland it is much more difficult to generalize. In some communities, such as the Garia of Madang, unilineal descent groups are only weakly developed, and a man maintains relations with a wide range of kin. Nonunilineal or ambilineal descent, in which membership can be claimed in the descent groups of either parent, has been reported in what was formerly Netherlands New Guinea and among the Huli (central highlands). On the whole, most of the kinship systems so far studied show a bias toward a patrilineal reckoning of descent, but there is considerable flexibility in affiliation; genealogies are of shallow generation depth, and great importance is attached to affinal and uterine relationships.

The village is an autonomous political unit. Intercommunity relations are for the most part characterized by hostility and fighting, with intermittent periods of truce; alliances with neighbours are often temporary. Distinctions of rank occur in only a few areas (northern Massim and Manam Island); elsewhere societies are egalitarian, and status is determined by kinship, age and achievement. With few exceptions authority is vested in the elders of small localized clans or subclans and they act as an informal council in matters affecting the community as a whole. Among these, certain individuals achieve a dominant role as leaders on the basis of prowess in warfare, oratory and especially the ability to accumulate, manipulate and distribute wealth. They act as entrepreneurs in economic activities and rituals, and are able to exercise some influence in the settlement of disputes.

Ritual and Belief.—These vary, but there is widespread belief in spirits. They are frequently associated with parts of the bush or rivers; they may assume the guise of animals; and, along with ancestors, may be impersonated in initiation ceremonies. Fully developed ancestor cults do not obtain, except perhaps in Manus (in the Admiralty group), but a belief in spirits of the dead appears to be universal. Sacrifices are sometimes made to them in connection with warfare, gardening and hunting; and mortuary ceremonies are often complex, involving the distribution of food and valuables. Fertility cults associated with sacred flutes occur on the highlands; and nearly everywhere elaborate initiation rites for men take place. Complex systems of productive magic for economic and other activities are typical, and belief in sorcery and black magic is also widespread. Indeed, accusations of sorcery are among the most frequent causes of intervillage hostilities.

Cultural phenomena of New Guinea and of much of Melanesia are the so-called cargo cults (*q.v.*), of which the Vailala Madness (rebellion) of the Purari delta and the Taro cult of the Orokaiva

people near Buna were early examples. During and after World War II many forms of these cults appeared; in general, they postulate the disappearance of the Europeans and the acquisition of their cargo (wealth) by the natives. (P. M. K.)

HISTORY

Early European Contacts.—For 400 years the history of New Guinea is of discovery, exploration and tentative annexation, as one European nation after another led the world in navigation and commerce. A Portuguese, Antonio d'Abreu, sighted the coast in 1512, but discovery is usually attributed to the Spaniard, Jorge de Menezes, who landed on the north coast in 1527. Inigo Ortiz de Retes gave New Guinea its name in 1545, and claimed it for Spain. The subsequent supremacy of Dutch sea power brought William Jansz (1605–06), Luis Vaez de Torres (1606), Jacques le Maire and Willem Schouten (1616) and Abel Tasman (1642). The Dutch East India company claimed a large, undefined part of the mainland for the Netherlands in 1660, but failed to establish a profitable trade.

William Dampier (1699–1700) and Philip Carteret (1767) were the first Englishmen to navigate these waters, and charted the islands now known as New Britain, New Ireland and Buka. Later English visitors were James Cook (1770), T. Forrester (1774), Lieut. T. G. Shortland (1788–89), J. Hunter and J. McCluer (1791). New Guinea came within the monopoly area of the English East India company, which for some years after 1793 maintained a garrison at Restoration bay. A claim of annexation was made, but nothing came of it. L. A. de Bougainville initiated a series of French expeditions in 1768. In 1828 the Dutch government erected Fort de Bus, and declared northwest New Guinea part of the empire. Twenty years later, the frontier was stated to run from Cape Bonpland to the north coast.

From the 1840s European interest in the rest of the island steadily increased. The most notable explorers of this period were F. P. Blackwood (1842–46), Owen Stanley (1846–50), Charles Yule (1846) and J. Moresby (1873). Both Yule and Moresby claimed the southern coast for the British empire, but the imperial government repudiated their actions. The first German investigators were Gustav Schleinitz and Otto Finsch. E. Teysmann, P. van der Crab and others led expeditions on behalf of the Dutch East Indies government. A pioneer scientific survey was made by A. R. Wallace in 1858, and in the same year the Utrecht Mission society settled at Port Dorey. Twelve years later the London Missionary society sent Samuel MacFarlane and A. W. Murray from the Loyalty Islands to Darnley Island in Torres strait. A station opened at Port Moresby in 1874 became the centre of mission activity on the mainland, to which came during the 1870s W. G. Lawes and James Chalmers (*q.v.*), two outstanding personalities.

By this time, expressions of the European interest in the riches of New Guinea had become more definite. From the 1840s miscellaneous traders, often unscrupulous and belligerent, took trepang, cedar, ebony, sandalwood, rubber, pearls and copra. Two abortive enterprises, the New Guinea company (1867) and the New Guinea Prospecting association (1871), were formed in Sydney; wild stories of gold discoveries caused a rush to the Mai-Kusa river in 1877. As so often happened in the history of New Guinea, the resources of the island had been exaggerated far beyond reality.

From 1857, when the Hamburg firm of J. C. Godeffroy was established in Samoa, German commercial power in the South Pacific had steadily grown. In 1880 the Deutsche Seehandelgeschaft was formed in Berlin to exploit New Guinea resources. This expression of German interest considerably strengthened opinion in Australia that Great Britain should annex eastern New Guinea. There was, too, fear of French expansion, and growing hope among Australian capitalists that the island promised riches. The consequent feeling reached a climax in March–April 1883 when Sir Thomas McIlwraith, premier of Queensland, caused eastern New Guinea to be annexed in the name of Great Britain. The British cabinet again determined to disallow annexation. However, in 1884 Bismarck announced that he would protect German traders in the Pacific, where they possessed commercial preponderance. This step moved the British government to authorize the declaration of a temporary protectorate over an undefined area of southeastern New Guinea (Nov. 6, 1884). Ten days later the German flag was raised on the northeast coast.

West New Guinea.—The adjustments of 1884–85 established the meridian 141° E. as the division between West (Netherlands) New Guinea and the areas annexed by both Germany and Great Britain, a division slightly altered in 1895 by the substitution of the Fly river as part of the boundary with the British territory.

The basis of the original Dutch claim to New Guinea had been the nominal suzerainty of the sultan of Tidore, a Dutch dependency, over a vague area of the western part of the island. Southwest New Guinea was officially purchased from the sultan by the Netherlands in 1905. West New Guinea was attached to the Amboina residency in 1911, and after many years' negotiation, the northwest division was legally transferred to the Netherlands when Indonesia became independent in 1949. During World War II the Japanese conquered all but the extreme southeast coast line. Gen. Douglas MacArthur's headquarters were established at Hollandia (Kota Baru) for a time.

Following the establishment of Indonesia, the new republic asserted that West New Guinea (Irian Barat; West Irian) should be released by the Dutch. Indonesia pressed its claim with great vigour throughout the 1950s; the issue became important in the republic's domestic politics and exacerbated its relations with the Netherlands and Australia. Matters came to a head early in 1962, when Indonesia threatened to invade West New Guinea unless its administration was quickly handed over by the Dutch. A number of armed clashes followed between Dutch and Indonesian forces, but by the end of July the two countries had negotiated an agreement (signed at UN headquarters Aug. 15, 1962) under which the Dutch handed over the administration of West New Guinea to the UN on Oct. 1, while provision was made for the administration to be transferred to Indonesia on May 1, 1963, and for a plebiscite to be held by 1969 to decide the area's future. Accordingly, Indonesia took over the administration on May 1, 1963.

UN Trust Territory.—The area annexed by Bismarck in 1884 comprised the Bismarck archipelago (New Britain, New Ireland and the Admiralty islands), the northern Solomon islands and the mainland between 2° 15′ S. and 8° S. and 141° to 148° E. The mainland division was known as Kaiser Wilhelmsland. In May 1885 the Neu-Guinea Kompanie was given an imperial charter of protection over the entire area. Rights of sovereignty and administration were vested in the company, although any laws had to be made by the German parliament. The company's early years were unsuccessful. The science of tropical agriculture was then insufficiently developed; native labour was inefficient; the importation of Chinese coolies became unworkable; disease killed natives, Europeans and cattle. At the company's request, its administrative functions were taken over by the German government between 1889 and 1893. The seat of government was removed from Finsch Harbour to Stephanscourt, then to Friedrich-Wilhelms Harbour (Madang), and finally to Herbertshöhe (Kokopo). The German government ultimately assumed full control in 1899 when Rudolf von Benningsen was appointed governor. The following years were marked by greater stability in the plantation economy. The chief crop was copra, which was harvested extensively along the coast and on the islands. Notable progress was made in various scientific inquiries such as botanical research, tropical medicine and anthropology.

Following the declaration of war in Aug. 1914 Australian troops landed on the eastern shores of the Gazelle peninsula. Within a week the Germans capitulated and until 1921 the *status quo* was maintained by the Australian military administration. Former German New Guinea was then assigned to Australia as a mandate under the League of Nations. The New Guinea act, 1920 (proclaimed May 1921), established a civil administration and introduced a new set of ordinances. These aimed at achieving justice before the law; preservation of rights of cultivation, barter, fishing and hunting; and protection of tribal institutions. The supply of opium, intoxicating liquor, ammunition and firearms to the natives was forbidden.

When Australia took over, only a small part of the territory

was under even partial control, but gradually district officers, patrol officers and the indispensable native constabulary pushed farther into the interior. An area would be put first under "partial influence," then "influence" and finally "control." Penetration was accelerated by the gold rushes to Edie Creek in 1925, and later to the headwaters of the Purari and Ramu rivers. Roman Catholic, Lutheran and Seventh-day Adventist missions were established south of the Bismarck ranges by the mid-1930s.

One problem facing the administration was the development of a trained civil service. Constant reorganization was necessary, and although a cadet system was instituted in 1926, the pressure of the gold rushes forced its suspension soon after, and it was not resumed until 1939. Copra remained the basis of the economy, but by 1938 experiments had also been made with kapok, tobacco, wood pulp and coir fibre; these were all grown on the islands rather than on the mainland. The administration aimed at strict and just control of the native indenture system, and attempted, during the later 1930s, to enforce a provision requiring the labourer's consent. Nevertheless, there was some criticism of this feature of the administration before the Mandates commission. Education lay chiefly in the hands of the missions. Central hospitals and medical patrols were established to protect native health.

In 1942 the territory was invaded and partially occupied by the Japanese. By April the civil administration was suspended in both Papua and the mandated territory and replaced by the Australian New Guinea Administrative unit. Following the Japanese surrender, civil administration was progressively restored between Oct. 1945 and June 1946, and since then the two sections have formed one administrative unit. On Dec. 13, 1946, the UN general assembly approved the agreement by which the trust (*i.e.*, former mandated) territory remained under Australian supervision.

Papua.—The administrative system established immediately after the declaration of a British protectorate over the southeast of the island (1884) provided that the Australian colonies should take political and financial responsibility, while Great Britain undertook to provide a special commissioner to lead the local government. This arrangement having proved unsatisfactory, it was altered by the British New Guinea (Queensland) act of 1887. Queensland (with the financial assistance of New South Wales and Victoria) was to supervise the administration and report back to the imperial parliament; after ten years this "joint control" was to cease through Great Britain's withdrawal, the area was to be at once formally annexed and a lieutenant governor appointed.

From 1887 to 1897 Papua was administered by Sir William MacGregor. With the assistance of a legislative and an executive council, both nominated by himself, he created a framework of government of which a notable feature was the role played by natives, both in the constabulary and as village police. Moreover, in administering justice an attempt was made to allow for native concepts. MacGregor determinedly tackled the essential features of colonial policy—native agriculture, land regulation, the protection of native labour and the preservation of the village unit. Although he has been accused of arrogance, his achievement appears, under the circumstances, to have been worthy of note.

From 1898 to 1903, during Sir George le Hunte's lieutenant governorship, control passed to the Commonwealth of Australia. The chief policy development was the improvement in health services. However, after the status and title of Papua were defined in the Papua act, 1905, a more lively interest appeared in Australia. This was expressed by the appointment of the 1906 royal commission, which emphasized the desirability of European investment and settlement. Liberal terms for long leasehold were offered to prospective settlers in a lands ordinance of the same year.

The next lieutenant governor (which office he combined with that of chief justice) was J. H. P. (Sir Hubert) Murray. As he held office for more than 30 years (1907–40) the extent to which his personality and abilities constitute the history of Papua was considerable. In pursuit of native welfare his basic policies were broadly the same as MacGregor's: for example, the Natives Plantation ordinance fostered indigenous agriculture and revenue—with some success, for in the following years not only copra but coffee, rice and rubber were grown by Papuans. The policy of indirect rule was kept to the forefront, and partially realized by the successful introduction of village councils. Financial stringency restricted provision of health and, even more, educational facilities.

Murray, however, was concerned not only with native welfare but also with economic development. During his term of office the number of acres under cultivation rose from 1,467 to 63,609. But these figures give a rather false impression, for economic progress never came as fast or as easily as Murray hoped and many people expected. The Australian market was insufficient to absorb the production of copra and rubber, hence there was a great need for cheap freighting of these products so they could compete in the world market. However, from 1921 to 1925 freight charges were forced up by the Navigation act, which required that all exports be shipped through Sydney, and limited competition among the shipping lines. Papua was barely recovering from the effects of the act, when the world depression of the 1930s dealt further severe blows. Gold and, to a lesser extent, copper added to the value of exports. But it was oil which aroused Murray's highest hopes: hopes which remained unrealized in the early 1960s despite tremendous sums spent in investigation.

The post-World War II years saw a quickening of official concern with Papua. In July 1945 the minister for territories, E. J. Ward, announced his intention to establish a new labour policy which would aim at the abolition of the indenture system—an ideal of Sir Hubert Murray. A new post of administrator of the combined territories was created, the office being held first by J. K. Murray and then (1952) by D. M. Cleland. The foundation of the School of Pacific Administration (1946) and the South Pacific commission (1947) represented further moves toward an efficient and informed administration. P. M. C. Hasluck, minister for territories from 1951, reversed earlier hints that R. G. Menzies' Liberal governments (1949–) might be partial to European, as against native, welfare. Nevertheless there developed various elements—a strong settler interest, native awareness of politics, an administration well-meaning but irredeemably paternalist—which threatened to join with economic instability to produce a difficult colonial situation. In Australia criticism of the administration and suggestions for any change in the island's political status were generally regarded with suspicion. (O. M. R.)

POPULATION

Despite the large size of the island, the population of New Guinea is scanty, a reflection of the extreme difficulties presented by the environment; the way of life of many New Guinea peoples makes dense populations impossible. The total population (1961 est.) of New Guinea, including that of several small island groups

Administrative divisions	Area (sq. mi.)	Population (1961 est.)		Administrative centre
		Indigenous	Nonindigenous	
New Guinea Trust Territory*	92,160	1,433,383	15,536	Port Moresby
Papua Territory	86,100	513,648	9,794	
West New Guinea	160,618	700,000	36,731	Sukarnapura (Hollandia)

*Includes area (23,273 sq. mi.) and population (233,239) of the Bismarck Archipelago and Buka and Bougainville Islands of the Solomon Islands), which constitute a part of the New Guinea Trust Territory.

within the former Dutch and the Australian-administered areas, was 2,709,092; this includes estimates of about 300,000 for areas of West New Guinea, and of almost 250,000 for areas in the Australian territories, not yet brought under firm administration. The total European population numbered about 36,000, of whom nearly half were in West New Guinea; total nonindigenous population was 62,061. The European proportion, however, was inflated by the inclusion of a large number of Eurasian immigrants from Indonesia in the Dutch statistics, in conformity with the practice of the former Netherlands Indies which recognized such peoples as Europeans. The remaining nonindigenous people are mainly Asians. In the Australian territories the Chinese are the most important elements in this group; they are mainly urban

shopkeepers and traders, and are most numerous in the trust territory, which is economically the most advanced part of the island. There are very few Chinese in West New Guinea and the Asian population consists largely of Ambonese and other Christian peoples from Molucca province, Indon., who were unwilling to remain in Indonesia when sovereignty was transferred in 1949.

The distribution of the indigenous population is very uneven, and large parts of the island are virtually uninhabited. The densest populations are found on the areas of better soil, particularly where derived from recent volcanic activity. Thus the island of New Britain in the New Guinea trust territory, and certain other small volcanic islands off the northern coast, have populations of above average density; certain of the valleys of the eastern highlands district are relatively densely populated, parts of the Chimbu area having a density of almost 300 persons per square mile. Such high densities are, however, quite exceptional. In West New Guinea the highest densities are found in the islands of Geelvink bay (Biak, Noemfoor and Japen) and in certain valleys of the central highlands.

The nonindigenous population is almost entirely urban, but all the towns are of small size; Rabaul in New Britain (New Guinea trust territory) has a population of (1958 est.) 8,400. Port Moresby (on the south coast of the tail of New Guinea), the administrative centre of the Australian territories, has a municipal population of (1961 est.) 22,243; the largest town in West New Guinea is the administrative capital of Sukarnapura (formerly Kota Baru) on the north coast, with about 14,100; Sorong (on the west coast of the island's "head"), the headquarters of the petroleum industry in West New Guinea, has 9,150.

ADMINISTRATION AND SOCIAL CONDITIONS

The trust territory of New Guinea and the territory of Papua form an administrative union under the control of the department of territories in Canberra. There is an administrator who is assisted by an administrative council which, until 1964, consisted of the administrator and six members of the legislative council (three of these being territorial officers and three being other members, of whom at least two had to be elected council members). Until 1964 a legislative council was empowered to make ordinances but these had no force until assented to by the administrator or the governor general, and its function was mainly advisory. After 1961 the legislative council had an unofficial majority; it was made up of the administrator as president, 14 official members drawn from heads of departments, 6 elected and 5 nominated indigenous members and 6 elected and 5 nominated nonindigenous members. Each of the nine administrative divisions of New Guinea territory and the six divisions of Papua territory provided an observer.

In 1962 a mission of the United Nations Trusteeship council visited the territories and urged an acceleration of progress toward self-government. As a result of the mission's report the territories established their own select committee on political development and recommended the creation of a parliament with an indigenous majority. In 1963 the Australian parliament passed a law providing for the establishment in 1964 of a house of assembly, composed of 10 official members, 44 members elected from a common roll and 10 nonindigenous elected members.

The administration of Netherlands New Guinea was exercised by a governor appointed by the crown and assisted by a council of heads of departments. There was a legislative council composed of 13 elected and 10 nominated indigenous members, and 5 Europeans. A number of local advisory councils were also set up, in which the indigenous peoples participated. There were six administrative divisions in Netherlands New Guinea. There were liaison officers at Port Moresby and Kota Baru (formerly Hollandia), respectively, to facilitate co-operation between the Dutch and the Australian administrations, and in the 1950s such co-operation increased.

By the 1962 agreement West New Guinea was administered by the United Nations Temporary Executive authority (UNTEA). This consisted of an administrator appointed by the secretary-general of the UN, assisted by departmental heads who were to be neither Dutch nor Indonesian. As many indigenous persons as possible were to be included in the administration, and others might be recruited from Indonesia. The administration was turned over to Indonesia in May 1963.

Taxation.—An income tax was levied in the Australian territories for the first time in 1959, import and export duties having previously accounted for the greater part of the locally derived revenue. Adult males in the Australian territories pay a personal tax, except where they are liable for an equivalent or higher tax levied by native local government councils. In Netherlands New Guinea income tax was levied on both indigenous and nonindigenous inhabitants.

Living Conditions.—The great majority of the indigenous population is engaged in subsistence farming and is organized in village communities which have a high degree of self-sufficiency. The employment of native labour is controlled by both administrations in order to prevent the disruption of native society, and to check the social problems that would arise from an over-rapid expansion of the urban areas, in which most of the opportunities for western-type employment are to be found. The total number of workers in paid employment in the late 1950s was only about 80,000, of whom more than half were employed in the trust territory of New Guinea; about 21,000 were employed in the territory of Papua and about 16,000 in Netherlands New Guinea. In the Australian territories the employment of indigenous workers is limited to two years, with the possibility of an extension for a further year except in the case of natives from the highlands recruited to work in the coastal lowlands. The European coconut and rubber estates account for almost half the total native employment in the Australian territories, but in Netherlands New Guinea most native workers were employed in building and construction, and in domestic service.

Minimum rates of pay for most classes of native workers are determined by ordinances in all territories; minimum standards of housing are also specified where this is provided by employers, as is usually the case. There are no real trade unions but there are workers' associations in the Australian territories, whose development is being encouraged by the administration.

Welfare Services.—The principal welfare services are provided by the respective departments of health and by the missions. In the Australian territories simple medical treatment is provided free in village dispensaries, and medical patrols penetrate into the outlying areas. Most of the larger centres have hospitals for indigenes operated by the administration, which also assists those operated by the missions through grants-in-aid and the provision of supplies. Broadly similar arrangements existed in the Netherlands territory.

Justice.—In the territories of Papua and New Guinea, courts for native matters deal with civil actions in which all the parties are indigenes, and with breaches of the native regulations; courts of petty sessions try summary and nonindictable offenses. The highest judicial authority is the supreme court of the territories of Papua and New Guinea. Internal order is maintained by the Royal Papua and New Guinea constabulary, whose native members are recruited by voluntary enlistment. Judicial organization in Netherlands New Guinea had much in common with that of the former Netherlands Indies, justice in certain areas being administered in conformity with native customary law.

Education.—The provision of educational facilities for a sparse and scattered population, much of which has limited contact with European activity, has presented many problems. Both administrations provide different facilities in the urban areas—where there has been the greatest contact with European activities—from those in the rural areas. Village schools tend to stress basic manual and technical skills, but in the Australian territories literacy in English is also a major educational aim. In the towns the facilities for elementary education are broadly similar to those of the Netherlands and Australia, respectively, but intermediate and secondary education is still on a rather limited scale. In West New Guinea education has been largely in the hands of the missions, whose activities were subsidized. In the Australian territories government schools are relatively more impor-

tent, although the missions still serve the largest number of pupils.

THE ECONOMY

The economic development of New Guinea has been greatly hindered by physical obstacles, a very limited labour supply of low productivity and, before World War II, the preoccupation of the two administrations with other interests. For the Netherlands, New Guinea was never more than a distant and thinly populated marginal territory of the populous Netherlands Indies, and Australia's main concern was with strategic considerations. It was only after 1945 that the two administrations allocated enough funds to make a modest rate of economic development possible. It was clear that for some time to come the main stimulus to economic development must be provided by nonindigenous peoples, but both governments were endeavouring to promote a higher level of indigenous economic activity, consistent with their policies of easing the transition from a multiplicity of self-sufficient village economies to a commercialized, territorial economy. The greater part of the native land is held in communal tenure; no land can be acquired from native owners except by the administration.

Agriculture.—Subsistence agriculture is predominant in the economic life of New Guinea, the traditional food crops including sweet potatoes, taros, yams and bananas, grown on small garden plots under a system of shifting cultivation, or bush fallow. Near towns, and where transport facilities are available, surplus foodstuffs may be offered for sale, and some cash crops are usually cultivated. In certain restricted parts of the island, generally on the coastal areas of better soil, European estate agriculture is found, and there the cultivation of similar crops has also been taken up by native smallholders, with governmental support. The greatest development of commercial agriculture largely directed to an export market is in the trust territory, where the growth of estate agriculture owes much to the former German administration. Coconuts are the most important crop; there are about 350 estates totaling 350,000 ac., approximately half of which are in New Britain and New Ireland; the greatest concentration is in the Gazelle peninsula. In the years after World War II there was marked increase in planting by native growers. A leading activity in the Gazelle peninsula is the cultivation of cacao by native growers organized into co-operatives, and by the early 1960s about 10,000 ac. had been planted. Cacao is also grown by small holders in other parts of New Guinea territory, and there is a small production of coffee and tea in the highlands. Labour shortages operate against the extension of estate agriculture, and the provision of labour for existing estates presents many problems. In Papua territory coconut estates are less numerous than in New Guinea territory, but about 30,000 ac. are under rubber. Ten estates in the vicinity of Kanosia and Sogeri, within easy reach of Port Moresby, produce about two-thirds of the annual output of about 4,000 tons. Commercial agriculture in West New Guinea is on a much more limited scale; the total area under coconuts is estimated at about 25,000 ac.

The only livestock kept by the indigenous population of New Guinea consists of pigs and poultry; cattle are few in number and are kept entirely by Europeans. Fishing is universal around the coasts, but commercial fishing is confined to the vicinities of the major settlements.

Mining.—The principal mineral product is petroleum, which is produced by a mixed British, Dutch and U.S. company in the Klamono, Wasian and Mogoi areas of the Vogelkop peninsula in West New Guinea. Petroleum was discovered shortly before World War II, but the search for further oilfields was disappointing. At the end of the 1950s production was about 500,000 tons a year but by the early 1960s it had declined to around 150,000 tons; crude oil is shipped from Sorong for refining in Australia. Considerable effort has been expended on the search for oil in the Australian territories, principally at the head of the Gulf of Papua. The main mineral product of the Australian territories is gold, which is largely produced from alluvial deposits in the Wau-Bulolo area in the trust territory of New Guinea, though a little is also produced from the Kieta area of Bougainville Island. Annual production of gold declined from almost 300,000 oz. in 1940 to less than 50,000 oz., and only one of the former eight dredges was still working in the early 1960s.

Manufacturing Industries.—Because of limited markets, lack of power and poor transport facilities, industrial development is on a very small scale and is largely confined to the processing of local raw materials. The main activities are copra drying and crushing, cacao fermentation and sawmilling; there is also a plywood factory in the Bulolo valley, one of the main centres of timber production. Small food and drink plants are found at Lae, Rabaul and Port Moresby and in some of the larger centres in West New Guinea. Manokwari on the Vogelkop peninsula has a sawmill, a shipyard and a small oxygen plant, and there are a number of industrial activities at Sorong in connection with petroleum production.

Trade and Finance.—The bulk of the trading activities has been in the hands of Europeans, and to a lesser extent of Asians. External trade is small and in both Australian and western territories there is an excess of imports over exports, indicative of the low level of economic development in the island. However, the adverse trade balance is comparatively slight for the trust territory of New Guinea, which generates by far the larger proportion of the exports of the Australian-administered portion of the island. The principal items in the export trade are copra and coconut oil, rubber, cocoa beans, gold and plywood. The trade of Papua territory is almost entirely with Australia, but the trust territory is heavily dependent upon the United Kingdom as a buyer for its exports. Crude petroleum, copra and nutmeg are the principal exports of West New Guinea. Both the Netherlands and Australian governments paid a large subsidy to maintain the administration of their respective territories.

Communications.—Transport facilities are poor or nonexistent over much of New Guinea, and the lack of such facilities is probably the biggest obstacle to economic development. There are no railways, and roads are confined to the immediate vicinity of the towns. After World War II there was a growing awareness of the desirability of a better road system, and there was a considerable extension of roads suitable for cross-country vehicles such as jeeps in the Australian territories. To some extent the shortcomings of land transport are made good by a remarkable development of air transport, but its commercial impact is slight. Most estates are dependent upon coastal shipping for their supplies and for transporting their produce. Commercial activity is thus largely confined to the immediate vicinity of the coasts. The principal ports are Rabaul, Lae, Madang, Kavieng (in New Ireland), Port Moresby, Salamaua and Samarai in the Australian territories, and Kota Baru, Sorong, and Merauke in West New Guinea.

There are about 6,000 telephones in the Australian territories. The Australian Broadcasting commission operates a station at Port Moresby. External communications are by means of radio telegraphy; an administrative radio telephone channel connects Port Moresby and Kota Baru. *See* also references under "New Guinea" in the Index. (D. W. F.)

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NEWHAM, one of the 32 London boroughs constituting Greater London, Eng., lies about 4 mi. (6 km.) E of the City. The Thames forms its southern boundary while to the west and east the Rivers Lea (Lee) and Roding broadly separate it from the neighbouring boroughs of Tower Hamlets and Barking; it has a short boundary with Hackney in the northwest and is bounded in the north by Waltham Forest and Redbridge. This outer London borough was established on April 1, 1965, under the London Government Act 1963 (*see* LONDON) by the amalgamation of the former county boroughs of East Ham and West Ham and small parts of Woolwich (north of the Thames) and Barking. Area 14.5 sq.mi. (37.6 sq.km.). Pop. (mid-1965 est.) 260,070. It comprises four parliamentary constituencies and includes the districts of North Woolwich, Silvertown, Custom House, Canning Town, Plaistow, Upton Park, East Ham, Manor Park, Little Ilford, Forest Gate, and Stratford.

Newham's northern and eastern parts are mainly residential. To the south the extensive Royal Docks predominates in a large Thames-side industrial area which concentrates on ship repairing, engineering, milling, gas, and manufacturing industries. In the northwest chemical and allied trades prevail and there are railway yards at Stratford.

Two major routes eastward from the City traverse the borough —Barking Road (an extension of the Commercial and East India Dock roads) and Romford Road (an extension of the Whitechapel, Mile End, Bow roads, and High Street), and, in the south, the Silvertown Way and the East Ham-Barking By-Pass connect with the Royal and Tilbury docks. The North Circular Road which enters Newham via Wanstead ends at North Woolwich where the free ferry conveys vehicular and passenger traffic across the Thames. Newham is served by the District and Central lines of the London Underground, and the Eastern Region of British Rail provides links with Tilbury, Southend, and East Anglia.

Newham was previously in the county of Essex (*q.v.*), and Wanstead Flats, on its northern boundary, is a detached portion of Epping Forest. In all there are about 400 ac. (162 ha.) of parks and open spaces including West Ham Park (77 ac. [31 ha.]) which is maintained by the Corporation of London.

The Abbey of Stratford Langthorne was founded in 1135 by William de Monfichet, Lord of Ham (Hame in the Domesday Book); this Cistercian house, which flourished for four centuries, was responsible for draining the riverside marshes and for developing agriculture and a substantial wool trade. The churches of St. Mary Magdalene (East Ham), St. Mary (Little Ilford), and All Saints (West Ham) date from the Norman period.

Few other buildings in Newham are more than a century old as the growth of the area was the result of the 19th-century industrial expansion of London. In the southwestern section especially, rapid and unplanned extension resulted in poor social and housing conditions. By the 1960s much of the substandard housing, which sustained widespread damage and destruction during World War II air raids, had been replaced by blocks of flats and modern estates, while new roads, schools, and clinics contributed to the changing face of the borough.

The West Ham College of Technology, opened in 1898, the largest of the educational establishments, is a regional college affiliated with the University of London, and the adjacent Passmore Edwards Museum contains items of natural and local history, and a collection of locally made Bow China. Lord Lister (1827–1912), who introduced antiseptic surgery, was born at Upton House, and the Jesuit poet Gerard Manley Hopkins (1844–89) was born at Stratford. Elizabeth Fry, the philanthropist, lived successively from 1809 till her death in 1845 at Plashet and Upton Lane House (both premises now demolished). (J. H. F. K.; Fx. S.)

NEW HAMPSHIRE, popularly known as the "Granite state," is one of the New England group of the United States and one of the original 13, being the ninth to ratify the constitution. It is bounded north by the Canadian province of Quebec; east by Maine, and by the Atlantic ocean; southeast and south by Massachusetts; west and northwest by Vermont (from which it is separated by the Connecticut river—the low-water mark on the west bank of the Connecticut is New Hampshire's west boundary) and by Halls stream, which separates it from Quebec. The state has an area of 9,304 sq.mi., of which 290 sq.mi. are water surface; it is the 44th state in size. The state flag of New Hampshire is a field of blue on which is a representation of the state seal surrounded by a wreath of laurel leaves with nine stars interspersed. The state flower is the purple lilac (*Syringa vulgaris*), the state bird (unofficial) the purple finch. The capital of New Hampshire is at Concord (*q.v.*).

PHYSICAL GEOGRAPHY

Physical Features.—In the north-central portion of the state which lies between approximately 42° 40′ and 45° 18′ N., and between 70° 37′ and 72° 37′ W., the White mountains (*q.v.*), a continuation of the Appalachian system, rise abruptly in several short ranges and in outlying mountain masses from a base level of 700 to 1,500 ft. The highest peak, Mt. Washington (*q.v.*), attains an elevation of 6,288 ft. The principal ranges, the Presidential, the Franconia and the Carter-Moriah, have a northeastern and southwestern trend. The Presidential, in the northeastern part of the region, is separated from the Franconia on the southwest by the Crawford or White mountain notch, about 2,000 ft. in depth, in which the Ammonoosuc and Saco rivers find a passage, and from the Carter-Moriah, parallel to it on the east, by the Glen-Ellis and Peabody rivers, the former noted for its beautiful falls. On the Presidential range, which is about 20 mi. in length, are Mt. Washington and nine other peaks exceeding 5,000 ft. in height. On the Franconia, a much shorter range, are Mt. Lafayette, 5,249 ft.; Mt. Lincoln, 5,108 ft.; and four others exceeding 4,000 ft. The highest peak on the Carter-Moriah range is Carter Dome, 4,843 ft.; but seven others exceed 4,000 ft. Separating Franconia and Pemigewasset ranges is the Franconia notch, overlooking which from the upper cliffs of Profile mountain is the Great Stone Face, immortalized by Nathaniel Hawthorne.

The part of the state that lies north of the White mountains is occupied by ridges and wide rolling valleys, the ridges rising occasionally to heights of 2,000 ft. or more. South of the mountains a plateaulike surface—a part of the New England uplands—extends from the intervales of the Connecticut river to the eastern border of the Merrimack valley. Between the Merrimack valley and the sea is the only low surface in the state; a considerable portion of this region is less than 500 ft. above sea level. The seashore, about 18 mi. in length, is mainly a low sandy beach. The only harbour is at Portsmouth near the mouth of the Piscataqua. About nine miles from the shore are the bleak and nearly barren Isles of Shoals, divided between New Hampshire and Maine.

The lakes and ponds, numbering several hundred, were formed by glacial action; and the scenery of many of them is scarcely less attractive than that of the mountains. The largest and most widely known is Lake Winnipesaukee, 20 mi. long and 12 mi. wide, dotted by 274 islands, mostly verdant. The rivers with their

BY COURTESY OF (TOP LEFT) NEW HAMPSHIRE STATE PLANNING AND DEVELOPMENT COMMISSION, (CENTRE LEFT) JOHN SWENSON GRANITE COMPANY; PHOTOGRAPHS, (TOP LEFT, BOTTOM RIGHT) ERIC M. SANFORD, (TOP RIGHT) AARON G. FRYER, (CENTRE LEFT) ROBERT SWENSON, (BOTTOM LEFT) DOUGLAS ARMSDEN

HISTORICAL, INDUSTRIAL AND CITY SCENES IN NEW HAMPSHIRE

Top left: Two-room cabin where Daniel Webster was born, near Franklin
Top right: Maple-lined mall at Orford, the only street in the town
Centre left: Shaping granite blocks in a quarry near Concord
Bottom left: Aerial view of Portsmouth showing mouths of the Piscataqua river
Bottom right: Aerial view of Manchester; the Merrimack river flows through the city

NEW HAMPSHIRE

BY COURTESY OF (TOP LEFT, BOTTOM LEFT) NEW HAMPSHIRE STATE PLANNING AND DEVELOPMENT COMMISSION. PHOTOGRAPHS, (TOP LEFT, BOTTOM LEFT) DICK SMITH, (TOP RIGHT, CENTRE RIGHT) ERIC M. SANFORD, (BOTTOM RIGHT) DON SIEBURG

VIEWS OF NEW HAMPSHIRE

Top left: Pinkham notch; in the background are the ski trails of Tuckerman ravine, Mt. Washington

Top right: The John Paul Jones house, Portsmouth, erected in 1758. It was a boardinghouse when Jones lived there while supervising construction of the "Ranger" for the continental navy

Centre right: Stack of pulpwood for paper mill on Upper Ammonoosuc river at Groveton

Bottom left: Mt. Washington cog railway taking tourists to the summit of the Presidential range. Mountains in the background are Adams and Jefferson. This railway was the first of its kind in the world and was later adapted for the Swiss Alps

Bottom right: The Old Man of the Mountain (Great Stone Face) in the White mountains is New Hampshire's best-known natural wonder

numerous falls and the lakes with their high altitudes furnish a vast amount of water power for manufacturing—the Merrimack, in particular, into which many of the larger lakes, including Winnipesaukee, find an outlet.

Climate.—The winters are usually long and severe, and the summers cool and fine. The mean annual temperature ranges from about 40° F. (about 4.4° C.) at only moderate elevations in the White mountain region and farther north to 47° F. (about 8.3° C.) at low altitudes in the southeast. The greatest extremes of temperature occur in the deep mountain valleys, where it sometimes rises to 102° F. or above in summer and falls to −38° F. or below in winter; higher up on the mountains it is never so warm, and along the seacoast both extremes are considerably less. The mean precipitation for the entire state is about 40 in. The distribution is even throughout the year, but summer and autumn are slightly wetter than winter and spring. Among the mountains and in the northern part of the state the annual fall of snow is from 7 to 8 ft., but in the southeast corner it is little more than one-half that amount. The prevailing winds are generally northwest, but in the vicinity of the sea they are southeast during summer.

Soil.—Fertile soil in New Hampshire is confined largely to the bottomlands of the Merrimack and Connecticut rivers. In the southeastern section is also a moderately productive soil derived largely from the disintegration of slate. Elsewhere south of the mountains, the surface soil is mostly hardpan or till, this being deepest on the drumlins. In the mountain region the soil is mostly a sandy loam composed of disintegrated granite gneiss and organic matter.

Vegetation.—Flowering shrubs and vines are found in abandoned fields and pastures and beside the roads, chiefly wild grapes, pin cherry and chokecherry, sweet fern, red osier, American elder, several varieties of sumacs, sheep laurel or lambkill, elderberries, blackberries, blueberries, both lowbush and highbush, and raspberries. Mountain laurel is commonest in the Monadnock area, while the flowering dogwood is confined chiefly to the lower Connecticut valley region. The wild flowers of the state include goldenrod, asters, fireweed, paintbrush, daisies, black-eyed Susans, painted and purple trilliums, fringed gentian, blue, yellow and white violets, trailing arbutus, lady's-slippers, Indian pipe, several varieties of honeysuckle, lilies, blue flag iris, ferns and bracken. On the higher elevations are found alpine plants, such as Labrador tea, mountain sandwort, cinquefoil, as well as arctic rushes, sedges and lichens.

Animal Life.—Deer and bear are the most abundant of the larger animals, and there are a few moose. Mink, beaver, raccoon, pine marten, otter, Canadian lynx and fisher inhabit the state, although the last two are decreasing in number. Red and gray squirrels, striped chipmunks, skunks, porcupines, moles, shrews, wood and meadow mice, the fox and the cottontail are common, while snowshoe rabbits are found in the northern part.

Historic Sites, Parks and Recreation.—New Hampshire has many places of historical interest. Among them are the Woodman institute in Dover, which includes the Dam Garrison, built in 1675, and the Gilman-Clifford, or Garrison, house (1650–58) in Exeter, of which a part is claimed to be at least the second-oldest house in the state. Portsmouth has the Jackson house (1664), the Warner house (1718), the John Paul Jones house (1758), the Wentworth Gardner house (1760), the Moffat-Ladd house (1763), the John Langdon house (1784) and St. John's church (1807), all open to the public in the summer months. Nearby, in New Castle, is Ft. Constitution, formerly Ft. William and Mary, where on Dec. 14 and 15, 1774, New Hampshire patriots captured powder and arms, some of which was later used at the battle of Bunker Hill. At Peterborough is the MacDowell colony for creative artists; the Saint-Gaudens memorial is at Cornish.

The state maintains 40 state parks, wayside picnic areas and historic sites, among which are the Hampton Beach, Crawford Notch and Franconia Notch parks and the Daniel Webster memorial (Franklin), Wentworth Coolidge mansion (Portsmouth) and Franklin Pierce homestead (Hillsborough) historic sites. About 805,000 ac. of forest are publicly owned, by towns, the state or the national government. The largest is the White Mountain National forest.

HISTORY

Martin Pring was at the mouth of the Piscataqua in 1603 and, returning to England in the same year, gave an account of the New England coast from Casco bay to Cape Cod bay. Samuel de Champlain discovered the Isles of Shoals and sailed along the New Hampshire coast in 1605, and much more information concerning this part of the new world was gathered in 1614 by Capt. John Smith, who in his *Description of New England* refers to the convenient harbour at the mouth of the Piscataqua and praises the country back from the rocky shore.

Colonization.—Under the leadership of Sir Ferdinando Gorges there was formed in 1620 the Council for New England, which procured from King James I a grant of all the country from sea to sea between latitude 40° and 48° N., and which made nine grants bearing upon the history of New Hampshire. The first of these grants was to John Mason, who has been called "the founder of New Hampshire," on March 9, 1622. The name New Hampshire was first applied to a grant which lay between the Merrimack and Piscataqua, and given to Mason on Nov. 7, 1629.

The first settlement of which there is indisputable evidence was established in 1623 by David Thomson at Little harbour, now in the town of Rye. Thomson was the head of a company which was organized for fishing and trading and whose entire stock was to be held jointly for five years. He built a house on Odiorne's point overlooking Little harbour, and, although he moved to an island in Boston harbour in 1626, he may have continued to superintend the business of the company until the expiration of the five-year term. At least there was a settlement there which was assessed in 1628, and it may not have been completely abandoned when colonists sent over by the Laconia company, which had received a grant on Nov. 17, 1629, arrived in 1630.

The Laconia company received its first grant under the erroneous impression that the Piscataqua river had its source in or near Lake Champlain, and its principal object was to establish an extensive fur trade with the Iroquois Indians. The company sent over colonists who occupied the house left standing by Thomson and, not far away, built Mason hall or the Great house in what is now Portsmouth, a name (for the entire settlement) that replaced Strawberry Banke in 1653. Edward Hilton with a few associates appears to have established a settlement on Dover point about the time of Thomson's arrival at Little harbour, and in the Hilton grant of 1630 it is stated that he had already built houses and planted there; as early as 1630 this settlement was named Dover.

In 1638 the Rev. John Wheelwright, an Antinomian leader who had been banished from Massachusetts, founded Exeter on land claimed to have been bought by him from the Indians. In the same year Massachusetts encouraged friendly Puritans to settle Hampton on the same purchase, and about a year later this colony organized Hampton as a town with the right to send a deputy to the general court.

Serious dissensions had already arisen between Puritan and Anglican factions in Dover, and Capt. John Underhill, another Antinomian, became for a time a leader of the Puritan faction. Puritan Massachusetts was naturally hostile to the Antinomians at Exeter as well as to the Anglicans at Strawberry Banke. Under these conditions Massachusetts discovered a new claim for its northern boundary. The charter of that colony was drafted under the impression that the Merrimack flowed east for its entire course, but now an investigation was in progress which was to show that its source in Lake Winnipesaukee was several miles north of any of the four settlements in New Hampshire. Accordingly, Massachusetts resolved to make the most of the clause in the charter which described the northern boundary as three English miles north of the Merrimack river, "or to the northward of any and every part thereof," to ignore the conflicting grants to Mason and to extend its jurisdiction over the offending settlements.

The heirs of Mason protested, but little was done about the

matter during the period of Puritan ascendancy in the mother country. Immediately after the resignation of Richard Cromwell, however, Robert Tufton Mason (a grandson of the original proprietor), who had become sole heir in 1655, began petitioning, first parliament and later the king, for relief. The commission appointed by the king in 1664 to hear and determine complaints in New England decided that Mason's lands were not within the jurisdiction of Massachusetts and made an attempt to set up a government under which his claims could be tried, but this was a failure. Mason then petitioned again, and this time Massachusetts was requested to send agents to England to answer his complaints. They arrived in Dec. 1676, and the case was tried before the lords chief justices of the king's bench and common pleas in April 1677.

Mason presented no claim to the right of government, and as to the title to the lands claimed by him the court decided that this was a question between him and the several tenants to be determined by the local court having jurisdiction in such matters. Thereupon Mason, in Jan. 1679, petitioned the king to appoint a governor who should have jurisdiction over all the lands that he claimed, and on Sept. 18 of that year New Hampshire was constituted a separate province with a government vested in a president and council appointed by the king and an assembly chosen by the people.

Provincial Period.—From 1686 to 1689 New Hampshire formed a part of the dominion of New England, which, after the first few months, was under Sir Edmund Andros as governor general. There being no provincial authority in New Hampshire at the close of this period, a convention of the leading citizens of its four towns attempted to establish one. Upon the failure of this attempt, a temporary nominal union with Massachusetts was formed, but in 1692 Samuel Allen, the assign of Mason, caused a royal government to be established with his son-in-law, John Usher, as lieutenant governor, and during the remainder of the colonial era New Hampshire was separate from Massachusetts except that from 1699 to 1741 the two had the same governor.

The boundary disputes between Massachusetts and New Hampshire were long and bitter. Both provinces granted townships within the disputed territory; Massachusetts arrested men there who refused to pay taxes to its officers, and sought to defer the settlement of the dispute. New Hampshire, being on more friendly terms with the home government, finally petitioned the king to decide the matter, and in 1737 a royal order referred it to a commission to be composed of councilors from New York, Nova Scotia and Rhode Island. This body agreed upon the eastern boundary but evaded deciding on the southern one. Both parties then appealed to the king, and in 1741 the king in council confirmed the decision of the commission in regard to the eastern boundary and established a southern boundary very favourable to New Hampshire. The western boundary was not yet defined, and as early as 1749 a controversy over that arose with New York. The governor of New Hampshire made 138 grants in the disputed territory which were rapidly settled, but there was a reluctance to incur the expense of a contest with so powerful a neighbour as New York. In 1764 New York procured a royal order declaring the western boundary of New Hampshire to be the western bank of the Connecticut river.

Revolution and Independence.—At the outbreak of the American Revolution New Hampshire had about 80,000 inhabitants, the great majority of whom were Loyalists, or Tories, during the struggle. By June 1775 the once popular governor Sir John Wentworth was a refugee; on Jan. 5, 1776, the fifth provincial congress established a provisional government; on June 15 the first assembly elected under that government declared for independence; and on Aug. 16, 1777, the important victory at Bennington, Vt., was won by New Hampshire and Vermont troops under the command of Gen. John Stark, who had a commission from New Hampshire. Six states had ratified the federal constitution when the New Hampshire convention met at Exeter on Feb. 13, 1788, to accept or reject that instrument, and so great was the opposition to it among the delegates from the central part of the state that after a discussion of ten days the leaders in favour of ratification dared not risk a decisive vote but procured an adjournment in order that certain delegates who had been instructed to vote against it might consult their constituents. Eight states had ratified when the convention reassembled at Concord on June 17, and four days later, when a motion to ratify was carried by a vote of 57 to 47, adoption by the necessary nine states was assured.

Statehood.—The American Revolution left the state heavily burdened with debt and many of its citizens threatened with debtor's prison. As a means of relief, a number of citizens demanded of the legislature the issue of paper money equal in amount to the state's debt; and, as this was refused, an armed mob numbering about 200 surrounded the meetinghouse in Exeter in which the legislature was in session, toward evening on Sept. 20, 1786. But Gen. John Sullivan (*q.v.*) was at the time president of the state; and on Sept. 21 he, with 2,000 or more militia and volunteers, captured 39 of the leaders and suppressed the revolt without bloodshed.

National elections in New Hampshire were carried by the Federalists until 1816, except in 1804 when Pres. Thomas Jefferson won by a small majority; but within this period of Federalist supremacy in national politics the Democrat-Republicans elected the governor from 1805 to 1812 inclusive except in 1809. In 1816 the Democrats won both state and national elections; and out of the transition from Federalist to Democratic control, which was effected under the leadership of William Plumer (1759–1850), a prominent politician in New Hampshire for half a century, arose the famous Dartmouth college case. As the trustees of this institution were Federalists with the right to fill vacancies in their number, the Democrats attempted to gain control by converting it into a state university and increasing the number of trustees, but when the case reached the U.S. supreme court that body pronounced (1819) the charter a contract which the federal constitution forbade the state to violate. Heretofore the Federalist regime had taxed the people to support the Congregational Church, but now the Baptists, Methodists and Universalists joined the Democrats and in 1819 this state support was abolished by the Toleration act.

Because of Daniel Webster's eloquently successful arguments in the Dartmouth college case, and because his party had favoured the support of the Congregational Church by public taxation, he became very unpopular in this his native state. Accordingly, his denunciation of Pres. Andrew Jackson's bank policy added strength to the Jacksonian democracy, and, later, his Whig connections were the greatest source of the Whig party's weakness in New Hampshire. John Quincy Adams was an intimate friend of William Plumer, the Democratic leader, and carried the state in both 1824 and 1828. The Whigs never won a national or state election and often their vote was only about one-half that of the Democrats. But the Democrats broke into two factions in 1846 over the question of slavery (*see* HALE, JOHN PARKER); the Know-Nothing party elected a governor in 1855 and 1856; and then control of the state passed to the Republican party, which held it until the presidential election of 1912 and 1916 when the Democrats won. Thereafter the state returned to its Republican tradition until 1936, 1940 and 1944 when it supported Franklin D. Roosevelt. The state government remained Republican although a Democratic governor was elected in 1922. In 1962 John W. King became the first Democratic governor elected in 40 years, and Thomas J. McIntyre the first Democratic U.S. senator in 30 years. Both were re-elected in 1966.

New Hampshire sent more than 20,000 men into the armed services during World War I. Many New Hampshire men were in the 26th or "Yankee" division. The Portsmouth navy yard was involved with building submarines and small boats and in repairing warships. About 60,000 men and women of New Hampshire served in the armed forces during World War II. The state was the site of the Bretton Woods conference (July 1944), at which representatives of 44 nations drew up plans for the International Monetary fund and the International Bank for Reconstruction and Development.

The industrial centres of New Hampshire suffered especially during the depression years of 1929–36. Many industrial plants decreased the number of employees and in some cases discon-

tinued operation, especially in Hillsborough county and in the cotton industries. The depression was less severe outside the industrial centres, and there was a considerable return of people from city areas to small towns and farms. After 1936 conditions improved, especially in Manchester, where the Amoskeag mills were partly used by many small manufacturers. Increased industrial diversification in the 1950s and 1960s saw the establishment of new plants in smaller communities, as well as in the larger cities, and New Hampshire became the only New England state to gain in manufacturing employment. At the same time the increase in nonmanufacturing employment was the highest in the region.

GOVERNMENT

New Hampshire was the first of the original states to establish a government wholly independent of Great Britain. This was designed to be only temporary but was in operation from Jan. 5, 1776, to June 2, 1784. The constitution provided for a general court consisting of a senate and a house of representatives and made the council a body advisory to the state president. The 1784 instrument was amended in 1792; with the amendments adopted in that year it is in large measure the constitution of today. For 60 years there was no change whatever, and only three amendments, those of 1852 (removing the property qualifications of representatives, senators and the governor), were adopted until 1877, when 12 amendments were adopted; the most important were those providing for biennial (instead of annual) state elections in November (instead of March), and those doing away with the previous requirement that representatives, senators and the governor "be of the Protestant religion." Five amendments were ratified in 1889, four in 1902 and four in 1912. Most important of those adopted in 1912 was one providing for the election of the governor and members of the council by a plurality instead of a majority vote. In 1956 two amendments became effective, one to permit the legislature to authorize absentee voting in primary elections and one to allow the governor to transact official business while absent from the state in line of duty.

New Hampshire is the only state in which amendments to the constitution may be proposed only by a constitutional convention, and once in seven years at the general election a popular vote is taken on the necessity of a revision of the constitution. By an act approved on April 9, 1909, provision was made for direct nominations of candidates at primaries. The government of the state was extensively reorganized as a result of legislation passed in 1949.

Executive.—There is a governor's council of five members, one from each councilor district, which has advisory duties and shares with the governor most of his powers. There is no lieutenant governor. The governor and the councilors are elected for terms of two years. The governor and council appoint all judicial officers, the attorney general, comptroller, important administrative boards and commissions and the medical referees; they have power to pardon offenses; and they may exercise some control over expenditure through the constitutional requirement of the governor's warrant for drawing money from the treasury. Reorganization legislation in 1961 placed many existing agencies in three new departments: health and welfare; resources and economic development; and safety. The governor may veto within five days, besides Sunday, after it has been presented to him any bill or resolution of which he disapproves, and a two-thirds vote of the members of both houses is required to pass over his veto.

General Court.—A senate and a house of representatives, which together constitute the general court, meet at Concord on the first Wednesday in January of every odd-numbered year, and at such other times as the governor may appoint for a special session, principally for the making of laws and for the election of the secretary of state and the state treasurer. The senate is composed of 24 members, one from each senatorial district. Membership in the house of representatives varies from not less than 375 to not more than 400 according to a plan adopted in 1931, by which towns having fewer than 600 inhabitants elect representatives according to a special schedule. In 1961 the house was reapportioned in accordance with the 1960 census, as required by the state constitution, and senate districts were redrawn for the first time since 1915. Both senators and representatives are elected for two-year terms.

Judiciary.—For the administration of justice the state has a supreme court and a superior court, and each county has a probate court. The supreme court consists of a chief justice and four associate justices; the superior court comprises a chief justice and five associate justices. The supreme court sits at Concord on the first Tuesday of every month except July and August, while the superior court holds two or three sessions a year in each of the ten counties. Each county has a single probate judge, who has jurisdiction over the probating of wills, insolvency proceedings, decisions regarding adoption of children and similar judicial functions. Supreme, superior and probate judges are appointed by the governor and council to serve until they are 70 years of age.

The legislature in 1963 established 37 district courts to consolidate 87 autonomous municipal courts, administered by a committee of three district court judges appointed by the supreme court.

Finance.—The chief sources of the income of the state government are the gasoline tax, motor vehicle and operators' licence fees, taxes on beer and taxes on or sale of liquor (sold in state liquor stores), the tobacco tax and income derived from the regulation of betting on horse racing.

New Hampshire, the first state since 1894 to establish a legal sweepstakes, adopted a sweepstakes bill in 1963, effective 1964. Receipts were earmarked for education. The law provided for $3 tickets, to be drawn in lotteries held twice a year, to be sold (at local option) at state-operated liquor stores and at the state's two racetracks.

Local Government.—Local affairs are administered by counties (ten in number), towns (townships), village districts and cities. In each county a convention, composed of representatives from the towns, meets every two years to levy taxes and to authorize expenditures for grounds and buildings whenever more than $1,000 is required. For the discharge of other county functions the qualified electors of each county elect every two years three commissioners, a sheriff, a solicitor, a treasurer, a register of deeds and a register of probate; two auditors also are appointed annually by the supreme court. The county commissioners have the care of all county property, as well as of county paupers; and once every four years they are required to visit each town of their county, inspect the taxable property therein, determine whether it is incorrectly assessed and report to the state board of equalization. In each town a regular annual meeting of the qualified electors is called on the second Tuesday in March for the transaction of miscellaneous business and the election of town officers.

POPULATION

The population of New Hampshire in 1790 was 141,885; in 1840 it was 284,574; in 1880, 346,991; in 1910, 430,572; in 1940, 491,524; in 1950, 533,242; and in 1960, 606,921. The last figure represented an increase of 13.8% over the population in 1950. The population per square mile in 1960 was 67.3, as compared with 59.1 in 1950 and with 49.6 for the U.S. in 1960.

The urban area of New Hampshire in 1940 comprised 11 cities, the smallest having a population of more than 6,000, and 7 towns (townships) classified as urban under special rule. The population of this area was 283,225, or 57.6% of the state total. The population of the same area in 1950 was 301,249, or 6.4% more than in 1940, and represented 56.5% of the state total. According to the census of 1960 the state had two standard metropolitan statistical areas—Lawrence-Haverhill (shared with Massachusetts) and Manchester. New Hampshire residents in these areas totaled 107,637, or 17.7% of the total population of the state. The urban population (1960) was 353,766, or 58.3% of the state total.

Analysis of the federal census of 1790 indicated that in that year better than two-thirds of the population of New Hampshire was of English or Welsh origin. There were small percentages of Scotch, Irish, Scotch-Irish, Germans, Dutch and French. While

foreign immigration, especially Irish, to the state began in the first half of the 19th century, the ethnic composition changed most after 1860. By the middle of the 20th century French-Canadians represented one of the largest ethnic groups in the state, along with the English-Welsh. In the order of size the other ethnic groups are English, from both England and Canada, Irish, Poles, Greeks, Scotch, Italians, Germans, Russians, Swedes,

*New Hampshire: Places of 5,000 or More Population (1960 Census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	606,921	533,242	491,524	443,083	411,588
Berlin	17,821	16,615	19,084	16,104	8,886
Claremont	13,563	12,811	12,144	9,524	6,498
Concord	28,991	27,988	27,177	22,167	19,632
Dover	19,131	15,874	14,090	13,029	13,207
Exeter	5,896	4,977	5,398	4,604	4,922
Franklin	6,742	6,552	6,749	6,318	5,846
Hanover	5,649	4,999	3,425	2,264	1,884
Keene	17,562	15,638	13,832	11,210	9,165
Laconia	15,288	14,745	13,484	10,897	8,042
Lebanon	9,299	4,614	7,590	6,162	—
Manchester	88,282	82,732	77,685	78,384	56,987
Nashua	39,096	34,669	32,927	28,379	23,898
Portsmouth	25,833	18,830	14,821	13,569	10,637
Rochester	15,927	13,776	12,012	9,673	8,466
Somersworth	8,529	6,927	6,136	6,688	7,023

*Populations are reported as constituted at date of each census.
Note: Dash indicates place did not exist during reported census, or data not available.

Finns, Norwegians, Portuguese, Austrians and Hungarians.

While there was a large migration of younger people out of the state, this was partly offset by the choice of New Hampshire as a place for retirement, so that during the 20th century the population was relatively stable.

The number of households in 1960 was 180,020, as compared with 149,475 in 1950 and 135,960 in 1940. The average population per household had declined from 3.7 in 1940 to 3.4 in 1950 and to 3.2 in 1960.

The population of the state was distributed by colour and nativity in 1960 as follows: 92.2% native white; 7.3% foreign-born white; and 0.5% nonwhite. Of the 44,418 foreign-born white, 60.0% were born in Canada, including 42.9% Canadian-French alone. There were 97.8 males per 100 females in the native white population and 81.4 in the foreign-born; 10.7% of the population was 65 years old or over; and 54.1% of the population 14 years old and over was in the labour force. Of the total number of employed males, 4.3% was engaged in agriculture, 8.7% in construction, 41.2% in manufacturing, 21.5% in transportation and trade and 17.8% in services of various kinds.

EDUCATION

New Hampshire formed a part of Massachusetts when, in 1647, the general court of that province passed the famous act requiring every town in which there were 50 householders to maintain a school for teaching reading and writing, and every town in which there were 100 householders to maintain a grammar school. During the 19th and early part of the 20th century various experiments for improving the public-school system were tried.

The public-school system has at its head a state board of education composed of seven persons appointed by the governor and council. The administrative work is carried on by a commissioner of education, appointed by the board for an indefinite term, a deputy commissioner, nominated by the commissioner and appointed by the board, and a director of technical institutes, appointed by the board. Each town is constituted a school district, and some special districts are organized under special acts of the legislature. For the purpose of inspecting and supervising all institutions in which state money is spent, the several school districts in the state are combined into supervision unions consisting of one or more school districts. The schools are maintained chiefly out of the proceeds of a district school property tax.

All children between the ages of 8 and 16 are required to attend either a public or an approved private school for the full term unless they are more than 14 years old and have completed the studies prescribed for the elementary schools, or have been excused by the school board on account of physical or mental infirmity. State aid for the education of mentally retarded children in local public schools was authorized in the 1960s.

The only state institutions of higher education are the Plymouth Teachers college (1870) at Plymouth, the Keene Teachers college (1909) at Keene and the University of New Hampshire, organized in 1866 at Hanover as the New Hampshire College of Agriculture and the Mechanic Arts and moved to Durham in 1893. By an act of the legislature it became a university in 1923 and offers undergraduate work in agriculture, engineering and liberal arts. There is also a graduate school offering both the master's and the doctor of philosophy degrees. Other institutions of higher learning in the state are Dartmouth college (nonsectarian, 1770) at Hanover (*q.v.*); Saint Anselm's college (Roman Catholic, 1889) at Manchester; Mount St. Mary college (Roman Catholic, 1934) at Hooksett; Rivier college (Roman Catholic, 1933) at Nashua, New England college (nonsectarian, 1946) at Henniker; and Colby Junior college for women (academy, 1837; college, 1928) at New London.

HEALTH, WELFARE AND CORRECTIONS

The state charitable and correctional institutions include the New Hampshire school for feeble-minded children at Laconia (*q.v.*); the New Hampshire soldiers' home at Tilton; the New Hampshire industrial school at Manchester (*q.v.*); the New Hampshire hospital for the mentally ill, and the state prison at Concord; and the New Hampshire sanatorium for tuberculosis patients at Glencliff in the town of Warren. The state also makes annual appropriations for the care and education of blind and deaf and mute persons in institutions outside the state.

ECONOMY

Agriculture.—Agriculture in New Hampshire was greatly modified in the 20th century, the production of vegetables, fruits, dairy products, poultry and eggs largely supplanting the production of cereals. The total acreage in farms decreased from over 3,000,000 in 1910 to less than 1,500,000 in the second half of the century. During the same period the number of farms decreased from 27,000 to fewer than 7,000, but the average acreage per farm increased from 120 to 143. Nearly all farms are worked by owners or part owners. Livestock, poultry and their products account for about 75% of annual value of farm products. Dairying, long an important New Hampshire industry, was supplanted by poultry and poultry products as the major source of farm income. Apples, potatoes and hay are the principal crops.

Forests and Fisheries.—Except on the summits of the higher mountains, New Hampshire was originally an unbroken forest of which the principal trees were white pine, hemlock, sugar maple, yellow birch, beech, red oak and white oak in the south, red spruce, balsam and white birch on the upper mountain slopes, and red spruce, white pine, sugar maple, white spruce and white cedar in the other parts of the north. The white pines of New Hampshire were an important source of masts for the British Royal Navy during the colonial period. Even in the second half of the 20th century nearly 85% of the state was forested. Two-thirds of the timber harvested was sawlogs, one-fifth was pulpwood and most of the rest was firewood. One-sixth of the state's commercial forest land is publicly owned, most being in the White Mountain National forest.

New Hampshire, with only one coastal county (Rockingham), ranks sixth among the New England states in its fishing yield.

Minerals.—Formerly granite was the most important of the mineral products of New Hampshire. New Hampshire granite was used for building as early as 1623, and at the beginning of the 20th century New Hampshire was one of the leading states in granite quarrying. But the use of steel and concrete in building caused a rapid decline in the industry, and by the second half of the 20th century New Hampshire's minerals, in order of value, were sand and gravel, stone, mica and feldspar. Sand and gravel, which account for about half the state's mineral output (value), are produced in nearly all counties. Stone, the second most important mineral, is quarried in Rockingham, Merrimack, Grafton, Hills-

borough, Carroll and Coos counties. Mica, first mined in Grafton, Grafton county, in 1803, was later found in other parts of the state in such quantities that for 60 years during the 19th century New Hampshire was the largest producer of mica in the United States. In the 1960s large reserves of thorium were reported in the state.

Manufactures.—Since the beginning of the 20th century New Hampshire's chief source of employment and income has been in manufacturing. There were 1,618 manufacturing establishments in 1904, and 50 years later there were 1,609 (1954 census of manufactures). For the same period the number of persons employed increased slightly, from 68,032 to 77,071, the value added by manufacture multiplied, from $50,400,000 to $408,800,000, and payrolls rose from $30,700,000 to $245,300,000. By the 1960s the number of plants was below 1,200, but the number of employees had increased to well over 80,000 and payrolls to over $350,000,000. Until the late 1940s textiles and leather products (chiefly boots and shoes) were the major manufactures. After that time some cotton and woolen mills ceased operation or moved south. New industries, especially the production of electrical and electronic goods, partly replaced textiles. Other important industries in New Hampshire are nonelectrical machinery, pulp, paper and paper products, lumber and wood products, and printing and publishing. Most of the manufacturing centres of the state are south of Lake Winnipesaukee. An exception is Berlin, the chief manufacturing centre north of the White mountains, important for its manufacture of paper and wood pulp.

Transportation and Communications.—Most of the railways in the state are owned or leased by the Boston and Maine. This company was the first to operate a railway within the state, service being maintained between Boston, Mass., and Dover, N.H., as early as 1842. Railway mileage decreased from more than 1,200 mi. in the 1920s to less than 1,000 mi. in the second half of the 20th century. There were over 14,000 mi. of public roads, of which better than two-thirds were surfaced.

Ten daily newspapers and about 40 weeklies are published in New Hampshire. The *New Hampshire Gazette*, founded in 1756, is claimed to be the oldest continuously published newspaper in the United States; it is printed as a part of the *Portsmouth Herald*. There are two television stations in the state, and broadcasting facilities for two out-of-state stations are located in Winchester and on top of Mt. Washington. Of the 25 radio-broadcasting stations, two are both AM and FM.

See also NEW ENGLAND and references under "New Hampshire" in the Index.

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(H. W. K.; W. E. Ss.; P. M. M.)

NEW HARMONY, a town of Posey county in southwestern Indiana, U.S., about 22 mi. N.W. of Evansville is situated on the Wabash river. In the 19th century it was the scene of two famous experimental co-operative communities.

The site, a tree-studded meadow safely above flood stage of the Wabash, was occupied by prehistoric Mound Builders and later became a camping ground for Piankashaw and Kickapoo Indians. In 1814 it was bought by the followers of George Rapp, a German Pietist preacher who had led disciples to the U.S. in 1803. Their original colony in western Pennsylvania had prospered but Rapp elected to move westward. On the Wabash the Rappites laid out their town and named it Harmonie. They planted the rich land, set out orchards and vineyards and built residences, two churches, shops and factories. They also built separate dormitories for men and women because "Father" Rapp advocated celibacy, though the practice was not enforced. Soon a winery, brewery, distillery, looms, smithy, hattery and other industries to supply frontier merchandise were in production. Rappite traders carried their products on all midwestern rivers, and their trade-mark, the Rappite rose, soon came to be a guarantee of quality.

But neighbouring frontiersmen were suspicious of clannish, German-speaking Harmonie and its celibacy; or perhaps they were jealous of its prosperity. Besides, the market was smaller than Rapp had expected, and by 1824 Rappite leaders were ready to sell out and return to Pennsylvania. The buyer was Robert Owen (*q.v.*), British reformer who came to the U.S. to found a perfect co-operative community which would be based on his plan for the ultimate salvation of all mankind through "rational" thinking, co-operation and free education. In 1825 he bought Rapp's ready-built Harmonie with cash and notes, renamed it New Harmony and invited all to join him in Utopia and live at his expense until they could carry out his program and become self-supporting. William Maclure (*q.v.*), a geologist, businessman and philanthropist, who joined Owen and agreed to finance the schools, brought and paid his own teachers and supplied scientific equipment and a library.

Owen was adept at publicity. Myriads of persons talked of joining him and more than 1,000 actually arrived. With few exceptions, however, they were incompetent, greedy or daydreaming misfits. They ate Owen's rations, argued about their own government and debated the merits of Owen's "new system" while the farms and factories lay idle.

By May 1827 Owen's available cash had been expended on payments for the land and groceries for his followers. Maclure paid the last Rappite note in 1828 and Owen returned to Great Britain. Maclure's teachers and the best of Owen's recruits, including his sons, stayed on and developed one of the most notable pre-Civil War cultural centres in the U.S.

In the 20th century New Harmony is basically an agricultural community. Although its population has remained less than 2,000 (1,121 in 1960), its many original Rappite buildings have made it a charming but little understood monument to an interesting phase of the U.S. past. (R. E. BA.)

NEWHAVEN, a seaport and urban district in the Lewes parliamentary division of East Sussex, Eng., 7 mi. S.S.E. of Lewes by road, on the English channel at the mouth of the Ouse; after a great storm in 1570 the river shifted westward from its original outlet at Seaford to enter the sea at Meeching, which became known as the "new" haven. Pop. (1961) 8,419. Area 2.8 sq.mi. A fort dominates the entrance to the harbour, which was first granted to Newhaven in 1713. It is the English terminus (since 1843) of a cross-channel steamer service to Dieppe, and there is a large trade with the continent. There is some light industry (on a factory estate) and boatbuilding. The sandy beach offers bathing facilities. St. Michael's parish church is one of the earliest Norman churches in England.

NEW HAVEN, a city and port of entry in southwestern Connecticut, U.S., on Long Island sound at the mouth of the Quinnipiac river, is about 70 mi. E.N.E. of New York city. It is the seat of Yale university (*q.v.*).

It was originally settled in 1638 by about 500 English Puritans under the leadership of John Davenport and Theophilus Eaton. Most of the settlers had come from England the previous year and had wintered in the Massachusetts Bay colony. Originally called Quinnipiac, an Indian word meaning "long water land," in 1640 the settlement was renamed for the port city of Newhaven in England. In 1643 New Haven and three adjacent towns, together with Stamford, 30 mi. W., and Southold on Long Island, joined to form the New Haven colony, of which Eaton was governor until his death in 1658. Strong Puritan sympathies made the colony a refuge, in 1661, for Col. Edward Whalley and Col. William Goffe, two officers in Cromwell's army, who had been members of the court that condemned Charles I and fled to New

England seeking sanctuary. Although the political consequences of this sympathetic action are disputed, within four years New Haven colony was assimilated into Connecticut colony, which had been based on Hartford and enjoyed a royal charter.

In 1701, however, New Haven became co-capital with Hartford, a position it maintained in both colony and state until 1873, when Hartford became the sole seat of government. A collector of the port was appointed in 1760 and thereafter a flourishing shipping trade grew up with the West Indies, Newfoundland and other American ports. During the American Revolution New Haven, strongly supporting the Continental cause, was sacked (July 5, 1779) by Loyalist forces under Gen. William Tryon, colonial governor of New York. Tryon, however, was driven off before he could burn the town. New Haven was incorporated as a city in 1784 and, following the War of 1812 during which many local seafarers turned to privateering, trade with ports throughout the world sprang up and manufacturing began to make itself felt as an important part of the economy.

Around 1830 immigrants began to arrive from Ireland and Bavaria. A wave of Italian immigration commenced in 1870, and a decade later, partly as a result of pogroms in Russia, eastern European Jews began arriving in considerable numbers. Slavery was gradually eliminated in Connecticut after 1784, and by 1820 there were over 600 Negroes in New Haven; in the decades before the American Civil War the city was an important centre of abolitionist sentiment.

These waves of immigration greatly facilitated the economic growth of the area, as did the proverbial Yankee ingenuity. New Haven was where Eli Whitney developed interchangeable parts for firearms, thus helping to usher in the principle of mass production; where Charles Goodyear discovered vulcanized rubber; and where Samuel Colt improved his invention of the repeating revolver. In the second half of the 20th century New Haven industries included shipbuilding and the manufacture of firearms, ammunition, aircraft parts, hardware tools, rubber goods, watches, clocks, textiles and paper products.

The cultural life of New Haven is a blend of contributions from Yankees and later immigrants. The Puritans' deep interest in education led to the founding in 1660 of Hopkins grammar school, which still exists. Yale university, founded (1701) as the Collegiate School of Connecticut in Saybrook, moved to New Haven in 1716. Other institutions of higher learning in New Haven include Albertus Magnus college (Roman Catholic, 1925) for women; Southern Connecticut State college, founded (1893) as New Haven Normal school; and New Haven (junior) college (1920).

Although much of the area's cultural activities depend upon Yale's art gallery, drama and music schools, and its famed Peabody Museum of Natural History, New Haven has its own symphony orchestra, and in 1958 it instituted a community-wide festival of arts. For years Broadway plays and musicals have used the old Shubert theatre for public tryouts before opening in New York.

Pop. (1960) 152,048; standard metropolitan statistical area (New Haven, Branford, East Haven, Guilford, Hamden, North Haven, Orange, West Haven and Woodbridge) 311,681. In 1963 Bethany and North Branford towns, pop. (1960) 9,155, were added. For comparative population figures *see* table in CONNECTICUT: *Population.* (R. A. DL.)

NEW HEBRIDES, a western Pacific island group consisting of 12 principal islands lying about 500 mi. W. of Fiji and 250 mi. N.E. of New Caledonia. It has a multiracial society governed jointly by France and Great Britain. Area 5,700 sq.mi.; pop. (1960 est.) 60,474, including Europeans, Vietnamese, Chinese, Tahitians, Wallis islanders, New Caledonians and Melanesians.

Physical Geography.—Diversification characterizes the relief, which ranges from rugged mountains and high plateaus to rolling hills and low plateaus, with coastal terraces and offshore coral reefs. Sedimentary and coral limestones with volcanics preponderate and the frequent earthquakes indicate structural instability (*see* also PACIFIC ISLANDS). Some islands comprise a single volcanic cone and there are three active volcanoes. The climate is hot and wet at all seasons, though eastern slopes are drier than western, as the southeasterly trades are the prevailing winds. Much of the group is covered by dense rain forest, but drier regions have savanna woods. Black earths and brown forest formations appear to be the principal soil groups. Abundant bird life contrasts with the sparse land fauna.

The People.—A complex settler community of Europeans, Asians and Polynesians, legally divided into French and British, has been imposed on the native Melanesians. The Europeans are dominant. The Asians are prosperous, the Chinese socially assimilating to the Europeans and contrasting with the isolationist Vietnamese who are former coolies. Polynesian Wallis islanders entered the group as plantation labourers in the mid-20th century.

Traditionally organized in mutually hostile tribes, the natives now seek adjustment to European intrusion. Remote villages with few European contacts, apart from missionaries, have achieved temporary adjustment, but most natives are resentful of white wealth; hence the growth of antisettler cults to acquire power either through neopagan rituals or elaborate organization. Resentment is less and adjustment better around Vila, the capital, where the natives are acquiring greater wealth. Basically the Melanesians want higher standards and a voice in their own destiny.

History.—Originally found by the Portuguese navigator Pedro Fernandez de Quirós (1606), rediscovered by the French explorer Louis de Bougainville (1768) and chartered by the English captain James Cook (1774), the New Hebrides were exclusively British commercially until 1870. Subsequently French interest developed rapidly, leading to a policy of mutual exclusiveness (convention of 1878), rudimentary joint control (mixed naval commission, 1887), and finally the condominium (1906 protocol). In 1940 the local French were Gen. Charles de Gaulle's first overseas adherents and the group escaped Japanese invasion, becoming a major Allied base.

The first settlers were sandalwooders (1843) and missionaries (1848) followed by cotton planters about 1868. Cotton gave way to bananas and coffee after 1880, only to be replaced by coconuts and maize (corn) in the first decade of the 20th century. Unprecedented prosperity, based on copra, cocoa and coffee produced by cheap Vietnamese labour, occurred in the 1920s, but this vanished during the world depression. Although only a minor revival occurred before World War II, the postwar period witnessed a tremendous boom.

Government.—While exercising joint sovereignty over the indigenous people, the corulers retain separate responsibility for their nationals. Under the 1914 protocol (ratified 1922) authority is vested in the French and British high commissioners who are represented in Vila by resident commissioners. These officials jointly control the condominium administration, whose sphere is defined in the protocol and by their respective national authorities. This tripartite arrangement is continued into local affairs by parallel national district agents, jointly supervising village chiefs or councils of elders. Jurisdiction over native and land cases lies with the condominium courts centring on the joint court under a neutral president, but disputes involving settlers are taken before the appropriate national court. Representative institutions are confined to a few elected village councils and the French national advisory council.

The Economy.—The economy of the New Hebrides is based primarily on copra production. The group is, however, a marginal copra producer suffering from high costs, low productivity and distance from the market. Although there is a labour shortage and wages are the highest in the Pacific, the planters continue to rely on obsolete cultivation practices depending on ample cheap labour while native methods are extremely primitive. Equally poor processing causes dependence on the unrewarding French market for soap-grade copra. Improvement is slow as boom profits were largely exported and capital is therefore short. Copra (44% native-produced) provides 85% of the condominium's exports, but some cocoa (17% native-grown) and coffee are also planted.

New Hebridean commerce is dominated by two concerns, one

Australian and the other French. Australia supplies 59% of the condominium's imports, largely foodstuffs, gasoline and textiles, while 95% of the exports are taken by France. Vila, handling 49% of the total trade, and Santo are the group's ports of entry.

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NEW IRELAND, an island of the Bismarck archipelago (*q.v.*), is situated to the north of New Britain, from which it is separated by St. George's channel. With the adjacent islands it forms an administrative district of the Australian Trust Territory of New Guinea (*see* NEW GUINEA). Area (including adjacent islands) 3,800 sq.mi. Pop. (1962) 40,659, of whom a small number are European or Chinese. The island is 220 mi. long but very narrow. The southern portion attains a breadth of 30 mi. but the prolongation which extends northwestward for almost 130 mi. is nowhere wider than 15 mi. and in places narrows to about 5 mi. across. Unlike New Britain (*q.v.*) the island contains no active volcanoes, but it is rugged and mountainous, especially in the south where the Rossel mountains rise to 6,430 ft. Limestone mountains and plateaus occupy much of the long northwest peninsula, but there is generally a fringe of coastal plain, of raised coral or alluvium, and at the constrictions the coasts are separated only by low saddles.

Commercial development is practically confined to copra production, especially on the east coast. In addition to the plantations (more than 72,000 ac. in the 1960s) there has been an increasing production from native groves. Most of the inhabitants live in the north of the island. The administrative centre and chief port is Kavieng at the northern end connected by a motor road along the east coast to Samo. The southern portion of the island is administered from Namatanai, on the east coast.

New Ireland was first discovered by the Dutch navigators Jacob Le Maire and William Schouten in 1616. An attempt to colonize it failed in 1880. Annexed by Germany in 1884, it was renamed New Mecklenburg. After World War I it was mandated to Australia. In Jan. 1942 it was occupied by the Japanese; it was reoccupied by Australia in 1945. (D. W. F.)

NEW JERSEY, usually referred to as the "Garden state" because of its many truck farms, is located along the eastern seaboard of the United States about 38° N. of the equator. It is bounded on the north by New York, on the west by Pennsylvania, on the south by the Delaware river bay which separates it from Delaware, and on the east by the Atlantic ocean and the Hudson river. New Jersey ranks 46th in size among the states and measures 166 mi. in length from the northernmost to the southernmost extremities, 60 mi. in width at its greatest girth and 32 mi. at its narrowest. It has a total area of 7,836 sq.mi., of which 315 sq.mi. consist of lakes and other inland water areas. New Jersey, one of the 13 original colonies, became the third state of the union on Dec. 18, 1787; its state capital is Trenton. The red oak has been adopted as the state's official tree, the purple violet as the official flower and the eastern goldfinch as the official bird. The state's flag is buff-coloured with the blue seal of the state in its centre.

PHYSICAL GEOGRAPHY

Physical Features.—Though New Jersey is small in area, it is geologically interesting. Viewed from above it looks like a series of descending steps from the mountains in the northwest to the tidal marshes along the eastern and southeastern seacoasts. It has been estimated that the state's land masses are more than 1,000,000,000 years old and record the geological cycle of rock formation and decay through the phases of mountain building, erosion, flooding, re-emergence, the Ice Age and the subsequent breakdown after the glaciers receded. The Appalachian mountains cut across the northwest corner of the state. These mountains vary from 1,200 to 1,500 ft. above sea level and contain High Point (1,803 ft.), the state's highest elevation. Alongside this mountain range, but just south and east of it, is a small belt of highlands about 400 ft. lower in average elevation, which covers about one-seventh of the state's area. The remainder of the northeastern and north-central portions of the state are a lowland area that varies between 200 and 800 ft. in elevation. The rest of the state, that is, somewhat more than half of it (4,400 sq.mi.), consists of a flat coastal plain mostly less than 100 ft. above sea level, of which about one-eighth is tidal marshland, usually flooded at high tides, lying between the barrier beaches of the coastline and the actual mainland. The average mean elevation of the state is only 250 ft. above sea level.

The four "steps" or belts correspond closely to the major geological epochs of land formation. The great glaciers of the Ice Age covered a little more than one-third of the state and left large deposits of debris in an irregular line roughly from just west of Staten Island southwestward to Pennsylvania.

The Delaware river, from its junction with the Neversink river to the capes, flows along the western and southern borders of the state for 245 mi. The Hudson river drains only a small part of the state, but has contributed materially to its economic development. The principal stream of the highlands and Triassic lowland, the Passaic, rising in Morris county, passes through a gap in the traprock at Little Falls, descends 40 ft. and at Paterson drops 70 ft. as the Great falls of the Passaic and, bending southward, empties into Newark bay. The Hackensack river enters the state about 5 mi. W. of the Hudson, flows almost parallel with it and empties into Newark bay, having a length of 34 mi. The Raritan, the largest stream lying wholly within New Jersey, flows eastward through the centre of the state. Among the highlands are numerous lakes of which the largest are Lake Hopatcong, in Morris and Sussex counties, and Greenwood lake, partly in New York and partly in New Jersey.

Soil.—The soils of New Jersey generally follow the "steps" of elevation that descend from the mountains in the northwest to the coastal plain in the southern and eastern parts of the state. In the northwestern mountains the soil is regarded as heavy; that is, containing large amounts of sandstone and limestone. The soil of the northern highlands area is also heavy, but includes granite loams and gneiss in addition to limestone, while the southern highlands soil has large quantities of shale and red sandstone as well as traprock. The lowlands tend to be a mixture of loams, sand loams and greensand marl. The coastal plain is composed mostly of sand soils with pockets of loam.

Climate.—New Jersey's climate varies greatly between the northern and southern parts of the state, largely because of the higher elevation in the north and the dominating effect of the Atlantic ocean over the southern coastal plain and lowlands. The average annual temperature is about 50° F. in the extreme north and about 55° in the extreme south, less than 200 mi. away. In the north the winter temperatures average about 28° F. while the summer averages 70°. In southern New Jersey the winter temperatures average about 35° and the average summer temperature is 71°. For the state as a whole the winter temperatures average just above the freezing point (33°) and in the summer generally tend to be reasonably comfortable (average of 74°) though high humidity prevails almost all year round.

The length of the growing season in the state is about 155 days in the northwest and about 203 days along the southeastern coast. The annual average rainfall is about 46 in. for the state as a whole, though southern New Jersey averages only 36 in. while northern New Jersey usually exceeds 50 in.

Vegetation.—The vegetation of northern New Jersey does not vary much from that of the surrounding states, and in the south, especially in the pine forests, there are many examples of plant life common to North America. Plants commonly found in the state include the honeysuckle, beach plum, wild azalea, wintergreen and cardinal flower. Slightly over 30% of the state consists of wasteland, much of which is in scrub forests.

About two-fifths of the state's area is in forest growths of various kinds. The largest forest region is the pine barrens, which covers more than 1,200,000 ac. and includes a very large part of the southern half of the state. The pine barrens is composed of many varieties of pine, including areas of badly stunted growth and white cedar in the swamps. The next largest forest area

comprises about 500,000 ac. in the major river valleys. The principal growth is oak, but there are also birch, maple, ash, elm, walnut and chestnut. Finally, in the mountains of the northwest and highlands of the north central part of the state, there are about 300,000 additional acres of forest lands in which almost all trees common to North America may be found. Throughout all of these forests are ferns, many herbaceous plants, holly and the usual wild flowers native to the eastern United States.

Animal Life.—In the pine forest and the mountains deer, bear and wildcat are common. Other animals often seen in New Jersey are squirrels, chipmunks, rabbits, opossums, raccoons, foxes, muskrats and woodchucks. Snakes also are commonly found, most especially in the south. Many migratory birds pass over the state as do the shore and land birds which populate the southern forests.

State Parks, Forests and Historic Sites.—New Jersey has established 23 state parks with an area totaling approximately 27,000 ac. In the parks are preserved sites of historic significance, native plants and animals and sanctuaries for wildlife. Hunting is not allowed, although fishing is permitted under state regulations. Some of the parks are Allaire (1,277 ac.) in Monmouth county, Cheesequake (975 ac.) in Middlesex county, High Point (10,935 ac.) in Sussex county, Parvin (1,025 ac.) in Salem county, Ringwood Manor (579 ac.) in Passaic county and Washington Crossing (372 ac.) in Mercer county.

Eleven state forests, with a total area of more than 150,000 ac., occupy the least-developed sections, such as the mountain area in the north and the lowlands in the pine barrens. These forests provide facilities for camping, picnicking, bathing and water sports, and serve as laboratories for the study of wildlife and also forest plantings. The Wharton tract, covering more than 90,000 ac., was acquired by the state in 1954 as a state forest. Other forests are Bass River forest (9,270 ac.) in Burlington and Ocean counties, Lebanon forest (22,216 ac.) in Burlington and Ocean counties and Stokes forest (12,429 ac.) in Sussex county. The state parks and forests are under the supervision of the department of conservation and economic development.

The state's historic sites serve as reminders of New Jersey's stirring past. A monument at Freehold commemorates a battle of the Revolutionary War fought on June 28, 1778, in which Molly Pitcher figured. Other signs of the Revolutionary period include the Old Barracks at Trenton, built in 1758 to quarter British troops and later occupied by the Continental army; the Wallace house at Somerville, which served as General Washington's headquarters during the winter of 1778–79; and the Morristown National Historical park, which includes Fort Nonsense and Jockey Hollow with replicas of the quarters occupied by the Continental army during two winters. Another famous landmark is the Berrien house at Rocky Hill, where Washington wrote in 1783 the farewell address to his troops. The Continental congress met for a time in Nassau hall (built in 1756) at Princeton university. Another important colonial landmark was the home of Col. William Richards, restored in 1874 by Joseph Wharton. The Edison research laboratory, established in 1887 by Thomas A. Edison at West Orange, became a national monument in 1956.

HISTORY

Exploration and Settlement.—The Lenni Lenape Indians (called Delawares by the first settlers), a tribe of the Algonkian group, early inhabited the region now known as New Jersey. In 1758 the dwindling tribe moved to a reservation at Brotherton, now called Indian Mills, in Burlington county.

In 1524 Giovanni da Verrazano, a Florentine explorer who sailed for France, touched the New Jersey shore, but it was not until 1609 that Henry Hudson, employed by the Dutch East India company, dispatched a party to explore Newark bay. He then sailed his ship the "Half Moon" up the river now known as the Hudson and established Dutch claims. Nine years later a Dutch trading post was located at Bergen. Cornelius Jacobsen Mey in 1614, and later Cornelius Hendricksen, explored the Delaware river. By 1623 New Netherland (that part of North America between New France, or Canada, and Virginia) was established as a province, and soon Fort Nassau was built at the present site of Gloucester. Fifteen years later Swedish settlers were trading at Fort Christina on the west bank of the Delaware near the present site of Wilmington.

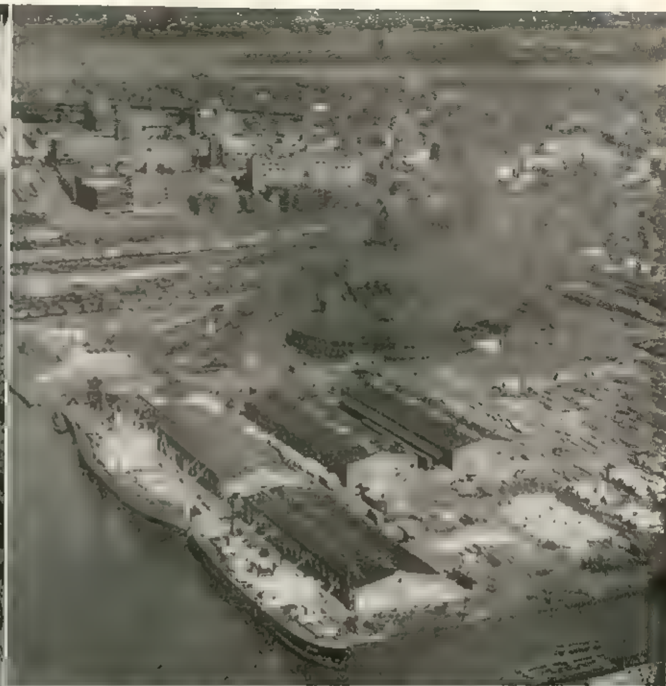
Colonial Rule.—In 1664 King Charles II of England granted to his brother James, duke of York, the vast Dutch holdings that included the present state of New Jersey. The region between the Hudson and Delaware rivers was soon transferred by the duke to John, Lord Berkeley, and Sir George Carteret. By this grant the duke of York created the colony of New Jersey or New Caesarea, named in honour of Carteret, a Royalist, who as its governor had defended the Isle of Jersey for the crown during the English Civil War.

To attract immigrants the proprietors in Feb. 1665 published their "Concessions and Agreements" by which they provided for a governor, a governor's council and an assembly chosen by the freemen and empowered to levy taxes. Meanwhile Gov. Richard Nicolls of New York, ignorant of the grant to Berkeley and Carteret, had confirmed sales to settlers of sites which later became Elizabethtown, Middletown and Shrewsbury. In 1669 trouble between the proprietary governor and the inhabitants of the last two towns over quitrents caused the nullification of the grants made by Nicolls. Four years later the Dutch fleet brought New Jersey under Dutch control, but England reacquired it by the treaty of Westminster, Feb. 9, 1674. The eastern half of the state was restored to Carteret's proprietorship. Berkeley had sold to John Fenwicke and Edward Byllynge, Quakers, his lands which subsequently were acquired by William Penn, Gawen Lawrie and Nicholas Lucas.

By the "quintipartite deed" of July 1676, the province east of a line from Little Egg harbour to a point on the Delaware river in 41° 40′ N. (East Jersey) was assigned to Carteret, and that west of this line (West Jersey), about five-eighths of the whole, to the Quaker associates (first Quaker colony in America). In 1677, 230 Quakers from London and Yorkshire founded a settlement which became Burlington. West Jersey was never actually governed under the liberal "Concessions and Agreements," presumably drafted by Penn, because Byllynge's title to the land conveyed to him alone the right to govern. Byllynge commissioned Samuel Jennings as deputy governor with the consent of the other proprietors. Jennings called the first assembly which passed fundamental laws providing for a governor and council. In 1680, after Philip Carteret, the governor of East Jersey, had been forcibly carried to New York and imprisoned, Sir Edmund Andros appeared before the East Jersey assembly as governor, but the deputies refused to pass the measures he recommended. A New York jury freed Carteret of charges of illegal exercise of authority and the duke of York recalled Andros from New York. In 1682 the province, which Sir George Carteret had bequeathed to eight trustees to administer for the benefit of his creditors, was purchased at public auction by Penn and 11 associates for £3,400. Each sold one-half of his share, thus making 24 proprietors whom the duke of York authorized to govern the province. They directed the appointment of the American Board of Proprietors (1684) who with the deputy governor cared for such proprietary interests as approval of legislation and grant of lands. In 1686 Perth Amboy, the newly created port of East Jersey, became its seat of government. After becoming king in 1685, James II—determined to unite New York, New Jersey and the New England colonies—extended accordingly the authority of Andros, now viceroy of New England.

In April 1702 the proprietors transferred to the crown all of their rights of jurisdiction but retained their rights to the soil. The provinces of East and West Jersey were then united and governed as a royal province. Until 1738 New York and New Jersey had the same governor; thereafter each had its own. The legislature met alternately at Burlington and Perth Amboy until 1790 when Trenton became the capital.

The diverse population of the colony grew steadily and at the time of the Revolutionary War it was estimated at 138,000. Those settlers who previously had acquired land grants were in constant conflict with the proprietors. A continuous discord pre-



BY COURTESY OF (TOP LEFT) NEW JERSEY DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT, (TOP RIGHT) CAMDEN CHAMBER OF COMMERCE; PHOTOGRAPHS, (BOTTOM LEFT) CRANE FROM BLACK STAR, (BOTTOM RIGHT) WARD ALLAN HOWE FROM EWING GALLOWAY

VIEWS OF NEW JERSEY

Top left: Scene in Hunterdon county, northwest New Jersey, a dairying and vegetable-farming area

Top right: Marine terminal and rail yards, Camden

Bottom left: Loading tomatoes on a farm near Camden where fertile, loamy soil is suited to truck gardening

Bottom right: Harvey S. Firestone Memorial library, erected at Princeton university in 1948

PHOTOGRAPHS, FAIRCHILD AERIAL SURVEYS, INC.

AERIAL VIEWS OF TWO NEW JERSEY CITIES

Top: Jersey City, with the Hudson river in the foreground and the Pulaski Skyway leading to the Holland tunnel on the extreme right

Bottom: Atlantic City, showing the famous boardwalk and resort hotels

vailed between the royal governors and the assemblies, which, coupled with British commercial restriction, became a factor favouring the Revolution.

The Revolution.—New Jersey was active during the Revolutionary War period. In 1774, following the action of the other colonies, a committee of correspondence and local committees were organized to disseminate information, and on July 21 a provincial congress met at New Brunswick and selected delegates to the first continental congress at Philadelphia. In June 1776 Gov. William Franklin was arrested by the provincial congress, thus ending the royal authority. A constitution was adopted on July 2, 1776. New Jersey's people were divided. The loyalists, or Tories, had early organized six battalions, while other groups supported the patriots. British sympathizers in the Revolution engaged in guerrilla action, and their "pine barren robbers" conducted raids in southern New Jersey.

Important battles of the war were fought in New Jersey. Late in 1776 General Washington, commander in chief of the Continental forces, unable any longer to hold the lower Hudson, retreated to the Delaware near Trenton and, by commandeering all available boats, won for his dispirited troops the river as defense against their pursuers. Recrossing with 2,500 men on Dec. 25, he surprised three Hessian regiments next morning and took 1,000 prisoners and 1,000 stands of arms. Outmaneuvering Lord Cornwallis, the British commander, Washington defeated a detachment of Cornwallis' army at Princeton on Jan. 3, 1777. As the British army was retreating from Philadelphia to New York, Washington's forces engaged it in the indecisive battle of Monmouth on June 28, 1778. During the war the Continental army crossed the state four times, and Washington twice had his winter quarters at Morristown.

Delegates from the state attended both the Annapolis convention (*q.v.*) in 1786 and the Constitutional Convention at Philadelphia in 1787. At the latter, New Jersey leadership sponsored the small states' position (New Jersey plan) in opposition to the Virginia or large states' plan. The New Jersey plan left its imprint in the provision of the federal constitution for equal representation for large and small states in the national senate and for the supremacy of federal law (*see* CONSTITUTIONAL CONVENTION [U.S.]). On Dec. 18, 1787, New Jersey became the third state to ratify the federal constitution.

19th Century.—On Aug. 22, 1787, John Fitch demonstrated on the Delaware the first steamboat, and 31 years later the Vail works near Morristown built the machinery for the "Savannah," the first steamboat to cross the Atlantic. In 1794, under the auspices of Alexander Hamilton's Society for the Establishment of Useful Manufactures, chartered by the legislature in 1791, a calico-printing factory inaugurated at the Great falls of the Passaic the first factory town in the U.S., now Paterson. In 1806 the first interstate railroad bridge was opened at Trenton. This material progress was interrupted by the War of 1812, which in the beginning was very unpopular, especially among the Quakers. After the war the construction of the Morris (1824–38) and the Delaware and Raritan (1826–38) canals and the completion of New Jersey's first railway, the Camden and Amboy (1834), provided facilities for a widespread industrial development.

Agitation for democratic reform culminated in a constitutional convention at Trenton (May 14–June 27, 1844), which drafted a new frame of government by which New Jersey abolished property qualifications for suffrage, modified the basis of representation in the assembly, separated the legislative, executive and judicial powers and provided for the direct election of the governor.

Opinion in New Jersey was divided on the question of slavery. The underground railroad transported fugitives to freedom, but when the American Civil War broke out, 18 people in New Jersey were legally still slaves. In 1860 three of the state's electoral votes went to Democrat Stephen Douglas and four to Abraham Lincoln, and New Jersey was one of the three states which voted for Lincoln's opponent in 1864. The state furnished 88,305 men for the Union cause and incurred extraordinary expenditures to the amount of $2,894,385. Ratifications of the 13th and 15th amendments were each first refused by the respective legislatures before being voted by their successors in which the Republican party had gained a majority; in 1868 the Democratic legislature sought in vain to withdraw the ratification of the 14th amendment voted by its Republican-controlled predecessor.

A bitter railway war followed the Civil War. The Pennsylvania railroad was charged with virtually monopolizing the route between New York city and Philadelphia as a result of a 999-year lease through which it had gained control of the properties of companies previously granted monopolistic privileges. In 1873 the state opened the route to other railroads. This same period was marked by great cultural, scientific and industrial development.

Modern Times.—With no limit fixed either to capitalization or to bonded indebtedness, and with a policy of encouraging the holding company structure, coupled with a tax rate lower for large than for small corporations, New Jersey by 1904 had chartered 3 of the 7 largest trusts and had "mothered" 150 of the 298 next largest business organizations in the U.S. A growing concern over the effects of industrialism led to direct primaries (1907, 1911), a new ballot form (1911), the election of Woodrow Wilson as governor (1911–13) and the passage in 1913 of the "Seven Sisters" acts for eliminating the power of trusts to create monopoly, limit production, fix prices and restrain trade. New laws limited public service franchises to 20 years, subject to municipal referendum.

Political power has usually been shared by the two major parties, but between 1914 and 1965 the Democrats never gained control of the senate and only five times had control of the house. In presidential elections since 1900 the state voted Democratic in 1912 (Woodrow Wilson), 1932, 1936 and 1940 (F. D. Roosevelt), 1960 (J. F. Kennedy) and 1964 (L. B. Johnson).

An intensely industrial state, New Jersey produced great quantities of war matériel during World War II. Important embarkation points for soldiers going to the European theatre of war were at Fort Dix and Camp Kilmer. The U.S. signal corps had its headquarters during the war at Fort Monmouth.

A constitutional convention, delegates to which had been popularly elected in 1947, assembled in New Brunswick and prepared a new constitution which the voters approved and which on Jan. 1, 1948, replaced the 103-year-old constitution. For the first time in more than 100 years the electorate beginning in Nov. 1949 could re-elect a governor and for the first time in 40 years the Republicans held the governorship for two successive terms. Legislative sessions in 1948–51 enacted the basic measures for effecting the structural changes required under the new constitution.

New Jersey had the lowest per capita state taxes of any state in the union at mid-20th century. In the decade between 1950 and 1960, construction, both industrial and residential, boomed. Gov. Robert B. Meyner became the first Democratic governor to succeed himself when he was re-elected in 1957.

GOVERNMENT

After New Jersey joined with the other Colonies in 1776 in declaring its independence, it set up a new form of government that established almost absolute legislative supremacy. This in a modified form was continued in the second constitution of 1844 and lasted till pressures generated by dynamic changes in 1947 forced the adoption of a third constitution.

Executive.—The 1947 constitution created a powerful governor, elected at large by the people, who serves a four-year term and is eligible for immediate re-election once and may serve additional terms after a lapse of one administration. The governor appoints all the state's executive officers, all the judicial officers whose jurisdictions extend farther than one community, the county prosecutors (district attorneys) and certain other county officials. The governor also prepares the annual budget, and may call special sessions of the legislature at will or of the senate separately. He has the right to veto acts of the legislature and specific terms in appropriation bills but only within 10 days of their submission to him while the legislature is in session or within 45 days after it adjourns sine die. He is empowered to supersede a county prosecutor as well as specifically order local police to move against specific offenses or offenders, and he has full powers of investigation concerning state and local administration. He is commander

in chief of the state's national guard and chairman ex officio of the state board of canvassers, which certifies all elections. Finally, he is empowered to make temporary appointments to the U.S. senate. In the event of his death, resignation or removal from office, he is succeeded by the president of the senate.

The constitution requires that all state administrative units be organized into not more than 20 departments whose heads are appointed by the governor and who serve at his pleasure. The only exceptions are the attorney general and the secretary of state, whose terms must coincide with that of the governor.

Legislature.—The state has a bicameral legislature composed of a general assembly and a senate. The general assembly comprises 60 members apportioned among the counties every ten years on the basis of population, although each county has at least one seat in the chamber. Senate membership of 21, one from each county, was increased in 1965 to 29, apportioned by population. Terms of office are two years for assemblymen and four for senators, with half the senators elected every two years.

The once extensive powers of the legislature were considerably reduced by the 1947 constitution. Under that constitution, the legislature enacts all state laws; adopts, approves or revises the state budget; enacts all appropriation bills; fixes all taxes; appoints the state auditor; may remove any executive or judicial officer by the impeachment process; and may override a governor's veto by a two-thirds majority of both houses. The senate, acting alone, confirms or rejects the executive and judicial appointments of the governor.

The legislature meets annually, usually from January until late spring, and then reassembles 45 days after its adjournment for a "veto session"; *i.e.*, to consider all bills the governor has vetoed.

Judiciary.—The New Jersey court system has been hailed by judiciary experts as the best and most flexible in the United States. At the head of the system is the supreme court, composed of a powerful chief justice and six associate justices. The supreme court is the final court of appeal in New Jersey and must finally decide all constitutional questions. Its members are appointed by the governor for an initial seven-year probationary term, after which they may be reappointed on a permanent basis, during their good behaviour, until the compulsory retirement age of 70.

Immediately below the supreme court is the superior court, composed of three divisions: law, appeals and chancery. The law division hears civil and criminal cases; the chancery division equity cases; the appeals division hears appeals from the law and chancery divisions and also from the lower courts. The qualifications, method of appointment and reappointment and terms for justice of the superior court are the same as those for the supreme court.

The lesser courts in the state are the county courts and the district courts, the judges of which are appointed by the governor; municipal courts appointed by local mayors; and the county surrogates are elected at large in each county. The county courts handle all types of cases and review the actions of the district and municipal courts. The district courts, covering only parts of counties, handle only those civil cases in which the amount of damages claimed is less than $3,000 or the crime is a misdemeanor. The municipal courts judge motor vehicle code violations and other lesser offenses.

Local Government.—County government in New Jersey is a hybrid of past and present customs of government in that it is composed of the old and large board of chosen freeholders (37 in Atlantic county, for example) in some areas and small boards (as few as 3) in others. The freeholders nominally operate and direct county government, but as many officials are either elected at large or appointed by the state the freeholders control little more than the county welfare institutions and some lesser clerical functions.

Since the 1947 constitution was adopted, municipal home rule has been the practice in New Jersey, whose more than 500 communities choose between 16 different combinations of the mayor-council, mayor-commission or council-manager types of municipal government. The most prevalent type is the mayor-commission form first advocated by Gov. Woodrow Wilson in 1911.

Finance and Taxation.—In the second half of the 20th century, the state's general treasury fund receipts amounted to more than $700,000,000 annually. Of this sum, about 10% was derived from the federal government and about 50% from state tax sources. Motor fuels, motor vehicle and operators licences, tobacco products, alcoholic beverages and property were the chief sources of tax revenues. The state's annual disbursements totaled slightly more than the general fund receipts and the state had a bonded debt of a little more than $200,000,000. Approximately 29% of the state's revenues was being spent on highways, about 26% on education, slightly more than 10% on health and hospitals and about 8% on public welfare. The state's income in the 1950s and 1960s was more than four times as great as it had been prior to World War II, but expenditures had multiplied at an even greater pace. New Jersey's per capita income had long been among the highest in the nation, and in 1960 it was about $2,200, well above the national average.

POPULATION

The population of New Jersey in the first federal census, 1790, was 184,139. This made it ninth among the 18 states and territories that then composed the union, and the population was classified as 100% rural. In 1850 the population of the state was 489,555, making it 19th in size among a total of 37; the state was still classified as rural in character—82.4% of its inhabitants were considered nonurban dwellers. The next decade was the period of the most rapid growth in the state's history—the population increased 37.3% between 1850 and 1860. At the beginning of the 20th century the state had advanced to 16th in rank of population with a total of 1,883,669 persons according to the 1900 census. The complexion of the state had been completely altered since 1850—in 1900 New Jersey was classified as 70.6% urban in character. The economically depressed decade between 1930 and 1940 was the slowest in population growth in New Jersey—in 1940 the population was only 2.9% greater than it had been in 1930. The 1950 population showed a total of 4,835,329 persons living within the state, making New Jersey eighth in size of population among the states. It was then nearly 87% urban in classification. In 1950 there were two complete standard metropolitan areas (Atlantic City and Trenton) and Bergen, Essex, Hudson, Middlesex, Morris, Passaic, Somerset and Union counties were a part of the New York-Northeastern New Jersey standard metropolitan area; they contained nearly three-fourths of the total population. By 1960 the standard metropolitan statistical areas housed 78.9% of the total population. In 1960 New Jersey had a total population of 6,066,782, an increase of 1,231,453 or 25.5% over 1950. It ranked eighth among the states.

The population per square mile in 1960, highest of the states, was 774.2, as compared with 49.6 for the U.S. as a whole. The 1960 urban population was 5,359,035 or 88.3% of the total. Distribution by colour and nativity, according to the 1960 census, was as follows: 81.3% native white; 10.0% foreign-born white; and 8.7% nonwhite. In line with the rest of the U.S. the percentage of persons 65 years old or over was increasing, being 9.1% in 1960. The percentage of the population 14 years old and over that was in the labour force was steadily decreasing, the result of prolonged schooling for that age group.

The population is not uniformly distributed across the state, but is concentrated in the urban belts opposite New York city and Philadelphia, with greater concentration opposite New York. Two-thirds of the population of the state live within 30 air miles of that city. Population density runs from an average of 40,000 persons per square mile in the industrial cities in the northeastern part of the state to sections of the state that have no people at all—in fact, almost one-fourth of the whole state's area is free of human habitation.

The over-all complexion of the state's population has changed slowly so that in 1960 New Jersey families tended to be older on the average and have fewer children than those of several decades previously. Also, the number of women increased more rapidly than that of men.

The basic characteristics of New Jersey's population tend to differ somewhat from the general national tendencies in regard to race, religion and degrees of concentration. In New Jersey there

*New Jersey: Places of 5,000 or More Population (1960 Census)**

Place	Population 1960	1950	1940	1920	1900
Total state	6,066,782	4,835,329	4,160,165	3,155,900	1,883,669
Asbury Park	17,366	17,094	14,617	12,400	4,148
Atlantic City	59,544	61,657	64,094	50,707	27,838
Audubon	10,440	9,531	8,906	4,740	—
Barrington	7,943	2,651	2,329	1,333	—
Bayonne	74,215	77,203	79,198	76,754	32,722
Belleville	35,005	32,019	28,167	15,660	5,907
Bellmawr	11,853	5,213	1,250	—	—
Belmar	5,190	4,636	3,435	1,987	902
Bergenfield	27,203	17,647	10,275	3,667	729
Bernardsville	5,515	3,956	3,405	—	—
Bloomfield	51,867	49,307	41,623	22,019	9,668
Bloomingdale	5,293	3,251	2,606	2,193	—
Bogota	7,965	7,662	7,346	3,906	337
Boonton	7,981	7,163	6,739	5,372	3,901
Bound Brook	10,263	8,374	7,616	5,906	2,622
Bridgeton	20,966	18,378	15,992	14,323	13,913
Burlington	12,687	12,051	10,905	9,049	7,392
Butler	5,414	4,050	3,351	2,886	—
Caldwell	6,942	6,270	4,932	3,993	1,367
Camden	117,159	124,555	117,536	116,309	75,935
Carlstadt	6,042	5,591	5,644	4,472	2,574
Carteret	20,502	13,030	11,976	—	—
Cedar Grove	14,603†	8,022†	5,208†	3,181†	—
Chatham	9,517	7,391	4,888	2,421	1,361
Cherry Hill (formerly Delaware)	31,522†	10,358†	5,811†	2,331†	1,679†
Clark	12,195†	4,352†	2,083†	794†	374†
Cliffside Park	17,642	17,116	16,892	5,709	968
Clifton	82,084	64,511	48,827	26,470	—
Closter	7,767	3,376	2,603	1,840	—
Collingswood	17,370	15,800	12,723	8,714	1,633
Cranford	26,424†	18,602†	12,860†	6,001†	2,854†
Cresskill	7,290	3,534	2,246	942	486
Dover	13,034	11,174	10,491	9,803	5,938
Dumont	18,882	13,013	7,556	2,537	643
Dunellen	6,840	6,291	5,360	3,394	1,239
East Orange	77,259	79,340	68,945	50,710	21,506
East Paterson	19,344	15,386	4,937	2,441	—
East Rutherford	7,769	7,438	7,268	5,463	2,640
Eatontown	10,334	3,044	1,758	—	—
Edison‡	44,799†	16,348†	11,470†	5,419†	2,801†
Elizabeth	107,698	112,817	109,912	95,783	52,130
Emerson	6,849	1,744	1,487	973	—
Englewood	26,057	23,145	18,966	11,627	6,253
Ewing	26,628†	16,840†	10,146†	3,475†	1,333†
Fair Haven	5,678	3,560	2,491	1,295	—
Fair Lawn	36,421	23,885	9,017	—	—
Fairview	9,399	8,661	8,770	4,882	1,003
Fanwood	7,963	3,228	2,310	724	399
Florham Park	7,222	2,385	1,609	787	752
Fort Lee	21,815	11,648	9,468	5,761	—
Freehold	9,140	7,550	6,952	4,768	2,934
Garfield	29,253	27,550	28,044	19,381	3,504
Garwood	5,426	4,622	3,622	2,084	—
Glassboro	10,253	5,867	4,925	3,073	2,677
Glen Ridge	8,322	7,620	7,331	4,620	1,960
Glen Rock	12,896	7,145	5,177	2,181	613
Gloucester City	15,511	14,357	13,692	12,162	6,840
Guttenberg	5,118	5,566	6,200	6,726	3,825
Hackensack	30,521	29,219	26,279	17,667	9,443
Hackettstown	5,276	3,894	3,289	2,936	2,474
Haddon	17,099†	12,379†	9,708†	2,708†	2,012†
Haddonfield	13,201	10,495	9,742	5,646	2,776
Haddon Heights	9,260	7,287	5,555	2,950	—
Haledon	6,161	6,204	5,303	3,435	—
Hamilton	65,035†	41,156†	30,219†	14,580†	4,164†
Hammonton	9,854	8,411	7,668	6,417	3,481
Harrison	11,743	13,490	14,171	15,721	10,596
Hasbrouck Heights	13,046	9,181	6,716	2,895	1,255
Hawthorne	17,735	14,816	12,610	5,135	2,096
Highland Park	11,049	9,721	9,002	4,866	—
Hillsdale	8,734	4,127	3,438	1,720	891
Hillside	22,304†	21,007†	18,556†	5,267†	—
Hoboken	48,441	50,676	50,115	68,166	59,364
Irvington	59,379	59,201	55,328	25,480	5,255
Jersey City	276,101	299,017	301,173	298,103	206,433
Keansburg	6,854	5,559	2,904	1,321	—
Kearny	37,472	39,952	39,467	26,724	10,896
Kenilworth	8,379	4,922	2,451	1,312	—
Keyport	6,440	5,888	5,147	4,415	3,413
Lakewood	13,004	9,970	8,502	6,110	3,094
Leonia	8,384	7,378	5,763	2,979	804
Levittown	11,861	—	—	—	—
Lincoln Park	6,048	3,376	2,186	—	—
Linden	39,931	30,644	24,115	1,756	402
Lindenwold	7,335	3,479	2,552	—	—
Little Falls	9,730†	6,405†	5,368†	3,310†	2,908†
Little Ferry	6,175	4,955	4,545	2,715	1,240
Little Silver	5,202	2,595	1,461	—	—
Livingston	23,124†	9,932†	5,972†	1,126†	1,412†
Lodi	23,502	15,392	11,552	8,175	1,917
Long Branch	26,228	23,090	17,408	13,571	8,872
Lyndhurst	21,867†	19,980†	17,454†	9,515†	1,590†
Madison	15,122	10,417	7,944	5,523	3,754
Manville	10,995	8,597	6,065	—	—
Maple Shade§	12,947†	6,560†	5,535†	7,273†	4,420†
Maplewood‖	23,977†	25,201†	23,139†	5,283†	1,630†
Margate City	9,474	4,715	3,266	249	—
Matawan	5,097	3,739	2,758	1,910	1,511
Maywood	11,460	8,667	4,052	1,618	536
Metuchen	14,041	9,879	6,557	3,334	1,786
Middlesex	10,520	5,943	3,763	1,852	—
Middletown	39,675†	16,203†	11,018†	5,917†	5,479†
Midland Park	7,543	5,164	4,525	2,243	1,348
Millburn	18,799†	14,560†	11,652†	4,633†	2,837†
Milltown	5,435	3,786	3,515	2,573	561
Millville	19,096	16,041	14,806	14,691	10,583
Montclair	43,129	43,927	39,807	28,810	13,962
Morristown	17,712	17,124	15,270	12,548	11,267
Mountainside	6,325	2,046	1,148	493	367
Mount Ephraim	5,447	4,449	2,282	—	—
Mount Holly	13,271†	8,206†	—	—	—
Neptune	21,487†	13,613†	10,207†	6,470†	7,943†
Newark	405,220	438,776	429,760	414,524	246,070
New Brunswick	40,139	38,811	33,180	32,779	20,006
New Hanover	28,528†	18,168†	983†	586†	1,827†
New Milford	18,810	6,006	3,215	—	—
New Providence	10,243	3,380	2,374	1,203	565
New Shrewsbury	7,313	—	—	—	—
Newton	6,563	5,781	5,533	4,125	4,376
North Arlington	17,477	15,970	9,904	1,767	290
North Bergen	42,387†	41,560†	39,714†	23,344†	9,213†
Northfield	5,849	3,498	2,848	1,127	—
North Haledon	6,026	3,550	2,761	887	—
North Plainfield	16,993	12,766	10,586	6,916	5,009
Nutley	29,513	26,992	21,954	9,421	—
Oakland	9,446	1,817	932	497	—
Ocean City	7,618	6,040	4,672	2,512	1,307
Oradell	7,487	3,665	2,802	—	—
Orange	35,789	38,037	35,717	33,268	24,141
Palisades Park	11,943	9,635	8,141	2,633	644
Palmyra	7,036	5,802	5,178	3,834	2,300
Paramus	23,238	6,268	3,688	—	—
Park Ridge	6,389	3,189	2,519	1,481	870
Parsippany-Troy Hills	25,557†	15,290†	10,976†	—	—
Passaic	53,963	57,702	61,394	63,841	27,777
Paterson	143,663	139,336	131,656	135,875	105,171
Paulsboro	8,121	7,842	7,011	4,352	—
Pennsauken	33,771†	22,767†	17,745†	6,474†	3,145†
Penns Grove	6,176	6,669	6,488	6,060	1,826
Perth Amboy	38,007	41,330	41,242	41,707	17,699
Phillipsburg	18,502	18,919	18,314	16,923	10,052
Pitman	8,644	6,960	5,507	3,385	—
Plainfield	45,330	42,366	37,469	27,700	15,369
Pleasantville	15,172	11,938	11,050	5,887	2,182
Point Pleasant	10,182	4,009	2,059	1,575	746
Pompton Lakes	9,445	4,654	3,189	2,008	847
Princeton	11,890	12,230	7,719	5,917	3,899
Prospect Park	5,201	5,242	5,714	4,292	—
Rahway	27,699	21,290	17,498	11,042	7,935
Ramsey	9,527	4,670	3,566	2,090	—
Raritan (Monmouth)	15,334†	2,763†	1,662†	1,659†	1,524†
Raritan (Somerset)	6,137	5,131	4,839	4,457	3,244
Red Bank	12,482	12,743	10,974	9,251	5,428
Ridgefield	10,788	8,312	5,271	1,560	584
Ridgefield Park	12,701	11,993	11,277	8,575	—
Ridgewood	25,391	17,481	14,948	7,580	2,685
River Edge¶	13,264	9,204	3,287	1,077	561
Riverside	8,474†	7,199†	7,072†	6,018†	2,581†
Rochelle Parkδ	6,119†	4,483†	2,511†	2,203†	1,298†
Rockaway	5,413	3,812	3,514	2,655	1,483
Roselle	21,032	17,681	13,597	5,737	1,652
Roselle Park	12,546	11,537	9,661	5,438	—
Rumson	6,405	4,044	2,926	1,658	—
Runnemede	8,396	4,217	2,835	—	—
Rutherford	20,473	17,411	15,466	9,497	4,411
Saddle Brook	13,834†	7,955†	3,169†	2,845†	1,954†
Salem	8,941	9,050	8,618	7,435	5,811
Sayreville	22,553	10,338	8,186	7,181	4,155
Scotch Plains	18,491†	9,069†	4,993†	2,343†	1,200†
Secaucus	12,154	9,750	9,754	5,423	1,626
Somerville	12,458	11,571	8,720	6,718	4,843
South Amboy	8,422	8,422	7,802	7,897	6,349
South Orange	16,175	15,230	13,742	7,274	4,608
South Plainfield	17,879	8,008	5,379	—	—
South River	13,397	11,308	10,714	6,596	2,792
Spotswood	5,788	2,325	1,201	704	—
Springfield	14,467†	7,214†	4,148†	1,715†	1,073†
Summit	23,677	17,929	16,165	10,174	5,302
Teaneck	42,085†	33,772†	25,275†	4,192†	768†
Tenafly	14,264	9,651	7,413	3,585	1,746
Toms River	6,062	2,517	—	—	—
Totowa	10,897	6,045	5,130	1,864	562
Trenton	114,167	128,009	124,697	119,289	73,307
Union	51,499†	38,004†	24,730†	3,962†	4,315†
Union Beach	5,862	3,636	2,076	—	—
Union City	52,180	55,537	56,173	20,651	15,187
Ventnor City	8,688	8,158	7,905	2,193	—
Verona	13,782	10,921	8,957	3,039	2,139
Vineland	37,685	8,155	7,914	6,799	4,370
Waldwick	10,495	3,963	2,475	1,296	—
Wallington	9,261	8,910	8,981	5,715	1,812
Wanaque	7,126	4,222	3,143	2,916	—
Washington	5,723	4,802	4,643	3,341	3,580
Wayne	29,353†	11,822†	6,868†	2,302†	1,985†
Weehawken	13,504†	14,830†	14,363†	14,485†	5,325†
West Caldwell	8,314	4,666	3,458	1,085	—
Westfield	31,447	21,243	18,458	9,063	4,328
West Long Branch	5,337	2,739	2,030	966	—
West New York	35,547	37,683	39,439	29,926	5,267
West Orange	39,895	28,605	25,662	15,573	6,889
West Paterson	7,602	3,931	3,306	1,858	—
Westwood	9,046	6,766	5,388	2,597	828
Wharton	5,006	3,853	3,854	2,877	2,069
Woodbridge	78,846†	35,758†	27,191†	13,423†	7,631†
Woodbury	12,453	10,931	8,306	5,801	4,087
Wood Ridge	7,964	6,283	5,739	1,923	582
Wyckoff♀	11,205†	5,590†	3,847†	1,671†	2,139†

*Populations are reported as constituted at date of each census. †Urban town (township). ‡Reported through 1950 as Raritan. §Name changed in 1945 from Chester. ‖Reported until 1940 as South Orange. ¶In Bergen county, name changed from Riverside in 1930. δReported until 1920 as Midland. ♀Reported until 1920 as Franklin.
Note Dash indicates place did not exist during reported census, or data not available.

are more Protestants than Roman Catholics, although the ratios are closer than in the nation as a whole. Likewise, New Jersey is one of the 11 major areas in the United States in which the nation's Jewish population is concentrated. There is a reversal in the state of the traditional trend of Negroes and foreign born to concentrate in industrial cities and towns. Agricultural southern New Jersey proportionately has more Negroes than does industrial northern New Jersey, and the coastal portions of the state have proportionately almost as many foreign born as do the industrialized areas. In some sections of the southern part of the state Negroes constitute a virtual majority of the residents. Roman Catholicism tends to be the major religious affiliation of the people in the industrialized cities and towns, while Protestantism usually predominates in the suburban, residential and agricultural portions of the state.

In the northeastern part of New Jersey the populace is largely comprised of persons who were born elsewhere than in New Jersey, but the number of nonnative-born diminishes sharply toward the south and west. In the farm areas of the state the people are almost entirely native born.

EDUCATION

History and Administration.—Public education in New Jersey progressed steadily throughout the 19th and 20th centuries. Early in the state's history the legislature gave consideration to funds for public schools, and in 1846 the post of state superintendent of public schools was established. The state constitution was amended in 1867 to require that "the Legislature shall provide for the maintenance of free public schools for the instruction of all children in the State between the ages of 5 and 18" with the result that a compulsory education law was enacted in 1867. Later, industrial and vocational schools were established, and special facilities were made available for crippled, blind, deaf and subnormal children.

Administration of the New Jersey schools is delegated to a state board of education and a commissioner of education appointed by the governor. A county superintendent of schools, appointed by the state board of education upon the recommendation of the state commissioner of education, has supervision over the public schools in each of the 21 counties. However, each city has a superintendent who exercises authority over the schools in the local area. Each municipality is theoretically also a school district, though efforts to provide better facilities have caused some municipal boards to merge and form combined districts.

There are two basic types of school boards in the state, one primarily designed for cities and the other for small municipalities. In the cities the mayor appoints the members of the board. In the small municipalities voters elect the members. The boards direct the finances and general policies of the school districts, select teachers, administrative personnel and materials and prescribe the curriculum. The boards also may expel pupils. The budgets of city boards are approved by a board of school estimates composed of members of the school board and the municipal council; in small municipalities the budget is adopted by voter action in a special election. In the 1960s, New Jersey was spending more than $500 annually per pupil—far above the national average.

Universities and Colleges.—Higher education has its roots in the colonial period. Princeton university, one of the nation's finest liberal arts universities for men, was established as the College of New Jersey at Princeton in 1746 (*see* PRINCETON UNIVERSITY). Rutgers, the state university, was founded as Queens college at New Brunswick in 1766; in 1825 its name was changed to Rutgers college in honour of Col. Henry Rutgers. The New Jersey legislature in 1864 selected the Rutgers Scientific school to be the land-grant college of the state. In 1880 the legislature established the New Jersey agricultural experiment station which was located on the Rutgers college farm. In 1917 Rutgers became the state university; in 1945 the title was extended to all its divisions. The corporate name was changed to Rutgers–the State university, in 1956. Rutgers now comprises these major units in New Brunswick: the college of arts and sciences, including the school of chemistry and the school of journalism; the college of engineering; the college of agriculture; the graduate school of education; Douglass college (founded as the New Jersey College for Women); the graduate school of library service; the graduate school of social work; and the graduate school of arts and sciences. In Newark are the college of pharmacy; the Newark college of arts and sciences; the school of business; the college of nursing; and the school of law. In Camden are the College of South Jersey and the South Jersey division of the school of law. Included in the university are the state agricultural experiment station, the Eagleton Institute of Politics, the Urban Studies centre and the Rutgers University press.

In 1855 the first New Jersey state normal school (now Trenton State college) was established by an act of the legislature at Trenton. Other teachers colleges are at Glassboro (1923), Jersey City (1946), Upper Montclair (1908), Union (1855) and Paterson (1855). In 1958 the six were designated as state colleges but continued to train teachers for the elementary and secondary schools.

Among the other institutions of higher learning are Seton Hall university at South Orange, Newark, Jersey City and Paterson (Roman Catholic; 1856); Fairleigh Dickinson university at Rutherford, Teaneck and Madison (nonsectarian; 1941); Drew university at Madison (Methodist; 1867); Stevens Institute of Technology at Hoboken (nonsectarian; 1870); Newark College of Engineering at Newark (state and municipal control; 1881); Caldwell College for Women at Caldwell (Roman Catholic; 1939); College of St. Elizabeth at Convent Station (Roman Catholic; 1899); Georgian Court college at Lakewood (Roman Catholic; 1908); Monmouth college at West Long Branch (nonsectarian; 1933); Rider college at Trenton (nonsectarian; 1865); St. Peter's college at Jersey City (Roman Catholic; 1872); Bloomfield college at Bloomfield (Presbyterian; 1868); and Upsala college at East Orange (Lutheran; 1893).

HEALTH, WELFARE AND CORRECTIONS

The state department of health is an outgrowth of a sanitary commission set up in 1865 and converted into a board of health in 1877. In 1954 the board became an eight-member public health council, two of whose members must be physicians and another a dentist. The council members, who are appointed by the governor, serve without pay. The council is charged with establishing and enforcing the state sanitary code as well as fixing the qualifications for health and food inspectors. Local health boards may establish higher, but not lower, standards than the state code by local ordinance and with the state's permission.

The state officially approves fluoridation of municipal water supplies, though less than 10% of the communities in the state had done so by 1960. About one-fifth of the state's communities have full- or part-time health officers, but only 13 counties have such an official. A special health problem in New Jersey is that of mosquito control. Fifteen counties maintain extermination commissions.

Public welfare activities in New Jersey are handled by the state department of institutions and agencies or the county boards of chosen freeholders. The state licenses and inspects all hospitals, nursing homes and sanatoria in addition to operating institutions for the insane, mentally deficient, feeble-minded and tubercular. Further, the state maintains diagnostic centres for juvenile and sex offenders and homes for aged public servants and veterans.

The state commission for the blind administers the education of the visually handicapped and assists them financially when necessary. The state board of child welfare cares for neglected and dependent children; the bureau of assistance aids the aged, disabled and indigent.

County governments and often the larger municipal governments aid in the welfare work of the state. Most counties and municipalities support or maintain general hospitals. Several counties of northern New Jersey have special hospitals or asylums for the treatment of chronic illnesses or mental disorders and clinics and welfare stations for the treatment of alcoholism and for child-care and other welfare problems. The counties and the municipalities augment the state's welfare payments to the aged, disabled and destitute.

The state has reformatories near Clinton and at Annandale and Bordentown; reform schools near Jamesburg and at Trenton; a state prison at Trenton and prison farms at Rahway and Leesburg.

THE ECONOMY

Living Conditions.—Living conditions generally are good in New Jersey, though in some northern areas where the population concentration is greatest housing tends to be inadequate and in some places substandard conditions prevail. In the second half of the 20th century urban renewal projects and new local housing and sanitation standards ordinances were rapidly eliminating the substandard areas. Newark, the largest city in the state, located in wholly urban Essex county, proportionately has had more federal housing aid than any other city in the United States (*see* NEWARK). Vast housing developments sprang up in the northeastern counties of the state as the move to suburbs extended outward from New York city into northern New Jersey. Extensive housing developments exist also all along the Delaware river and bay shore lines southward from Trenton to Gloucester City below Camden.

Industry.—Aside from the thousands of persons who work in the urban areas of New York city and Philadelphia, the state's people are engaged in those activities common to a major industrial state. During the second half of the 20th century more than 35% of the state's workers were employed by more than 12,000 different manufacturing concerns. Of the remaining labour force, about 17% were engaged in trade, 18% in services, 6% in construction activities, 3% in transportation operations, 5% in finance and insurance services, 3% in the communications industries and utilities, with the balance divided among all the other classifications except farming.

Industries have concentrated in New Jersey because of its proximity to major markets, easy access to transport facilities and a generally favourable tax climate. The state is well located for servicing a market consisting of more than 12 states, and it is within overnight hauling distance of 30% of the national population. The average weekly wage of a New Jersey resident employed in manufacturing is among the highest in the U.S.

The greater part of the important chemical industry is located in Middlesex, Union and Essex counties; auto and aircraft production are mainly in Bergen county; the electrical supplies industry is in Essex and Hudson counties, and shipbuilding is exclusive to Hudson and Camden counties. Transportation, fabricating, machine, ferrous metal and clothing industries are also of great importance. In the latter half of the 20th century, the factories of the state produced nearly $5,000,000,000 worth of finished goods annually. After World War II, many industrial research centres were established in New Jersey.

Agriculture.—The farms of the state include about 1,500,000 ac. of land of varying fertility which is concentrated on producing cash crops, chiefly products that may be readily canned or frozen, for the nearby metropolitan centres. In a typical year, the total value of the state's crops exceeds $150,000,000, with a crop volume measured in hundreds of thousands of tons. Principal crops are sweet corn, peppers, tomatoes, asparagus, beets, beans, melons and potatoes. In addition, the state produces large quantities of berries of all kinds, grapes, apples (nearly 4,000,000 bu. a year) and peaches (nearly 2,500,000 bu. a year). Livestock and livestock products are also important to the agricultural economy. Eggs, a major agricultural product, exceed 2,500,000,000 annually. Milk production is more than 1,000,000,000 lb. yearly. Meat production is less spectacular, though chickens and broilers are of major importance.

Fisheries.—The commercial aspects of fishing are largely confined to clam digging and hard- and soft-shell mussel trawling off the marshes of the three southernmost counties fronting on Delaware bay. Otherwise, most of the rest of the fishing done is of a sporting nature and is classified as part of the vacation industry.

Mining.—New Jersey is rich in a few mineral resources. Its zinc deposits are among the finest in the world, assaying at more than 20% pure ore; the Ogdensberg zinc mines in Sussex county are especially famous for their richness. Other minerals found in the state are iron ore, building materials, lime, greensand marl, peat and semiprecious stones. Iron has been mined in New Jersey for nearly 300 years, and great quantities of magnetite ore are found throughout the northern two-thirds of the state; the industry declined after the Civil War, and only a few mines were in operation in the second half of the 20th century. Building materials minerals are the most developed and are commercially the most significant minerals. Annual quantities of clay produced for brick, tile and terra-cotta ware total many millions of tons, as does stone, sand, gravel and lime production. The average annual value of all mineral products produced in New Jersey is a little less than $100,000,000, which, compared with other phases of the state's economy, makes mining a small operation.

Resorts.—Another important New Jersey industry is vacation recreation. Aside from the smaller (but often year-round) vacation industries found along the state's more than 700 lakes, the vacation industry principally is spread in an ever-widening belt along the Atlantic coast line from the Atlantic Highlands off lower Hudson river bay southward to Cape May, with principal concentrations in Ocean and Atlantic counties. There, several cities and many towns offer fine, wide, safe, sandy beaches and cool, moderate surf in which to swim, boat or fish. This "New Jersey Riviera" has its finest facilities at Atlantic City (*q.v.*), a year-round resort centre with eight miles of boardwalks, large amusement piers and a large convention hall. Off these resorts are some of the finest sport fishing grounds in the world, especially for bluefish, weakfish, bonita, tuna, marlin and striped bass.

Transportation and Communication.—Its many transportation facilities and its geographical location helped make New Jersey a crossroads of the eastern section of the nation. The network of railroads number 23, including eight trunk lines; the trackage per square mile exceeds that of any other state. Eight freight terminals handle cargo bound for all parts of the world.

The state is favourably located for shipping near the port of New York (*see* also PORT) and with its own port facilities along the Delaware river. Port Newark handles export and import tonnage of major economic significance. There are ports also at Camden and Trenton.

There are approximately 30,000 mi. of modern highways and roads in the state, which pioneered in building the clover-leaf circle, the dual highway and the elevated highway. The two principal highways in the state system are the New Jersey turnpike and the Garden State parkway. The turnpike, operated by the New Jersey Turnpike authority, is a 131-mi. toll road extending from the George Washington bridge in the north to the Delaware Memorial bridge to the south and with a spur to the Holland tunnel and a link to the Pennsylvania turnpike. The parkway, also a toll road, is 173 mi. in length and is operated under the direction of the New Jersey Highway authority. It extends from the New York state line in the north to Cape May in the south.

There are approximately 100 commercial airports and private landing fields in the state. Newark and Teterboro, operating as passenger and air freight terminals, are the largest.

Both television and radio experiments have been conducted in the laboratories of the state. Stations WJZ (later WCBS) and WOR, initially in Newark, were pioneers in the field of radio. Research in television has been done by the Radio Corporation of America research laboratory in Princeton and the Allen B. Dumont laboratory in Clifton. There are more than 250 newspapers in the state, of which about 25 are daily.

See also references under "New Jersey" in the Index.

BIBLIOGRAPHY.—*Geography:* For fuller descriptions consult the United States Geological Survey, *Bulletins 177* and *301* as well as the *Final Report* of the New Jersey Geological Survey and the *Annual Reports* of the New Jersey State Museum. For a listing of the state parks consult Fitzgerald's *Legislative Manual* (annual) and the individual publications of the parks themselves or the general pamphlet materials obtainable from the state Department of Conservation. *History:* For further historical details *see* the *Outline History of New Jersey* (1950) by the New Jersey History Committee; E. J. Fisher, *New Jersey as a Royal Province, 1738 1776* (1911); E. P. Panner, *The Province of New Jersey, 1664–1738* (1908); W. E. Sackett, *Modern Battles of Trenton* (1895); and the *New Jersey Archives* by the New Jersey Historical Association for specific areas or periods. *Government:* For a thorough

study of New Jersey government consult Bennett M. Rich, *The Government and Administration of New Jersey* (1957), which contains a thorough bibliography for the detailed aspects of specific phases of state government, as well as Fitzgerald's *Legislative Manual* (annual) for administrative details. Other useful sources are the *Reports* of state commissions and agencies. *Education:* The *Report* of the Commission to Survey Public Education (1928) is useful as are the *Annual Reports* of the state Department of Education and the somewhat more recent state Board of Education study on *Opportunities for Higher Education in New Jersey* (1958). *Health and Welfare:* The best sources are the special reports of the Department of Institutions and Agencies dealing with *Public Health Resources in New Jersey* (1947); the *Report on Mental Deficiency in New Jersey* (1954) by a select commission to study the problem, while Paul T. Stafford generally covers public assistance in his work *Government and the Needy* (1941). *Economy:* The *Reports* of the Department of Conservation and Development generally give the most accurate and current picture of the state's economy as do the *Reports* and *Studies* of the state Tax Commission. General works such as those by the Department of Economics and Social Institutions of Princeton University may be very helpful as also might the *Reports* of the state Department of Agriculture, the Commission on Water Supply, the Utilities Commission, the Turnpike Authority, and the publication *New Jersey Business* by the state Department of Conservation and Economic Development in conjunction with the Rutgers School of Business Administration.

Other useful books on New Jersey are the Federal Writers' Project book *New Jersey* (1939), the state's Department of Public Instruction study, *New Jersey, Its History, Resources and Life* (1940), and John T. Cunningham, *This is New Jersey* (1953), among many others. There are numerous specialized works on special areas of the state listed in many of the above.

Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures are summarized annually in the *Britannica Book of the Year*, American edition. (D. N. A.; M. P. M.)

NEW JERSEY TEA (*Ceanothus americanus*), a North American shrub of the buckthorn family (Rhamnaceae), called also Indian or Walpole tea and redroot, native to dry open woods and gravelly banks from Manitoba southward to Florida and Texas. Its low, branching stems, one to three feet high, which spring from a dark red root, bear ovate, three-ribbed, somewhat downy, toothed leaves and attractive white flowers in umbellike clusters. During the American Revolutionary War the leaves were used as tea. *See* also CEANOTHUS.

NEW KENSINGTON, a city of Westmoreland county in western Pennsylvania, U.S., about 18 mi. N.E. of Pittsburgh, is located on the Allegheny river.

Situated in the centre of a coal-mining district, the city has been a leading producer of aluminum since 1892 and is one of the earliest homes of that industry. Manufactures include, besides aluminum products, tubing, conduits, steel castings, water heaters, glass and textiles.

New Kensington was laid out in 1891 on the site of Ft. Crawford of the American Revolutionary period by a group of Pittsburgh capitalists interested in the reduction of aluminum. Incorporated as a borough in 1892, it absorbed neighbouring Parnassus in 1931 and became a city in 1933. For comparative population figures *see* table in PENNSYLVANIA: *Population.* (M. R. Wo.)

NEWLANDS, JOHN ALEXANDER REINA (1838–1898), English chemist whose law of octaves anticipated later discoveries concerning the periodic law (*q.v.*), was born in Southwark in 1838. He studied under August W. von Hofmann in the Royal College of Chemistry, London. Of Italian extraction on his mother's side, he fought as a volunteer in the cause of Italian freedom under Giuseppe Garibaldi in 1860. Later he was employed as an industrial chemist.

Newlands was one of the first to propound the conception of periodicity among the chemical elements, his earliest contribution to the question taking the form of a letter published in the *Chemical News* in Feb. 1863. In the succeeding year he showed, in the same journal, that if the elements be arranged in the order of their atomic weights, those having consecutive numbers frequently either belong to the same group or occupy similar positions in different groups, and he pointed out that each eighth element starting from a given one is in this arrangement a kind of repetition of the first, like the eighth note of an octave in music. The law of octaves thus enunciated was at first ignored or treated with ridicule as a fantastic notion unworthy of serious consideration, but the idea, subsequently elaborated by D. I. Mendeléyev (*q.v.*) and other investigators of the periodic law, took its place as an important generalization in modern chemical theory. Newlands collected his various papers on the elements in a little volume entitled *Discovery of the Periodic Law* (1884). He was awarded the Davy medal of the Royal society in 1887. He died in London on July 29, 1898.

NEW LAWS, rules for the government of Spain's American colonies, were promulgated by Charles I of Spain on Nov. 20, 1542, to remedy problems resulting from imperial expansion and from continued abuse of the Indians. Purportedly inspired by Father Bartolomé de Las Casas, these laws provided for: (1) an administrative reorganization of the American colonies; (2) checking an incipient feudalism; and (3) more humane treatment for the Indians. One series of clauses dealt with administrative divisions and the operation of the courts and bureaucracy. Feudalism was to be controlled by reducing the powers of the Spanish overlords in regard to their encomiendas, the system by which they collected tribute from specified Indian villages in return for protecting and Christianizing them. Encomiendas were to be examined for possible reductions in size, some were to be abolished, no new ones were to be granted and they could no longer be inherited. The laws provided for more humane treatment of the Indians by forbidding their enslavement and branding; releasing slaves held under defective titles; abolishing compulsory Indian service; controlling the working conditions of porters and pearl divers; granting Indians special privileges in the law courts; freeing the remaining Indians of the West Indies from tribute payments and making them legally equal to Spaniards; and, finally, enlarging the powers of royal officials in supervising Indian affairs and in collecting tribute for the crown.

The New laws proved unenforceable. Spaniards in Peru revolted and beheaded the viceroy. In Mexico the laws were not even proclaimed. Petitions of protest flooded Spain. In 1545 and 1546 the more unpopular sections of the laws were revoked, particularly those that affected existing encomiendas. Despite this initial setback, continued pressure was maintained by the crown until the encomienda disappeared in the 18th century. (M. D. Br.)

NEW LONDON, a city and port of entry in southeastern Connecticut, U.S., about 50 mi. E. of New Haven, is situated on Long Island sound at the mouth of the Thames river. Originally called Nameaug by the Indians and Pequot by white settlers when founded by John Winthrop the Younger in 1646, its name was changed to New London in 1658. In 1709 the first printing press in Connecticut was established there. During the American Revolution New London's privateers irritated British commanders so much they dispatched a landing force under Benedict Arnold which set fire to the city and nearly wiped it out on Sept. 6, 1781. Soon rebuilt, it was incorporated as a city in 1784. New London has one of the deepest harbours on the Atlantic coast and its early history was decisively influenced by the sea. During the 19th century it was a leading whaling and sealing port and, before being blockaded during the War of 1812, had a large trade with the West Indies and the Mediterranean. In the 20th century the New London area became the site of a U.S. navy submarine base with its school for submariners and underwater sound laboratory. Major industries include shipbuilding and the manufacture of clothing, pharmaceuticals, printing presses, engines, paper products, furniture and metal fabrications. Among the educational facilities of New London are Connecticut college (1911) for women, the U.S. Coast Guard academy (1876) and Mitchell (junior) college (1938). Notable buildings include old Fort Trumbull at the harbour entrance, the old town mill (1650), Hempstead house (1678), the Huguenot house (1759), the county courthouse (1784) and the New London lighthouse (1760). The annual Yale-Harvard boat races are held on the Thames in June. Pop. (1960) 34,182; New London-Groton-Norwich standard metropolitan statistical area (New London and Norwich cities and East Lyme, Groton, Ledyard, Montville, Preston, Stonington and Waterford towns), 156,913. Griswold, Lisbon, Old Lyme and Sprague towns, pop. (1960) 14,068, were added in 1963. For comparative population figures *see* table in CONNECTICUT: *Population.* (W. D. Lo.)

NEW MADRID, a small town on the right bank of the Mississippi river is the seat of New Madrid county, Mo. It originated as an Indian trading post about 1783. In 1789 Col. George Morgan of New Jersey received a large land grant from the Spanish minister to the U.S. as part of a plan to attach western settlers to the Spanish province of Louisiana; hence the name. He laid out an elaborate townsite extending for four miles along the river; it has several times been relocated because of floods and changes in the course of the river. The town grew rapidly in farming and trade after the purchase of the Louisiana territory by the U.S. in 1803, but was set back by a series of severe earthquakes in 1811–12.

The city played a minor role in the American Civil War in 1862. When the loss of Forts Henry and Donelson made their base at Columbus, Ky., untenable, the Confederates withdrew downriver 60 mi. to Island No. 10, a heavily fortified position of great natural strength at a sharp bend in the river. New Madrid, seven miles farther down the river on a reverse bend, was also occupied. The Federals immediately pushed downriver, employing the amphibious tactics that were proving so effective on western waters. Maj. Gen. John Pope worked his way southward through the Missouri swamps with an army of 20,000 while Commodore A. H. Foote headed downstream with his flotilla of ironclads, wooden gunboats, transports and barges. Pope outflanked New Madrid by occupying Point Pleasant eight miles below, and when the Confederates withdrew across the river to safety, he occupied the post. But he could not move farther so long as the Confederates controlled the river below Island No. 10. When naval bombardment failed to reduce the defenses at the Island stronghold, two ironclads, the "Carondelet" and the "Pittsburgh," ran the batteries on April 4 and 7. Meanwhile, the army cut a shallow canal across the peninsula in front of the island and enabled light draft transports and supply barges to avoid the heavy guns and bring supplies and support to Pope. The Confederates, trapped between Federal forces and unable to escape into Tennessee because of the high water in the swamps, had no choice but to surrender.

See Phillips Melville, "The *Carondelet* Runs the Gantlet," *American Heritage*, vol. x, no. 6 (Oct. 1959); Writers' Program, *Missouri* (1941).
(C. W. Te.)

NEWMAN, JOHN HENRY (1801–1890), Tractarian leader in the Church of England and then one of the most influential Roman Catholic converts of the 19th century, was born in London on Feb. 21, 1801. After an education in an evangelical home and at Trinity college, Oxford, he was made a fellow of Oriel college, Oxford, in 1822; vice-principal of Alban hall in 1825; and vicar of St. Mary's, Oxford, in 1828. Under the influence of John Keble and Richard Hurrell Froude (*qq.v.*) he became a convinced high churchman. When the Oxford movement (*q.v.*) began he was its effective organizer and intellectual leader, supplying the most acute thought produced by that movement. His editing of the *Tracts for the Times* and his contributing of 24 tracts among them were less significant for the influence of the movement than his books, especially the *Lectures on the Prophetical Office of the Church* (1837), the classic statement of the Tractarian doctrine of authority; the *University Sermons* (1843), similarly classical for the theory of religious beliefs; and above all his *Parochial and Plain Sermons* (1834–42), which in their published form took the principles of the movement, in their best expression, into the country at large. In 1838 and 1839 Newman was beginning to exercise far-reaching influence in the Church of England, because the stress upon the dogmatic authority of the church was felt to be a much-needed reemphasis in a new liberal age; because he seemed so decisively to know what he stood for and where he was going; because in the quality of his personal devotion his followers found a man who practised what he preached; and because he had been endowed with the gift of writing sensitive and sometimes magical prose.

Newman was contending that the Church of England represented true catholicity and that the test of this catholicity (as against Rome upon the one side and what he termed "the popular Protestants" upon the other) lay in the teaching of the ancient and undivided church of the Fathers. From 1834 onward this *via media* was beginning to be attacked on the ground that it undervalued the Reformation; and when in 1838–39 Newman and Keble edited and published Froude's *Remains*, in which the Reformation was violently denounced, moderate men began to suspect their leader. Their worst fears were confirmed in 1841 by Newman's *Tract 90*, which, in reconciling the Thirty-Nine Articles with the teaching of the ancient and undivided church, appeared to some to assert that the articles were not incompatible with the doctrines of the Council of Trent; and Newman's extreme disciple, W. G. Ward (*q.v.*), claimed that this was indeed the consequence. Bishop Richard Bagot of Oxford requested that the tracts be suspended; and in the distress of the consequent denunciations Newman increasingly withdrew into isolation, his confidence in himself shattered and his belief in the catholicity of the English church weakening. He moved out of Oxford to his chapelry of Littlemore, where he gathered a few intimate disciples and established a quasi monastery. He resigned St. Mary's Oxford on Sept. 18, 1843, and preached his last Anglican sermon ("The Parting of Friends") in Littlemore church a week later. He delayed long, because his intellectual integrity found an obstacle in the historical contrast between the early church and the modern Roman Catholic Church; but meditating upon the idea of development, a word then much discussed in connection with biological evolution, he applied the law of historical development to the Christian society and tried to show (to himself as much as to others) that the early and undivided church had developed rightly into the modern Roman Catholic Church, and that the Protestant churches represented a break in this development, both in doctrine and in devotion. These meditations removed the obstacle and on Oct. 9, 1845, he was received at Littlemore into the Roman Catholic Church, publishing a few weeks later his *Essay on the Development of Christian Doctrine*.

Newman went to Rome to be ordained to the priesthood and after some uncertainties founded the Oratory at Birmingham in 1848. He was suspect to the more rigorous among Roman Catholic clergy because of the quasi-liberal spirit which he seemed to have brought with him (his mode of expressing the idea of doctrinal development, his teaching on the nature of faith) and therefore, though in fact he was no liberal in any normal sense of the word, his early career as a Roman Catholic priest was marked by a series of frustrations, as he at least felt them to be. In 1852–53 he was convicted of libeling the immoral Italian priest Achilli. He was summoned to Ireland to be the first rector of the new Catholic university in Dublin, but the task was in the conditions impossible, and the only useful result was his lectures on the *Idea of a University* (1852). His part in the *Rambler*, and in the endeavour of Lord Acton (*q.v.*) to encourage critical scholarship among Catholics, rendered him further suspect and caused a breach with H. E. Manning, once himself a Tractarian and soon to be the new archbishop of Westminster. One of Newman's articles ("On Consulting the Faithful in Matters of Doctrine") was delated to Rome on suspicion of heresy. He attempted to found a Catholic hostel at Oxford and was thwarted by the opposition of Manning.

From the sense of frustration engendered by these experiences Newman was delivered in 1864 by an unwarranted attack from Charles Kingsley upon his moral teaching. Kingsley in effect challenged him to justify the honesty of his life as an Anglican. And though he treated Kingsley more hardly than was justified, the resulting history of his religious opinions, *Apologia pro vita sua* (1864), was read and approved far beyond the limits of the Roman Catholic Church; and by its fairness, candour, interest and the beauty of some passages recaptured that almost national status which he had once held. Though the *Apologia* was not liked by Manning and those who thought with him, because it seemed to show the quasi-liberal spirit which they feared, it assured Newman's stature in the Roman Catholic Church; and the new pope (Leo XIII) made him a cardinal (1879). Meanwhile he had expressed opposition to a definition of papal infallibility in 1870, though himself a believer in the doctrine, and had published his most important book of theology since 1845, *An Essay in Aid of a Grammar of Assent* (1870), which contains a further consideration

of the nature of faith and an attempt to show how faith can possess certainty when it rises out of evidence which can never be more than probable. He died at Birmingham on Aug. 11, 1890, and is buried (with his closest friend, Ambrose St. John) at Rednal, the rest house of the Oratory.

Newman's portraits show a face of sensitivity and aesthetic delicacy. He was a poet—most famous are his contributions in the *Lyra Apostolica* of his Anglican days, including the hymn "Lead, kindly light," written in 1832 when he was becalmed in the strait between Sardinia and Corsica, and *The Dream of Gerontius* (1865), based upon the requiem offices and including such well-known hymns as "Praise to the holiest in the height" and "Firmly I believe and truly"—and his thought as a philosopher or theologian was never far from the poetic apprehension. He was always conscious of the limitations of prose and aware of the necessity for parable and analogy, and logical theologians sometimes found him elusive or thought him muddled. But his was a mind of penetration and power, trained upon Aristotle, Hume, Bishop Joseph Butler and Richard Whately, and his superficial contempt for logic and dialectic blinded some readers into the error of thinking his mind illogical. His intellectual defect was rather that of over-subtlety; he enjoyed the niceties of argumentation, was inclined to be captivated by the twists of his own ingenuity, and had a habit of using the *reductio ad absurdum* in dangerous places. Newman's mind at its best is probably to be found in parts of the *Parochial and Plain Sermons* or the *University Sermons*, at its worst in the *Essay on Ecclesiastical Miracles* of 1843.

His sensitive nature, though it made him lovable to his few intimates, made him prickly and resentful of public criticism, and his distresses under the suspicions of his opponents, whether Anglicans defending the Reformation or ultramontanes attacking his Roman theology, weakened his confidence and prevented him from becoming the leader which he was otherwise so well equipped to be. Nevertheless as the effective creator of the Oxford movement he helped to transform the Church of England; and as the upholder of a theory of doctrinal development he helped Catholic theology to become more reconciled to the findings of the new critical scholarship, while in England the *Apologia* was important in helping to break down the cruder prejudices of Englishmen against Catholic priests. In both churches his influence has been momentous.

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(W. O. C.)

NEWMARKET, the "gateway to East Anglia," a market town and urban district of West Suffolk, Eng., 13 mi. E.N.E. of Cambridge by road. Pop. (1961) 11,207. Though the town is in West Suffolk, and Suffolk is its postal address, the rural district is in Cambridgeshire. Newmarket, on the main London to Norwich road, is the home of the Jockey club and has been celebrated for its horse races from the time of James I. Charles I instituted the first cup race there in 1634. Two of the five "classic" races are held there in the spring—namely, the Two Thousand Guineas (colts) and the One Thousand Guineas (fillies) both for three-year olds—and in the autumn two of the most popular handicap races, the Cesarewitch and the Cambridgeshire. Besides the breeding, training, racing and selling of racehorses, light industry in the form of caravan (trailer) manufacture and the making of electronic and magnetic devices has been established.

There are two racecourses on Newmarket heath, southwest of the town: the Rowley Mile course, used in the spring and autumn, and the July course, used in the summer. The Rowley Mile intersects the Devil's ditch or dike, an earthwork extending 7½ mi. from Wood Ditton to Reach, which is thought to have been built by the East Anglians as a defense against the Mercians about the 6th century A.D. and which later formed the boundary of East Anglia. The district contains chalk downland with its peculiar flora and fauna, and Wicken fen, a nature reserve belonging to the National trust.

(J. Cr.)

NEW MEXICO, the "Land of Enchantment" or "Sunshine state," one of the states of the United States, is located in the southwestern part of the country. Roughly rectangular in shape, it is bounded north by Colorado, east by Oklahoma and Texas, south by Texas and the republic of Mexico and west by Arizona. Its length north and south is 391 mi., its width east and west 344 mi.; the total area is 121,666 sq.mi. (of which only 156 sq.mi. are water surface), making it fifth in area among the states. New Mexico was admitted to the union in 1912 as the 47th state. The state flag is a field of yellow containing in its centre the ancient Zia sun symbol in red. The state flower is the yucca flower, the bird the road runner (*Geococcyx californianus*), the state song "O, Fair New Mexico." The capital is at Santa Fe (*q.v.*).

PHYSICAL GEOGRAPHY

Physical Features.—The borders of New Mexico (lat. 31° 20′ to 37° N.; long. 103° to 109° W.) are high plateaus cut by deep canyons; in the central part faulted mountains surround comparatively level areas formed of alluvial deposits. Between the Rio Grande and the Pecos valleys the mountains form a more continuous range than on the west side of the Rio Grande, where the elevated areas carry the continental divide.

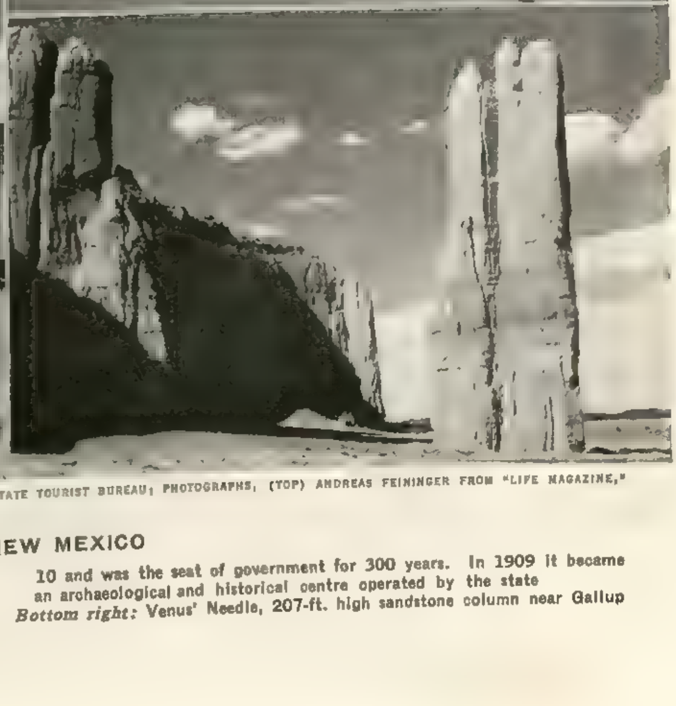
The Sangre de Cristo mass, an extension of the Colorado mountains, lies slightly east of the north-central part of New Mexico east of the Rio Grande. South of this northern mass two series of ranges extend to the southern boundary: nearest the Rio Grande the Sandía, Manzano, San Andrés, Oscura and Organ mountains, farther east the Pedernal, White, Sacramento and Guadalupe mountains.

West of the Rio Grande the San Juan mountains dominate the country north of the Chama river; a somewhat smaller mass the Jemez mountains, lies between the Chama and the Jemez river. The Puerco river separates the Jemez mountains from the Mt Taylor mountains, which carry the main divide southwesterly to the Zuni mountains and on into one of the largest mountain masses in the state, with the Black range closest to the Rio Grande and the Mogollons, the San Mateo and the Magdalena as outlying ridges toward the west. In the extreme southwestern part of the state the mountains terminate in several parallel ridges: the Burro, Big Hatchet and Peloncillo mountains.

The major divides, following the tops of the ridges and the high plateaus, run generally north and south. The most important are the divides between the Pecos and the Canadian valleys; between the Pecos and Tularosa valleys; between the Tularosa and the Rio Grande; and between the Rio Grande and the San Juan, Little Colorado and Gila valleys.

The rivers are the only important bodies of water, but the Rio Grande and the Canadian have been dammed to form the Elephant Butte and Caballo reservoirs on the Rio Grande, and Conchas reservoir on the Canadian; primarily useful for irrigation, these reservoirs also offer fishing and water sports. The Cimarron, tributary to the Arkansas, and North Canadian rivers rise in the northeastern part of the state, in Union county. The Canadian, also tributary to the Arkansas, flows through Colfax, Mora, San Miguel and Quay counties, draining the eastern slope of the Sangre de Cristo range, the southern flank of which drains into the Pecos river; this in turn flows southward across the state.

The Rio Grande, the only important river that does not have its source in the state, enters New Mexico through a deep canyon just east of the 106th meridian and flows south through the centre of the state. On the western side of the continental divide the principal rivers are the San Juan, Little Colorado and Gila, tributaries



BY COURTESY OF (CENTRE RIGHT) SANTA FE RAILWAY, (BOTTOM RIGHT) NEW MEXICO STATE TOURIST BUREAU; PHOTOGRAPHS, (TOP) ANDREAS FEININGER FROM "LIFE MAGAZINE," (BOTTOM LEFT) HARVEY CAPLIN

SCENES IN NEW MEXICO

Top: Acoma, Pueblo Indian village on a mesa 357 ft. above the plains. It was an ancient village when Spanish explorers first saw it in 1540

Bottom left: Stock raising along the Chisum trail

Centre right: Palace of the Governors at Santa Fe. It was built in 1609–10 and was the seat of government for 300 years. In 1909 it became an archaeological and historical centre operated by the state

Bottom right: Venus' Needle, 207-ft. high sandstone column near Gallup

NEW MEXICO

BY COURTESY OF (TOP LEFT) LOS ALAMOS SCIENTIFIC LABORATORY, (TOP RIGHT) SANTA FE RAILWAY, (CENTRE RIGHT) NEW MEXICO STATE TOURIST BUREAU; PHOTOGRAPHS, (CENTRE LEFT) HARVEY CAPLIN, (BOTTOM) © E. "TEX" HELM

VIEWS OF NEW MEXICO

Top left: Church at Los Alamos, nuclear experiment testing area
Top right: Street scene in Taos
Centre left: Rio Grande near Taos, north-central New Mexico
Centre right: State capitol at Santa Fe, completed in 1953
Bottom: The Big Room, largest of the numerous underground areas at Carlsbad Caverns National park

of the Colorado, which flows into the Gulf of California.

Climate.—The climate of New Mexico is generally sunny and relatively dry (average rainfall 14.3 in.) but with considerable variation depending on altitude. Extremes of temperature range from 110° to −29° F. Winter average temperature is about 39° in the south and 29° in the north; summer averages are about 77° and 68°, respectively. Prevailing summer winds blow from the southeast, bringing the summer rains from the Gulf of Mexico. Occasional winter winds from the northwest bring cold, especially to the northwest quarter of the state. Relative humidity is low; Albuquerque, in the centre of the state, has a winter minimum of 24% and a maximum of 58%.

Soil.—The soils of New Mexico generally contain a large amount of mineral matter and a small amount of organic matter; the alluvial soils are deep and very productive when irrigated.

Vegetation and Animal Life.—Altitude, determining climate, also largely determines the distribution of plants and animals. Six zones are recognized, ranging generally from southern valleys of less than 3,000 ft. above sea level to above the timber line, where only arctic lichens and grasses grow. The tallest peak, Wheeler peak in the Sangre de Cristo range above Taos, rises to 13,600 ft.

Lower Sonoran Zone.—The lowest zone, Lower Sonoran, is characterized by mesquite, creosote bush, yucca, desert willow, cottonwood, many varieties of cactus and Spanish bayonet. There are many species of mice, rats, squirrels, skunks and bats; also the coyote, the New Mexico desert fox and weasel and the Mexican badger. Birds include the scaled quail, Scott's oriole, the sparrow, the western mockingbird and the road runner. This zone covers about 18,000 sq.mi. of the state's most fertile land, which is very productive with irrigation.

Upper Sonoran Zone.—The zone above, the Upper Sonoran, from 3,000 to 7,500 ft. of altitude, is the largest, covering about 92,000 sq.mi., three-quarters of the state, and with irrigation is the most productive. Its natural growth consists of piñon and juniper trees and blue grama, galleta, buffalo and porcupine grasses, which make fine range for cattle. These wide grassy plains extend eastward into Texas as the Staked plains (Llano Estacado). Several species of deer, antelope, coyote, wolves and prairie dogs are common to the area; mountain sheep, which had almost disappeared, are coming back with protection.

Upper Zones.—The three zones above the Upper Sonoran—Transition, Canadian and Hudsonian—bear fine timber. Above 8,000 ft., ponderosa pine is replaced by several varieties of fir and spruce, all varied by scrub oak and quaking aspen which covers burned over areas with its delicate green in summer, its golden yellow in autumn. These forests offer good hunting of deer and, in some places, elk. Black and brown bears are found there, and mountain lions prey on smaller animals and domestic stock. In the Arctic-Alpine zone, above 12,000 ft., only a few grasses, lichens and alpine sedges grow.

Parks, Monuments and Recreation.—New Mexico possesses many attractions for tourists, among them the Carlsbad Caverns National park (*q.v.*), at Carlsbad. The state also embraces nine national monuments: Aztec ruins, at Aztec; Bandelier, near Santa Fe; Capulin mountain, near Raton; Chaco canyon, near Bloomfield; El Morro, at El Morro; Ft. Union, near Watrous; Gila cliff dwellings, near Silver City; Gran Quivira, at Gran Quivira; and White Sands, near Alamogordo. State parks are Hyde, at Santa Fe, Bottomless lakes, near Roswell; Conchas dam, Tucumcari; Kit Carson memorial, Taos; City of Rocks, near Deming; and Bluewater lake, near Grants. State monuments are Mesilla plaza, Mesilla; El Palacio, Santa Fe; Abo, near Mountainair; Pecos, Pecos; Coronado, near Bernalillo; Quarai, near Mountainair; Jemez, Jemez Springs; Lincoln, Lincoln.

HISTORY

Prehistory.—In New Mexico and other areas of the southwest the peripheries of at least two distinct prehistoric Indian cultures touched: the agrarian, docile early groups, and the later aggressive and nomadic Navaho and Apache. The Sandia cave and Folsom men represent the earliest evidences of human life discovered on the North American continent. For at least 10,000 years man has inhabited New Mexico. Pre-Pueblo Hohokam and Salado Indians were agriculturalists and irrigators. The Anasazi built cities. Among their more interesting ruins are those in the San Juan valley and Chaco canyon. Approximately 1,000 years ago came the Navaho and then the Apache.

Exploration.—Recorded history began between 1525 and 1543 when Spanish explorations extending from Florida to California paved the way for Spain's colonization of Florida and New Mexico in the 16th and 17th centuries, Texas and California in the 18th. The first explorer to cross the continent was Alvar Núñez Cabeza de Vaca, who, with three companions, reached the Gulf of California and went on to Mexico City, capital of the viceroyalty of New Spain. There his reports inspired Viceroy Antonio de Mendoza to undertake explorations to the north. He sent out an expedition headed by a Franciscan friar, Marcos de Niza, which reached the Zuñi pueblos in western New Mexico and brought back such dazzling (though untrue) reports of wealth (the myth of the Seven Golden Cities of Cibola) that in 1540 Francisco Coronado, with a well-equipped force of 300 soldiers, marched north over the same trail. Coronado proceeded to the Rio Grande and established winter quarters near Bernalillo. His lieutenants conquered the pueblos as far north as Taos and pushed as far west as the Grand canyon. Coronado himself reached mid-Kansas.

Coronado found no gold, but the friars converted many Pueblo Indians, who farmed small irrigated plots of land and were generally peaceful. His reports, circulated in Mexico, inspired missionaries, and in 1581 Augustín Rodríguez, a Franciscan friar, led an expedition into New Mexico. Rodríguez' military escort soon returned to Mexico, however, leaving the friars behind, and in 1582 Antonio de Espejo set out to rescue them. In this year the name New Mexico was applied to the Rio Grande pueblos, and it appeared in a contract made in 1595 with Juan de Oñate for the colonization of the area.

Colonization.—Oñate's expedition entered New Mexico at the pass (present El Paso) and proceeded up the Rio Grande to its confluence with the Chama river. There Oñate established San Juan de los Caballeros as his capital, and the first mass was said there on Sept. 9, 1598. Santa Fe, the present capital of New Mexico, was founded in 1610. To Oñate may be attributed the permanent settlement of the area. His conquest and settlement were described in Villagrá's *Historia del Nuevo Méjico*, an epic poem, the first poem written about any section of the U.S., published at Alcalá de Henares, Spain, in 1610.

New Mexico remained a frontier mission field until the 19th century. Twenty friars were serving there in 1624, there were 43 churches and Christian Indians were counted as 3,400. The total Spanish population was only 2,000, an indication that the colony had not become an important source of wealth. The friars, pressing hard to eradicate the Indians' traditional beliefs, aroused such opposition that in 1680 the Pueblos revolted, killed many Spanish settlers, including priests, and drove the rest south to El Paso.

In 1692 Spanish troops under Diego de Vargas re-entered New Mexico, occupied the whole province and by 1696 had peaceably re-established Spanish rule. Later the Spanish kings confirmed the Pueblos' ownership of their lands by royal grants which are the basis of their present holdings. During the 18th century colonists from Mexico continued to enter New Mexico and were granted lands as groups or as individuals. They founded such enduring towns as Socorro in the south, Don Fernando de Taos near Taos pueblo, Santa Cruz north of Santa Fe and others less important.

Albuquerque (*q.v.*), founded in 1706, became the centre of southern New Mexico, with a population of 4,020 by 1799. The total population of the province, which extended from Louisiana to California, was then about 30,000, including 20,000 Spanish and 10,000 peaceful Indians. Warlike Indians, especially Navaho, Apache and Comanche (*qq.v.*) nomads, harried Spanish towns and Indian pueblos alike. Spain offered the Indians, the towns and pueblos little protection, as the Spanish empire was breaking up.

Mexican Rule.—By 1823 the old viceroyalty of New Spain had attained its independence and had become the republic of Mexico. This change was little noted in New Mexico, which was

beginning to look eastward. The Mexican government had legalized trade with the Missouri valley towns, which had been discouraged by Spain, and in 1821 the first annual caravan left Missouri for Santa Fe (*see* SANTA FE TRAIL). Trade over the Santa Fe trail grew in value from $15,000 in 1822 to $450,000 in 1843.

The republic of Texas, established in 1836, claimed the Rio Grande as its western boundary and, tempted by the rich Santa Fe trade, invaded New Mexico in 1841; but the badly organized Texas-Santa Fe expedition was easily defeated by New Mexicans under Gov. Manuel Armijo.

Territorial Period.—War between the United States and Mexico broke out in 1846, and during that year the army of the west entered New Mexico under Stephen Watts Kearny. Kearny took formal possession of New Mexico at Las Vegas on Aug. 15, 1846, promising all inhabitants who would take the oath of allegiance to the United States amnesty and full citizenship, with freedom of religion and property rights. Three days later Kearny occupied Santa Fe, where he established a military government and appointed Charles Bent civil governor. Bent was assassinated in a short-lived rebellion in Taos on Jan. 19, 1847. Congress on Sept. 9, 1850, created the territory of New Mexico, extending from meridian 103° on the east to the territory of California at approximately meridian 114°. Part of the Compromise of 1850, the act included provision for Texan surrender of claims to the New Mexico panhandle or lands of the upper Rio Grande in exchange for federal payment of $10,000,000 to Texas. In 1861 the line between New Mexico and Colorado was drawn at 37° N. lat.; the territory of Arizona was created in 1863 of the western half of New Mexico.

During the American Civil War, a Confederate force under Brig. Gen. H. H. Sibley invaded New Mexico, hoping to reach the California gold fields. They advanced up the Rio Grande and took Santa Fe, but Col. E. R. S. Canby's Union troops, reinforced by the 1st Colorado volunteers, met and decisively defeated them at Apache canyon on March 28, 1862.

The period following the American occupation was marked by the solution of the Indian problem and by the economic development of the territory. The Navahos, defeated in 1865, were established in 1868 on a large reservation that crosses the New Mexico-Arizona boundary. The Apaches, in 1880, were settled on two reservations in Arizona and two in New Mexico, the Mescalero in the southern part of the state, and the Jicarilla in the northwest, lands which these tribes still hold. The United States had confirmed the Spanish and Mexican land grants to the Pueblo Indians, to individuals and to groups of Spanish settlers, but it took years and special courts to settle these complicated claims.

The settlement of the Indian troubles and the building of railways into the west brought increased population, the building of towns, the opening of mines and the introduction of cattle from Texas into eastern New Mexico. Spanish and Mexican ranchers had run sheep, and conflicts between cattle- and sheepmen over the use of water and the open range sometimes led to armed conflict. But the cattle wars common to other parts of the west were few in New Mexico. Most publicized was the Lincoln County War, 1877–80, which caused the U.S. government to dispatch Gen. Lewis (Lew) Wallace (*q.v.*) to Santa Fe as territorial governor in an attempt to restore order.

The Atlantic and Pacific railroad (later the Atchison, Topeka and Santa Fe) reached Albuquerque in 1880, building toward California. Later it connected with the Southern Pacific at Deming and ran a branch line to El Paso. New Mexico now had transcontinental roads. In 1891 a public-school system was established. English, the official language since 1846, was beginning to reach the Spanish-speaking majority of the population.

Statehood.—Constant efforts to secure statehood were finally successful; congress passed an enabling act on June 20, 1910; a constitution was drafted and approved; and on Jan. 6, 1912, New Mexico was formally admitted as a state.

Since the location of the Manhattan District project in New Mexico in 1942, atomic research laboratories and related developments have led to great population changes in the state. Establishment of scientific centres at Los Alamos, Albuquerque and Roswell caused an influx of highly trained scientists, tech- and supporting personnel, including military and service m- These new elements, coming from all the states and fro- foreign countries, have radically altered the political colo- state, and vast government expenditures (such as an annu- roll of $30,000,000 at Los Alamos) have led to a great incre- the state's per capita income.

Part of this economic advance has been due to the disco- oil, gas and uranium on Indian lands, which has made the N- Laguna and Jicarilla Apache wealthy; their wealth is own- ally and is largely devoted to education and improvement o- conditions.

Two world wars greatly affected the state's Indian and S- peoples. English has become more widely and better spoke- young men have seen the world; many have profited by - tional opportunities; in general, they have become fully integ- into the American scene.

New Mexico has voted Democratic in presidential election- cept in 1920, 1924, 1928, 1952 and 1956.

GOVERNMENT

The constitution adopted in 1911 remains the basis of the N- Mexican State government, though some amendments have - approved by the voters.

The state legislature is composed of a senate of 42 mem- (1966; formerly 37) and a house of representatives havin- members. Annual sessions were prescribed by constit- amendment approved by the voters in 1964. Representative- elected for two years and senators for four. The govern- call special sessions, and must do so on request of three-f- the legislature. The governor possesses the veto power, wh- be overridden by a two-thirds vote of the legislative member- ent and voting. The people have the right of referendum.

A direct primary was established in 1938 but in 194- changed to a preprimary nominating convention. The state- two senators and two representatives in the national congr-

The ten elective executive officials—governor, lieutenant g- ernor, secretary of state, auditor, treasurer, attorney ge- commissioner of public lands and three corporation commis- —are elected for two-year terms. They may serve two c- tive terms and are eligible for re-election after two years.

State boards, departments, agencies and commissions in- department of finance and administration, an advisory b- deposits and investments, and commissions on forest c- tion, youth, Indian affairs, alcoholism, fair employment p- a five-member highway commission, members of which - overlapping six-year terms, and a five-member board of - with six-year overlapping terms, for institutions of higher - tion.

There are 5 supreme court justices elected for terms of - years; 12 district judges, elected for six years, who als- as juvenile judges; probate judges elected in each county - years; and justices of the peace elected in each precinct - years. A 4-judge appellate court was established in 196-

The cost of state government rose from $22,300,000 in - about $250,000,000 annually in the 1950s and 1960s. A c- tional amendment limiting property tax to 20 mills neces- sales tax in 1935, a severance tax in 1937, a compensat- 1939 and a tobacco tax in 1943. The state's revenue c- marily from the sales tax, gasoline tax and oil and gas re- royalties.

POPULATION

The population of New Mexico in 1850 was 61,547; - 327,301; in 1940, 531,818; in 1950, 681,187; and in 1960 - This last figure represented an increase of 39.6% over the - lation in 1950. The population per square mile in 1960 was - compared with 4.4 in 1940 and 5.6 in 1950, and with 49.6 - United States in 1960.

Of the 1960 population, 626,479, or 65.9%, lived in i- rated places of 2,500 or more, as compared with 46.2% - and with 33.2% in 1940 when these places constituted the -

[illegible] The state has one standard metropolitan statistical area, [illegible] (Bernalillo county). This area had a population of [illegible] or 27.6% of the total population of the state in 1960.

The number of households in 1960 was 251,209 as compared with 177,128 in 1950. The average population per household had [illegible] from 4.1 in 1940 to 3.8 in 1950 and to 3.7 in 1960.

Of the total 1960 population, 5.4% was 65 years old or over, and 54.1% of the population 14 years old and over was in the [illegible]. Of the total number of employed persons, 7.1% was [illegible] in agriculture, 6.7% in mining, 9.3% in construction, [illegible] manufacturing, 4.2% in transportation and 19.2% in wholesale and retail trade.

New Mexico's ethnic composition is a fair cross section of the United States except for the fact that the usual mixture is based on Indian and Spanish elements rather than Anglo-Saxon. The state's Indians number around 55,000, and a considerable portion of the population has Spanish names. Since the first census of 1850, immigrants from the states and foreign countries have included a preponderance of Germans, with the addition of Jewish, Italian, eastern European and middle eastern persons and some orientals, mostly from China and Japan. Most of the state's English-speaking people have come from the states. Mexicans have come across the border, especially after World War II.

Both Indian and Spanish cultures have left traces in architecture and the other arts, including household furnishings, speech, [illegible] and foods.

New Mexico's Indian population in 1960 was 56,255 including Navahos, Apaches and Pueblos. Indians, declared citizens by act of congress in 1924, were granted the vote in New Mexico in 1948. [illegible] economic contribution to the state is considerable as stockmen, farmers, craftsmen and workers in many lines of industry.

Contemporary pueblo villages are Zuni, near Gallup; Acoma and Laguna, near Albuquerque; and the eastern pueblos of the [illegible] Grande and its tributaries. Mescalero, the chief Mescalero Apache village, is south of Ruidoso. Jicarilla Apache headquarters [illegible] Dulce, in northern New Mexico. The Navaho capital is [illegible] Window Rock, on the Arizona-New Mexico border.

*New Mexico: Places of 5,000 or More Population (1960 census)**

Place	Census of population				
	1960	1950	1940	1920	1900
[illegible]	951,023	681,187	531,818	360,350	195,310
[illegible]	21,723	6,783	3,950	2,363	—
[illegible]	201,189	96,815	35,449	15,157	6,238
[illegible]	12,000	8,244	4,071	1,115	—
[illegible]	5,0[illegible]	4,495	3,038	1,306	—
[illegible]	25,541	17,975	7,116	2,205	—
[illegible]	23,713	17,318	10,065	4,904	—
[illegible]	6,764	5,672	3,608	3,212	—
[illegible]	23,786	3,637	2,161	728	—
[illegible]	14,089	9,133	7,041	3,920	2,946
[illegible]	10,[illegible]74	2,251	—	—	—
[illegible]	2[illegible],275	13,875	10,619	—	—
[illegible]	29,367	12,325	8,385	—	—
[illegible]	7,790	7,494	5,941	4,304	3,552
[illegible]	6,028	6,269	6,421	3,902	—
[illegible]	12,584	9,934	—	—	—
[illegible]	9,660	3,134	1,916	411	—
[illegible]	9,695	8,112	5,104	1,154	—
[illegible]	8,146	8,241	7,607	5,544	3,540
[illegible]	39,593	25,738	13,482	7,033	2,049
[illegible] City	33,394	27,998	20,325	7,236	5,603
[illegible]	6,972	7,022	5,044	2,662	2,735
Tucumcari	5,271	4,334	3,712	1,256	1,512
[illegible]	8,143	8,419	6,194	3,117	—

*[illegible] reported as constituted at date of each census.
[illegible] indicates place did not exist during reported census, or data not available.

EDUCATION

Public Schools.—Until the establishment of the public-school system in 1891 education was carried on by private and religious [illegible] schools. Progress in public-school education was rapid [illegible] New Mexico became a state in 1912.

The public-school system is governed by the state board of education, consisting of the governor, the superintendent of public instruction (appointed by the board) and ten members elected from the state's ten judicial districts. This method of choosing superintendent and board members was established by an amendment [illegible] constitution approved at the general election of Nov. 1958. Between the late 1940s and the late 1950s enrollment in the public schools more than doubled, as did school expenditures and property valuation. In the second half of the 20th century there were nearly 100 public-school systems, employing approximately 10,000 teachers, principals and supervisors. After July 1956 certification was granted only to teachers holding the bachelor's or higher degree; about one-third of all New Mexico teachers held the master's degree. Free basic textbooks were available to all pupils in grades 1 to 12.

The New Mexico Military institute at Roswell, partly supported by state funds, offers high school and junior college work, as well as military training.

Private and parochial schools enroll about 24,000 pupils. Some state control is exercised over courses of study, but the state gives no direct financial support for instruction or buildings.

In 1957 a retirement system for teachers and certain other school employees was inaugurated, with both teachers and the state contributing.

Higher Education.—The University of New Mexico at Albuquerque, chartered in 1889 and opened in 1892, consists of a graduate school and nine colleges: arts and sciences, business administration, education, engineering, fine arts, law, nursing, pharmacy and university. Regular courses are offered through two semesters, a summer session and extension courses. Other services are offered the state's schools through the college of education. Naval and air force reserve training corps units are located on the campus. The university offers the Ph.D. degree in American studies, anthropology, biology, chemistry, education, English, geology, history, mathematics, physics and Spanish.

New Mexico State university (formerly New Mexico College of Agriculture and Mechanic Arts), established at Las Cruces (State College) in 1889, offers work in schools of arts and sciences, engineering, teacher education and agriculture. New Mexico Institute of Mining and Technology in Socorro (established in 1889), includes the college, the bureau of mines and mineral resources and the research and development divisions. New Mexico Highlands university (formerly New Mexico Normal university, chartered in 1893) in Las Vegas offers extension work and grants degrees through the M.A. Eastern New Mexico university (established 1934, formerly Eastern New Mexico college), in Portales has schools of liberal arts and sciences, business and economics, music, teacher education and vocations. New Mexico Western university (established 1893; formerly New Mexico State Teachers college), at Silver City offers work in liberal arts, teacher education and vocational training.

Financial support and programs of all state institutions of higher learning are co-ordinated through the board of educational finance, appointed by the governor, which, with its executive secretary, is responsible for screening all college and university budget requirements and for approving all educational programs.

There are two private colleges in the state: St. Michael's (1947), at Santa Fe, and the College of St. Joseph on the Rio Grande (1940), at Albuquerque, both Roman Catholic.

Museums.—The Museum of New Mexico, Hall of Archaeology, and the Museum of New Mexico Art gallery are in Santa Fe, as are the Laboratory of Anthropology, the Museum of International Folk Art and the Museum of Navaho Ceremonial Art. The Roswell Museum and Art centre is at Roswell, the Taos Historical Museum and Art gallery at Taos. Albuquerque has the Old Albuquerque museum and the Albuquerque Modern museum. Old Lincoln County Court House museum is in that county seat.

HEALTH, WELFARE AND CORRECTIONS

The state supports a penitentiary (1884) at Santa Fe and a prison farm (1939) at Los Lunas, a hospital for the insane (1889) and a home for the aged (1947), both at Las Vegas; a home for the aged (1952) at Alcalde, a miners' hospital (1903) at Raton, an industrial school for boys (1903) at El Rito, moved to Springer in 1909; a girls' welfare home (1919) at Albuquerque; a school for mental defectives (1925) at Los Lunas; the Carrie Tingley Crippled Children's hospital (1937) at Truth or Consequences, a school for the blind (1903) at Alamogordo; and a school for the deaf (1887) at Santa Fe.

State provision is made for unemployment compensation. There is a joint federal and state program of financial aid to dependent children, and child welfare services of the state provide both financial and social services to dependent children.

THE ECONOMY

Agriculture.—The area east of the Rio Grande contains about four-fifths of the state's cropland. The Rio Grande valley and the area west of it, principally in Catron county, contain an acreage of about 330,000. In Curry, Roosevelt, Quay, Harding, Union and Colfax counties an average rainfall of about 14.3 in. permits dry farming; over the rest of the state, crops are dependent upon irrigation and hence are confined to the river valleys where irrigation is practicable: the Rio Grande, San Juan, Pecos, Gila, Canadian and their tributaries.

Since prehistoric times man has attempted to bring usable water to New Mexico. Early Pueblo Indians practised limited irrigation. The white settlers used windmills, artesian wells and privately financed irrigation, begun in the 1880s. The Reclamation act of 1902 ultimately resulted in a number of publicly financed dams that make possible irrigation of more than 500,000 ac. Waste and silt are problems. The Navajo dam and reservoir, dedicated in 1962 as a unit of the Colorado river storage system, was planned to irrigate about 110,000 ac. of Navaho land in the northwestern part of the state.

Value of the major crops of New Mexico approaches $100,000,000 annually; total cropland, including minor crops, is about 1,000,000 ac. The leading cash crop is cotton, followed by grain sorghums, hay, winter wheat, corn and dry beans. The chief farm animals are cattle, sheep, horses, mules and hogs; the number of horses and mules declines steadily. Livestock brings New Mexico farmers and ranchers more than half again as much income as do crops.

Industry.—Manufacturing increased slowly in the first half of the 20th century. In 1899, 175 establishments employed 2,600 persons, paid them $1,290,000 and added $2,062,000 to value by manufacture. Comparable figures in the second half of the 20th century were 700; 15,000; $72,000,000; and $150,000,000. The great increase occurred after the census of 1939, when value added by manufacture was only $8,640,000. The chief industries were food and kindred products, stone, clay and glass, printing and publishing, chemical and allied products and petroleum products.

Mining.—New Mexico is important as a source of minerals, ranking about eighth (in value of minerals produced) among the states. By the second half of the 20th century its mineral products were valued at more than $550,000,000 annually, chief among them being petroleum, natural gas and natural gas liquids, potash, copper and uranium. All of these except copper are comparatively new sources of mineral wealth, the state being known in its earlier years as a source of metals, headed by gold, silver, copper, lead and zinc. Gold was discovered in the Fray Cristóbal mountains in 1683 by Pedro de Abalos, and in 1833 the Ortiz mine, the first gold lode discovered and worked west of the Mississippi, was located. Peak gold production was reached in 1915, with 70,681 oz.; production dropped during World War I, reached a new high in 1938 and thereafter declined (to around 5,000 oz. in the 1960s). Silver mines were worked as early as the 17th century. Production reached a high point of 2,005,531 oz. in 1915 and 1,400,876 oz. in 1939 and then declined to less than 500,000 oz. in the 1960s. Copper remains a leading mineral. Lead ranged above an annual production of 20,000,000 lb. during the depression years 1929–33, then declined to 9,340,000 lb. in 1949, worth $1,470,032; by the 1960s it was mined in negligible quantities. Zinc reached a production of 119,048,000 lb. in 1943, declined to 58,692,000 lb. in 1949 and by the 1960s it, too, was of little importance. Coal production showed a similar decline from 14,133,000 tons in 1917 to 1,354,000 tons in 1949 to less than 500,000 tons in the 1960s.

The petroleum and natural gas industry did not get under way until the 1930s, but by the second half of the century oil and gas were valued at more than five times as much yearly as the next most valuable mineral product. Principal oil fields are located in Lea, Eddy, Chaves and San Juan counties. Potash mining, also dating from the 1930s, increased ten times in value between the early 1940s and the early 1960s; the state produces about 90% of the potash mined in the United States. It leads the nation in output of perlite.

New Mexico contains more than two-thirds of the United States' known uranium ore reserves, estimated at 54,900,000,000 tons averaging 0.26% uranium oxide. Production in the first year of record, 1950, was valued at about $61,000; by the 1960s it was more than $60,000,000 annually. Chief uranium-producing counties are Valencia, where the spectacular developments near Grants attracted much attention, McKinley, San Juan and Socorro.

Transportation and Communications.—In the second half of the 20th century six railroads operated in New Mexico, the most important being the Atchison, Topeka and Santa Fe railway. Commercial air transportation was provided by transcontinental and regional lines; Albuquerque was the junction airport. Improved surface highways increased from about 2,100 mi. in 1929 to 9,154 mi. in 1948 and to nearly 14,000 in the early 1960s. A motorized state police was established in 1933. The ports of entry established to collect the commercial mileage tax instituted in 1933, were placed under the state police as registration stations.

New Mexico had 16 daily papers and about 45 weeklies in the second half of the 20th century. In addition, there were many trade, professional, technical and religious publications, most of which had a state-wide circulation. The *New Mexico Historical Review*, published by the New Mexico Historical society; the *New Mexico Quarterly Review*, published by the University of New Mexico; and the *New Mexico Magazine*, a state publication, are well known. *See* also references under "New Mexico" in the Index.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures are summarized annually in the *Britannica Book of the Year*, American edition. (E. Fe.)

NEW ORLEANS, a city of Louisiana, U.S., situated on the east bank of the Mississippi river about 107 mi. from its mouth. It is located along a bend in the river, which accounts for its popular name, "Crescent city." The boundaries of the parish (county) of Orleans and the city of New Orleans are the same with a land area of 198.8 sq.mi. The boundary line is very irregular; approximately Lake Pontchartrain on the north and Lake Borgne on the east, the two being connected by a channel called the Rigolets; the parish of St. Bernard and the Mississippi

The Courtyard of the Deux Soeurs in the French quarter. It is said that the Louisiana Purchase agreement was signed by the representatives of Napoleon and the U.S. here

New Orleans' modern International airport

The Union railway passenger terminal

THE FRENCH QUARTER AND TRANSPORTATION CENTRES

This three-story walk-up on St. Peter street shows the beautiful iron grillwork for which the French quarter is noted

Tourists in a fiacre on Chartres street pass the Lower Pontalba apartments, erected in mid-19th century

PHOTOGRAPHS, (TOP LEFT) BRASSAI—RAPHO GUILLUMETTE, (BOTTOM LEFT, BOTTOM RIGHT) FRANK GORDON—PIX FROM PUBLIX, (TOP RIGHT, CENTRE RIGHT) LEON TRICE—FROM PUBLIX

NEW ORLEANS

The Civic centre, with its state and federal government buildings, and the Hospital Medical complex

The new Federal Office building adjoins the Union Passenger terminal

THE MODERN CITY

A major interchange on the Pontchartrain expressway running from the Greater New Orleans Mississippi River bridge to Lake Pontchartrain

The Greater New Orleans Mississippi River bridge

The Port of New Orleans facing Eads plaza and a skyline view of the city with Canal street cutting through the central business district

BY COURTESY OF (CENTRE) CHAMBER OF COMMERCE OF THE NEW ORLEANS AREA; PHOTOGRAPHS, (OTHERS) LEON TRICE—FROM PUBLIX

river on the south; and the river and Jefferson parish on the west. The population of the city in 1960 was 627,525, an increase of 10% from 1950. That of the standard metropolitan statistical area (Jefferson, Orleans, St. Bernard and St. Tammany parishes) was 907,123, an increase of 32.3% in the decade. (For comparative population figures for the city *see* table in LOUISIANA: *Population*.)

The soil in the New Orleans area is an alluvial deposit from the river and therefore has its greatest elevation at the river bank, where the ground behind the levees is from 10 to 15 ft. above the mean level of the Gulf of Mexico; but the lower parts of the city are below gulf level. Built on the narrow ridge of land at the river bank, the growing city first expanded along the river front and later, the cypress swamps between the river and Lake Pontchartrain having been cleared and drained, into that area.

The river approaches New Orleans flowing eastward, turns rather abruptly to the south at the upper municipal limits, then eastward as it passes the modern city, and finally northward in one of the sharpest bends to be found in the lower river, near the site of the original city, now called the *vieux carré* or French quarter. The difficulties involved in building a city on such a site as that of New Orleans were great. Drainage, sanitation and a satisfactory water supply were not realized until nearly two centuries after the establishment of the first settlement, and in the interim yellow fever and cholera took frightful tolls. Modern engineering and sanitation finally triumphed and the city overcame these former threats to its existence.

It is noted for its mild and balmy winters; the summers are uniformly warm but extreme heat is unknown. The highest temperature recorded by the weather bureau is 102° F.; a temperature of 100° F. is seldom reached because of the cool breezes from the Gulf of Mexico.

History.—The city of La Nouvelle Orléans was founded by a French governor of Louisiana, Jean Baptiste le Moyne, sieur de Bienville, and was named in honour of the regent, the duc d'Orléans. The site chosen was on an elevation along the east bank of the river between the head of Bayou St. John and the river. Among its advantages were the higher land, accessibility by two main waterways (the Mississippi and the lakes), and by Bayou St. John for the small craft of that day. On the other side of the river it was not far to Bayou Barataria, which later was destined to become the rendezvous of the famous pirates, Jean and Pierre Laffite, and which offered access to the gulf without stemming the current of the Mississippi.

There is some doubt as to the exact date of the founding of New Orleans but it is generally given as 1718. Louisiana at that time was held by a company organized by John Law (*q.v.*), who returned it to the crown in 1731. In the meantime, however, it was proposed that the headquarters of the company should be moved away from the barren coast country and in 1722 New Orleans became the capital of the colony. At this time the city had only about 100 houses and 500 inhabitants. It was laid out in approximately a parallelogram, 4,000 ft. long on the river by 1,800 ft. in depth, divided into regular squares 300 ft. on each side. In 1724 the streets were named. The houses were rude cabins of split cypress boards, roofed with cypress bark. They were separated from one another by willow copses and weed-grown ponds swarming with reptiles. Two squares on the river front near the centre of the city were set apart for military and ecclesiastical uses. The front was the Place d'Armes, now Jackson square; the rear one was early occupied by a church. In 1726 a monastery was erected to the east of the church for the Capuchin monks, who had arrived two years earlier. A company of Ursuline nuns came to New Orleans in 1727. At the same time the Jesuits arrived and received a large tract of land from Bienville. This tract, bounded by what is now Common, Tchoupitoulas, Annunciation and Terpsichore streets, was later added to by donation and purchase and extended to Felicity street. There the Jesuits cultivated myrtle, the wax of which was then a staple article of commerce, and oranges, figs, indigo and probably sugar cane. When the order was suppressed for political reasons in 1763 its great plantation was confiscated by the king of Spain; the Jesuits did not return to Louisiana until 1837.

Many storms and disasters occurred during the early years of the city. In 1719 the river rose to a great height and the site was completely inundated to a depth of a few inches. In 1722 a hurricane destroyed 30 houses and damaged crops. German colonists who had settled on the banks of the Arkansas managed to reach New Orleans and there implored Bienville to send them back to their homes. He persuaded them to establish themselves along the river above the city, and thus was formed the nucleus of the German settlement, which to this day is called the German coast.

There were few women of good character in the colony in the early days; and many of the better class of settlers, missing their home life, desired to return to France. It thus became imperative that if the settlement was to survive, the men must have good wives to make homes for them. When Bienville left the colony in 1724, he promised to send a group of young women as soon as possible. The "casket girls" (*filles à la cassette*), so called because of the small chests of clothes and linens allotted to them by the French government, arrived in 1727 and during the period of courtship were placed under the care of the Ursuline nuns whose convent had been established in the same year. Some of the distinguished families of modern New Orleans claim to be descended from these marriages. The nuns were first domiciled in Bienville's former home but in 1730 their own house on Chartres and Ursuline streets was completed. This is one of the oldest buildings in the United States west of the Alleghenies.

In 1763 the treaty of Paris was concluded between France and England, by which England gained all the territory east of the Mississippi except the Isle of Orleans. By a secret treaty of Nov. 3, 1762, Louis XV had given the Isle of Orleans and all of Louisiana west of the Mississippi to his cousin, Charles III of Spain. It was not until Oct. 1764 that the French king notified the governor of the colony of the transfer and ordered him to surrender Louisiana to accredited Spanish commissioners when they should present themselves. The news was not well received in New Orleans. In 1783 the treaty of Paris confirmed Spain in possession of this territory and granted free and open navigation of the Mississippi river to the subjects of Great Britain and the United States. In 1788 and again in 1794 fires destroyed large portions of the city. By the first, 19 squares were devastated and 856 houses were burned. The second fire destroyed 212 houses and caused a loss estimated at $2,600,000. Rebuilding with brick instead of wood resulted in a more permanent city. During this period the Spanish merchant, Almonaster y Rojas, was the greatest benefactor of New Orleans; he gave freely of his private fortune for many purposes. He rented in perpetuity the squares flanking the Place d'Armes and erected a row of brick buildings to be used as shops and retail stores. These were replaced in 1845 by the Pontalba buildings, which bear the name of their builder, Baroness Pontalba, Rojas' daughter. He rebuilt the Charity hospital, which had been destroyed by a hurricane, and a chapel for the Ursuline nuns. Through his generosity the cathedral was completed in 1794; it was constructed of bricks and had much the same appearance as today except in details of the belfry and towers. A town hall, or hall of the Cabildo, presented to the city in 1795 was the seat of Spanish rule and is now the state museum.

Before the cultivation of sugar cane the staple crop of Louisiana had been indigo but a caterpillar plague in 1793 and the two years following caused such extensive damage that its cultivation was temporarily abandoned. In 1794 Étienne de Boré, whose plantation is now within the city limits, succeeded in making granulated sugar and thereafter the production of sugar cane increased considerably. By the treaty of Madrid, signed in Oct. 1795, Spain and the United States agreed that New Orleans should be open to the Americans as a port of deposit for three years; the produce was to be free of duty but a reasonable price for storage was to be paid. The commerce of New Orleans increased greatly and the levee was the scene of noisy, bustling business.

From 1800 to 1803 Louisiana was again a French possession and in 1803 the territory was purchased by the United States (*see* LOUISIANA PURCHASE). This transfer had a further bene-

ficial effect on trade. The first half of that year showed an increase of 37% in tonnage over that of 1802; exports exceeded $2,000,000 and imports $2,500,000. The flatboat trade with the upper valley also increased enormously. Above the *vieux carré* commercial houses were erected and this newer portion of the city gradually became a business centre. Many of the street names are reminders of the first owners or of the first use of the locality. Gravier street bears the name of its original owner, Poydras that of a philanthropist; Magazine was so named because of the great tobacco warehouses on Magazine and Common, and Camp street because of a slave camp between Poydras and Girod. Along the Bayou St. John road there was an aristocratic suburb.

In 1805 New Orleans was incorporated as a city and the people exercised their right of suffrage for the first time in electing aldermen. Between 1803 and 1810 the population more than doubled with the arrival of many whites, mulattoes and slaves from Cuba, Santo Domingo and other islands of the West Indies. The population of the city has been cosmopolitan from the beginning, and an unusual characteristic up to the time of the American Civil War was the presence of considerable numbers of *gens de couleur* —"free people of colour," many of whom themselves owned slaves. After the war, however, the distinction between "free men of colour" and "freedmen of colour" (the former slaves) was lost and the *gens de couleur* lost the social advantages they had held.

During the War of 1812 New Orleans was not endangered until the autumn of 1814, when a British fleet entered the Gulf of Mexico. Gen. Andrew Jackson, commander of the U.S. army in the southwest, reached the city on Dec. 1 and immediately began preparations for its defense. Because of slow communications neither the British nor the Americans had received notice of the conclusion of the war by the treaty of Ghent, signed two weeks previously, when the British attacked on the morning of Jan. 8, 1815. The outcome of the brief battle, a decisive victory for the Americans, had considerable psychological value and greatly advanced the political fortunes of Jackson. (*See* also WAR OF 1812.)

Commerce on the Mississippi was greatly stimulated by the advent of steam navigation; the first steamboat to descend the river was the "New Orleans," which arrived on Jan. 10, 1812, on its maiden trip from Pittsburgh, Pa. The river trade was carried on in spite of the danger from sandbars on entering the river. In the space of a few weeks, in 1852, 40 ships went aground at the entrance to the river. The terrible yellow fever epidemics of 1853–55 reduced the volume of trade, which was regained, however, and a high-water mark reached in 1857, to be followed by a financial crash which was disastrous to the business houses of New Orleans.

Louisiana seceded from the union on Jan. 26, 1861. New Orleans was recognized as a strategic point by the authorities at Washington and two expeditions started to secure the Mississippi for the union: Gen. U. S. Grant was to descend the river and Adm. David Farragut and Gen. Benjamin F. Butler were to ascend it. The city had sent 5,000 soldiers to the defense of the northern line of the Confederacy but the southern government seemed oblivious to the importance of holding New Orleans. While Grant was endeavouring to push his way downstream, Farragut was entering the river from the gulf with a fleet of 43 vessels. The assistance asked by Gen. Mansfield Lovell could not be given by the Confederacy. An attempt was made to obstruct the passage of the Federal fleet by cables put across the river below the city, but New Orleans was captured by Farragut on April 25, 1862, and the city front blazed with the fire from thousands of bales of cotton and hogsheads of sugar and molasses which were burned to prevent their falling into the hands of the Federals.

General Butler with 15,000 soldiers took charge of the city on May 1, 1862. The mayor was removed from office and a military commandant appointed in his place; the city council was replaced by the bureau of finance and the bureau of streets and landings. Butler's rule in New Orleans was execrated by the people of the city; his removal before the end of the year curtailed some of the worst excesses of the occupation.

The years 1865–77, the period of Reconstruction, were a time of racial and political strife. In the wake of the war came a host of undesirables seeking fortunes by easy means—the "carpetbaggers," who with their southern friends and associates called "scalawags" gained control of the city government through leadership of the voting population, largely composed of the newly enfranchised Negroes. Much of the property of the city disappeared; extravagant expenditures reached $6,961,381 in 1872 and the bonded indebtedness $21,000,000, paying up to 10% interest. The white men of the city, who were virtually deprived of the ballot by all the restrictions placed upon its exercise, formed the "white league" for the expulsion of the "carpetbag" government and the restoration of white supremacy. Riots broke out frequently and there were armed encounters between the white league and the metropolitan police. The white league made a number of gradual gains and the situation in general aroused northern sympathies, so that in 1877 home rule (which meant in effect white supremacy) was restored in New Orleans by the federal government. These Reconstruction experiences not unnaturally left a bitter aftermath in New Orleans and for many years the Negro was in one way or another almost totally disenfranchised. In the 20th century, however, substantial gains were made, particularly through reform measures that benefitted the economically underprivileged, white or Negro, and in the governor's election of 1959, out of a total registration of 205,000 for the city, 34,000 Negroes were registered voters and an estimated 85%–90% voted. In the early 1960s, however, there was considerable opposition by white-supremacy groups and the state legislature to the racial integration of New Orleans schools.

Municipal improvements made slow progress during restoration times and for many years after; the city undertook the operation of the waterworks in 1869; a drainage system was proposed in 1871 but proved too expensive to be carried out; in 1871 the board of park commissioners bought the Upper City park, now Audubon park. The population in 1860 was 168,755 and had increased by 1870 to 191,418. During this decade many freed Negroes had come to the city from country districts. In 1870 the fifth and sixth districts were added by the annexation of the town of Algiers on the opposite bank of the river and of Jefferson City a town adjoining the fourth district. In 1874 Carrollton was admitted as the seventh municipal district, and New Orleans attained its present limits.

The history of New Orleans in the late 19th and early 20th century is largely its commercial and industrial expansion, and a building program discussed in *Government* below. The channel at the mouth of the river was deepened in the 1870s; by 1883 the city was linked by railroad with the west and north and formed the hub of the state network, as it still does. Although New Orleans was and is primarily a commercial city, there has been increasing development of industry in the 20th century (see *Commerce, Transportation and Industry* below).

In the spring of 1927, the city was saved from a great Mississippi river flood by blasting the levee at Poydras, about 15 mi. below the city, on April 29. This operation sacrificed the adjacent parishes of St. Bernard and Plaquemines at a cost to the city of approximately $5,000,000. To avoid similar danger in the future the Bonnet Carre spillway was constructed about 35 mi. above the city to remove 250,000 sec.-ft. of water from the river during excessive floods and deliver it into Lake Pontchartrain. Protected by this device and similar safeguards on the lower river, the city survived an even greater flood in 1945 without mishap or any emergency action.

Population Characteristics.—Of the 1960 population of the city 60.9% was native-born white, 2.3% foreign-born white and 39.1% Negroes, including mulattoes and others of mixed blood. Among the foreign-born, almost every nationality is represented; the Italians, who came in considerable numbers after 1900, are the most numerous. The creoles—by current usage the descendants of the original French and Spanish settlers—are perhaps the group for which New Orleans is best known. (Until late in the 19th century, this term as used in New Orleans meant persons born in the city, so that there were "creole" Anglo-Americans,

Irish and Germans as well as "creole" Latins.) Although numerically less important than popularly believed (both in the 19th and 20th centuries large numbers of Anglo-Americans from southern and northern states and of immigrants from other European countries settled in the city) the Latin creoles still help give New Orleans a distinctive atmosphere among U.S. cities and the French language continues to be used. When a considerable number of Americans of Anglo-Saxon descent began settling in the city in the early part of the 19th century they built a quarter for themselves upstream from the *vieux carré*, the upper boundary of this settlement being Canal street. In the 20th century, however, the lines were not nearly so strictly drawn.

Government and Administration.—The city government was at first carried out by a mayor and administrators, seven in number. In 1912, by act of the legislature, the commission form of government was adopted; the mayor became commissioner of public affairs. Four other commissioners had charge of public finances, public safety, public utilities and public property. In 1950 the legislature restored a mayor-council system, increasing the number of commissioners to seven, each elected by a separate municipal district.

Municipal Works.—During the administrations of deLesseps Morrison, reform mayor who in 1946 defeated the Old Regular Democratic machine which had long controlled local government, a tremendous physical rehabilitation of the city was effected. Besides major transportation innovations, such as bridges (discussed below), 22 new overpasses eliminating 144 grade crossings were constructed, a central, modern railroad terminal and an extensive new municipal centre, consisting of six major buildings including the city hall, library, state supreme court building and a state office building were erected in the heart of the city on the site of a former slum area; many miles of streets were widened and improved and a program was launched to rehabilitate 45,000 substandard buildings over a ten-year period.

The location of New Orleans presents certain problems in regard to such municipal concerns as water and sewage. The entire city, except for its levees, is below the river high-water mark while a large portion of it is below that of Lake Pontchartrain. Combined with these difficulties New Orleans has heavy rainfall; occasionally more than 3 in. in 1 hour, 7 in. in 5 hours and 9 in. in 12 hours, having been experienced. As a result of the occasional excessive rainfalls, it has been necessary to provide large canal systems to convey the water to and from the pumping plants, and 11 pumping stations for the removal of storm water have been built. The average annual rainfall is more than 50 in.; the topography is such that the runoff must be removed by pumping. The sewage of the city is collected separately from the drainage and is finally discharged into the Mississippi, where the dilution is so great that it is not noticeable farther downstream. Like the drainage, the sewage has to be pumped, much of it through two or more lifts, and this is accomplished by electric pumping stations operating automatically.

Commerce, Transportation and Industry.—Among North American ports New Orleans is second only to New York in most categories. It accommodates more than 80 steamship lines and about 4,000 vessels enter the port annually. Located at the intersection of the Gulf Intracoastal waterway and the Mississippi river, it handles both internal river traffic and foreign trade. The limits of the port include a frontage of 51 mi. on both sides of the river and 11 mi. on the Industrial canal, which connects the river with Lake Pontchartrain; 20 mi. of publicly owned wharves, steel sheds, warehouses, grain elevators and similar facilities are maintained.

By the middle of the 20th century New Orleans had regained the pre-eminence as a port which it enjoyed before the Civil War but the most significant economic development in the post-World War II period was a great increase in industry along the entire lower river south of Baton Rouge. This boom was set off mainly by the discovery of great quantities of oil and sulfur on the Louisiana tidelands, petrochemicals being the most important of the new industries. Other factors responsible, besides the natural advantages of a port, were the accessibility of a cheap fuel, natural gas; free-water supply (300,000,000,000 gal. of water pass New Orleans each day at high river stages, twice as much as is used by the rest of the nation for all purposes); and the apparently successful control of floods on the lower river.

New Orleans is also served by trunk railroads, airlines, barge lines, truck lines, and a public belt railroad 128 mi. in length. It has three airports: the New Orleans airport on the lake, for private planes; the Moisant international airport in Jefferson parish for commercial traffic; and Callender field, across the river below the city for military craft.

In 1928 the first bridge across Lake Pontchartrain, 25,000 ft. long, was completed. Shortly thereafter bridges across Chef Menteur and the Rigolets provided a more direct line to the Gulf coast. In 1935 the Huey P. Long bridge across the Mississippi 5 mi. above the city was opened to traffic, and in 1958 a second river bridge in the heart of the city was completed. In 1957 another bridge across Lake Pontchartrain, 24 mi. long, was put into operation.

Education and Cultural Activities.—The New Orleans public-school system includes kindergarten, elementary and high schools, evening schools and trade schools. In addition there are in the city over 100 nonpublic schools, both private and parochial (mostly Roman Catholic; some Lutheran). Uniform textbooks purchased by the state department of education are supplied to all nonpublic schools and their classes are conducted under a curriculum approved by the department. Largest of the strictly private schools is the Isidore Newman school, founded in 1903, which is coeducational.

Universities and Colleges.—New Orleans has several distinguished colleges and universities. The history of Tulane, a private university, dates from the foundation of a medical college (called the Medical College of Louisiana) in 1834. It was chartered in 1835 and in the following year issued the first degree in medicine conferred in the southwest. Other departments were added and in 1847 the institution took the name University of Louisiana; in 1884 it was renamed in honour of Paul Tulane, who had been a merchant in New Orleans for many years and who had made a very large gift of money to the institution. The university now includes a college of arts and sciences, schools of architecture, business administration, engineering, law, medicine and social work, and H. Sophie Newcomb Memorial College of Tulane university, for women, chartered in 1886.

Loyola university, a Roman Catholic university founded in 1904, is coeducational in its professional departments and for men in other departments. In addition to arts and sciences it has schools of dentistry and law and colleges of pharmacy, music and business administration.

Dillard university, established in 1930 by the merger of two earlier institutions, is affiliated with the Congregational Christian and Methodist churches. It grants the B.A. degree and the B.S. in nursing. Xavier University of Louisiana, a Roman Catholic university, began as a high school in 1915 but became a teachers' college two years later and has since added liberal arts and premedical departments and a graduate school. Originally for Negroes and Indians, it is now open to all races. St. Mary's Dominican college is a Roman Catholic liberal arts college for women, established in 1860. Louisiana State university in New Orleans, an integral part of the state university in Baton Rouge (*see* LOUISIANA: *Education*), opened in 1958 with a freshman class and added an additional class each of the following years until a four-year program was in operation.

Other Institutions.—The Isaac Delgado Museum of Art in City park was established by a gift from Isaac M. Delgado in 1911. The annual exhibition of the Art association is an important event. The Cabildo houses an important historical museum containing much of interest and value pertaining to the history of Louisiana and New Orleans. The Presbytère, facing Jackson square on the side of the Cathedral of St. Louis, contains a valuable museum of natural history, principally relating to Louisiana. The Confederate Memorial hall, located on Camp street, contains relics of the Civil War. The Tulane university museum occupies the entire third floor of Gibson hall; it contains petrological, paleon-

tological, zoological and anthropological sections. Several galleries exhibiting contemporary art are to be found in the *vieux carré*. A civic symphony has been established and the Philharmonic society brings the great contemporary musicians and concerts to the city. The Metropolitan Opera comes annually, thus reviving interest in French opera which was originally heard in New Orleans long before it was heard in New York. The Department of Middle-American research, created in 1924 as a department of Tulane university, has a museum and library, field work and publications as its primary activities. The library of 40,000 items and the museum contain manuscripts, documents and other material relating to Mexico and Central America from expeditions and purchases which are being constantly increased. The institute has a permanent endowment of $300,000. The New Orleans spring fiesta was organized in 1937 and has created tourist interest in art, architecture, gardens and local traditions. The city has more than 12 major hospitals of various types, the largest of which is the Charity.

Journalism.—New Orleans has long been an important newspaper and publishing centre. The *New Orleans Picayune* was founded in 1837, the *Daily Times* in 1863, the *Daily Democrat* in 1875. The two latter formed the *Times-Democrat* in 1881 and this and the *Picayune* became the *Times-Picayune* in 1914. The *Daily Item* began publication in 1877, later becoming the *New Orleans Item*. The *Daily States*, started in 1880, was purchased by the Times-Picayune company in 1933 as an afternoon and combined Sunday publication. In 1959 the same company bought the *Item* and merged it with the *States*. This exemplified the tendency, common in the larger U.S. cities, of consolidating ownership of newspapers and thereby eliminating competition; many observers felt that as a result the press in New Orleans in the latter part of the 20th century was characterized mainly by its anemia.

Among the many writers associated with New Orleans Lafcadio Hearn and George W. Cable are probably the best known. John James Audubon, the artist-naturalist, made his home there for several years.

Recreation and Tourist Attractions.—New Orleans is well known as the home of the largest and most colourful Mardi Gras celebration in the United States. The carnival season extends from Twelfth Night (Jan. 6) to Lent and is climaxed by the festivities of Mardi Gras, "fat Tuesday" before Ash Wednesday. Out of the simple idea of masked revelry in the open streets has developed a complex organization of gorgeous torch-lighted parades and balls. The first carnival parade (as distinguished from the Mardi Gras celebration) was held in 1827 by masked students who had recently returned from Paris. In 1837 and 1839 the first processions with "floats" were held in New Orleans. The regular annual pageants, almost uninterrupted except during the Civil War, date from 1857, when the "Mystic Krewe of Comus," the oldest of the carnival organizations, was formed. There are a number of other organizations, secret societies and clubs which assume responsibility for certain portions of the Mardi Gras celebration, which extends for several days. Most of the balls are private but the public parades are a major tourist attraction.

Other tourist attractions are the *vieux carré* and the Garden district. In the *vieux carré*, Spanish and French influences combined to form a unique creole style of architecture; characteristic features of the buildings in the area (many of which are now preserved as historic monuments and are open to the public) are enclosed rear courts, balconies and extensive use of wrought-iron railings and cast-iron "lace." The Garden district, originally a residential district for the American aristocracy who arrived after 1803, is between St. Charles avenue and the river; it is characterized by handsome homes, mostly Greek Revival in style. The city is also famous for its fine restaurants.

Extensive plantings of azaleas and camellias have beautified the city and it is well supplied with parks. Audubon park, with 234 ac. is situated in the upper portion of the city and contains a statue of Audubon. The original area of City park was about 1,400 ac., later developed and beautified further. The area was added to by hydraulic dredging on the lake shore front between West End and beyond Bayou St. John on the east. A large municipal yacht harbour was constructed at West End. Many miles of boulevards and driveways, with parks and bathing beaches, were also developed as residential areas.

The salubrious climate, the Gulf of Mexico and the hundreds of bayous, rivers and lakes in southern Louisiana make New Orleans a sportsman's paradise. Opportunities for sailing, boating, hunting and fishing, both salt and fresh-water, are excellent. Tarpon are frequently caught within the city limits and numerous fishing rodeos are held annually.

During the Christmas holidays a Mid-Winter Sports carnival is held, ending with the Sugar Bowl football game on New Year's day. The Fair Grounds race track opens its season each year on Thanksgiving day; races are held every day except Sunday for three months. As matters of incidental interest it may be mentioned that jazz (*q.v.*) derived most of its original impetus from the Negro musicians of New Orleans and the term Dixie (*q.v.*) is said to have originated there.

See also references under "New Orleans" in the Index.

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(G. M. Ca.)

NEW PHILADELPHIA, a city of eastern Ohio, U.S., about 22 mi. S. of Canton; the seat of Tuscarawas county. Located in Ohio's unglaciated hill country in the valley of the Tuscarawas river, the city and its surrounding countryside comprise one of the most scenic and historic areas in Ohio. Just south of the city, the Moravian missionary, David Zeisberger (1721–1808) founded the mission village of Schoenbrunn ("beautiful spring") among the Delaware Indians in 1772. There the first church and schoolhouse in Ohio were built, but in 1777 the settlement had to be abandoned on account of the hostility of neighbouring Indians. The site of Schoenbrunn, discovered in 1923, has been restored. To the north, Ft. Laurens, the only Revolutionary War fort in Ohio, was built in 1778, while nearby a band of German Separatists in 1817 established the communal village of Zoar which lasted until 1898.

New Philadelphia itself was founded in 1804 by John Knisely on lands set aside by the federal congress in 1796 as the United States military district, tracts within which were to be distributed to veterans of the Revolutionary War. Named in honour of Philadelphia, Pa., the community grew slowly at first, the population reaching but 1,413 by 1850. After the American Civil War, however, growth was more rapid, principally because of the development of large deposits of coal and clay in the immediate area which enabled it to emerge as one of the important small industrial centres of Ohio. Principal industries include the manufacture of mining and road equipment, tapered roller bearings, tools, batteries, spark plugs and ceramics.

Serving as headquarters for the Muskingum Watershed Conservancy district, New Philadelphia is in the heart of one of the nation's most important conservation, flood control and recreational areas. New Philadelphia was incorporated as a village in 1815 and as a city in 1896. For comparative population figures see table in OHIO: *Population*. (P. R. S.)

NEW PLYMOUTH, a municipality and seaport on the west coast of the North Island, New Zealand, chief town of the land district of Taranaki, 251 mi. N.N.W. of Wellington by rail. Pop. (1961) 29,368 (urban area 32,387). The town is noted for its parks and gardens, and the district is the chief dairy centre of New Zealand. The settlement was founded in 1841 by the Plymouth company under the auspices of the New Zealand company and consisted chiefly of emigrants from Devonshire and Cornwall. Mt. Egmont (8,260 ft.), 18 mi. S. of New Plymouth, is well known

for its winter sports and is the centre of Egmont National park (128 sq.mi.).

NEWPORT, a market town, municipal borough and county town of the Isle of Wight, England. Pop. (1961) 19,482. It is near the centre of the island, at the head of the wide estuary of the Medina river, 5 mi. S. from its mouth at Cowes. Industries include plastics and woodwork, milling, brewing and mineral water (soft drink) manufacture. Newport is the centre of the island's agriculture and its harbour is used for import and export business. The church of St. Thomas of Canterbury was rebuilt in 1854 in the Decorated style; the county hall was built in 1938 and the town hall (1816) was designed by John Nash. The grammar school was founded in 1614. The Albany barracks, Parkhurst prison and Camp Hill Borstal institution, the last two in Parkhurst forest, lie north of the town. Newport was probably a Roman settlement, then known as Medina; remains of a villa in good preservation were found in 1926. There are no traces of Saxon occupation and no evidence that Newport became a borough before the reign of Henry II. The first charter was granted by Richard de Redvers between 1177 and 1184, and a second, by Isabel de Fortibus, was confirmed by successive kings. The borough was incorporated by James I in 1608 and the final charter, by which Newport was governed until 1835, was granted by Charles II in 1661. It was represented in parliament in 1295, but no other return was made until 1584, when it regularly sent two members. From 1867 to 1885 it sent one but in 1885 its representation was merged in that of the island. The Saturday market dates from 1184, and there is a Tuesday market. Because of its facilities for trade, Newport early superseded Carisbrooke (*q.v.*) as the capital of the island.

NEWPORT (CASNEWYDD-AR-WYSG), a municipal, county and parliamentary borough of Monmouthshire (*q.v.*) is the easternmost of the Bristol channel seaports that serve the mining and industrial area of south Wales and Monmouthshire. Though not the county town, it is the administrative centre of Monmouthshire. Newport lies on the river Usk, 4 mi. from its confluence with the Severn, and it is 12 mi. N.E. of Cardiff and 24 mi. S.W. of Monmouth by road. Pop. (1961) 108,107.

Giraldus Cambrensis called it Novus Burgus ("New Town"). The burgesses obtained a monopoly of trade and self-government evidenced by a charter from the earl of Stafford in 1385. A charter of the duke of Buckingham, the landlord in 1476, shows the reeve to have been superseded by a mayor. In 1623 James I gave the townsmen their first royal charter, which served until the Municipal Corporations act of 1835. The town was the scene of Chartist riots in 1839 and Chartist bullet marks are preserved in the pillars of the Westgate hotel. County borough status was achieved in 1891 and one member of parliament is returned.

Two bridges over the river Usk form the main gateway for road traffic from London to south Wales. The new cable cantilever bridge, the first of its kind in Britain, was completed in 1964. The old parish church of St. Woolos became the procathedral of the diocese of Monmouth in 1921. Between the Lady chapel and the nave is a splendid 12th-century Norman arch. The square, three-story tower (*c.* 1480) is attributed to Jasper Tudor, duke of Bedford. The Norman castle (*c.* 1126) stands in ruins and nearby in High street is a fine old Tudor building named after the original Murenger's house. The main shopping centre comprises High street, Commercial street, Bridge street and Dock street. The new civic centre at Clytha park, partly opened in 1940, now contains the main offices of the town council. The Newport and Monmouthshire Joint College of Technology is an imposing modern building (1958) near the civic centre. The Central Library, Museum and Art gallery are situated in Dock street. The provision market built in 1888 lies between Dock street and High street. Belle Vue at Cardiff road and Beechwood at Chepstow road are the main parks. A 245-ft.-high transporter bridge, opened in 1906, spans the river near the docks.

The modern port grew from the local coal and iron export trade and the present Alexandra docks comprise the North and South docks forming a continuous deepwater area of 125 ac. with 4 mi. of quays and six transit sheds providing 234,000 sq.ft. of covered floor space. There are three commodious dry docks. The principal exports are manufactured iron and steel products, machinery, vehicles and vehicle parts, galvanized iron, tinplate, coal and miscellaneous goods. Imports are primarily iron ore and nonferrous ores such as bauxite, petroleum, semimanufactured iron and steel, timber, pitwood, aluminum and building and roadmaking materials. The principal industries, apart from shipping and export packing, produce steel, structural steelwork, aluminum, chemicals, electrical goods, clothing and fibreboard.

Newport is a good tourist centre for the Wye valley, the Vale of Usk and the northern shore of the Severn estuary.

(R. W. H. H.)

NEWPORT, a city of northern Kentucky, U.S., on the Ohio river, near the mouth of the Licking, opposite Cincinnati, O.; one of the seats of Campbell county and a part of the Cincinnati standard metropolitan statistical area (*see* CINCINNATI). Across the Licking is Newport's sister city, Covington.

The first settlement, planned in 1790 by Hubbard Taylor, a young soldier, was named in honour of Christopher Newport, commander of the first ship to reach Jamestown in 1607. In 1795 Newport was incorporated as a village and in 1835 as a city. The only antislavery newspaper published in Kentucky during the 1850s was edited in Newport by William Shreve Bailey. It was given various names by its editor, the last being *The Free South*. On Oct. 28, 1859, after a proslavery mob threw his presses and type into the street, Bailey took his paper across the river to Cincinnati.

Newport experienced its greatest growth in the 1880s and 1890s because of the influx of many German settlers and the completion of bridges to Cincinnati, which promoted its development as a residential suburb of that city. A metal fabricating centre, Newport was the scene of a seven-year (1921–28) strike by steelworkers. In 1932 Newport adopted a council-manager form of government. For comparative population figures *see* table in KENTUCKY: *Population*. (W. F. ST.)

NEWPORT, a city of southeastern Rhode Island, U.S., about 30 mi. S.S.E. of Providence, occupying the southern end of the island of Rhode Island (or Aquidneck) in Narragansett bay; a port of entry and the seat of Newport county. It is a place of historic interest, important formerly as a fashionable summer resort for some of the wealthiest U.S. families and in the second half of the 20th century for its naval installations.

From the harbour on the west, the city rises up a gentle hillside to a plateau at about 250 ft. elevation. Famous for its mild climate the year round, it attracted southerners and West Indian planters in summer as early as the first quarter of the 18th century. The city itself is a community of contrasts. An old section, dating from the colonial period, consists of historic buildings and homes set on narrow streets which climb the slope eastward from the harbour. Along Newport's Bellevue avenue, which runs through the heart of the island, and around the southern coast line can be seen the magnificent mansions of 19th- and early 20th-century millionaires. Some of these have been boarded up while others have been converted for church and school use. A few are still used as summer homes.

Until 1900 Newport was one of Rhode Island's two capital cities, sharing that honour with Providence. The Old State house or Old Colony house (1739), one of the most interesting colonial buildings in the state, still stands at the head of the old Parade, now Washington square. Not far away are such historic structures as Trinity church (1725); Touro synagogue (1763), the oldest in America (designated a national historic site in 1946), famous for the architectural beauty of its interior; and the Redwood library (1750).

The old section known as "the Point," on the harbour front, contains many fine homes of colonial merchant princes. Some of these homes have been restored and opened as museums by the Preservation Society of Newport county. One such is the Hunter house, furnished with outstanding antique furniture, much of it produced by the famous Newport dynasty of colonial cabinetmakers, the Townsends and Goddards. Also restored and opened to the public is the pre-Revolutionary White Horse tavern.

In Touro park at the top of the hill is Newport's most enigmatic structure, a stone tower set on stone pillars. Long thought to be a vestige of the Norsemen's visits to America before Columbus, it is now held by most responsible archaeologists and historians to be the remains of a 17th-century windmill built by Benedict Arnold, one of the early settlers and an ancestor of the traitor of the same name.

Other points of interest include the Newport casino, scene of an annual grass-court tennis tournament and the American Lawn Tennis association's tennis "Hall of Fame," and "The Breakers," former summer home of Cornelius Vanderbilt, now open in summer as a museum.

Newport was founded in 1639 by a group of refugees from the Antinomian controversy (*see* HUTCHINSON, ANNE), in Massachusetts who had first settled the year before at the north end of the island in the present town of Portsmouth. Following a schism in that settlement a group led by William Coddington moved to the south end of the island and established Newport which, because of its excellent harbour and strategic position for water-borne commerce, soon became one of the richest and most flourishing cities in colonial America, surpassed only by Boston, Philadelphia and New York city.

The British occupation of Newport during the American Revolution, which resulted in a flight of almost all the leading merchants to the mainland, followed within a few decades by the shift of Rhode Island's income from commerce and shipping to textile mills and other manufacturing, brought about the economic decline of the city. But its splendid climate and its charm remained unchanged and right after the American Civil War its rise as a summer resort was spectacular.

In the second half of the 20th century manufactures included electrical instruments and appliances but the largest industry was the complex of naval installations. Comprised of the Naval War college and the several components of the Newport naval base, which includes the naval station (formerly the naval training station), the naval underwater ordnance station (formerly the naval torpedo station), the Melville net and fuel depot in nearby Portsmouth and the naval hospital. The naval station, formerly used to train recruits, consists of the officers candidate school and fleet training centre, the legal school, chaplains indoctrination school, WAVES general line school and navy supply school.

Printing in Rhode Island was begun at Newport in 1727 by James Franklin, an older brother of Benjamin, and the colony's first newspaper was published there in 1732. It failed shortly but in 1758 James Franklin, Jr., established the *Newport Mercury*, still published as a weekly.

Newport, beginning in 1954, was the home of an annual jazz festival, generally held over the Independence day week end. Newport is the seat of Salve Regina college (Roman Catholic, 1947) for women.

Chartered as a city in 1784, Newport resumed the town form of government in 1787, but again became a city in 1853. In 1953 Newport adopted a council-manager form of government. For comparative population figures *see* table in RHODE ISLAND: *Population.* (B. F. S.)

NEWPORT BEACH, a city of Orange county in southern California, U.S., 35 mi. S.E. of Los Angeles. It includes the communities of Newport Beach and Balboa on a four-mile-long sandspit between lower Newport bay and the Pacific ocean, Lido Isle and Balboa Island in the bay, and Corona del Mar and Newport Heights on terraces above the northeast shores of the bay. The area is popular as a recreational resort developed around yachting, sportfishing and beach activities, and as a residential community for commuters to Long Beach and Los Angeles. Industries include boatbuilding and repairing, fish canning and packing and the manufacture of electronic components and plastics. The bay itself was a port for Yankee skippers during the Spanish and Mexican periods of California history and from 1872 to 1898 it achieved some local significance as a commercial port. Incorporated in 1906, the city adopted a council-manager form of government in 1946. For comparative population figures *see* table in CALIFORNIA: *Population.* (R. A. K.)

NEWPORT NEWS, a city and port of entry in the tidewater region of southeastern Virginia, U.S., on the north side of the great harbour of Hampton Roads (*q.v.*) and the James river. Pop. (1960) 113,662; Newport News-Hampton standard metropolitan statistical area (Newport News and Hampton cities and York county), 224,503. (For comparative population figures see table in VIRGINIA: *Population.*)

Settled by Daniel Gookin, who arrived from Ireland in 1621 with 50 colonists, the area was already known as Newportes Newes. There is no satisfactory explanation of the origin of this unusual name. Newport News remained a tiny hamlet until 1880 when it was chosen as the Atlantic deep-water coal shipping port for the Chesapeake & Ohio Railway system. Two years later the town was laid out and in 1896 it was incorporated as a city. During World War I Newport News was an important port for supplying the Allies and also served as a major supply and embarkation port for U.S. forces in 1917–18. In World War II it was headquarters for the Hampton Roads port of embarkation. In 1952 Newport News was made administratively independent of Warwick county in which it was located. That same year Warwick county was incorporated as the city of Warwick, and in 1958 Newport News and Warwick merged as the city of Newport News. In 1920 the city adopted a council-manager form of government. Its port facilities, along with those of Norfolk, Portsmouth, Chesapeake (*qq.v.*) and Hampton, are under the jurisdiction of the Virginia State Port authority of Hampton Roads, created in 1926. Modern pier facilities can handle more than 30,000,000 tons of coal per year as well as ore, bulk liquids and general cargo. The Newport News Shipbuilding and Dry Dock company, founded in 1886, has one of the largest and most complete shipyards in the world. Among the vessels built there were the luxury liners "America" and "United States," the giant aircraft carriers "Forrestal" and "Enterprise" and the submarine "Robert E. Lee," designed for firing Polaris guided missiles. Both the "Enterprise" and the "Lee" were nuclear powered. In addition to shipbuilding and repairing, Newport News' industries include railroad shops, oil refineries, fish processing plants and the manufacture of textiles, paper products, radar and electronic equipment and mica products. Among points of interest in the city is the Mariners' museum (1930), containing a collection of ships' figureheads, ship models, anchors, deck and navigation gear, volumes of sea lore, maps, charts and globes. (M. Bx.)

NEWQUAY, an urban district and seaside town in the North Cornwall parliamentary division of Cornwall, Eng., 20 mi. W.S.W. of Bodmin by road. Pop. (1961) 11,877. Area 7.2 sq.mi. Newquay, on the tidal Gannel, is almost entirely a modern resort town, having grown since the mid-19th century from a small fishing village. It stands mostly on bold cliffs overlooking sandy beaches, sheltered on the west from the Atlantic by Towan headland. The golf course overlooks Fistral bay. The climate is equable and tropical plants grow in the Trenance valley. The small harbour, in the shelter of Towan headland, is now used only by local fishing and pleasure boats.

NEW QUEBEC (NOUVEAU QUEBEC), the Quebec part of the great Labrador-Ungava peninsula. It comprises the entire peninsula between Hudson and James bays and the Coast of Labrador portion of Newfoundland, north of the general line of the Eastmain and Hamilton rivers. Formerly the Ungava district of the Northwest Territories, it was annexed to Quebec in 1912; the boundary with Newfoundland was established in 1927. Development of immense iron deposits began in the 1950s. *See* LABRADOR-UNGAVA; QUEBEC.

NEW ROCHELLE, a city of Westchester county, N.Y., U.S., on Long Island sound about 14 mi. N.E. of New York city. Founded in 1688 by a group of Huguenots who had fled persecution in France, it became in modern times largely a residential city for those who work in the nearby metropolis. The few local industries produce a variety of light products including surgical instruments, television parts, plumbing supplies and electrical machinery. Many parks lie within the city, while Glen Island nearby on the sound provides 108 ac. of recreational space. There are two colleges, both Roman Catholic, located there. The Col

lege of New Rochelle (women) was founded in 1904, while Iona college, a business and liberal arts institution for men, dates from 1940. Named for La Rochelle, the old Huguenot bastion in France, the community has continued since its founding to figure in history. Men and women of prominence who were born or lived there include Peter Faneuil, John Jay, Gen. Philip Schuyler, Thomas Paine and Susan B. Anthony. Points of particular interest are Ft. Slocum, an army post offshore, and a farm cottage given to Thomas Paine by the state of New York, where he spent several of his last years. Incorporated as a village in 1858 and a city in 1899, New Rochelle adopted the council-manager form of government in 1932. Pop. (1960) 76,812; for comparative population figures *see* table in NEW YORK: *Population*. (C. B. F.)

NEW ROMNEY, a municipal borough in the Ashford parliamentary division of Kent, Eng., and one of the Cinque Ports (*q.v.*), 18 mi. S.S.E. of Ashford by road, and more than a mile from the sea. Pop. (1961) 2,556. Between the town and the sea has grown Littlestone-on-Sea. New Romney lies on Romney marsh, part of a level extending from Winchelsea in the southwest to Hythe in the northeast, which was within historic times in great part covered by an inlet of the sea. The marsh is cordoned off by the Royal Military canal. The river Rother, which now has its mouth at Rye harbour, formerly entered the sea there, but had its course wholly changed during a great storm in 1287, and the gradual accretion of land led to the decay not only of New Romney but of Winchelsea and Rye as seaports. Romney marsh itself is protected by a sea wall, and its guardianship and drainage are in the hands of a special corporation dating from 1462.

Its harbour was the cause of the early importance of Romney, as it was called before 1562–63, and the annual assembly of the Cinque Ports, called the Brodhull, was held there. At the time of Domesday Book the archbishop of Canterbury and the bishop of Bayeux were joint lords. Romney owed the maritime service to the king of supplying five ships to serve for 15 days in the year. A confirmation of liberties was granted by John in 1205. The town was incorporated by Edward III and was represented in the parliament of 1265. It returned two members from 1366 to 1832. After Elizabeth I's charter of 1563, the town was officially called New Romney. A large collection of records, maps, etc., relating to the Cinque Ports are in the town hall. There is a big sheep fair in August. Of the five churches mentioned in Domesday Book only the Norman church of St. Nicholas remains; there are ruins of a 13th-century priory. The Romney, Hythe and Dymchurch light railway, of 15 in. gauge, incorporated in 1926, is one of the smallest public railways.

NEW ROSS (ROS MHIC TREOIN), a town of County Wexford, Republic of Ireland, on the Barrow, 2 mi. below its junction with the Nore, 87 mi. S.S.W. of Dublin by road. Pop. (1961) 4,494. St. Abban founded the abbey of Rossmactreoin in the 6th century, which gave rise to the ancient city Rossglas or Rossponte. There are remains of a 13th-century Dominican foundation in Rosbercon, on the Kilkenny side of the Barrow which is there crossed by a swing bridge (1869). The Protestant church occupies part of the site of the old Franciscan friary (13th century). In 1269 the town, which stands on a steep hill overlooking the river, was surrounded by walls. The fortresses were dismantled by Oliver Cromwell. Inland water communications reach Dublin by means of the Barrow and the Grand canal. New Ross has breweries and tanyards, a salmon fishery and a fertilizer factory, and exports agricultural produce.

The nearby village of Dunganstown is the ancestral home of John F. Kennedy, who paid a sentimental visit to the family farmstead in June 1963. It was from New Ross that his great-grandfather sailed for the United States in the 1840s.

NEWRY, a seaport, urban district and market town of County Down, N.Ire., is situated on the Clanrye river and Newry canal, 38 mi. S. of Belfast by road. It lies in a valley to the north of Carlingford lough and is within a few miles of the mountains of Mourne. Pop. (1961) 12,450.

The town developed around a Cistercian abbey founded on the left bank of the Clanrye by St. Malachy about the year 1144. The abbey was granted a charter in 1157 by Muirchertach O'Lochlainn, king of Ulster. The name of the town in Irish (Iubhar Cinn Trágha) means "the yew tree at the head of the strand" and it is said that the original yew, the symbol of immortality, was planted by St. Patrick himself. Because of its position in a gap of the hills, Newry has seen much fighting and was set on fire by James II's forces in 1689. St. Patrick's parish church (Church of Ireland), founded in 1578 by Sir Nicholas Bagenal, was the first Protestant church to be built in Ireland, all Protestant churches before that time being existing structures taken over after the Reformation. Newry is the seat of the Roman Catholic bishop of Dromore and the cathedral of SS. Patrick and Colman was completed in 1825. On Trevor hill a private residence, erected in 1775, is a perfectly preserved example of Ulster Georgian architecture.

Newry's industries include the spinning and weaving of linen and cotton, the manufacture of waterproof clothing, the production of mashed-potato powder, and granite quarrying. There are weekly sailings from Newry to Liverpool for freight and livestock.

NEWS AGENCY, an organization that supplies news reports to newspapers, magazines, radio and television stations and other users. It does not publish news itself but supplies news to its subscribers who, by sharing costs, obtain services they could not otherwise afford. All of the mass media depend upon the agencies for the bulk of the news, even including those few that have extensive news-gathering resources of their own.

The news agency has a variety of forms. In some large cities, newspapers and radio and television stations have joined forces to obtain routine coverage of news about the police, courts, government offices and the like. National agencies have extended the area of such coverage by gathering and distributing stock-market quotations, sports results and election reports. A few agencies have extended their service to include worldwide news. The service has grown to include news interpretation, special columns, news photographs and motion-picture film for television news reports.

Many agencies are co-operatives and the trend has been in that direction since World War II. Under this form of organization, individual members provide news from their own circulation areas to an agency pool for general use. In major news centres the national and worldwide agencies have their own reporters to cover important events, and they maintain offices to facilitate distribution of their service.

In addition to general news agencies, several specialized services have developed. In the United States alone these number well over 100, including such major ones as Science service, Religious News service, Jewish Telegraphic agency and Nuclear News service. Specialized services in other countries include the Swiss Katholische Internationale Presseagentur, which reports news of special interest to Catholics, and the Star News agency of Pakistan, which supplies news of Muslim interest in English and Urdu. Several large newspapers syndicate the work of their own correspondents through special agencies such as the New York Times News service, Chicago Daily News service, Chicago Tribune Press service, New York Herald Tribune News service, and the syndicated services of the *Times* and *Daily Express* of London.

The major U.S. press associations have expanded their service to include entertainment features and some feature syndicates provide straight news coverage as a part of their service. The Newspaper Enterprise association (N.E.A.) and the North American Newspaper alliance (N.A.N.A.) distribute both news and features in the United States.

Despite the plethora of news services, most news printed and broadcast throughout the world each day comes from only a few major agencies. A survey of world communications by the United Nations Educational, Scientific and Cultural organization listed more than 80 important news services, but only 5 of them ranked as "world agencies." These five have the financial resources to station experienced reporters in all areas of the world where news develops regularly, to assure them access to well-organized transmission facilities or to send them wherever news develops unexpectedly. These agencies are equipped, also, to distribute the service almost instantaneously. The Associated Press, for instance, estimates it can send a bulletin to 80 countries in less than one minute.

The world agencies have established a variety of relationships with other agencies and with individual news media. Most of them purchase the news services of national or local agencies to supplement news gathered by their own staff representatives at key points. Reuters, the British agency, reports that it is "affiliated with the principal news agency in every country in the world." Reuters, like the Agence France-Presse, supplies a worldwide news file to be distributed by some national agencies along with their domestic news reports. The U.S. services more often contract to deliver their service directly to individual users abroad.

A different relationship exists in the Communist orbit. Each major Communist country has its own national news service. Each news service is officially controlled, usually by the minister of information. The services exchange news reports, some of which come from their own correspondents at key points. Tass, the Soviet news agency, is their principal source of world news. Tass also makes Communist party policy known throughout the orbit, either in the form of a daily *Pravda* editorial or other material forming an important part of its service.

Most countries of the world have one or more national news agencies. Some depend on a common service, such as the Arab News agency, which provides news for a half-dozen states in the middle east. Others are national newspaper co-operatives, such as the Ritzaus bureau of Denmark, founded in 1866, which has a well-developed teleprinter network. A few, like ANSA (Agenzia Nazionale Stampa Associata) of Italy, have expanded coverage abroad in limited degree to supplement their domestic service, but still depend on Reuters and Agence France-Presse for much of their foreign news. The Federal Republic of Germany since 1949 has built up Deutsche-Presse Agentur (D.P.A.), now one of the more important news agencies in Europe, with an extensive exchange with other national services. In Canada the Canadian Press is a co-operative news agency with headquarters in Toronto, Ont.

The oldest and largest news agency operating exclusively in Britain is the Press association (P.A.), founded by provincial newspapers on a co-operative basis in 1868. It began active work on Feb. 5, 1870, when the post office took over the private telegraph companies that had previously supplied the provincial papers with news. For 50 years the P.A. transmitted news by press telegrams but in 1920 it leased private telegraph wires from the post office. The association occupied its new London headquarters building in Fleet street in 1939. From this building it supplies news to all the London daily and Sunday newspapers, provincial papers and trade journals and other periodicals.

Capacity for speed has greatly increased during the 20th century. Radioteleprinters that make possible fast automatic transmission of news messages link all major areas. Picture transmission by radio and high-fidelity wires is well developed. During 1951 the Associated Press began a teletypesetter service—a system of wire delivery of news on punched tape that operates typesetting machines automatically—for its U.S. members and clients. United Press International provides a similar service.

The following paragraphs briefly describe the major news agencies of the world:

Associated Press (A.P.).—This is the oldest and largest of the U.S. news agencies. In May 1848 six New York city dailies joined to finance a telegraphic relay of foreign news brought by ships to Boston, first U.S. port of call for westbound transatlantic ships. In 1856 the service took the name of the New York Associated Press, a mutual, which sold its service to various regional newspaper groups. Pressure from the regional customers forced changes in its control, and in 1892 the modern A.P. was set up under the laws of Illinois. The *Chicago Inter Ocean* brought an antimonopoly suit in 1900, and A.P. moved to New York, where association laws permitted the group to continue its strict control of membership, including blackballing of applicants for membership by existing members. In the early 1940s Marshall Field III, who had established the *Chicago Sun,* fought his exclusion from the A.P. service. Prosecution under the federal antitrust powers ended the A.P.'s restrictive practices.

A.P.'s annual budget, approximately $35,000,000, is the highest in the news agency field. In addition to its regular staff, the U.S. members contribute local and regional news gathered by more than 100,000 newsmen. By the 1960s A.P. had its own staff in news centres throughout the world, with 100 offices in the United States and more than 50 abroad. It operated more than 400,000 mi. of leased wire to carry its reports to 1,760 U.S. newspapers and almost 2,000 radio and television stations. More than 7,000 news outlets in 80 nations received its service. In Aug. 1952 it started use of radioteleprinter receivers to link all of South America directly to the New York city headquarters, and the service was extended to Asia, Europe and Africa. A.P. also operates Associated Press, Ltd., in Great Britain.

United Press International (U.P.I.).—This news agency was formed in May 1958 by a merger of United Press (U.P.) and International News service (I.N.S.). U.P. had been founded in 1907 when E. W. Scripps combined three U.S. regional services under his control to sell news to all newspapers. I.N.S. had been formed in 1909 by William Randolph Hearst to provide news to morning newspapers; later, through merger with other Hearst services in 1928, it provided 'round-the-clock service. The 1958 merger consolidated nearly 2,000 domestic and foreign clients of I.N.S. with the more extensive clientele of U.P.

In the early 1960s U.P.I. served nearly 1,600 newspapers and 2,000 radio stations in the United States and approximately 1,200 newspapers and more than 300 radio stations abroad. These and other clients received news in 48 languages, transmitted over wireless and other commercial communication, and through 465,607 mi. of leased wire in North and South America, Europe and the far east. U.P.I. maintained 221 news and picture bureaus, 98 of them outside the United States. It has developed a variety of special service subsidiaries, among them United Features syndicate and U.P. Movietone News; the latter provides news on film to television stations. Another auxiliary, British United Press, serves papers and broadcasters in the United Kingdom and Canada.

Reuters.—This news agency is owned by the newspapers of the United Kingdom, Australia and New Zealand and is operated "as a trust rather than as an investment" to provide a world news service. It was founded by German-born Paul Julius Reuter (*q.v.*), when he moved to England in 1851. Reuter saw the possibilities of the telegraph for news reporting and built up an organization that maintained correspondents throughout the world. The Reuters agency remained in private hands until 1925 when the Press association (P.A.) acquired major control of it and then gained full control in 1941. P.A. later in 1941 sold half of Reuters to the Newspaper Proprietors' association, representing London newspapers, and in 1947 membership was extended to associations representing the daily newspapers of Australia and New Zealand.

As a co-operative Reuters draws from the provincial news coverage of the P.A., the resources of its London newspaper members and from its Australasian partners. It employs about 200 staff correspondents and hundreds of part-time correspondents abroad, who have access to the news files of agencies with which it exchanges copy. Reuters exchanges the Press association's U.K. report for A.P.'s coverage of U.S. news, but each retains the right to market its world report in the other's territory. About 80 U.S. newspapers and radio and television stations buy Reuters service. Directly or through national news agencies Reuters provides its services to about 110 countries and territories, reaching nearly all the world's 8,000 daily newspapers and hundreds of radio and television stations.

Agence France-Presse (A.F.P.).—This agency is the successor to an earlier French world news agency, Havas, which was founded in 1835 but was suppressed at the time of the German occupation of France in 1940. After the liberation of Paris in Sept. 1944 A.F.P. was set up by a group of newspapermen, including former Havas representatives in London and elsewhere and others who had been active in the underground movement in Paris and Algiers. The French government gave them the assets of Havas, including its Paris building, which became the A.F.P. headquarters.

With the assistance of the French government A.F.P. rebuilt a considerable part of the worldwide service of Havas. It is organized as a commercial but nonprofit agency, and a majority of

its board of directors are representatives of the French press. A.F.P. has established 40 offices at home and more than 70 abroad. In addition to contracts with A.P. and Reuters for exchange of news reports, it sells a domestic French news report to most of the world's news agencies and provides its worldwide report to many of them. Within France it has a leased-wire circuit and distributes news to its foreign clients from Paris through radioteleprinter. A.F.P. also has a photo service and a number of specialized news reports, several concerned with African matters.

Tass (**Telegrafnoye Agentstvo Sovietskogo Soyuza**).—This is the central information agency of the U.S.S.R. and is responsible to the council of ministers. It had its origin in the old Petrograd telegraph agency, which was reorganized in April 1918 as Rosta (Russian telegraph agency). On July 10, 1925, Tass was founded.

In the early 1960s Tass supplied news to 4,400 Soviet newspapers and to all Soviet radio stations; it exchanged news with 25 foreign news agencies and had correspondents in 52 countries. It employed 550 staff correspondents and about 300 part-time reporters in the Soviet Union. Its service to foreign clients is transmitted in Russian, English, French, German and Spanish; transmission inside the Soviet Union is mostly by telegraph. Wireless teletype has, however, been widely used and, since 1962, foreign correspondents in Moscow have transmitted their news through leased teletype.

See also Press Syndicate.

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(C. M. H.)

NEW SIBERIAN ISLANDS (Novosibirskiye Ostrova), an archipelago in the Arctic ocean ranging 30–350 mi. off the northern mainland of the U.S.S.R., in the Yakut Autonomous Soviet Socialist Republic, lies between longitude 135° and 158° E. and latitude 73° and 77° N. It divides the Laptev sea from the East Siberian sea. There are three groups of islands: the Lyakhov Islands (Lyakhovskie Ostrova) in the south, separated from the mainland by Dmitri Laptev strait (Proliv Dmitria Lapteva); the New Siberian Islands proper, also called the Anjou Islands (Ostrova Anzhu), in the centre; and the five small De Long Islands (Ostrova De-Longa) in the northeast. The total land area is about 14,500 sq.mi. The islands are low-lying (greatest elevation 1,050 ft.), and consist of limestones and shales with granite and granodiorite intrusions, largely covered by Quaternary deposits and thick layers of fossil ice. The latter contain animal remains, including mammoth tusks, hunting for which became the islands' main industry. True glaciers are now found only in the De Long Islands. Several deposits of lignite are known. The climate is typically arctic, with a mean July temperature of 3° C. (37° F.), low precipitation, and snow lying for nine months of the year. Vegetation is that of the tundra, and wild life includes reindeer, arctic fox, lemming and rare polar bear. Many birds come to nest in summer. There has never been a native population, but the U.S.S.R. has established hunting stations, where hunters may live all the year round if they wish, and several weather stations.

Cossack explorers, sailing from the Lena and Kolyma rivers in the 17th century, heard stories of, and probably even saw, land to the north, but the first to reach it was Merkuri Vagin, who visited the most southerly island in 1712. Ivan Lyakhov, a Yakutsk merchant, became interested in the prospects of mammoth ivory, and went there in 1770 and 1773–74. He obtained a monopoly of ivory-trading in the area and the two southerly islands were named after him, but he also discovered parts of the central group. Other merchants followed him and made further explorations, notably Yakov Sannikov in 1800 and 1805. Sannikov joined an official exploring expedition in 1809–10 led by M. M. Hedenström (Gedenshtrom), an exiled civil servant from the Baltic states. Sledge parties covered much of the central and southern groups. Hedenström saw open water to the northward, a fact which contributed to the idea, very prevalent later, of an open polar sea. Another expedition, whose object was to improve Hedenström's map, worked successfully in 1821–23 under Lieut. P. F. Anjou. The De Long Islands were discovered in 1881 by the American G. W. De Long, whose ship "Jeanette" was crushed by the ice near them. The next phase of exploration is associated with the Russian geologist E. von Toll, who worked in the group in 1886, 1893, and again in 1901–02, when he lost his life there. These expeditions yielded important scientific results. The Russian ships "Taimyr" and "Vaigach" visited the archipelago in 1912–14 and the Norwegian ship "Maud" in 1924. The Academy of Sciences set up the first scientific station on Bolshoi Lyakhovski Island in 1927–30; since then one or more such stations have been continuously manned and have acted as bases for further exploration.

See I. M. Ivanov, ***Novosibirskiye Ostrova*** (1935). (T. E. A.)

NEW SOUTH WALES, the most populous state of the commonwealth of Australia, was discovered and named by Capt. James Cook in 1770 and settled by Capt. Arthur Phillip in 1788. It consisted originally of all Australian territory east of longitude 135° E. (more than half the continent), but the western boundary was moved to longitude 129° E. in 1825, and thereafter the other eastern states were formed by separating from this area: Tasmania in 1825, South Australia in 1836, Victoria in 1851, Queensland in 1859, the Northern Territory in 1861–63 and the Australian Capital Territory in 1911. Thus the original area of 1,584,389 sq.mi. was reduced to 309,433 sq.mi., or about one-tenth of the continent. The present boundaries are as follows: on the east, the Pacific ocean from Point Danger to Cape Howe; on the west, the 141st meridian of east longitude; on the north, the 29th parallel of south latitude, proceeding east along the Barwon and a spur of the Eastern highlands, and thence along the crest of the McPherson range to the sea; on the south, the southern bank of the Murray river to its source, and thence a straight line to Cape Howe. The coastal boundary, direct from Point Danger to Cape Howe, is 683 mi. long; the western boundary is 340 mi.; and the average breadth between these is about 650 mi. The capital is Sydney.

PHYSICAL GEOGRAPHY

Geology.—The state can be divided into three geological areas: the coastal plains, the tablelands, and the western slopes and plains. The coastal plains consist mainly of post-Tertiary fluviatile deposits. In the north, between the Richmond and Tweed rivers, an area of decomposed basalt is particularly fertile and suitable for intensive agriculture and dairy farming. The coastal area also contains two coal-bearing basins, the more important extending between the Hunter and Shoalhaven rivers. The tablelands of the dividing range are composed largely of Paleozoic sediments together with granite and other igneous rocks. The area west of Sydney, north to Maitland and south to Wollongong, is capped with Mesozoic strata. The western slopes and plains are underlaid with granitic rocks and sediments of the Paleozoic, Mesozoic and Early Tertiary ages. In the south, on the lower Darling and Murray rivers, there is a large area of Early Tertiary marine beds, and in the Riverina underlying granitic, Silurian and Devonian rocks. In the north, Mesozoic (Triassic) strata form part of the Great Artesian basin, bordering southward with a Paleozoic belt that stretches west to the South Australian border. The surface of the plains is generally covered with post-Tertiary deposits and flood loams except where occasional outcroppings of earlier formations rise to the surface.

Physical Features.—The state consists of four natural geographical divisions: the coastal lowlands; the tablelands forming part of the Eastern highlands (*q.v.*) between the coast and the plains; the western slopes of the highlands; and the western plains. The tablelands form a watershed: the coastal division is drained by numerous short, rapid rivers which flow eastward from the plateau to the sea; in the west, the one river system, the Murray-Darling, drains the slopes and plains, entering the sea in South Australia. The Murray river (*q.v.*), rising in the southern highlands, and joined by the Lachlan-Murrumbidgee (watering the southeastern slopes) and the Darling river (*q.v.*) and its tributaries (watering the central north and northwest), is the longest and most important river. The coastal rivers are rain fed and

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liable to flood. The western rivers are longer and have larger drainage areas, but they have a less reliable flow and, particularly the Darling and its tributaries, are subject to regular droughts. The lack of water is a continual problem west of the Eastern highlands except in the irrigation area along the Murrumbidgee and the Murray.

The Coastal Lowlands.—These are low lying, undulating, well watered and fertile. Their average width is 50 mi. in the north and 20 mi. in the south, the widest part being the 150 mi. of the Hunter valley. The climate is mild to hot, and humid. The average monthly temperatures vary between 14° and 24° C. (57° and 76° F.) in the north and 11° and 20° C. (51° and 68° F.) in the south. The rainfall ranges between 30 and 80 in. a year and is greater in the north. The coastline consists of a succession of rugged promontories alternating with sandy beaches, inlets, river estuaries and, occasionally, marine and estuarine lakes. The river mouths are usually sand obstructed, but in the central coast subsidence has produced some fine drowned valleys, of which Port Jackson (Sydney) is outstanding. Along the rivers lies fertile alluvial land suitable for intensive agriculture (fodder crops, market gardening, fruit and, in the north, sugarcane) and dairy farming. There are rich coalfields round Newcastle and Wollongong. Almost everywhere the tablelands are separated from the coast by steep and often precipitous escarpments and gorges.

Although less than 35,000 sq.mi. in area, this division has four-fifths of the state's population and most of the factory employees. It contains the capital and the next two largest towns, nearly all the coal and manufacturing areas, all the seaports, the bulk of the dairying and maize (corn) growing, and the state's governmental, financial and commercial headquarters. Wheat and sheep, however, are virtually excluded from this division because of the damp climate. The most heavily populated areas are Sydney, the Hunter valley, the Clarence-Richmond-Tweed basins and the Illawarra district.

The Tablelands.—These form an extensive and almost unbroken belt of plateaus running roughly parallel with the coast, varying in width from 30 to 100 mi., averaging 2,500 ft. in height and rising to 4,877 ft. in the north (Ben Lomond), about 3,400 ft. in the centre (Blackheath) and 7,316 ft. at Mt. Kosciusko (Australia's highest peak) in the south; the average height of the northern plateau exceeds that of the southern. To the east the tablelands fall steeply to the coast; to the west they slope gradually to the plains. The climate is cool or cold, with uniform and reliable rainfall. The average monthly temperatures are 7°–21° C. (45°–70° F.) in the north and 3°–17° C. (38°–63° F.) in the south—about 5° C. (10° F.) lower on the average than in the corresponding coastal regions. The average annual rainfall varies from 40 in. in the east to 30 in. in the west.

Although there is good agricultural land on the tablelands, much of the country is too rough for anything but grazing sheep and cattle. There are, however, important mineral resources: tin in the north, coal in the centre (around Lithgow) and gold in both north and south. Lithgow is the only large manufacturing town, and most other towns are commercial centres for pastoral, agricultural and mining activities. The Blue mountains, due west of Sydney, are a convenient and popular tourist resort. The tablelands account for only 13% of the area of New South Wales, and less than one-tenth of the state's population lives there. Agriculture consists mainly of mixed farming, particularly a combination of sheep (nearly one-quarter of the state's total) and/or cattle and crops.

The Western Slopes.—To the west the tablelands slope gradually to the great western plains. The slopes, varying from 150 to 300 mi. in width, consist of gently rolling country that descends from the plateaus (at elevations above 2,000 ft.) to levels of less than 1,000 ft. on the plains. The climate is warm and dry, with a uniform rainfall. Average monthly temperatures are 23°–27° C. (73°–81° F.) in summer and 8°–12° C. (46°–53° F.) in winter. The average annual rainfall varies from 30 in. in the east to 20 in. in the west.

This division, with an ample and fairly reliable rainfall and fertile soil, is devoted mainly to mixed farming, particularly the production of wool and wheat, the state's best wheat-growing area being the southern slopes. In this area, also, the upper basins of the western rivers and streams and the outcrops of ancient rocks along the slopes in the past yielded rich minerals, particularly gold. The western slopes, with only 14% of the state's area and one-twelfth of the population, account for half the wheat crop and nearly one-third of the sheep. Tamworth is the largest town.

The Plains.—Covering nearly two-thirds of New South Wales, the plains extend from the edge of the slopes to the state's western boundary, being interrupted only by the elevated country from Orange to Cobar, and the Grey and Main Barrier ranges in the far west. They can be divided into the central plains and the western plains. The central plains consist of the Riverina (*q.v.*) district, divided from the western plains by the Lachlan and Murrumbidgee rivers (*qq.v.*), and the low flatlands stretching east of the Barwon and Bogan rivers. The western plains consist of the area west of the Lachlan, Bogan and Barwon rivers. Both plains, substantially the large flat basins of the Murray-Darling system, are floored with generally fertile red and black soils but receive a scanty rainfall. However, the northwestern plains fall substantially within the Great Artesian basin, and the southwestern plains in the Murray river artesian basin. Moreover, the dams on the upper courses of the Murray, Lachlan and Murrumbidgee have greatly increased the agricultural possibilities of the Riverina by irrigation. The Snowy mountains hydroelectric scheme has diverted many streams and rivers from their original eastward courses, so that water that was originally lost to agriculture is now available for irrigation in the Murray basin. (*See* AUSTRALIA, COMMONWEALTH OF: *The Economy: Production: Power;* and AUSTRALIAN ALPS.) The climate is warm to hot, and dry, with a coolish winter. The average monthly temperatures are 24°–29° C. (75°–84° F.) in summer and 9°–12° C. (49°–54° F.) in winter. The average annual rainfall varies from 7 in. in the northwest to 10–15 in. along the Darling and 20 in. in the east.

In the western plains pastoral and mining activities alone have significance. Silver, lead and zinc are mined at Broken Hill, and opals at Lightning Ridge. Pastoral holdings are large, and towns well spaced and, except Broken Hill, small. In the central plains, while wool and wheat predominate throughout, farming is relatively less important in the north and more important, especially in the irrigation area, in the south. The division accounts for two-fifths of the state's land but has only one-twentieth of the population (mostly in the central plains). It has two-fifths of the sheep (largely in the centre) and contributes similar proportions of the wheat crop (in the centre) and of the mineral production (from Broken Hill in the west).

Climate.—New South Wales is situated entirely in the temperate zone, and its climate is generally mild, although occasional

high temperatures are experienced in the northwest and some extreme cold on the southern tablelands. There is abundant sunshine in all seasons. Average temperatures are higher by 3°–4° C. (5°–7° F.) in the north than in the south, and the mean daily range increases from 9° C. (19° F.) on the coast to about 14° C. (26° F.) on the western plains. Most of the state has frosts for up to five months of the year, but these are severe only on the tablelands and western slopes. Snow is rare except on the tablelands; perennial snow is found only on the highest peaks in the south. The seasons are well defined, autumn beginning in March, winter in June, spring in September and summer in December. The weather is determined chiefly by anticyclones that pass almost continually across the state from west to east, with consequent tropical and antarctic depressions; the state is fairly free from cyclonic disturbances. In summer the prevailing winds on the coast are northeasterly; in the west they are variable, with a marked northerly component in the north and a pronounced southerly component in the south. In that season the prevailing direction of the wind is westerly in the southern and southerly in the northern part of the state. In winter New South Wales lies directly in the great high-pressure belt. Rainfall varies from an average 80 in. a year in the northeast to less than 7 in. in the northwest; generally, the east receives more rain, and more uniformly, than the interior. The rate of evaporation increases from about 40 in. a year on the coast to about 100 in. in the northwest. Heavy rains cause extensive flooding of the rivers, especially on the coast; and droughts, particularly in the interior, are also common. The winter rain region is bounded on the north by a line from Broken Hill to Wagga Wagga with a curve round to Albury, *i.e.*, the southwestern corner of the state; the summer rain region lies north of a line from the northwestern corner to Newcastle; between those regions the rainfall is fairly evenly distributed, except on a narrow southern coastal strip between Nowra and Broken bay, which receives its heaviest rain in autumn. Winter rains arise from antarctic, summer rains from tropical, depressions. Rainfall has exerted a powerful influence in determining the character of rural settlement, the intensity of which varies directly with the amount and certainty of the rain.

Vegetation.—Of the 9,000 botanical specimens found in Australia, about 3,600 are to be found in New South Wales. The natural vegetation is very varied, from the dense semitropical forest of the north coast to the sparse vegetation of the western plains. Except for the plains, the state is well wooded, nearly one-tenth of it being covered with forest and a much larger area with bush and scrub. The forest land is concentrated mainly on the coast and tablelands, giving way on the western slopes to shrub eucalypts, and in the far west to saltbush and spinifex. The predominant tree is the eucalyptus, which has a great variety of species and is the main source of the state's hardwood; it grows quickly and yields well, and its better varieties, *e.g.*, ironbark and tallowwood, provide excellent timber. The eucalypti are specialized in habitat: the ironbark is found mostly on the coast and warmer parts of the tablelands; the tallowwood on the north coast; the Murray red gum, though ubiquitous in Australia, in forests along the western rivers; and less valuable varieties (the box, the stringybark and the turpentine) on the coast and tablelands. The softwoods are found in much smaller quantities on the north coast (the red cedar, the colonial or hoop pine and rosewood) and on the western slopes (the cypress pine) and are used extensively as cabinet timbers. Native grasses cover most of the state except in the far west and where overstocking has been severe. Many varieties are drought resistant and good fodder and partly explain the excellence of the New South Wales pastures for sheep rearing.

Animal Life.—The fauna of New South Wales is rich in marsupials and birds. The dingo was once fairly common in western New South Wales, where it preyed on sheep, but fencing and hunting have made it rare. Of Australian marsupials, New South Wales has three of the four species of native cat, one species of wombat, the native bear or koala, the common and ring-tailed opossums, the common and long-nosed bandicoots, and a variety of kangaroos and wallabies. The platypus and echidna are both found. Bird life includes the emu in the west; of the mound builders, both the scrub turkey and the mallee bird; the lyrebird on the north coast; a host of parrots and other more common species. Snakes, particularly the black snake, are also found over most of the state. The best-known fish is the Murray cod, an excellent table fish, which is found in all the western rivers.

Both flora and fauna have been considerably modified by European settlement. Reforestation, particularly with softwoods, is changing the pattern of forests; introduced grasses and intensive agriculture are changing the character of pastures in many areas; and, generally, all animal life is retreating to the less inhabited regions of the state. Some immigrants, *e.g.*, the rabbit and the trout, are completely acclimatized (*see* also NATURALIZATION, PLANT AND ANIMAL).

HISTORY

The early history of New South Wales, from its settlement with convicts under Capt. Arthur Phillip in 1788, is one with the early history of the British period in Australia. For this period especially, until the end of Lachlan Macquarie's governorship in 1821, *see* AUSTRALIA: *History*.

Pastoral Expansion and Self-Government, 1822–55.—In these years the foundations of modern New South Wales were securely laid. Self-government was attained; radicalism emerged; voluntarism was established as the basis of colonial religion; transportation of convicts ceased; trial by jury and a free press were allowed; and the rapid expansion of the pastoral industry made the colony prosperous. New South Wales changed from a prison farm into a self-governing colony with a free and expanding economy. The basis of the expansion was wool. Exploration in the 1820s and 1830s opened up the whole of the colony, and the increasing demand for wool in Yorkshire enabled the squatter pastoralists to avail themselves of the new land, which provided excellent pastures for the fine-wooled Merino. Wool was a source of sterling funds and an inducement for capital imports and immigration. The consequent wealth was a solvent of autocracy. The growing body of free settlers was not prepared to suffer autocratic government and transportation, which lowered the moral tone of the colony. But the impetus for colonial reform came also from Britain.

Thus, acts of 1823 and 1828 gave New South Wales a nominated legislative council; an act of 1842 made this partly representative; and the Australian Constitutions act, 1850, made it completely representative with the powers of writing a constitution. Nevertheless, until 1855 executive control rested entirely with the governor and his executive council, consisting of officials. The legislative council was dominated by the pastoralists, who tried to frame a constitution to thwart the democratic aspirations of the city and labour interests; but the bicameral legislature finally adopted avoided the autocratic ambitions of the pastoralists and was the future source of much liberal legislation.

The most important social conflict between 1822 and 1855 concerned the status of the former convicts, but, after transportation was discontinued in 1840, wealthy emancipists and exclusives were brought into an alliance to fight for self-government and against the colony's growing radical movement. In religion the privileged status of the Church of England was modified, and the various Christian denominations demanded and received legal equality. The attempt by Gov. Sir Richard Bourke to introduce public secular education foundered on the opposition of the churches. But the most important political conflict concerned the alienation of land. The squatters had settled on land beyond "the limits of location" (a defined small area, to prevent undue dispersion and make government easier) and until 1847 had the most temporary titles to their estates. Gov. Sir George Gipps tried to prevent the complete alienation of the state's pasturelands but was unable to prevent the 1847 orders-in-council which gave the squatters favourable treatment. The quarrel over land, however, continued throughout the 19th century.

Colonial Liberalism, 1856–85.—In Feb. 1851 gold had been discovered near Bathurst, but the main tide of the gold rushes soon swung to the richer fields of Victoria. New South Wales

nevertheless gained in wealth and population from gold. In 1856 the new constitution was implemented with a bicameral legislature and responsible cabinet government. One of its early acts in 1858 introduced the ballot and universal adult male suffrage, and the new democracy soon moved against the squatters. "Radical" legislation in the next 30 years included the abolition of state aid to religion (1862), the Triennial Parliaments act (1874), the Public Instruction (public schools) act (1880) and public health legislation (1881). Sir John Robertson's land act of 1861 aimed at facilitating closer settlement by allowing selection before survey; anyone might select from 40 to 320 ac. within the "settled" or "intermediate" districts on payment of a quarter of the price, the balance being due, with the title, after three years' residence. Some genuine closer settlement resulted, especially on the coast, but the squatters' devices of "peacocking" and dummying, *i.e.*, picking the best land and using dummy selectors, left most of the western lands in their hands. The failure to settle much of the increasing population on the land meant greater concentration in the towns, besides the rapid growth of trade unionism and radicalism among the growing body of workers. Radicalism before 1870 was reflected in the land legislation and opposition to the British government. Between 1870 and 1885 it encouraged state intervention in social and economic life and increased the political aspirations of the trade unionists. Sir Henry Parkes (*q.v.*) was the most influential personality in politics, and between 1872 and 1891 his ministries introduced free trade, established nonsectarian public schools and sponsored railway development. He finally lost office because he favoured federation before the idea was popular in New South Wales.

This was a period of great economic development. By 1890 New South Wales was self supporting in foodstuffs; valuable minerals had been discovered and mined—gold at Captain's Flat in 1861, copper at Cobar in 1869, tin at Inverell in 1871 and silver-lead-zinc at Broken Hill in 1883; 1,215 mi. of railway were completed by 1884; unassisted immigration between 1873 and 1893 exceeded 230,000. These developments were greatly helped by the capital imports of the 1870s and 1880s, many of them by the government for public works.

Labour, Nationalism and Federation, 1886–1914.—This period was dominated by growing nationalism, the rise of the political labour movement and the federation of the Australian colonies into the commonwealth of Australia. The period began with the collapse of export prices and the great reduction of capital imports consequent on British financial difficulties. This led to wage reductions, industrial unrest, the great strikes of 1890–91 (in which the trade unions were defeated) and the financial crisis of 1892. Although a time of misfortune, culminating in the big drought of 1902–03, the 1890s were crucial in New South Wales' history. The *Sydney Bulletin*, a radical weekly, encouraged a nationalist literature, which included distinguished contributions from Henry Lawson, Joseph Furphy and many others. The failure of direct action in the 1890 strike forced the unions into politics with immediate influence on legislation. G. H. Reid, with Labor party support, introduced financial reforms (including income tax), removed the public service from political control, reformed the land law to allow the breakup of large estates and passed the Factories and Shops act (1896). Similarly, after 1900, liberal legislation supported by Labor introduced old-age pensions (1900), compulsory industrial arbitration (1901), women's franchise (1902) and free public education (1906). After federation Labor gradually increased its power until in 1910 J. S. T. McGowen was able to form the first Labor ministry. Undoubtedly the protection that came with federation favoured the development of New South Wales as the centre of Australian heavy industry and thus of the industrial proletariat and the Labor party. But a similar development also occurred in agriculture, where, between 1900 and 1914, the area of cultivation doubled, with a rapid increase in the production of wheat, fruit and dairy products. In 1912, also, the Riverina was opened up for closer settlement.

Boom and Depression, the 1920s and 1930s.—At the beginning of World War I, New South Wales had a Labor ministry under W. A. Holman, but his support of conscription led to his expulsion from the Labor party and his formation of a National ministry in 1916. Labor was returned to office in 1920, and Labor and Nationalist ministries alternated until the depression discredited Labor and put the Nationalists in office for a decade. The failure of Labor after its promising beginning was due mainly to its loss of both social purpose and emphasis on social experimentation, and to internal dissension. The 1920s were a period of boom, with considerable immigration and capital imports, and the expansion of public works, *e.g.*, railway building and the Sydney harbour bridge, and private industry. In the world depression after 1929, however, New South Wales suffered badly, with declining export income, the cessation of capital imports and high unemployment (one-quarter of the total male work force in 1933). Recovery was slow and not complete by 1939. John T. Lang, Labor premier in 1925–27 and 1930–32, is one of the most controversial figures in the history of the Australian Labor movement. He introduced some important social legislation, *e.g.*, widows' pensions, but was dismissed from office by the governor in 1932 for repudiating overseas debt payments after his government had legally committed itself, by agreement with the commonwealth, to paying them. In a landslide victory the Nationalists under B. S. B. Stevens were returned in 1932 and retained office until 1941. By then, however, Lang had been expelled from the party, and Labor had regained its unity of purpose.

World War II and Postwar Industrial Expansion.—Labor governments were returned throughout World War II and up to 1962, with W. J. McKell, J. McGirr, J. J. Cahill and R. J. Heffron as premiers. The only notable social legislation in this period was that for the 40-hour week (1947) and compulsory trade unionism for all wage earners (1954). After 1940, however, under the stimulus of war, the postwar boom and substantial immigration, New South Wales experienced the greatest industrial expansion in its history (see *The Economy*, below).

POPULATION

The population of New South Wales increased from 1,024 in 1788 to 3,917,013 in 1961 (37% of the Australian total), the population at intervening dates being 197,265 in 1851, 1,701,736 in 1911 and 2,984,838 in 1947. Until 1860 immigration was more important than natural increase in the growth of population; afterward the reverse was true. The important periods of immigration were 1830–40, 1850–60 (the gold rushes), 1861–85, 1911–14, 1924–28 and after 1948; net immigration between 1949 and 1961 was 369,649. But in the hundred years from 1861 net immigration was less than one-quarter of the total population increase. The crude birth rate fell between 1864 and 1903, improved until 1913, declined to a record low level in 1934 and then slowly increased. The net reproduction rate followed a similar pattern, and in the mid-1950s it was still greater than unity (1.396) and higher than that of most European countries. The infant mortality rate declined from 124 in 1881–85 to 21 in the early 1960s, and the average expectation of life increased from 47 to 70 during the same period. The sex distribution in the early 1960s was 101 males to 100 females (in 1911 the ratio had been 109:100); and the proportion of adults grew steadily from 1881.

There has always been a high degree of urbanization. Sydney increased its population from 95,789 (27.3% of the state total) in 1861 to 1,484,004 (49.7%) in 1947; in 1961 Sydney had 2,183,388 persons and the remainder of the state 1,733,625. The other large centres are Newcastle (208,630 in 1961), Wollongong (131,754) and Broken Hill (31,267); these, with Sydney, contain about two-thirds of the state's population. The drift toward the central coast caused concern, but little action was taken to reverse the trend. Between 1911 and 1961 total population increased by 138% and urban population by 358% (Sydney, 226%), while rural population decreased by 29%.

ADMINISTRATION AND SOCIAL CONDITIONS

New South Wales has its own constitution, conferred by imperial statute in 1855, and its own governor and legislature. Although still nominally subordinate to the parliament of the United

Kingdom, the parliament of New South Wales may for all practical purposes legislate in all matters not specifically reserved to the national (commonwealth) government. The governor is the crown representative in the state and the titular head of the government. The state legislature consists of the legislative council and the legislative assembly, and its enactments are restricted only by imperial legislation still applying to New South Wales and by commonwealth legislation validly applicable to the state. The legislative council consists of 60 members, 15 of whom are elected triennially by the two houses sitting together. The legislative assembly, the popular house, consists of 94 members elected triennially by adult suffrage. Compulsory voting was introduced in 1930. All money bills must originate in the legislative assembly, which, by its power over supply, controls the executive. The cabinet consists, by convention, of members of parliament of either house who have been chosen to administer departments of state.

In the early 1960s there were 15 main ministerial departments—the treasury, education, the attorney general, housing and co-operative societies, justice, the chief secretary, health, agriculture and conservation, labour and industry, transport, mines, land, social welfare, local government and highways, and works. There are also various important public services administered by statutory commissions, boards or trusts, concerned with such matters as fire fighting, main roads, railways, police, electricity, forestry, government insurance, ports and harbours, hospitals and housing. These, too, are subject to considerable ministerial control.

New South Wales is represented in the commonwealth parliament by 10 members in the senate (out of a total of 60) and 45 (of 122) in the house of representatives.

Education.—In New South Wales education is provided for by a system of public primary and secondary schools and technical colleges, by private schools and by three independent universities, which are, nevertheless, largely dependent on state finance. The University of Sydney, founded 1850, is Australia's oldest university; the University of New England, founded 1954, at Armidale, originally was the New England University college branch (1938) of the University of Sydney; and the University of New South Wales, founded 1958, at Kensington, grew out of the New South Wales University of Technology (1949). The private schools, which receive no public money, are largely Roman Catholic, although there are also large independent Protestant schools in Sydney.

Health and Welfare.—The health of the community is provided for largely by a private medical profession, a system of public hospitals and a government department of public health. This department supervises the work of local authorities in implementing acts concerned with health, and also the state hospitals, maternal and baby welfare services, and school medical and dental services. Roughly one-third of the cost of the hospitals was met from fees in the early 1960s.

Since World War II there has been little unemployment in New South Wales, although figures of more than 50,000 were recorded in 1957–58, 1958–59, 1960–61 and 1961–62. Both money and real wages have risen slowly but steadily; average weekly earnings in the early 1960s exceeded £A24.

THE ECONOMY

New South Wales is, economically, the most important state in Australia. Of total Australian personal incomes, it contributes about two-fifths. In the 1960s the state contained nearly half the sheep, one-quarter of the cattle and nearly one-third of the pigs of Australia. It produced two-fifths of the wool, one-fifth of the butter, nearly one-third of the bacon and ham, one-third of the wheat, one-quarter of the oats, more than one-third of the maize (corn) and all the rice. It mined three-quarters of the black coal of Australia and accounted for more than two-fifths of the value of factory production.

At the foundation of the colony in 1788 all land was vested in the British crown, but alienation was allowed, by grants up to 1830, and thereafter by sale and lease. By the 1960s, of the total area of New South Wales, nearly one-third was alienated land or land in process of alienation, three-fifths was leased crown land (mostly long term or perpetual) and the rest was land reserved to the crown.

Agriculture.—The pastoral industry was the basis of the expansion of the colony after 1820, and it is still statewide; the far west is devoted entirely to it. In the central west (including the Riverina), where the annual rainfall is 15–20 in., there is widespread mixed farming. The remainder of the state has large areas of agriculture. The density of settlement and of agriculture increases from west to east. On the tablelands and coast, intensive farming and dairying on compact holdings, with grazing on rugged backlands, are characteristic.

In the 1960s there were about 75,000 holdings larger than one acre, many of which were devoted to mixed farming. Most of them grew crops; nearly one-fifth were registered dairies; nearly one-third carried at least 20 beef cattle; about half had 50 or more sheep; and one-fifth carried pigs. Of the land under crops, about half is devoted to wheat, one-fifth to green fodder, and one-tenth each to oats and hay. Other crops are maize (corn), rice, potatoes, grapes and sugarcane.

Sheep rearing is the main rural industry. Up to 1900 the cultivation of crops barely met local needs, but wheat growing expanded rapidly after 1897, and, with new varieties (bred by William Farrer), closer settlement and the irrigation of the southwest, wheat became an important export crop second only to wool. The total area under crops thus increased from about 1,050,000 ac. in 1891–95 to a record peak of 7,150,000 ac. in 1948 (nearly one-quarter of the area suitable for cultivation).

However, nearly one-tenth of the land is still held for grazing, and the pastoral industry provides about two-fifths of the total value of primary production. Although sheep are the most valuable, cattle for slaughter and dairying are important on the coast and tablelands. Sheep are most numerous on the western slopes and central western plains. Of about 70,000,000 sheep in the early 1960s, roughly 50,000,000 were Merino. There were about 200,000 horses, more than 4,000,000 cattle and less than 500,000 pigs. The gross value of rural products increased from less than £A50,000,000 early in the 20th century to nearly £A400,000,000 in the mid-1950s (of which half was the value of the wool clip), but it declined afterward.

In the period 1918–39 the rural industries of New South Wales were faced with low home prices and unfavourable terms of trade for agricultural produce in the world markets. But World War II and the postwar boom (1946–51) boosted farm income with record prices and, in the case of wheat, record yields. Wheat prices increased sixfold between 1938–39 and 1947–48, and in 1951 wool prices reached a record level, ten times higher than in 1935–36, although they fell back afterward.

Forestry.—New South Wales is the most important timber-producing state of Australia, with an estimated area of forest reserves of 9,500,000 ac. The Forestry commission treats and places under intensive management at least 30,000 ac. of native forests annually in order to increase their yield of useful timber and also plants about 6,000 ac. of fast-growing pine trees every year. In the 1960s softwood plantations totaled more than 100,000 ac., and the total output of hardwood and softwood accounted for about one-quarter of Australian production. Included in the state forests are about 800,000 ac. of national parks, in addition to the 1,500,000 ac. of the Kosciusko State park.

Fisheries.—Prior to 1959 the bulk of fish caught consisted of mullet, shark and Australian salmon, in that order of importance, but since then tuna fishing, almost entirely for canning, has jumped to second place. In the 1960s the state accounted for about one-third of the boats employed in fishing in Australia and three-eighths of total Australian production; it provided almost all the oysters consumed in Australia.

Mining.—New South Wales contains extensive mineral deposits of great value and variety, of which coal is now the most important; it was discovered at Newcastle in 1797. By the 1960s, of total mining employment (exceeding 20,000) coal accounted for three-fifths and silver-lead-zinc for all the rest except for a few employed in the mining of gold and tin. The most important coal

fields are in the Hunter valley above Newcastle, round Wollongong and at Lithgow; two-thirds of the production comes from the northern field. The production of silver-lead-zinc is dominated by Broken Hill which has a massive deposit of rich ore; smaller quantities are found at Captains Flat. Most of the Broken Hill ore is sent (as ores or concentrates) for treatment in other parts of the commonwealth (mainly South Australia) or overseas. Between 1851 and 1951 gold, mainly from the Bathurst area, totaled more than £A75,000,000, of which two-thirds was mined before 1900, but it now amounts to less than £A300,000 annually. Copper is mined chiefly near Cobar, and tin in the central and northern tablelands.

Power.—The Electricity Commission of New South Wales is responsible for the generation and distribution of electricity, which is sold to local authorities, government railways and tramways, and to some large industrial users. In the 1960s the trend was toward large, centralized power stations supplying big areas through interconnected transmission grids. More than nine-tenths of electricity is generated by thermal power stations, and even after the completion of the Snowy mountains hydroelectric schemes less than one-sixth will be derived from water power. Since World War II there has been extensive electrification of rural areas.

Manufacturing Industries.—The manufacturing industries of New South Wales are located mainly in Sydney, where two-thirds of the factories are situated, with three-quarters of the factory employees. The only other important industrial centres are Newcastle, Wollongong, Lithgow and Broken Hill. Before 1900 manufactures consisted mainly of consumer and durable-consumer goods for local use, such as food, furniture and bricks, but federation brought both the removal of interstate trade barriers and a protective tariff for the whole of Australia. This fostered steady industrial expansion, which, although temporarily curtailed by the 1929–33 depression, was greatly stimulated by World Wars I and II. The most remarkable advance was in the manufacture of iron and steel and metal goods, which by the early 1960s employed more than 200,000 persons. Other important industrial fields are: textiles and clothing; food, drink and tobacco; chemicals and paints; and paper and printing. The period of greatest industrial development was after 1938, factory employment roughly doubling by the early 1960s. There are many small factories and relatively few large ones. Nevertheless, although three-quarters of the factories employ 10 or fewer workers each, and fewer than 3% employ more than 100 each, these large factories account for half the total number of employees. Some concerns, such as the Broken Hill Proprietary Co., Ltd. (iron and steel) and Australian Consolidated industry (glass), dominate whole industries.

Trade.—New South Wales has a large overseas and interstate trade. It accounts for about one-third of Australia's exports and, because Sydney is the port of entry for a large quantity of goods destined for other states, more than two-fifths of the imports. Exports consist largely of primary produce, but the proportion of manufactures and semimanufactures, especially to Asia, has been increasing since World War II. Imports consist mainly of machinery, metals and metal manufactures; yarn, textiles and clothing; petroleum; paper; tea; and tobacco. The main destinations of exports are the United Kingdom (although relatively a much smaller customer than before the war), other western European countries, other commonwealth countries, Japan and the United States. The United Kingdom is still very important as a supplier of imports, other suppliers being the United States and other commonwealth and European countries.

The interstate trade of New South Wales consists mainly of the import of large quantities of foodstuffs (sugar, salt, potatoes, fruit), minerals (from South Australia and Tasmania) and timber; and the export of iron, steel, cement and metal goods (mainly to Western Australia and Tasmania) and coal (to all states except Queensland).

Public Finance.—The revenue of the government (excluding income from the state-owned railways, tramways and buses, and Sydney harbour, which is self liquidating) comes partly from state taxation but mainly from the commonwealth government (chiefly from a tax reimbursement grant whereby the commonwealth collects income tax and redistributes it to the states). The most important state taxes are probate and stamp duties and the land tax, other sources of taxation being liquor licences and racing and betting. The chief items of expenditure, in order of importance, are: education; public health and recreation; law and order; and general administration.

Transport and Communications.—New South Wales is well served by rail, road and air services. The outstanding features of communications after World War II were the growth of motor transport for goods, and of air transport for passengers, and the rapid increase of television viewers after the service started in 1956. The state-owned railway lines are centred on Sydney and so distributed that most towns have reasonable access to rail transport. More than two-thirds of the roads are surfaced, and registered motor vehicles include one private car for every six persons. Air services within New South Wales, which include links between all the main towns, are provided by Trans-Australia Airlines and a small number of privately operated lines. The chief ports are Sydney, Newcastle, Port Kembla, Botany bay (for oil), Coff's harbour and Twofold bay (for timber) and the Clarence river (for sugar and timber). Since 1936 all ports have been administered by the Maritime Services Board of New South Wales, the state also being responsible for the construction, maintenance and dredging of all ports except Sydney. The Australian National line, operated by the Australian Coastal Shipping commission, is particularly important for New South Wales in supplying bulk ore carriers and a shipping service to Tasmania.

In the early 1960s there were 17 national and 37 commercial radio stations in the state. By the beginning of the decade there were one operating and five planned national television stations, together with two operating and four planned commercial stations.

See also references under "New South Wales" in the Index.

See *New South Wales Year Book* (for statistics). (R. M. Hl.)

NEWSPAPER. Some idea of the magnitude of the modern newspaper industry may be gathered from the fact that when in 1961 the United Nations Educational, Scientific and Cultural organization (UNESCO) published the results of an exhaustive investigation it reached the conclusion that not less than 8,000 daily newspapers were produced throughout the world. It stressed the fact that this must be regarded as the lowest rather than the highest figure because there were some parts of the world from which it was not possible to collect full details. There were 40 countries and territories in which no daily journal was published at all. The number of copies printed daily was at least 290,000,000, of which about 99,000,000 were printed in the English language in 2,350 publications in 70 countries. The country in which the daily press had the largest circulation was the U.S., with 58,000,000 copies or 20% of the world total, and the country with the highest daily newspaper circulation per 1,000 inhabitants was the United Kingdom, with 582 copies compared with the world daily circulation of 100 for every 1,000 inhabitants.

Newspapers themselves are a modern development; some of their functions have in the past been performed by a variety of means. There were writers of newsletters in ancient Rome who furnished news to those who resided at a distance from the capital, and written newsletters continued to be employed to supply intelligence to businessmen and political leaders until long after the invention of printing (*q.v.*). Indeed they have their modern counterparts in the "confidential newsletters" supplied to businessmen and others. In the consulship of Julius Caesar the *acta diurna* bulletins devoted chiefly to government announcements, came to be posted daily in public places in Rome (*see* also ACTA). Other forerunners of printed newspapers were the town criers (or bellmen), posted proclamations, controversial pamphlets, ballads, broadsides and news pamphlets. Many of the last named appeared in Germany and other European countries in the 16th century and were sold at fairs and in shops; they usually dealt with a battle, a disaster, a marvel or a coronation. In the first two decades of the 17th century, more or less regular papers printed from movable type sprang up in Germany, Austria, the Netherlands and Italy.

This article is divided into the following sections:

I. UNITED STATES

Although printing presses were established at Cambridge, Massachusetts Bay Colony, in 1638, at nearby Boston in 1674 and at Philadelphia in 1685, nothing that could properly be called a newspaper was published in the American colonies until Benjamin Harris issued his *Publick Occurrences Both Forreign and Domestick* in 1690. Free speech and free printing had no legal standing in the colonies in the 17th century. Royal charters commonly contained provisions for licensing the press, but the governors regarded printing as dangerous. Packets of newspapers were brought over from England, and at least two issues of the *London Gazette* were reprinted in the colonies. A few professional newsletter writers did some business, and private letters of news were passed from hand to hand. Ballads, proclamations and pamphlets contained some news. In 1689 Massachusetts leaders compiled and published a news broadside entitled *The Present State of New-English Affairs* in order "to Prevent False Reports" and to tell of Increase Mather's efforts in behalf of a new charter following the overthrow of Gov. Sir Edmund Andros.

1. First Newspapers.—The next year Benjamin Harris, London bookseller and publisher who had fled England after imprisonment for printing a seditious pamphlet, issued in Boston no. 1 of *Publick Occurrences Both Forreign and Domestick*, to be "furnished once a moneth (or if any Glut of Occurrences happen, oftener)," on Sept. 25, 1690. Four days later the governor and council suppressed it. This first American newspaper, which was thus ended summarily with its first number, was a very newsy three-page paper (the fourth page being left blank for private correspondence), measuring 6 in. by 9½ in. when folded.

Fourteen years passed before the next venture in American newspaper publishing. In 1704 John Campbell, newsletter writer, bookseller and postmaster, established the *Boston News-Letter*, the first continuously published American newspaper, and issued it "By Authority" for 15 years. Thereafter it was published until the Revolution; then, a Tory paper, it suspended shortly before the British evacuation of Boston. In 1719 William Brooker was appointed postmaster at Boston, and since Campbell refused to turn over the *News-Letter* to him, he founded the *Boston Gazette*. This paper had a long and influential career; during the struggle for independence it was edited by Benjamin Edes and John Gill, called "trumpeters of sedition" by their Tory enemies. It sur-

vived the Revolution but perished in 1798.

First printer of the *Gazette* was James Franklin, who had as apprentice his 13-year-old brother Benjamin. When Brooker lost both post office and newspaper in 1721, and the new proprietor took the printing of the *Gazette* to another shop, Franklin started a new paper called the *New-England Courant.* During its five and one-half lively years, the *Courant* was a spectacular sheet, first as an opposition organ critical of the Mather regime, and later, after the council had banned James Franklin as publisher, as a repository of periodical essays. To evade the council's order, James put his brother Benjamin in as nominal publisher. The latter had already written his first satirical essays, the early "Dogood Papers," for the *Courant;* but his brother treated him badly, and he soon ran away to Philadelphia.

2. Early Papers in Philadelphia and New York.—The *American Weekly Mercury* narrowly missed being the third American newspaper; its first issue, Dec. 22, 1719, was only one day later than that of the *Boston Gazette.* It was founded by Andrew Bradford, son of the William Bradford who introduced printing into Pennsylvania but who by this time had moved his press to New York. The second Philadelphia newspaper was begun by Samuel Keimer with the extraordinary title, *The Universal Instructor in All Arts and Sciences, and Pennsylvania Gazette,* in 1728. The first part of the title was due to the project of Keimer, a scientific deist and an eccentric, to print Ephraim Chambers' *Cyclopaedia* serially in his paper. Benjamin Franklin, now established as a printer in Philadelphia, helped to give the rival *Mercury* a competitive advantage in the town by writing his "Busy-Body Papers" for it, and in 1729 bought Keimer out. He abandoned the cyclopaedic serial, cut off the grandiloquent prefix of the paper's title and made such a success of the *Pennsylvania Gazette* that he was able to retire with a competency at 42. He completely disposed of the *Gazette* in 1766 to his partner David Hall who, with his sons and grandsons and various partners, conducted it until its end in 1815.

Meantime, William Bradford had founded the first New York newspaper in 1725 under the title *New-York Gazette.* It was definitely an organ of government in that colony, and when the bitter contest between Gov. William Cosby and the popular party developed in 1733, John Peter Zenger was induced to start an opposition paper. His paper, the *New-York Weekly Journal,* was supported by the contributions of James Alexander and other leaders of the popular party, much as James Franklin's crusading paper in Boston had been aided by a group of dissident writers there. When Zenger was jailed in 1734, Cosby disbarred the attorneys who were defending him, and Andrew Hamilton, a famous Philadelphia lawyer, was brought in to plead his case. Hamilton's masterly argument brought acquittal, was later reprinted as a pamphlet and did much for the cause of liberty.

3. Other Colonial Beginnings.—The initial papers in other colonies were *Maryland Gazette,* Annapolis, 1727, and *Virginia Gazette,* Williamsburg, 1736, both founded by William Parks, one of the best of the colonial printers; *Rhode-Island Gazette,* Newport, 1732, founded by James Franklin, who had moved his press there from Boston but was able to maintain the paper for only eight months; *South-Carolina Gazette,* Charleston, 1732, founded by one of Benjamin Franklin's printers, and carried on by another Franklin protégé, the talented Lewis Timothy; *North-Carolina Gazette,* New Bern, 1755, founded by James Davis; *Connecticut Gazette,* New Haven, 1755, founded by Timothy Green; *New-Hampshire Gazette,* Portsmouth, 1756, founded by Daniel Fowle, a paper which lived for 190 years; *Georgia Gazette and Weekly Mercury,* Savannah, 1763, founded by James Johnston; *New-York Gazette,* 1776, by chance New Jersey's first paper, since Hugh Gaine moved this sheet to Newark when the British occupied New York. John Adams, a Wilmington printer, is reported to have published a paper called the *Courier* in that town for a few months in 1762, but the earliest Delaware paper of which there is definite knowledge is the *Delaware Gazette,* begun at Wilmington in 1785 by Jacob A. Killen. The *East-Florida Gazette,* published at St. Augustine in 1783–84 by the Tory editor John Wells, was the first paper in what was later the state of Florida. Timothy Green, fourth of that name in a long line of printers, established the first Vermont paper in collaboration with J. P. Spooner; it was the *Vermont Gazette and Green Mountain Post-Boy,* of Westminster. The first paper in what is now Maine was the *Falmouth* (Portland) *Gazette,* founded in 1785 by Benjamin Titcomb, Jr., and Thomas B. Wait.

4. Patriots and Tories.—Leading patriot newspapers during the period extending from the enactment in 1765 of the Stamp act, which taxed the newspapers and aroused them to bitter opposition and noncompliance, to the end of the American Revolution were: the *Boston Gazette,* to which Samuel Adams and his group contributed; the *Massachusetts Spy,* founded in 1770 by Isaiah Thomas, who was later a successful book publisher as well as journalist and the founder of the American Antiquarian society; the *Connecticut Courant* of Hartford, founded in 1764 by Thomas Green; the *New-York Journal,* founded in 1767 by John Holt; the *New-York Packet,* founded by Samuel Loudon in 1775; the *Pennsylvania Journal,* founded in 1742 by William Bradford, grandson of the pioneer printer of the same name, himself an able editor and the outstanding soldier-editor of the Revolution; the *Pennsylvania Gazette,* conducted at this time by David Hall; the *Pennsylvania Packet,* founded in 1771 by John Dunlap, another soldier-editor, who later joined with David C. Claypool to make this paper one of the most successful in America during the years immediately after the war; and the *South-Carolina Gazette,* whose war editor was Peter Timothy. These papers had many bitter experiences during the war. While the British occupied Boston, the *Gazette* found a temporary home at Watertown, while the *Spy* moved permanently to Worcester. The New York papers had to find temporary homes in towns up the Hudson river when the city was lost to the patriots, and the patriot papers of Philadelphia were refugees during the shorter British occupation of their city. When Newport was taken, Solomon Southwick buried his press and type; later he exhumed them to continue the long career of his *Mercury.*

Leading royalist papers were: the *New York Gazetteer,* founded in 1773 by James Rivington; the *New-York Weekly Gazette and Mercury,* founded in 1753 by Hugh Gaine; the *Royal American Gazette* of New York; the *Royal Pennsylvania Gazette* of Philadelphia, published briefly by James Robertson; and the *Pennsylvania Evening Post,* founded in 1775 by Benjamin Towne, who was later to make his paper the first American daily.

5. Characteristics of Colonial Papers.—American newspapers in the colonial period were modeled on those of the mother country. The common size was four pages, each about 10 in. by 15 in. Extra pages were sometimes issued to accommodate heavy advertising. Headings of news stories were little more than date lines. The successful papers had good advertising patronage; advertisements were set single-column with little display, so that a page of them resembled modern classified make-up. Paper was obtained chiefly from England until the tax on that staple stimulated American manufacture. The collection of rags from which paper was made was regarded as a patriotic duty during the Revolution. Manufacture of ink, type and presses was also built up in America when importation was interrupted.

Chief news sources were the English newspapers, since interest in events in the homeland was paramount among the colonists. The second important source was "exchanges"—papers published in other American towns. The rule was for an editor to cover any news of first-rate importance in his own neighbourhood for his own paper, and for other papers to clip it; thus all colonial papers were members of an informal co-operative news-gathering system. Local news coverage was not intended to be thorough, and small happenings were usually disregarded; there were no local reporters, and the editors were commonly imbued with the concept of news as historical record. Other sources than those mentioned were letters from other cities or from England brought in by friends of the editor; word-of-mouth reports by ship captains, postriders and travelers; and official documents and communications. With the coming of the war, English papers were cut off almost entirely, and military operations interfered with colonial communications; but patriot committees were active in

sending news bulletins from one town to another.

There were no editorial pages, but editorial comment was interspersed with the news. Political and economic dissertations, satirical essays on social customs and poetry were common.

6. The Daily Newspaper.—A few semiweeklies and triweeklies had been published in the colonies. For example, Benjamin Towne's *Pennsylvania Evening Post* had been established as a triweekly; in 1783 Towne made it the first American daily. Generally it consisted of only two pages, and was a rather shabby sheet. Towne was indicted for treason a few months after he made his paper a daily, and its 17-month existence in that status was shadowed by its editor's disrepute. John Dunlap and David C. Claypool's *Pennsylvania Packet and Daily Advertiser* began daily publication in 1784. It was very successful, as was the *New York Daily Advertiser*, founded in 1785 by Francis Childs; the latter was the first American paper to be founded as a daily.

Dailies came into the picture less for the purpose of giving timely news than because publishers wished to compete with the coffee-shop bulletins in giving reports to merchants of the offerings of importers just as soon as ships arrived in the harbours of Philadelphia and New York. The political papers of the cities also adopted daily publication rather generally by the end of the 18th century, leaving the weeklies to the smaller towns.

7. The Party Press.—As national issues developed, newspapers took up the cudgels of partisan strife. From the second administration of George Washington until after the Civil War, ardent partisanship in journalism was the rule. The mercantile papers, as well as those confessedly established as political organs, took sides; and when the penny papers appeared in the 1830s, with their emphasis on local news and human-interest features, they, too, were soon involved in party controversy. At its height during the first two decades of the 19th century, this partisanship resulted not only in slanting and distorting news but in personal abuse and vilification of political figures, duels and assaults among editors and much prostitution of the newspaper's chief duty of disseminating the news accurately, fairly and fully. The situation improved in the 1840s and 1850s, but it was not until the doctrine of partisan independence made its great gains in the 1870s that biased reporting of public affairs was largely abated.

First national political organ was John Fenno's *Gazette of the United States* (1789–1818), Federalist, established at New York when the capital was situated there and later moved with the government offices to Philadelphia. Its great rival in the latter city was Philip Freneau's *National Gazette* (1791–93), Republican (Democratic). Alexander Hamilton and Thomas Jefferson, rivals in Washington's cabinet, were the respective sponsors of Fenno and Freneau in their editorial efforts. Supplanting the *National Gazette* as spokesman for the Jeffersonian Republicans was the *Philadelphia Aurora*, founded by Benjamin Franklin Bache, grandson of Benjamin Franklin, in 1790. Another notable political paper in that city was *Porcupine's Gazette* (1797–99), edited in vitriolic fashion by William Cobbett, at the time a refugee from England. In Boston Benjamin Russell's *Columbian Centinel* became a nationally recognized Federalist organ; founded in 1784, it was in many respects an excellent newspaper. Noah Webster, later famous as a lexicographer, founded the *American Minerva* in New York in 1793 as a Federalist organ; four years later this paper adopted the name *Commercial Advertiser*, which it kept for more than a century.

One cause of the Alien and Sedition acts (1798–1801) is to be found in the prevailing scurrility of attacks on public officers, but the immediate occasion was the threat of war with France and the consequent need to guard against disloyalty. There were about 25 arrests under the Sedition act and 11 trials resulting in 10 convictions. Actions under the common law brought total convictions to 15, of which 8 related to newspapers. But the censorship involved was greater than these figures indicate. The acts expired with the John Adams administration. Two years later Alexander Hamilton, in an argument for a new trial in the case of Harry Croswell, editor of the *Hudson* (N.Y.) *Wasp*, advanced the "Hamiltonian doctrine," later made a part of most state constitutions, to the effect that evidence of the truth of statements published with good intentions may be introduced by the defense in a criminal libel suit.

The *National Intelligencer*, established in Washington in 1800 as the organ of the Jefferson administration by Samuel Harrison Smith, proved to be mild in partisanship and reliable in news. Conducted after 1810 by Joseph Gales, Jr., and W. W. Seaton, the *Intelligencer* was considered by other papers for many years as the authority on Washington news. It was displaced as the government organ, however, when Andrew Jackson became president. Duff Green's *United States Telegraph* (1825) was Jackson's first Washington paper; it was supplanted in 1830 by the *Washington Globe*, edited by Francis P. Blair. Associated with the *Globe* also were Amos Kendall, editorial writer, and John C. Rivers, business manager, who, with Blair, were members of Jackson's "kitchen cabinet" of political advisers.

Meantime, in New York, James Cheetham's *American Citizen* was the vituperative organ of the George Clinton faction of the Democratic party during the first decade of the 19th century. Established largely in order to combat Cheetham's sheet was the *New York Evening Post*, founded in 1801 by Alexander Hamilton and friends associated in a joint-stock company. William Coleman was its first editor; he was followed in 1829 by William Cullen Bryant, who edited the paper until his death in 1878.

8. The Penny Press.—The chief characteristics of the penny press of the 1830s were smaller size, a one-cent price in comparison with the six cents charged by the larger papers, and adaptation to lower economic and social levels of readership. The penny papers featured local and human-interest matter, preferred news above support of a party or mercantile class, exposed abuses of banks and churches and tended to give a realistic picture of the news scene despite taboos.

The first successful penny daily was the *New York Sun*, founded in 1833 by Benjamin H. Day. Most important of its rivals in this field was the *New York Herald*, begun two years later by James Gordon Bennett. Three New York printers, William M. Swain, A. S. Abell and A. H. Simmons, founded the *Philadelphia Public Ledger* in 1836 and the *Baltimore Sun* in 1837; Swain was chiefly responsible for the former and Abell for the latter over many years. In 1841 Horace Greeley founded the *New York Tribune* as a penny paper, and ten years later the *New York Times* was started by Henry J. Raymond, George Jones and Edward B. Wesley at the same price. All these New York papers except the *Sun* soon went to the two-cent price, enlarging their size and scope. The penny papers initiated what may be called modern journalism by their emphasis on local news and timeliness. They were leaders in the use of expresses and the telegraph for quick transmission of news, and their large circulation and advertising receipts enabled them to improve their news services and install fast cylinder presses.

Bennett and Greeley, rival editors through three decades (both died in 1872), were leading figures in a period of personal journalism. Bennett was one of the most original of editors, initiating financial and society departments and playing a part in many other innovations. Greeley was the great idealist, a crusader against slavery and intemperance and in favour of westward expansion. His hospitality to new ideas brought Fourierism, spiritualism, women's rights, Grahamism and many other reforms and fads into the columns of the *Tribune*. His alliance with Thurlow Weed, the political boss who was editor of the *Albany Journal*, 1830–63, and William H. Seward was dissolved in 1854 by a letter in which he showed his resentment because he had not been given political office; later he had much to do with the defeat of Seward for the Republican presidential nomination. The *Tribune* did not always support Lincoln during his administration, however.

In Springfield, Mass., the *Republican* was begun as a two-cent daily in 1844. Its weekly edition had been founded by Samuel Bowles 20 years earlier, but the daily was the project of a son, also called Samuel, aged 18. It became one of the most famous of small-city dailies, and exerted a wide influence, largely through its weekly edition, for many years. Following a printers' strike in 1947, it was reduced to the status of a Sunday paper.

In New Orleans, George W. Kendall and Francis Lumsden started the *Picayune* in 1836, and it soon gained a wide reputation not only as a good newspaper but as a repository for amusing sketches and witty paragraphs. During the Mexican War Kendall became the first important and regular reporter of military actions from the field.

The war with Mexico was a great stimulant to speed in news transmission. The expense of efforts in this direction led to the first important effort in co-operative news gathering—a news agency in New York city in 1848 that was the forerunner of the present Associated Press. This group consisted of the *Sun, Herald, Tribune, Express, Courier and Enquirer* and *Journal of Commerce*—the leading papers of the metropolis. When the *Times* was begun, it was taken in. The *Express* (1836–81), conducted by James and Erastus Brooks, was a strong mercantile paper. The *Courier and Enquirer* was the result of a merger in 1829 of Mordecai M. Noah's *Enquirer* and James Watson Webb's *Morning Courier*. Under Webb's aggressive editorship it was bright, bellicose and enterprising. The *Journal of Commerce* was founded in 1827 by Arthur Tappan as a commercial paper with a strong religious bent; it soon became the property of Gerard Hallock and David Hale.

9. The Westward Movement.—The first newspaper west of the Appalachians was the *Pittsburgh Gazette* (*Gazette Times*, 1906; *Post-Gazette*, 1927), founded by John Scull and Joseph Hall in 1786. The following year the *Kentucky Gazette* was founded at Lexington by John Bradford. First paper in what is now West Virginia was the *Potowmac Guardian*, begun by Nathaniel Willis in 1790. Tennessee's first paper was the *Knoxville Gazette*, 1791, George Roulstone founder. Benjamin M. Stokes started the first Mississippi paper, the *Mississippi Gazette* (1799–1801) at Natchez. The first New Orleans paper was *Moniteur de la Louisiane*, a sheet of four small pages in French, 1794, by Louis Duclot. The earliest paper in what is now Alabama was the *Mobile Centinel* (1811–12) by Samuel Miller and John B. Hood.

First newspaper to be established in what is now Ohio was the *Centinel of the North-Western Territory*, founded at Cincinnati by William Maxwell in 1793. First in Indiana was Elihu Stout's *Indiana Gazette*, later *Western Sun*, at Vincennes in 1804. Joseph Charless founded the *Missouri Gazette* in 1808; it was the first paper printed wholly in English west of the Mississippi. Its name was later changed to *Missouri Republican* and in 1888 to *Republic;* it was merged with the *St. Louis Globe-Democrat* in 1919.

First Michigan paper was the *Michigan Essay*, produced briefly under the patronage of Gabriel Richard, a Catholic missionary; the first Michigan paper of longer life was the *Detroit Gazette* (1817–30). In 1814 Matthew Duncan brought his press up from Kentucky and founded Illinois' first paper at Kaskaskia, the *Illinois Herald*, which he later moved to the new capital at Vandalia and renamed the *Illinois Intelligencer*. The first Chicago paper was the *Democrat*, founded in 1833 by John Calhoun, later mayor of the city; it was merged with the *Tribune* in 1861. In 1819 the *Arkansas Gazette* was begun by William E. Woodruff at Arkansas Post; it was moved to Little Rock when that settlement was chosen as the capital.

First newspaper in Wisconsin territory was the *Green Bay Intelligencer* (1833–36). First in Iowa was John King's *Dubuque Visitor* of 1836, and first in Minnesota James M. Goodhue's *Minnesota Pioneer* of 1849, later famous as the *St. Paul Pioneer Press*. In 1854 the *Nebraska Palladium*, which had been begun in Iowa, was moved across the river to Belleview and published for several months in the new territory. First Kansas paper was a missionary sheet in an Indian language called in English *Shawnee Sun*, published in 1835 at the Baptist mission; first English-language paper in that territory was the *Kansas Weekly Herald* (1854–61) of Leavenworth. The pioneer Kansas papers were embroiled in the free-state war of 1855. The *Lawrence Herald of Freedom* office was destroyed by the proslavery faction, but it gave its type to be molded into balls used for the attack on Fort Titus, so that the discharges of the antislavery cannon were called "new editions" of the *Herald*.

The *Sioux Falls Democrat* was first of South Dakota papers in 1858; its name was soon changed to *Northwestern Independent*. The *Fort Union Frontier Scout* of 1864 was North Dakota's first paper.

In the southwest Oklahoma's first paper was a Baptist missionary organ, the *Cherokee Messenger*, printed in an Indian language, near the present site of Westville, in 1844–46. Pioneer Texas paper was the organ of the provisional revolutionary government at San Felipe called *Telegraph and Texas Register*, 1835; it had an adventurous career before it became the first Houston newspaper. A small campaign sheet called *El Crepusculo*, published in Santa Fe by Antonio Barreiro, was apparently the first publication in New Mexico, but the first real newspaper was the *Santa Fe Republican* (1847–49), with two pages in English and two in Spanish. The *Weekly Arizonian*, Tubac, 1859, was the first paper in Arizona.

California's first paper was founded in 1846. It was a small sheet printed on one side only at Monterey, and was called the *Californian*. It was soon moved to what is now San Francisco, where the *California Star* had been established in 1847. Both were absorbed into the *Alta California* when that famous paper was set up in 1849. The first paper printed in Nevada was the *Territorial Enterprise*, begun in 1858 at Genoa, but more famous as the Comstock lode organ at Virginia City, where Mark Twain and Dan De Quille worked on it. Another gold rush brought Colorado's first paper, the *Rocky Mountain News*, founded in Denver by William N. Byers in 1859; it became a Scripps paper in 1926. Other western "firsts" were the *Oregon Spectator*, Oregon City, 1846; the *Columbian*, Olympia, Wash., 1852; the *Deseret News*, famous Mormon paper in Salt Lake City, Utah, 1850; the *Golden Age*, Lewiston, Ida., 1862; the *Montana Post*, begun in 1864 at the Virginia City gold camp and moved to Helena in 1868; and the *Fort Bridger Daily Telegram* of 1863, first Wyoming and first state paper to begin as a daily.

The first paper in what is now Alaska was *Esquimaux*, printed monthly at Port Clarence, Russian America, by John J. Harrington for the Western Union Telegraph expedition in 1866–67. The *Klondike Nugget* was published at Dawson (1898–99) by Eugene C. Allen and was later established as a weekly at Nome. Anchorage, Juneau, Fairbanks and Ketchikan acquired small dailies, and by the mid-1960s there were a dozen weeklies.

The first Hawaiian newspaper was the weekly *Sandwich Island Gazette and Journal of Commerce* (1836–39), by Samuel D. Mackintosh and Nelson Hall, which was continued monthly (1839–40) as the *Sandwich Island Mirror and Commercial Gazette*. Of longer life was James Jackson Jarves' *Polynesian* (1840–64). The first daily was the *Hawaiian Herald* (1866). The chief papers in Honolulu in the mid-1960s were the *Star-Bulletin* and the *Advertiser*. The *Hawaiian Star* was begun in 1893 and the *Evening Bulletin* in 1882; they were merged in 1912 by Wallace R. Farrington, later governor of the territory. The *Advertiser* was founded as a weekly by Henry M. Whitney in 1856. The *Hawaii Times* was founded in 1885 and published in both English and Japanese. In Hilo the daily *Tribune-Herald* was founded in 1895.

10. The Civil War and Reconstruction.—The American Civil War was well covered by special correspondents in the field, more than 150 of whom served northern papers during the war. Military restrictions, government control of telegraph lines and mob violence—all sporadic—curbed press activity; but there was no regular and consistent censorship. A number of papers were forced to suspend publication by military commands or the post-office department.

Among these were the *New York Daily News* and the *Chicago Times*. The *News*, founded in 1855, was a penny paper, organ of the Tammany Democracy; it had come into the hands of Benjamin Wood, brother of Fernando Wood, New York's mayor. The Woods were strongly proslavery, and a combined military and postal blockade forced the *News* to close down for 18 months in 1861–62. After the war this paper won a very large circulation in the tenement-house districts as a penny sensation-monger. Wood lived until 1900, and the next year Frank A. Munsey bought the *News* from his widow for $34,000 in $1,000 bills.

Munsey improved it so much that it lost its public, and it perished in 1900. The *Chicago Times,* founded in 1854, had been bought by Wilbur F. Storey in 1861. Its editorial attacks on the Union cause led Gen. A. E. Burnside to seize and suspend the paper, but after three days President Lincoln requested that the order be rescinded. The *Times* became a successful sensation paper after the war, receding only as the *Tribune* came to control the Chicago morning field and absorbed the *Times* in 1895.

The *Chicago Daily Tribune* was founded in 1847; it had a difficult time until Joseph Medill and five partners (including Charles H. Ray and Alfred Cowles) took it over in 1855. After Medill gained control of the paper in 1874, he directed its destinies until his death 25 years later, making it a strong and successful paper.

A leading newspaper development of the 1870s was the rise of the *New York Sun* in prestige and influence. Purchased in 1868 by Charles A. Dana and associates, it soon became one of the best-written and edited papers in the country, independent in politics, bright and saucy, its human-interest stories of the great city one of its chief attractions. The *Evening Sun* was launched in 1887.

Notable in the 1870s also was the growing independence of the press from party control. Dating from the secession of Republican papers from the Ulysses S. Grant forces in 1872, what was sometimes called the "mugwump" movement gained in strength and caused the defeat of James G. Blaine in 1884. By 1880 one-fourth of American newspapers were listed in the directories as independent; by 1890 the proportion had reached one-third. By the 1950s one-half of the daily papers listed themselves as "independent" and another one-fourth as "independent Republican" or "independent Democratic."

11. The "New Journalism."—Joseph Pulitzer, Hungarian-born immigrant who had made a success of the *St. Louis Post-Dispatch*, which he had formed in 1878 of the unimportant *Dispatch* (founded 1864) and John A. Dillon's *Post* (founded 1875), upset the New York newspaper situation in the 1880s and did more than anyone else to set the pattern of modern journalism. In 1883 he bought the *New York World* and soon made it the country's most successful newspaper.

The *World* had been founded in 1860 by Alexander Cummings as a religious daily, but it did not flourish and soon came into the hands of Democratic politicians and financiers. In 1869 Manton Marble purchased majority control, and under his editorship the paper was influential and moderately successful. When he retired in 1876 the *World* came under the control of Thomas A. Scott of the Pennsylvania railroad, who unloaded it on Jay Gould in connection with a railroad deal. The paper had been losing $40,000 a year when Pulitzer bought it. The *Evening World* was established in 1887. The *Sunday World*, with a record-breaking circulation of 250,000, consisted of 26 to 44 pages, half advertising. The combined circulation of the dailies (374,000 by 1892) exceeded those of any two competitors. The *World* had become the most profitable paper published.

Other important New York papers in the 1870s and 1880s besides the *World, Sun* and *Daily News* were the *Herald*, under the control of James Gordon Bennett, Jr., 1872–1918, during which time he lived chiefly in Paris; the *Tribune*, under Whitelaw Reid, 1872–1905, which combined with the *Herald* to become the *Herald Tribune* in 1924; the *Evening Post*, under Edwin Lawrence Godkin, 1883–99; the *Times*, under George Jones, 1869–91; the *Commercial Advertiser*, descended from Noah Webster's *American Minerva*, under Hugh J. Hastings, 1868–83; and the *Mail and Express*, a consolidation formed by Cyrus W. Field in 1882 and edited and published in the 1880s by Elliott F. Shepard.

In Philadelphia a leading paper was the *Public Ledger*, published 1864–94 by George W. Childs. Later it came into the hands of Adolph S. Ochs, who sold it to Cyrus H. K. Curtis, the magazine publisher; Curtis made a great but unprofitable paper of it, and it perished in 1942. The *Record* was founded by William J. Swain in 1870 and published by William M. Singerly, 1877–98. It was published by Thomas B. Wanamaker, 1902–28, and by J. David Stern until it was sold to the *Bulletin* in 1947. The *Press* was founded in 1857 by John W. Forney, conducted in the 1880s by Charles Emory Smith and merged in the *Public Ledger* in 1920. The *Inquirer*, founded in 1829, was long conducted by Jesper Harding and his son William W., and later by the Elverson family; it was bought in 1936 by M. L. Annenberg. The *Times* was founded in 1875 by Alexander K. McClure, to become a great crusading paper. The *Evening Item*, founded in 1847 by Thomas Fitzgerald and conducted by him and his sons for nearly half a century, gained a large circulation. The *Evening Bulletin*, founded on the basis of the *American Centinel* (1816–46) by Alexander Cummings, was Philadelphia's first afternoon paper. In the 20th century, under William L. McLean and his sons, it gained the largest circulation in the city. At the end of 1957, with the purchase of the *Daily News* by the *Inquirer*, Philadelphia had morning and evening newspapers under one ownership.

In Washington, D.C., the *National Republican* (1860–88) was edited by W. J. Murtagh. The *Evening Star*, established in 1852, was purchased in 1867 by a group headed by Crosby S. Noyes and later conducted by his sons Frank B. and Theodore W. Noyes. The *Post*, founded by Stilson Hutchins in 1877, was edited by him until 1889. After a varied career, the *Post* was bought at auction in 1933 by Eugene Meyer, who made it again a successful newspaper.

In Boston the *Herald*, founded in 1846, was a leader under the editorship, 1862–87, of E. B. Haskell. In 1912 it bought the *Traveller*, founded in 1825, as its evening associate. The *Daily Advertiser*, founded in 1813, and made by Nathan Hale the first successful daily in New England, seemed moribund in the 1880s; but it lived to be made a tabloid by William Randolph Hearst in 1938, and later to become the *Sunday Advertiser*. The *Post*, founded by Charles G. Greene in 1831, also declined in the 1880s, but had a rebirth under Edwin A. Grozier in 1891. The *Journal* (1833–1917) was edited by W. W. Clapp in the 1880s in the sensational manner of the "new journalism." The *Transcript* (1830) was edited in this decade by Edward H. Clement; for many years it was the great newspaper organ of Boston culture, but it died in 1941. The *Globe* (1872) was highly successful under Gen. Charles H. Taylor and his son William O.

In Atlanta, Ga., Henry W. Grady in 1880 bought a quarter interest in the *Constitution* (1868) and as its managing editor made it a great newspaper; he died in 1889 and was succeeded by Clark Howell. In Louisville, Ky., Walter N. Haldeman consolidated the *Courier* and *Journal* in 1868, and put in charge Henry Watterson, who made the *Courier-Journal* famous and remained in service until 1919. In Cincinnati, Murat Halstead became editor of the *Commercial* (1843) in 1865; it became the *Commercial Gazette* when it was consolidated with the *Gazette* (1815) and Halstead sold it in 1890. John R. McLean took over the management of the *Cincinnati Enquirer* (1841) in 1870, and bought it from his father in 1881; in 1895 he bought also the *New York Journal* and in 1905 the *Washington Post*. Cincinnati's evening papers, the *Times* (1840) and the *Star* (1872), were merged in 1880 by Charles P. Taft and in 1958 was purchased by the Scripps-Howard chain. The great San Francisco paper of the period 1870–90 was the *Chronicle*, founded in 1865 by two brothers in their teens, Charles and Michel H. de Young; it was a lively, fighting paper, and Charles de Young was shot and killed in 1880 in connection with a political fight. The *Call* (1856) and the *Bulletin* (1855) were under the same management; much later (1928) they were consolidated by Hearst. The *San Francisco Examiner* (1865) was bought by George Hearst in 1880 to further his political ambitions. In 1965 the *Examiner* and the *News-Call Bulletin* were merged as an afternoon paper and consolidated, on a cost-sharing basis, with the morning *Chronicle*.

The great event in Chicago journalism in the post-Civil War period was the founding of the *Daily News* as a penny paper by Melville E. Stone in 1875. When the paper was on the verge of failure after a few months, Victor F. Lawson came in as partner, bringing needed capital. A liberal, crusading paper, the *Daily News* made a great success. In 1888 Stone sold out to Lawson, later becoming the first general manager of the re-

organized Associated Press. John S. Knight bought the paper in 1944, and it was sold to the *Chicago Sun-Times* in 1959. The *Herald* was founded in 1881 by James W. Scott, who combined it with the *Times* in 1895. The *Times-Herald* became the *Record-Herald* when Herman Kohlsaat, its owner since the consolidation, bought the *Record*, morning edition of the *Daily News*, in 1901 and made a new combination; after Kohlsaat's *Inter Ocean* (1872) was merged in the *Record-Herald* in 1914, it became the *Herald* again, but four years later Hearst bought it and merged it with his *Examiner* as the *Herald-Examiner*, later the *Herald-American* and still later as the *American*. In 1956 it was purchased by the *Chicago Tribune*.

In Kansas City, Mo., William Rockhill Nelson and Samuel E. Morss began the *Star* in 1880 as a small two-cent daily. Morss dropped out on account of ill-health after a year or two, but Nelson made the *Star* a strong, crusading local newspaper, adding a Sunday edition in 1894, buying the *Times* (1868) for its morning edition in 1901 and starting the *Weekly Star* as a farm paper in 1890. Nelson died in 1915 and staff members bought the paper for $11,000,000. Henry J. Haskell was editor 1928–52.

12. Yellow Journalism.—William Randolph Hearst's first paper was the *San Francisco Examiner*, which his father, George Hearst, turned over to him. Successful in his management of that paper, he went to New York in 1895 and bought the *Journal*. With this paper he challenged the supremacy of Pulitzer's *World* in New York. Some of his staff he brought from San Francisco and some he hired away from the *World*. He outdid his rival in sensationalism, crusades and Sunday features. A comic picture series called "The Yellow Kid" was drawn by Richard F. Outcault for the *Sunday World* and later for the *Sunday Journal*, but after the departure of the originator to the rival paper it was drawn by George B. Luks for the *World;* these picture series excited so much attention that the competition between the two newspapers came to be called "yellow journalism." This all-out rivalry and its accompanying promotion developed large circulations for both papers and affected U.S. journalism in many cities. The "yellow journalism" formula, as it developed, was distinguished by (1) "scare heads" in large type, printed in black or red; (2) lavish use of pictures; (3) pseudoscientific articles; (4) the Sunday supplement, with coloured comics and sensational features; (5) ostentatious crusading for popular causes. The era of "yellow journalism" may be said to have ended shortly after the turn of the century, with the *World's* gradual retirement from the competition in sensationalism and the rise of the *Times*.

One of the phenomena of the era was the promotion of the war with Spain through hysterical propaganda against that nation based on exposures of Spanish atrocities in Cuba. This jingoism was not limited to the *Journal* and *World*, though they were leaders in it. Some techniques of the "yellow journalism" period became more or less permanent and widespread, as banner headlines, coloured comics and copious illustration.

Adolph S. Ochs, publisher of the *Chattanooga* (Tenn.) *Times*, took over management of the failing *New York Times* in 1896. In 1898 Ochs reduced the price of the paper to one cent. Instead of getting into the "yellow" competition, the *Times* adopted the slogans "All the news that's fit to print" and "It does not soil the breakfast cloth." Ochs, who had actually put in only $75,000 in 1896, had a controlling interest by 1900. The *Times's* success as a clean, conservative newspaper was one of the most striking phenomena of the new century.

13. "Chains" and Consolidations.—If a newspaper "chain" is defined to include affiliations formed by coöperation rather than common ownership, the groups of colonial papers of which Benjamin Franklin and Isaiah Thomas were patrons and sometimes part owners might be said to be the first American chains. But modern chains began with the Scripps papers in 1878. By 1900 eight such groups could be listed; by 1910 there were a dozen and the number of papers in them had doubled. In the next decade the number of chain papers doubled again; and in the 1920s the number of chains reached more than 50, and the number of papers in them about 300. In the 1960s there were more than 100 chains—owners of about one-third of the nation's 1,700 dailies.

The first paper founded by E. W. Scripps (with assistance from his half brothers James E. and George) was the *Cleveland Press*, begun in 1878 as a penny paper. Successful there, he persuaded his half brothers to buy the *St. Louis Chronicle* (1880–1905), with which he failed to overcome the dominant competition of the *Post-Dispatch* and *Globe-Democrat*. A little later he bought a controlling interest in the *Cincinnati Post* (purchase of the *Times-Star* and merging of it with the *Post* in 1958 gave the Scripps-Howard chain control of all daily papers) and founded the *Kentucky Post* at Covington. By this time he had developed his formula: establish papers in medium-sized cities, put young men from his organization in charge with working partnerships, sell for a penny a copy and campaign for popular causes. With Milton A. McRae as partner in the Scripps-McRae league, he bought or founded many papers in the midwest in the years 1897–1911. McRae dropped out in 1914, and in 1917 Scripps placed management in the hands of two sons, James G. and Robert P. Scripps. Three years later, James was supplanted by Roy W. Howard, who had been general manager of the United Press associations, founded in 1907 as the Scripps news-gathering agency.

In 1922 E. W. Scripps retired completely, turning over his newspaper properties to his son Robert, who formed the organization known as Scripps-Howard. Chief Scripps-Howard additions to the chain in the 1920s were the *Pittsburgh Press* (1884) in 1923 and *New York Telegram* (1868) in 1927. Most important of all was the purchase of the *New York World* in 1931, and its merger with the *Telegram*. To this combination the *Sun* was added in 1950. In 1966 the *World-Telegram and Sun*, the *Journal-American* (1937) and the *Herald Tribune* (1924) were merged, by corporate agreement among the three owners (Scripps-Howard, Hearst and John Hay Whitney, respectively), to become an afternoon and Sunday paper, the *World Journal Tribune*. This paper, however, ceased publication in 1967.

The Hearst chain began with the *San Francisco Examiner* and the *New York Journal* and *Evening Journal*. In 1900 Hearst founded the *Chicago American*, in 1902 the *Examiner* and in 1904 the *Boston American*. Beginning in 1917, he added many more papers to his list, buying as many as seven in one year (1922). He bought or established altogether more than 40 daily papers, 16 of which he owned at the time of his death in 1951.

Though the Scripps and Hearst chains were the largest of such systems, there were many other groups, such as the Booth newspapers in Michigan, founded by George C. Booth; the Brush-Moore newspapers in Ohio, founded by Louis H. Brush and Roy D. Moore; the Lee syndicate in the upper Mississippi valley, founded by Alfred W. Lee; the Copley Press in Illinois and California, founded by Ira C. Copley; the nationwide Speidel newspapers, founded by Merritt C. Speidel; the Frank E. Gannett newspapers, chiefly in New York; the James M. Cox newspapers at Dayton and Springfield, O., Miami, Fla., and Atlanta, Ga.; Central newspapers, founded by E. C. Pulliam, chiefly in Indiana; the H. C. Ogden newspapers in West Virginia; the John H. Perry newspapers, chiefly in Florida; Stauffer publications, Oscar Stauffer president, in Kansas, Missouri and Oklahoma; Ridder publications, built up by the sons of Herman Ridder in New York, Minnesota and on the west coast; the Knight newspapers, owned by John S. Knight, comprising the *Chicago Daily News* (sold in 1959 to the Field Enterprises, publisher of the *Chicago Sun-Times*), the *Detroit Free Press*, the *Miami* (Fla.) *Herald*, the *Akron* (O.) *Beacon Journal* and the *Charlotte* (N.C.) *Observer*; and the group rising in the 1950s under the direction of S. I. Newhouse, including the *St. Louis Globe-Democrat*, the *Portland Oregonian*, the *Syracuse* (N.Y.) *Post-Standard* and the *Birmingham* (Ala.) *News*.

Consolidations, like chains, were not new in modern journalism. Ever since the consolidation of the *New-England Weekly Journal* with the *Boston Gazette* in 1741, weak papers had been absorbed by strong ones. But the large newspaper capital investments which, beginning in the 1890s, came to characterize the newspaper business of the 20th century made the merger a recognized technique for "cleaning up" a ruinous competitive situation. Especially dangerous, it seemed to critics of the modern communications

system, was the increasing number of large cities with only one newspaper ownership; by 1940 this was the case in more than one-fourth of U.S. cities of more than 100,000 population. Moreover, the number of daily newspapers in the United States declined from a peak of 2,519 in 1916 to 1,850 in 1945. Slight increases marked the latter half of the 1940s, but in 1955 the total was 1,841. In 1963 the total was 1,854. (These figures are from N. W. Ayer and Son's *Directory of Newspapers and Periodicals*; see *Bibliography*.)

Newspaper consolidation was dramatized about 1920 by Frank A. Munsey's activities. In 1916 Munsey bought the *New York Sun, Evening Sun* and *Press* and merged the *Press* in the *Sun*. Four years later he bought the *Herald* and its evening associate, the *Telegram*, and merged the *Sun* in the *Herald*, changing the name of the *Evening Sun* to *Sun*. His next move was to sell the *Herald* to the *Tribune* for another merger in 1924. Then he bought the *Globe*, which had been merged with the *Commercial Advertiser* in 1905, and merged it with the *Sun*. His last consolidation was that of the *Mail and Express* and the *Telegram* in 1924.

14. Varied Newspapers.—The *St. Louis Globe-Democrat* had been formed when J. B. McCullagh in 1875 bought the *Missouri Democrat* (founded 1852) and merged it with his *Globe* (founded 1872). The *St. Louis Star-Times* was formed in 1935 by the consolidation of the *Star* (founded 1878), which had absorbed the *Chronicle* (1905), and the *Times* (founded 1895). It was merged with the *Post-Dispatch* in 1951.

The Denver *Post*, founded in 1892, was purchased three years later by Fred G. Bonfils and Harry H. Tammen and made an outstanding exemplar of the "yellow journalism" of the period. Tammen died in 1924 and Bonfils in 1933; in 1946 Palmer Hoyt became publisher, modifying the policy of the paper. Edgar Watson Howe founded the *Atchison* (Kan.) *Globe* in 1877, and made it a widely quoted paper. Another famous editor in a small Kansas city was William Allen White, who bought the *Emporia Gazette* when it was five years old in 1895 and soon achieved national fame through his editorial writings.

The *Christian Science Monitor* was established in Boston by Mrs. Mary Baker Eddy in 1908. A handsome and high-minded general newspaper, it fought "yellow journalism" and emphasized international news The *Des Moines Register* was begun in 1856 as the *Iowa Citizen*, a Free Soil paper. From 1870 to the end of the century the *Register* was published by Coker F. Clarkson, followed by his two sons; in 1902 it absorbed the *Leader*, which had been begun as the *Iowa Star*, Des Moines's first newspaper, in 1849. The next year the combined paper was bought by Gardner Cowles, who in 1908 gave it the two-year-old *Tribune* as an evening associate. Following the retirement of Cowles, the *Register* and *Tribune* were conducted by his sons John Cowles and Gardner Cowles, Jr., who in 1935 purchased the *Minneapolis Star* and later the *Journal* and *Tribune* of that city. In 1949 the Minneapolis papers were reduced to two—the *Tribune* for morning and the *Star* for afternoon.

The *New Orleans Times-Picayune* was a combination of the two papers of that city which survived the Civil War period—the famous old *Picayune* and the *Times-Democrat* (founded 1863 1875; merged 1881). The *States* became its evening associate in 1933. The *Item* (1877) and *Tribune* (1924) were sold in 1949 to David Stern, son of the former publisher of the *Philadelphia Record*. In 1958 the *Item* was merged with the *States*, the merger being jointly owned by the *Times-Picayune*. The *Washington* (D.C.) *Times-Herald* was formed in 1939 when Mrs. Eleanor Patterson, granddaughter of Joseph Medill, bought the two papers from Hearst. The *Herald* had been founded in 1906 by Scott C. Bone, who had been managing editor of the *Washington Post*; the *Times* (1894) had been under Munsey ownership 1901–17. Mrs. Patterson left the *Times-Herald* to seven executives of the paper on her death in 1948; but the next year they sold it to Robert R. McCormick, publisher of the *Chicago Tribune*. It was merged with the *Post* in 1954.

15. The Tabloid.—The earliest American newspapers were all tabloids, if by that term only the small size of the pages is meant. The experimental Jan. 1, 1900, issue of the *New York World*, designed and edited by Alfred Harmsworth (later Viscount Northcliffe) and called by him a "tabloid newspaper" and "the newspaper of the 20th century," had the small page size and an emphasis on condensation. Tabloid journalism had come to stand for three techniques by the 1940s: (1) the folded-in-half page size, as compared with that of the normal eight-column paper; (2) the devotion of a large proportion of the paper's space to pictures; and (3) a terse, condensed and lively presentation of the news.

Two grandsons of Joseph Medill, Robert R. McCormick and Joseph Medill Patterson, took over jointly the management of the *Chicago Tribune* in 1914. Five years later they formed a subsidiary of the Tribune company to publish the *New York Daily News* as a new morning tabloid. In 1925, when the paper had reached nearly 1,000,000 circulation—largest in the U.S.—Patterson left his executive position on the *Tribune* and until his death in 1946 devoted himself to the management of the *Daily News*.

The sensationalism of the *Daily News* in the 1920s brought it into competition with Hearst's morning *American*, and Hearst first tried out the form in Boston by "tabbing" the *Daily Advertiser* and then founded the tabloid *Daily Mirror* in New York in 1924. Three months later Bernarr Macfadden began the *Daily Graphic* in the same form. Thus began the "war of the tabs" in New York, in which the three competitors tried to outdo each other in sensationalism. The *Graphic* perished in 1932, to be revived in 1955; the *Daily News* cleaned up its columns and prospered, and Hearst sold the *Mirror* in 1928. Later Hearst had to take the *Mirror* back and it went on to a 1,000,000 circulation by 1950—second only (among American dailies) to the 2,250,000 of the *Daily News*. Both these circulations declined somewhat in the later 1950s. The circulation of the *Mirror* continued to decline and in 1963 it ceased publication; the *Daily News* purchased its assets. Meanwhile, the success of the leaders among the tabloids had tempted publishers of dailies in other cities to try that form; there were about a dozen U.S. tabloids in 1930, 50 in 1940, 70 in 1950 and about the same number in the 1960s. Most important, besides those mentioned above, were the *Washington News* (1921), the *Philadelphia News* (1925), the *Chicago Times* (1929; later the *Sun-Times*), the *Denver Rocky Mountain News* ("tabbed" 1948), the *Los Angeles Mirror* (begun in 1908 as a tabloid, to become the standard-size morning edition of the *Times* in 1954) and the *New York Post* (the old *Evening Post*, "tabbed" in 1942).

16. Two World Wars.—There were comparatively few U.S. correspondents abroad when World War I broke out in Aug. 1914, and those who were rushed across found themselves hampered on all fronts by censorship. After the arrival of the American expeditionary force in 1918, several hundred U.S. newspaper, magazine and agency men covered the war in various foreign centres and on the several military fronts.

Censorship at the fronts, though often severe and stupid in the early years of the war, was somewhat more tenable after the arrival of the A.E.F. Maj. Frederick Palmer, Associated Press and magazine correspondent, wrote the section of the U.S. field service regulations dealing with war correspondents and was himself chief American censor for six months. Within the United States more than 75 papers had their mailing privileges withdrawn under the terms of the Espionage act. The German-language press declined about one-half. The Committee on Public Information, George Creel, chairman, participated in both propaganda and censorship, and presented to U.S. papers a "voluntary censorship" code.

Most famous of the many camp and field newspapers published by and for U.S. soldiers during World War I was *Stars and Stripes*, continued for 16 months from Feb. 1918.

When the United States entered World War II in Dec. 1941, there were more than 200 U.S. reporters gathering news abroad, mostly in belligerent countries. By the spring of 1943 the number had risen to 435. The U.S. war department accredited during the entire war, for longer or shorter periods, 1,186 American correspondents and news officials, representing all mediums, and

the navy department 460 more. Besides the press associations, 30 individual newspapers and 12 magazines had their own correspondents at the war fronts. Photographers played a far larger part in war reporting than ever before. Most famous of war pictures was that of a flag raising at Iwo Jima in Feb. 1945, taken by Joseph Rosenthal of the Associated Press. Most famous of war correspondents was Ernest Taylor ("Ernie") Pyle, who wrote from England, north Africa, Sicily, Italy, France and the Pacific; he was killed on Ie Shima in the Okinawa campaign. Casualties among writers, photographers and radiomen covering the war numbered 37 killed and 112 wounded, exclusive of combat correspondents. Among the best-known writers who perished were Raymond Clapper of Scripps-Howard Newspaper alliance and Webb Miller of the United Press.

The U.S. Office of Censorship, with Byron Price as director, was created Dec. 19, 1941, and lasted throughout the war. It promulgated the "Code of Wartime Practices for the American Press," which formed the basis for a remarkable co-operative self-censorship. Field censorship on the war fronts varied greatly in efficiency and reasonableness. A number of home periodicals were suppressed, chiefly after convictions of publishers and editors under the Foreign Agents' Registration act. The Office of War Information, with Elmer Davis as director, was set up on June 13, 1942, and handled an immense amount of news and propaganda at home and abroad.

Thousands of army unit, camp and installation, ordnance plant and combat ship papers served the American soldiers in World War II. Of this "G.I. journalism," *Stars and Stripes* was the chief daily newspaper and *Yank* the chief magazine. The former was reborn in London in April 1942 and was later printed in many editions on various fronts. *Yank* was begun about the same time in New York, and came to have 22 editions and a circulation of about 2,500,000. Altogether there were said to be about 600 army unit papers and twice that many camp papers in the United States.

The war of 1950–53 in Korea was thoroughly covered by correspondents of American newspapers and news services. In the first year 320 newsmen, serving all communication agencies, were at the front for varying periods. Nine correspondents were killed and many wounded and taken prisoner.

17. Marshall Field's Newspapers.—The New York tabloid *PM* was founded in 1940 by Ralph Ingersoll and associates as an ad-less daily of liberal opinions. Marshall Field III had some money in it at the start and later increased his holdings to a controlling interest. Sold in 1948, its name was changed to the *Star*, but it perished the next year. Ted O. Thackrey, former editor of the *Post*, founded the *Daily Compass* in 1949 with the financial backing of Mrs. Anita McCormick Blaine, publishing from the *Star's* former plant.

Marshall Field III founded the *Chicago Sun* in 1941 as a competitor for the *Tribune* in the morning field. Six years later he bought the *Times*, evening tabloid, and "tabbed" the *Sun;* in 1948 the two papers were combined as the *Sun-Times* with round-the-clock publication (since 1950, morning only). In its competition with the *Tribune*, the *Sun* felt the lack of an Associated Press membership, which it did not obtain until the government had brought suit against the A.P. for violation of the Sherman Anti-Trust act. This suit, instituted in 1942, was decided in favour of the government in 1945 and caused the A.P. to amend its rules to forbid the "blackballing" of competitors. In 1959 Field Enterprises bought the *Chicago Daily News*.

18. American Newspaper Guild.—The American Newspaper guild was organized in 1933 "to preserve the vocational interests of its members and to improve the conditions under which they work by collective bargaining, and to raise the standards of journalism." First contract negotiated was with the *Philadelphia Record*. In 1936 the guild affiliated with the American Federation of Labor, and the next year with the Committee for Industrial Organization. By mid-century it had 23,000 members and had contracts in force on about 175 dailies and several independent newspapers, as well as on other periodicals and with the news-gathering agencies. There were many strikes, some of which forced suspension of newspapers. One of the strikes, called by the International Typographical union (organized 1850) against the Chicago papers on Nov. 24, 1947, lasted 22 months. The papers resorted to "cold type" production methods, printing from plates made directly from typewritten ("varityped") copy.

19. Circulations and Profits.—In the 1950s the aggregate circulation of English-language dailies increased steadily, passing the 58,000,000 mark in 1959. Advertising business also increased, especially in the mid-1950s. It was estimated that in the years 1947–54 daily newspaper income increased over 100%. At the same time, however, costs rose more than 133%, thus greatly diminishing the margin of profit. Most dailies increased the price per copy to five cents, some to seven and a few to ten.

20. Weekly Newspapers.—Though the urban shift which began after the Civil War tended to highlight the metropolitan daily with its large circulation and fast service, the weekly newspaper of the small towns remained a powerful influence on the lives and thinking of a large part of the population of the U.S. The number of these community papers increased 1870–90 from fewer than 4,000 to about 12,000; the peak was reached in 1914 at 14,500, but consolidations reduced the number to about 10,000 shortly after mid-20th century. From the handwork of 1900, with much dependence on ready-printed sheets, the community weekly developed into a machine-set, power-driven operation, with strong emphasis on community service. In 1953 the Western Newspaper Union, which had furnished "ready prints" to weeklies since 1880, discontinued that service.

Nearly half the population increase of the 1940s took place in the suburbs of the metropolitan areas. This residential movement caused a shift in types of newspapers serving the newly populous centres. Two types grew up rapidly: the "middle-size" dailies, which served sizable suburbs or groups of suburbs (typical of these was *Newsday*, Garden City, Long Island); and the neighbourhood weeklies, often associated in groups. The latter type was by no means limited to suburban centres; it was found singly in small cities and made its most spectacular showing in groups in residential areas of Chicago and Philadelphia.

21. Foreign-Language Newspapers.—Benjamin Franklin was publisher of the first foreign-language newspaper in what is now the United States. It bore the title *Philadelphische Zeitung*, but it published only two issues, in 1732. Most notable of this class in the 18th century was Christopher Sauer's paper published 1739–78 under various titles but most prominently as the *Germantowner Zeitung*. The first daily in a foreign language was *Courrier Français* of Philadelphia, which supported the French cause in America in 1794–98. The phenomenal growth of the foreign-language press, however, waited upon the great waves of immigration, especially those from Germany. In 1830–60 German papers were founded in nearly all the states; and French, Italian, Spanish, Dutch, Swedish, Norwegian and Welsh languages were represented. By 1860 nearly 10% of the country's papers were in foreign languages, and two-thirds of these were in German. *New Yorker Staats-Zeitung*, foremost of them, was founded by Jacob Uhl in 1834 and was later conducted through successive periods by Oswald Ottendorfer and Herman Ridder. Though the foreign-language press reached its peak in the first decade of the 20th century, it declined relative to the growth of English-language papers in the United States after about 1880. Two world wars served to destroy the major prosperity of the foreign-language press. There were 140 dailies (about one-third German) in 1914; a decade after the end of World War II there were 76 (4 of them German, 12 Chinese). At the latter date 35 languages were represented.

22. The Negro Press.—The first Negro newspaper was *Freedom's Journal*, conducted in New York in 1827 by Samuel Cornish and John B. Russwurm. Like all Negro journals published before the Civil War (about 24 in number), this paper devoted a short life to the antislavery cause. The most important paper conducted by a Negro in the years after the war was the *New York Age*, founded in 1879 by the poet and essayist T. T. Fortune under the name of the *Globe*. In the 1950s it was for a time called the *New York Age-Defender* and was subsequently absorbed in the New York edition of the *Courier*.

In the 1960s there were about 90 Negro weeklies and semi-weeklies (excluding religious and other special interest papers) and two dailies, the *Atlanta World* (1928) and the *Chicago Daily Defender* (1956). The circulation of both dailies was about 30,-000. Circulation leaders among the weeklies included the *New York Amsterdam News* (1909), about 60,000; the *Courier* (1910), with headquarters in Pittsburgh, Pa., and 12 other editions throughout the U.S., with a total circulation of about 77,000; and in the 30,000–40,000 circulation range, the *Baltimore Afro-American* (1892), the *Michigan Chronicle*, Detroit (1936), the *Norfolk* (Va.) *Journal and Guide* (1901), and the weekly edition of the *Chicago Defender* (1905).

23. **Appraisals of the Press.**—Since the hostile criticism of the first American newspaper, *Publick Occurrences*, there has been a fairly steady stream of criticism of newspapers in books, magazines, public speeches and the newspapers themselves. These criticisms, by such men as Charles Dickens, James Fenimore Cooper, Lambert A. Wilmer, David G. Croly, Edwin Lawrence Godkin, Oswald Garrison Villard, George Seldes, Silas Bent, Harold L. Ickes and Herbert Brucker, have ranged from angry invective to sober appraisal, from personal or partisan motivation to the scholarly and sociological attitude. Perhaps the most important investigation was undertaken by the Commission on Freedom of the Press headed by Robert M. Hutchins, then chancellor of The University of Chicago. The commission's report, *A Free and Responsible Press* (1947), restated the principles of press freedom, emphasized dangers of mass publication and monopolistic control and made a series of recommendations, among them creation of an agency independent of press and government to appraise and report to the public on press performance. (F. L. Mt.)

II. UNITED KINGDOM

1. **Beginnings.**—Certain pamphlets may be taken as predecessors of the English newsbooks. *Newes Concernynge the General Councell Holden at Trydent* (Thomas Raynalde, London, 1549), a translation from the German, was one of the earliest. They dealt with political matters, murders, wonders, etc., and were commonly published some time after the events they chronicled. They were not so much budgets of news as "relations" of a single event and matters connected with such an event. As a type they were modeled upon continental (especially German and Dutch) newsbooks, of which they were sometimes translations or adaptations. The German compilations of a half-year's events, called *Messrelationen* because they were sold at the fairs, influenced later periodical development and were significant for England. Such a compilation in Latin by Micael ab Isselt, entitled *Mercurius Gallobelgicus*, continued 1594–1635, was widely popular in England, and brought the name "mercury" into use for newsbooks; some of the later issues were translated into English.

Doubtless under the influence of the *Messrelationen*, briefer compilations, many of which were translated or adapted for English readers, appeared from 1590 onward. When English editors took over the idea of the news budget in 1621, the publications were commonly called "corantos" to indicate running news. The first English-language corantos were, however, small single-sheet (two-page) publications, and they were published in the Netherlands from Dec. 1620 to Sept. 1621. George Veseler published 15 of them and Broer Jonson 6 or 8 in Amsterdam; others were issued in Alkmaar and The Hague. Apparently the next step was the publication of the same type of coranto in London in Sept. 1621, under the title *Corante, or, Weekely Newes From Italy, Germany, Hungarie, Spaine and France*. Six of these were issued "for N. B." with slight variations in title through September and October. The title is nearly enough identical, and the weekly periodicity (though actually irregular) clear enough in intention, to support the claim for this series as the first English newspaper. "N. B." was probably Nicholas Bourne. The sheets were translations of Dutch or German corantos.

The next year the single-sheet corantos gave place to those in pamphlet form; and comparative regularity in periodicity, if not in title, came with the *Weekly Newes*, issued by Nicholas Bourne and Thomas Archer beginning in May 1622. This series was generally referred to as composing the "first English newspaper" before the discovery in 1912 of the single-sheet corantos by "N. B." Continuity was by dates rather than identical title; for several years most coranto publishers depended upon changing headlines to sell their product and avoided identical titles. On Aug. 2, 1622, Nathaniel Butter began a *Newes*, "all of which do carry a like title . . . and have dependence upon one another" (Aug. 23). Butter became the most famous of the coranto publishers who flourished in the 1620s. In Oct. 1622, with Bourne and William Sheffard, Butter began *A Coranto*, with the introduction of serial numbering. In 1625 Archer founded *Mercurius Britannicus*, which probably lasted till the end of 1627. Butter and Bourne remained principal publishers of the corantos of various series until 1632, when all were suppressed because the Spanish ambassador had been offended by news they had published regarding the royal house of Austria. For six years thereafter there were no newsbooks in England, but in 1638 Butter and Bourne were given exclusive patent for publication of foreign news.

2. **Freedom and Censorship.**—The next step in the evolution of the newspaper was due to the abolition of the Star Chamber in 1641, and the consequent freeing of the press; and at last the English periodical with domestic news arrived. In Nov. 1641 began *The Head of Severall Proceedings in the Present Parliament* (outside title) or *Diurnal Occurrences* (inside title), the latter being the title under which it was soon known as a weekly; and on Jan. 31, 1642, appeared *A Perfect Diurnal of the Passages in Parliament*. These were printed for William Cooke, and were written apparently by Samuel Pecke, "the first of the patriarchs of English domestic journalism" (J. B. Williams). The weekly *Diurnals* were on the side of the parliament until in Jan. 1643 appeared at Oxford the first royalist diurnal, named *Mercurius Aulicus, a Diurnal Communicating the Intelligence and Affaires of the Court to the Rest of the Kingdome* (continued till Sept. 1645, and soon succeeded by *Mercurius Academicus*), which struck a higher literary note. It was conducted by Sir John Berkenhead, a fellow of All Souls, whose style is said to reflect that of the parliamentary oratory of his day. He afterward became master of requests. *Mercurius Civicus*, the first regularly illustrated periodical in London, was started by the parliamentarian Richard Collings on May 11, 1643 (continued to Dec. 1646); Collings had also started earlier in the year the *Kingdome's Weekly Intelligencer*, which lasted till Oct. 1649. In Sept. 1643 appeared another puritan opponent of *M. Aulicus* in the later *Mercurius Britannicus* of Capt. Thomas Audley, which in Sept. 1644 was taken over and continued for nearly two years by Marchamont (or Marchmont) Nedham. Nedham was a master of invective and one of the earliest to change sides when it suited him. From Oct. 1649 to June 1650, by a new act of parliament, the licensed press itself was entirely suppressed, and in 1649 two official journals were issued, *A Brief Relation* (up to Oct. 1650) and *Severall Proceedings in Parliament* (till Sept. 1655), a third licensed periodical, *A Perfect Diurnall* (till Sept. 1655), being added later in the year and a fourth, *Mercurius Politicus* (of which John Milton was the editor for a year or so and Nedham one of the principal writers), starting on June 13, 1650 (continuing till April 12, 1660). After the middle of 1650 there was a revival of some of the older licensed newsbooks; but the *Weekly Intelligence of the Commonwealth* (July 1650 to Sept. 1655) by R. Collings was the only important newcomer up to Sept. 1655, when Oliver Cromwell suppressed all such publications with the exception of *Mercurius Politicus* and the *Publick Intelligencer* (Oct. 1655 to April 1660), both being official and conducted by Nedham.

Till Cromwell's death (Sept. 3, 1658) Nedham reigned alone in the press, but in 1659 a rival appeared in Henry Muddiman (a great writer also of "newsletters"), whose *Parliamentary Intelligencer*, renamed the *Kingdom's Intelligencer* (till Aug. 1663), was supported by Gen. George Monk. Nedham's journalistic career came finally to an end (he died in 1678) at the hand of Monk's council of state in April 1660. His successor, Muddiman, was supplanted in 1663 by Sir Roger L'Estrange, formerly a royalist cavalry officer who narrowly escaped execution during the

Commonwealth; he was appointed "surveyor of the press." On him was conferred by royal grant—as it proved, for only a short period—"all the sole privilege of writing, printing and publishing all narratives, advertisements, mercuries, intelligencers, diurnals and other books of public intelligence; . . . with power to search for and seize the unlicensed and treasonable schismatical and scandalous books and papers." L'Estrange discontinued *Mercurius Politicus* and *Kingdom's Intelligencer* and substituted two papers, the *Intelligencer* (Aug. 1) and the *Newes* (Sept. 3), at a halfpenny, the former on Mondays and the latter on Thursdays; they were continued till Jan. 29, 1666.

3. The London Gazette.—The first number of the biweekly *Oxford Gazette*, licensed by Lord Arlington and written by Muddiman, was published on Nov. 16, 1665. With the publication of the 24th number (Monday, Feb. 5, 1666, old style) the *Oxford Gazette* became the *London Gazette*, which has appeared twice a week, on Tuesdays and Fridays, ever since as an official organ of the government. After the revolution of 1688 the press censorship was relaxed, being finally abandoned in 1693, and a number of newspapers came into being. *Worcester Post Man* (later *Berrow's Worcester Journal*) was the oldest of the provincial papers, having been founded in 1690. In 1699 appeared the *Edinburgh Gazette*, a biweekly. Elizabeth Mallet published the first English daily newspaper, *The Daily Courant*, on March 11, 1702. She abandoned the paper after the first nine issues but it was resumed a month later by Samuel Buckley.

4. The 18th Century.—Daniel Defoe was the first English journalistic writer of national importance. In Feb. 1704 he began his weekly, the *Review*, which eventually was printed three times a week and was a forerunner of the *Tatler* (started by Sir Richard Steele in 1709) and the *Spectator* (started by Steele and Joseph Addison in 1711). Defoe's *Review* came to an end in 1713, and between 1716 and 1720 he published a monthly with an old title, *Mercurius Politicus*.

The *Examiner*, started in 1710 as the chief Tory organ, enjoyed as its most influential contributor Jonathan Swift, the father of the leading article. Swift had control of the journal for 33 numbers between Nov. 1710 and June 1711, but on becoming dean of St. Patrick's he gave up regular journalistic work.

In 1696 Edward Lloyd—the virtual founder of the famous "Lloyd's" of commerce—started a thrice-a-week paper, *Lloyd's News*, which had but a brief existence in its first shape, but was the precursor of the modern *Lloyd's List*. No. 76 of the original paper contained a paragraph referring to the house of lords, for the appearance of which a public apology must, the publisher was told, be made. He preferred to discontinue his publication (Feb. 1697). In 1726 he in part revived it, under the title of *Lloyd's List*—published at first weekly, afterward twice a week. It later became a daily.

The increasing popularity and influence of the newspapers could not fail to be distasteful to the government of the day. The paper which seems to contain the first germ of the newspaper tax is still preserved among the treasury papers, and probably belongs to the year 1711. The duty eventually imposed (1712) was a halfpenny on papers of half a sheet or less, and a penny on such as ranged from half a sheet to a single sheet.

Swift's doubt, expressed in his *Journal to Stella* (Aug. 7, 1712), as to the ability of the *Spectator* to hold out against the tax was justified by its discontinuance in Dec. 1712, Steele starting the *Guardian* in 1713, which only ran for six months. But some of the worst journals that were already in existence kept their ground, and their number soon increased. Part of this increase may fairly be ascribed to political corruption. Later, toward the middle of the same century, the provisions and the penalties of the Stamp act were made more stringent. Yet the number of newspapers continued to rise. In 1753 the aggregate number of copies of newspapers annually sold in England, on an average of three years, amounted to 7,411,757. In 1760 it had risen to 9,464,790, and in 1767 to 11,300,980. In 1776 the number of newspapers published in London alone had increased to 53.

Thus the 18th century saw the gradual development of the purely political journal side by side with those papers which were primarily devoted to news, domestic and foreign, and commerce. It was left to Steele and Addison to develop the social side of journalism in their journals named above. Nor can Samuel Johnson's twopenny biweekly, the *Rambler*, started in 1750, and his weekly, the *Idler* (1758), be omitted. In 1762 the *North Briton* came out and it was largely as a result of John Wilkes's (*q.v.*) determined fight for the liberty of the press that at length the last shackles on free expression of opinion in Britain were cut away.

During the 18th century the epithet "grub street" for literary hackwork originated. According to Samuel Johnson's *Dictionary*, Grub street was "originally the name of a street near Moorfields, in London, much inhabited by writers of small histories, dictionaries, and temporary poems, hence any mean production is called *grubstreet*."

The outstanding daily paper in the middle of the 18th century was the *Public Advertiser*, which for about 25 years had been called the *General Advertiser* (and for some time the *London Daily Post*). It was published with notable success by Henry Woodfall and his son Henry Sampson Woodfall, and it was in this paper that the famous letters of Junius (*q.v.*) appeared. These papers led to a marked increase in its circulation, the monthly sale in Dec. 1771 being almost 84,000 as compared with 47,500 seven years previously. But in 1798 it was merged in the *Public Ledger*.

5. Early 19th Century.—In 1769 William Woodfall started the *Morning Chronicle*, whose daily circulation in 1819 reached 4,000, and in 1843, at a time when Charles Dickens was a contributor, 6,000. But in another six years the circulation had fallen to 3,000. For about five years it became the property of the duke of Newcastle, William Gladstone and others, but finally ended insolvent, after a life of more than 90 years. Another long-lived daily paper, whose top circulation was about 6,000, was the *Morning Herald* (1781–1869). It was William Cobbett who first attempted to reach the masses by his pen, and reduced the price of his *Weekly Political Register* from 1*s.* ½*d.* to twopence in his endeavour to appeal to the working classes for support of those principles of parliamentary reform dear to his heart. In 1808 Leigh Hunt brought out the *Examiner*, whose frank criticism of the prince regent landed him and a brother in prison.

The development of the press was enormously assisted by the gradual abolition of the "taxes on knowledge," and also by the introduction of a cheap postal system. In 1756 an additional halfpenny was added to the tax of 1712. In 1765 and in 1773 various restrictive regulations were imposed. In 1789 the three halfpence was increased to twopence, in 1798 to twopence-halfpenny in 1804 to threepence-halfpenny and in 1815 to fourpence, less a discount of 20%. As prosecutions multiplied, and the penalties became more serious, revolutionary tendencies increased in a still greater ratio. Blasphemy was added to sedition. Penny and halfpenny journals were established which dealt exclusively with narratives of gross vice and crime. Between 1831 and 1835 hundreds of unstamped newspapers made their appearance. The political tone of most of them was fiercely revolutionary. Prosecution followed prosecution, but all failed to suppress the obnoxious publications.

To Lord Lytton, the novelist and politician, and subsequently to Milner Gibson and Richard Cobden, is chiefly due the credit of grappling with this question in parliament to secure first the reduction of the tax to a penny in 1836, and then its total abolition in 1855. The number of newspapers established from the early part of 1855, when the repeal of the duty had become a certainty, and continuing in existence at the beginning of 1857, amounted to 107; 26 were metropolitan and 81 provincial. The duties on paper itself were finally abolished in 1861.

The abolition of the stamp taxes brought about such reductions in the prices of newspapers that they speedily began to reach the many instead of the few. Some idea of the extent of the tax on knowledge imposed in the early 19th century may be gathered from the fact that the number of stamps issued in 1820 was nearly 29,400,000, and the incidence of the advertisement tax fixed at 3*s.* 6*d.* in 1804, made it impossible for the newspaper owner to pass on the stamp tax to the advertiser. In 1828 the proprietors of *The Times* had to pay the state more than £68,000

in stamp and advertisement taxes and paper duty. But after the reduction of the stamp tax in 1836 the circulation of English newspapers rose from 39,000,000 to 122,000,000 in 1854.

6. The Growth of Parliamentary Reporting.—The first attempts to inform the public on what was being said and done in parliament were made by the *Gentlemen's Magazine* in 1736. As any reporting of the proceedings of the house was prohibited by a standing order of 1728, early reporters like Edward Cave (*q.v.*) could only take surreptitious notes; the published reports were written by another hand: by Dr. Johnson from 1740–43.

After a prosecution in 1771 the right of newspapers to publish parliamentary debates was never again challenged and early in the 19th century special galleries were provided for newspaper reporters. At first only *The Times* published full reports of the debates on the following day, but when the telegraphs were taken over by the state in 1870, the facilities for reporting were increased in every direction. News agencies began to supply identical accounts to provincial newspapers. Communications between the press gallery and the newspaper office were further developed when in 1951 *The Times* introduced remote-control typesetting of dispatches from the palace of Westminster.

7. London Morning Papers.—*The Times* was started by John Walter on Jan. 1, 1785, under the name of the *Daily Universal Register*. When it first appeared the *Register* was nothing more than a $2\frac{1}{2}d.$ broadsheet whose main function was to advertise an improved system of typography in which John Walter was interested and to give him cheap publicity for the books he published. On Jan. 1, 1788, its title was changed to *The Times*. It came into existence when free expression of opinion in the press was still a thing of the future, and within a few years of the establishment of his paper Walter had several sojourns in Newgate and had to pay several fines for criticisms of the authorities.

John Walter II practically took over the reins in 1803, and he also had to encounter the active opposition of governments which he had occasion to criticize, including that of William Pitt. He introduced a better system of news transmission and steam printing (1814), with the result that he was able to make the proud announcement that 1,100 sheets had been impressed in one hour. In view of the newspaper and advertisement tax and other disabilities, it was a considerable achievement when in 1815, the year of Waterloo, the daily circulation reached 5,000. In 20 years this was doubled, in 1851 it had reached 40,000 and three years later it was more than 50,000, when its most circulated rival, the *Morning Advertiser*, had a sale of fewer than 8,000 copies. When John Walter II assumed control *The Times* was a small four-page sheet; when he gave up control in 1847 it consisted of 12 large pages and the foundations of the paper's present reputation as the preeminent national journal and daily historical record were laid. John Stoddart, later governor of Malta, was editor until the end of 1816 when he resigned after a series of differences with John Walter II. He was succeeded in 1817 by the young Thomas Barnes, perhaps the greatest editor the paper has ever had, who had made his reputation as a critic and parliamentary reporter. When Barnes' health began to fail, much of the editorial work devolved upon Edward Sterling, whose pontifical and sometimes explosive style caused Thomas Carlyle to say: "He more than any other man was *The Times*, and thundered through it to the shaking of the spheres." It was, however, the *Morning Chronicle* in 1829 that first coined the popular description of *The Times* as the "thunderer."

In 1841, on the death of Barnes, the editorial chair was taken by John Thadeus Delane. In 1877 he was succeeded by Thomas Chenery, who died in 1884 and was followed by George Earle Buckle. Meanwhile, from 1848, John Walter III had been in command. He died in 1894, and was succeeded by Arthur Walter. At the beginning of the 20th century *The Times* began to feel the influence of the more go-ahead methods of the popular press, and there was a loss of circulation and revenue. It was a period when another great London daily paper, the *Standard*, was dying. Finally, in 1908, Lord Northcliffe realized his ambition and acquired control of the "Thunderer." He remodeled the organization and increased its efficiency. On his retirement Buckle was succeeded as editor by George Geoffrey Dawson. In 1919 he retired from the editorship because of a difference of opinion with Lord Northcliffe and his place was taken by Henry Wickham Steed, who died in 1956. In 1923 when, following the death of Lord Northcliffe, Maj. J. J. Astor, M.P. (later Lord Astor of Hever), became its chairman and chief proprietor, Dawson again became editor. Major Astor secured the future independence of the paper by a deed establishing a body of trustees consisting of holders of various public offices whose consent would be required to validate any future transfer of ownership. In 1941 Dawson retired from the editorship in favour of R. M. Barrington Ward who died seven years later and was succeeded by W. F. Casey. On his retirement in 1952 Sir William Haley, the then director-general of the British Broadcasting corporation, became the editor. With the issue of May 3, 1966, *The Times* broke tradition by devoting its front page to news instead of classified advertisements. The change brought a slight increase in circulation, to about 286,000, but not financial health. Money worries ceased later in the year when principal ownership of *The Times* was acquired by Lord Thomson of Fleet, proprietor of a worldwide chain of newspapers and magazines. He merged ownership of *The Times* and that of his flourishing *Sunday Times* (a paper that had no previous connection with *The Times*) in a new parent company, Times Newspapers, Ltd., under an arrangement that included four "independent national figures" on its board of directors. The editor of the *Sunday Times*, Denis Hamilton, became editor in chief of both papers, and Sir William Haley became chairman of the board.

The Times has always excelled in its home and foreign news departments and in mechanical production. On the editorial side it has at its command experts on every conceivable subject. From its earliest days it has maintained an able staff of correspondents in all the capitals of the world. Other publications issued from Printing House square, home of *The Times*, include the *Literary Supplement*; the *Educational Supplement*; the *Weekly Review*, first published in 1877 as the *Weekly Edition*; the monthly *Review of Industry and Technology*; and the bimonthly *Times Index*.

The *Daily Telegraph and Morning Post* was in the 1960s the second of the great national dailies and had a circulation of over 1,200,000. First published as the *Daily Telegraph and Courier* on June 29, 1855, it was owned by Col. Arthur B. Sleigh, who transferred it to Joseph Moses Levy in the following September. Levy produced it as the first penny newspaper in London, the name *Courier* being subsequently dropped. His son Edward Lawson (later the 1st Lord Burnham) soon became editor, which post he continued to hold till 1885. A long list of distinguished members of the staff included Sir Edwin Arnold, George Augustus Sala, Edward Dicey, Sir J. M. Le Sage, Bennet Burleigh, the war correspondent, J. L. Garvin and H. D. Traill; and among dramatic and literary critics Clement Scott, W. L. Courtney and W. A. Darlington. After 1890 Harry Lawson (later Viscount Burnham), eldest son of the owner, assisted in the general control. The repeal of the Stamp act in 1855 enabled the *Daily Telegraph* to challenge *The Times*. By 1861, only six years after it was started, it had a circulation of 130,000—more than double that of *The Times*—owing to its special appeal to the middle classes. It was consistently Liberal up to 1878 when it opposed Gladstone's foreign policy, and at the Irish Home Rule split in 1886 it became Unionist. Circulation by 1927, however, had declined to 84,000; and in 1928 Viscount Burnham sold the paper to Sir William Ewert Berry and Sir James Gomer Berry (later Viscount Camrose and Viscount Kemsley) and Sir Edward (later Lord) Iliffe. Circulation increased, doubling in 1930, when the price was reduced to a penny. The *Morning Post* was absorbed in 1937, and the *Daily Telegraph and Morning Post* was, in the early 1960s, a well-balanced morning newspaper, independent Conservative in politics.

The *Morning Post* had been founded in 1772 as the *Morning Post and Daily Advertising Pamphlet*, mostly an advertising sheet including state lotteries, then legal and popular. It developed into a national newspaper under the ownership of Peter and Daniel Stuart after 1795 and attracted a wonderful galaxy of writers, including Sir James Mackintosh, Samuel Taylor Coleridge, Robert Southey, Arthur Young, the poet Thomas Moore, William Words-

worth and Charles Lamb. The *Morning Post* maintained a tradition of vigorous and unblenching criticism, and Nicholas Byrne, editor-owner who succeeded Daniel Stuart, was murdered in his office as the result of an article which had given offense. In 1850 the paper came under the control of Peter Borthwick, and on his death in 1852 he was succeeded by his son Algernon (later Lord Glenesk). Among the editors of the *Morning Post* were Sir William Hardman, J. Nicol Dunn, Sir Fabian Ware and H. A. Gwynne. In 1937 the paper, as noted above, was consolidated with the *Daily Telegraph*.

The *Guardian* is the only example of a provincial paper that has acquired national standing. In 1960 the prefix "Manchester" was dropped from the title and two years later arrangements were made for the paper to be simultaneously printed in London and Manchester. Thus the *Guardian*, with a circulation in the early 1960s of 260,000, came to rival *The Times*. Founded as the *Manchester Guardian* in 1821, it was a weekly Whig organ and later became the chief exponent of Liberalism outside London. From 1872 to 1929 it was edited by C. P. Scott and gained a worldwide reputation. Apart from its vigorous politics it enjoyed an unrivaled literary prestige. It became a penny paper in 1857, two years after it had been turned into a daily.

Prominent names associated with it were C. P. Scott's son-in-law C. E. Montague, Leonard T. Hobhouse, Andrew Lang, Richard Jeffries, Richard Whiteing, Sir Claude Phillips, George Saintsbury, Laurence Housman, G. W. E. Russell, and Spenser Wilkinson. In its book reviewing, its dramatic criticism and its foreign correspondence the *Manchester Guardian* exercised an unparalleled influence in provincial journalism. The *Guardian* was helped by the prosperity of its evening associate, the *Manchester Evening News* (1868) acquired in 1924.

The *Daily Mail*, started by Alfred and Harold Harmsworth in 1896 as a halfpenny daily newspaper, was a phenomenal success from the first number. By 1900 it had already reached the 1,000,000 mark in circulation and by 1929 it had 2,000,000. In 1905 Sir Alfred Harmsworth started in Paris the *Continental Daily Mail*, later the property of Lord Rothermere. The *Daily Mail* also established editions in Manchester and Edinburgh. Sir Alfred Harmsworth (later Viscount Northcliffe) was not only a brilliant organizer but a keen journalist; he was the first to exploit the advantages of the short paragraph and introduced many other typographical features that are now standard practice in journalism. On his death in 1922, the paper came under the control of his brother, Lord Rothermere. On his retirement in 1937 the management passed to his son. In the late 1920s and early 1930s the *Daily Mail* had the largest daily circulation in the world. In the early 1960s its circulation of over 2,000,000, was exceeded by both the *Daily Express* and the *Daily Mirror*.

In 1960, the publishers of the *Daily Mail*, Associated Newspapers Ltd., purchased the *News Chronicle*. This paper was the result of the earlier amalgamation of several newspapers, notably the *Daily News* and the *Daily Chronicle*. The *Daily News* was founded in 1846 under the editorship of Charles Dickens. It became the champion of Liberalism, supporting the war of freedom in Italy and the emancipation of Bulgaria and the Armenians. Later it absorbed the *Morning Leader*, acquired the *Star* in 1909, absorbed the *Westminster Gazette* in 1928 and was amalgamated with the *Daily Chronicle* in 1930. The *Daily Chronicle* was established in 1877 and was turned into a general newspaper by Edward Lloyd, the founder of *Lloyd's News*. The paper reached a height of prosperity during World War I with Robert Donald as editor. The paper was owned by David Lloyd George for a brief period but in 1930 was amalgamated with the *Daily News* to form the *News Chronicle*. In 1955 it absorbed the *Daily Dispatch* of Manchester and at the time of its closure had a circulation of more than 1,500,000.

The *Daily Express*, which was founded as a halfpenny newspaper in 1900 by C. Arthur Pearson, passed the *Daily Mail* in circulation in the 1930s, partly through the use of free-gift inducements. Following the lead of U.S. newspapers, the *Daily Express* struck a new note of publishing its principal news on the front page. In 1904 R. D. Blumenfeld became editor and in 1912 he formed a syndicate which acquired control. Lord Beaverbrook began to take an interest in the paper while it was financially in low water, and in 1922 he obtained complete control. He spent prodigious sums in developing the paper, which in the early 1960s had 4,200,000 circulation and was being printed simultaneously in London, Manchester and Glasgow.

The *Daily Herald* was founded in 1912 as a Labour organ, but was not taken over officially by the Labour party until 1922. In 1929 Lord Southwood, head of Odhams Press Ltd., arranged to take a 51% interest, while the party retained 49%. It was agreed that the paper should support the policy of the Trades Union congress (T.U.C.). Shortly afterward the Labour party handed over its interest in the paper to the T.U.C. But in 1960 Odhams asked to be released from the agreement on the grounds that they could not make the paper pay unless they had complete editorial freedom. The T.U.C. agreed after Odhams had promised to "maintain the industrial and political integrity of the paper" and that it would continue as a "newspaper of the left." In 1961 control of the *Daily Herald*, together with the rest of Odhams Press, passed into the hands of the *Daily Mirror* group, later called the International Publishing corporation (I.P.C.). At that time the *Daily Herald* had a circulation of 1,400,000. In 1964 the I.P.C., having persuaded the T.U.C. to sell its interest for £75,000, produced a daily newspaper—the *Sun*—to replace the *Daily Herald*.

The *Daily Mirror* was originally issued in 1903 by Alfred Harmsworth as a woman's paper to be edited by women. When it did not succeed in this field, its owner soon made it into the first halfpenny illustrated tabloid. It retained a family flavour, however, with attention to women's interests. In the early 1960s it had the highest circulation of all the national dailies, selling 4,500,000 copies. The *Daily Sketch* was founded in 1909 as a halfpenny illustrated tabloid, absorbed the older and higher-priced *Daily Graphic* in the 1920s and was called for several years the *Daily Sketch and Graphic*. Coming into the hands of Lord Rothermere it was later sold by him to Lord Kemsley. The name of the *Graphic* was then dropped but in 1946 the *Daily Sketch* became the *Daily Graphic*. When, later on, it again passed into the control of Lord Rothermere, the title of the *Daily Sketch* was restored. In the early 1960s it had a circulation of 981,000.

Founded in 1930 as a Communist organ, the *Daily Worker* (renamed *Morning Star* in 1966) was suppressed in Jan. 1941 and did not appear again until Sept. 1942 when the U.S.S.R. had joined the war against Germany. Its circulation in the early 1960s was about 60,000.

8. London Evening Papers.—There are two evening papers published in London, the *Evening News* and the *Evening Standard*.

The *Evening News* was founded in 1881 and, after many vicissitudes, when in difficulty was acquired in 1895 by Alfred and Harold Harmsworth and Kennedy Jones. It was the Harmsworths' first incursion into daily journalism, and made a rich experimental field for the *Daily Mail*. One of the Associated Newspaper group, it had the largest circulation of any of the evening papers in the country in the early 1960s—approximately 1,458,000. In 1960 the group purchased the *Star*, which had been a London Liberal evening paper. It was started by T. P. O'Connor in 1888 as a halfpenny journal in support of Gladstone. In 1909 it was acquired by the *Daily News* and at the time of its demise had a circulation in excess of 1,000,000.

The *Evening Standard* was begun in the 1870s as the afternoon edition of the *Standard* (*see* below) and was devoted largely to commercial news. In 1923 it became the property of Lord Beaverbrook, and later it absorbed the famous old *Pall Mall Gazette* (*see* below). Often called a "quality" evening newspaper, it had a circulation of nearly 800,000 early in the 1960s.

9. Great Papers of the Past.—Fleet street is peopled with the ghosts of journals which in their time filled important places in the life of the country. There was the *Morning Chronicle*, which began its career in 1769 and had among its leading contributors R. B. Sheridan, Sir J. Mackintosh, John Campbell (afterward lord chancellor), the poet Thomas Campbell, Thomas Moore, Lord Brougham, Byron, William Hazlitt, J. S. Mill, Charles Lamb and W. M. Thackeray. John Black was its most famous editor. After

a notable career the *Morning Chronicle* died in 1862.

The *Standard* was established as an evening paper in the Tory interest in 1827. In the 1850s it was purchased by James Johnstone, who brought out the *Standard* as a morning paper (1857). One of its contributors in the 1860s was Lord Robert Cecil, later Lord Salisbury. Johnstone, to whose energy and perspicacity the paper owed so much, died in 1878, and under his will William H. Mudford was appointed editor and manager for life, or until resignation. In Mudford's hands the *Standard* entered upon a successful period. It had many famous war correspondents, foremost among whom were G. A. Henty, John A. Cameron and William Maxwell. In Jan. 1900 Mudford was succeeded by G. Byron Curtis (d. 1907). In Nov. 1904 the *Standard* was sold to Sir Arthur Pearson. In 1910 it passed into the control of Davison (later Lord) Dalziel and disappeared during World War I.

A disastrous experiment in newspaper production was the *Tribune*, founded by Franklin Thomasson in 1906 as a solid penny daily. After gathering a brilliant staff and expending very large sums he discontinued the paper in 1908. The unhappy enterprise was described in Sir Philip Gibbs's novel *The Street of Adventure*.

The first number of the *Pall Mall Gazette* (the name being borrowed from the incident in which Thackeray describes Captain Shandon in the Marshalsea prison drafting the prospectus of the *Pall Mall Gazette* as a paper "written by gentlemen for gentlemen") appeared in Feb. 1865. Its first editor was Frederick Greenwood, who gathered round him a brilliant array of talent in Sir Henry Maine, Sir J. Fitzjames Stephen, Anthony Trollope, Charles Reade, George Henry Lewes, George Eliot, Matthew Arnold and Richard Jefferies. In 1875 Greenwood was able to convey to Disraeli news of the French bid to secure control of the Suez canal, thereby enabling Britain to get in first. It had been a consistent supporter of Disraeli, and when on changing hands it became Liberal, John Morley (later Viscount Morley of Blackburn) became editor, with William T. Stead as assistant editor. When Morley exchanged journalism for politics in 1883, he was succeeded by Stead. Stead was succeeded by E. T. Cook in 1889. The *Pall Mall Gazette* was now steadily Liberal and a strong advocate of Irish Home Rule. Two distinguished editors at a later date were Sir Douglas Straight and J. L. Garvin. It was consolidated with the *Evening Standard* in 1925.

Founded in 1880 by H. Hucks Gibbs (later Lord Aldenham) for Frederick Greenwood to edit when he had left the *Pall Mall Gazette*, the *St. James's Gazette* represented the more intellectual and literary side of Tory journalism in opposition to the new liberalism of Greenwood's former organ. In 1888, the paper having been sold, Greenwood retired and was succeeded as editor (1888–97) by Sir Sidney Low, who in his turn was succeeded by Hugh Chisholm (1897–99). Among the contributors were Rudyard Kipling, Sir James Barrie and G. S. Street. Toward the end of the 19th century it assumed a more popular style and shape, and for a year or two before its acquisition by Pearson in 1903 and its final merging in the *Evening Standard* it was edited by Ronald McNeill (later Lord Cushendun).

When the *Pall Mall Gazette* was sold to Lord Astor in 1892 and converted into a Conservative organ, E. T. Cook, the editor, and most of his staff resigned; in 1893 they came together again on the *Westminster Gazette*, newly started for the purpose by Sir G. Newnes as a penny Liberal evening paper. The paper was conducted on the lines of the old *Pall Mall Gazette*, and it had the advantage of a brilliant political cartoonist in Sir Carruthers Gould. In 1896 Cook was appointed editor of the *Daily News*, and his place was ably filled by J. A. Spender. The *Westminster Gazette* became conspicuous for its high standard of political and literary criticism, and gradually became the chief organ of Liberal thought in London. In 1908 it was sold to a group of Liberal capitalists. After World War I it was replaced by a daily newspaper of the same name which was merged in the *Daily News* in 1928.

10. Provincial Press.—The first provincial paper in England was the weekly *Worcester Post Man* (1690), later the modern *Berrow's Worcester Journal*. In the first 20 years of the 18th century a number of other, mainly weekly, journals sprang up in country towns, among them the *Stamford Mercury* begun in 1713 and the *Northampton Mercury* begun in 1720. At the start of the 19th century the provincial press consisted of fewer than 100 journals, practically without influence. Benjamin Flower, printer of the *Cambridge Intelligencer*, was the first to introduce the leading article in the provincial press. The *Leeds Mercury*, founded in 1717, under the control of Edward Baines (1801) became the most important and influential of the north country papers in the first half of the 19th century. After the Reform act of 1830, the spread of self-education and the establishment of reading circles and newspaper clubs, the country newspapers developed in importance and usefulness. It was not, however, till the final removal of the taxes on knowledge that the provincial press came into its own.

Within ten years of the abolition of the paper duty, penny morning newspapers had taken up commanding positions in many cities in England, Scotland and Ireland. But any real importance as organs of opinion was still confined to only a few of the great penny provincial dailies, notably the *Yorkshire Post*, *Manchester Guardian*, *Birmingham Post* (1857), *Sheffield Telegraph* (associated with Sir W. Leng), *Liverpool Daily Post*, *Leeds Mercury* and *Western Morning News;* others were at the same time cradling journalists who were to become famous, such as the *Darlington Northern Echo*, on which W. T. Stead made his debut.

The first syndicate to send out war correspondents was formed by the *Glasgow News*, *Liverpool Daily Post*, *Manchester Courier*, *Birmingham Gazette* and *Western Morning News*, which dispatched two correspondents to Egypt. The Central News also sent out war correspondents to Egypt and the Sudan. During the South African War (1899–1902) the leading provincial newspapers, however, all formed syndicates to secure war telegrams.

The following were the leading English provincial daily papers in the early 1960s:

The *Yorkshire Post* began in 1754 and became the principal Conservative newspaper outside London, enjoying national prestige extending far beyond the borders of Yorkshire. In its early years it devoted especial attention to racing, which was neglected by most local papers in the country in those days, and under the control of the Beckett family it rapidly attained a solid prosperity. It had talented editors in H. J. Palmer, J. S. R. Phillips, Arthur H. Mann and Sir Linton Andrews.

The *Yorkshire Evening Post*, founded 1890, became the popular evening paper for all Yorkshire, with a circulation of 236,000.

The *Birmingham Daily Post* was founded in 1857 by J. F. Feeney and John Jaffray and later was controlled by Sir Charles Hyde. It came to hold a position in the midlands analogous to that of the *Yorkshire Post* in the north. It was purchased by Lord Iliffe after Hyde's death in 1942. Its evening associate, the *Birmingham Mail*, had a circulation of 294,000 in the early 1960s. In 1956 the group absorbed the *Birmingham Gazette*.

The *Liverpool Daily Post* was founded in 1855 as a Liberal paper. In 1904 it absorbed the *Liverpool Mercury* (founded in 1811), and it assumed a pre-eminent place in the life of the great seaport. It was far exceeded in circulation by its afternoon associate, the *Evening Echo*, with a circulation of 410,000.

11. Scotland, Wales and Ireland.—In Scotland the leading newspapers in the 1960s were still *The Scotsman* and the *Glasgow Herald*. The former was started as a biweekly in 1817 and became a daily in 1855. It was Liberal until the Home Rule split in 1886 when it adopted the Unionist cause. Alexander Russel was its most famous editor in the 19th century (1848–76) and worthy successors included Sir George Waters and J. Murray Watson. For many years it has been the only Edinburgh morning newspaper, and in 1959 was acquired by Roy Thomson from its former owner, Lord Kemsley. The *Glasgow Herald* dates from 1783, when it first came out with the extra name *and Advertiser*. It acquired a great literary reputation under an illustrious line of editors, including Samuel Hunter, George Outram, Sir Robert Bruce and Sir William Robieson.

The largest circulations in Scotland in the early 1960s were both achieved by papers owned by the International Publishing corporation; the *Sunday Mail* with 612,000 and the *Glasgow Daily Record* with 500,000.

In Wales the four Cardiff papers in 1929 were amalgamated into two, the *South Wales Echo* and the *Western Mail*, both Thomson newspapers; in the early 1960s the former had the largest of Welsh circulations—about 150,000. In 1929 also the two Swansea papers were consolidated by the Northcliffe newspaper group as the *South Wales Evening Post*.

In Northern Ireland, Belfast had three morning papers and one evening paper in 1963. The morning papers were the *Belfast News-Letter* (1737), the *Northern Whig* (1824) and the *Irish News* (1855). The evening paper was the *Belfast Telegraph* (1870). In Ireland three morning and two evening papers were published at Dublin and one of each at Cork. Largest of these was the *Irish Independent* and oldest was the *Cork Examiner* (1840, morning). There were also two local Sunday papers.

See also *Newspaper Chains*, below.

12. British Illustrated Newspapers.—English papers carried news pictures as early as 1731, when the *Grub Street Journal* printed a woodcut depicting the lord mayor's show, but not until 1842 did England have a fully illustrated newspaper.

Herbert Ingram brought out the first number of the weekly *Illustrated London News* on May 14, 1842. It contained 16 printed pages and 32 woodcuts. The chief engravings, by Sir John Gilbert, illustrated the first *bal masqué* given by Queen Victoria at Buckingham palace. Control of the paper passed in 1860 to Ingram's son, later Sir William Ingram. Its editors included Charles Mackay (1848–59), John Lash Latey (1859–90) and Clement K. Shorter (1890–99). In 1861 the first penny popular paper was started by the same proprietor, the *Penny Illustrated Paper*, edited by John Latey, Jr., who afterward was editor of the *Illustrated London News*. In 1869 the first serious rival of the *Illustrated London News* was published, the *Graphic*, produced by W. L. Thomas. *Black and White*, a paper of the same class as the *Illustrated London News*, followed in 1891; and in 1892 the *Sketch* was started by Sir William Ingram, under the editorship of Shorter, as a social and theatrical illustrated weekly.

From this time forward, many illustrated weeklies were started in the fields of the theatre, sports, fashion and society. Perhaps the most successful of all illustrated newspapers was *Picture Post*. It was started by Sir Edward Hulton in 1938 and ten years later had achieved a circulation of 1,400,000; by the time it closed in 1957 this figure had dropped by half. The owner attributed its collapse not so much to television as to a general change in reading habits. A year later Odhams' *Illustrated* whose circulation (at one time over 1,000,000) had suffered a similar decline also disappeared. The *Illustrated London News*, however, survived all these changes although its parent company, Illustrated Newspapers Ltd., had a number of owners over the years. It was created in 1926 by William Harrison, purchased in 1937 by Sir John Ellerman and Lord Southwood and changed hands again when Roy Thomson bought it in 1961.

13. Sunday Newspapers.—The *Observer*, the oldest of the Sunday newspapers, was founded in 1791. It kept on its respectable but somewhat sombre career until it was acquired by Lord Astor and edited by J. L. Garvin, when it assumed a distinctive character—a virile independence in its political outlook while making a strong feature of foreign correspondence, literature, the drama, etc. On Garvin's resignation in 1942 he was succeeded by David Astor. In 1964 its circulation was 716,000.

The *Sunday Times* was founded in 1822. Its course was similar to that of the *Observer* until 1915, when it was acquired by William and James Berry. The former was editor in chief of the *Sunday Times*, 1915–37. In 1959 the paper was bought from Lord Kemsley by Roy Thomson (later Lord Thomson of Fleet) but retained its conservative character. The feature side of the paper was expanded, the most notable development being the introduction of a colour section in 1962. Its circulation was about 1,360,000 in 1966, when it was merged with *The Times* (*see* above, *London Morning Papers*).

In 1961 the *Sunday Telegraph* came to join the *Observer* and the *Sunday Times* in the "quality" field. Launched by the *Daily Telegraph* it is, like its parent, an independent Conservative paper with a circulation of approximately 700,000.

The best-selling Sunday newspaper in the early 1960s was the *News of the World* (founded 1843), which devoted considerable space to sport and crime. Sir Emsley Carr was editor for half a century from 1891 until his death in 1941. The paper passed the 1,000,000 mark shortly after 1900 and by the early 1960s had a circulation of well over 6,484,000, being the largest newspaper in the free world. In 1960 the publishers acquired the *Empire News* (2,000,000), founded in Manchester in 1884.

The *People*, with a circulation in the early 1960s of over 5,500,000, was printed in London and Manchester, as was the *News of the World*. Founded in 1881, it was acquired by the *Daily Mirror* group in 1961 when it gained control of the former publishers, Odhams press. The *Sunday Express*, founded in 1918 as the Sunday edition of the *Daily Express*, sold about 4,333,000 copies. The *Sunday Dispatch*, founded in 1801 as the *Weekly Dispatch* and later affiliated with the *Daily Mail*, closed down in 1961; the *Sunday Graphic* established in 1915 closed down in 1960. *Reynolds News* (1850), the organ of the co-operative movement (circulation 361,000), changed its name in 1962 to the *Sunday Citizen*. The *Sunday Pictorial* (1915) had a circulation of more than 5,000,000 in 1964 when the name was changed to the *Sunday Mirror*.

14. Competition for Mass Circulation.—The competition for circulation reached its height between World Wars I and II and the popular newspapers resorted to many unusual expedients. Free insurance policies were offered to readers and their families and, in return for a subscription to the newspaper, the citizen could obtain free gifts which ranged from complete sets of books by well-known authors to washing machines. Crossword and other competitions for which substantial prizes were awarded were introduced. The result was that for a time circulations were artificially inflated and it is to be doubted whether the public read all the newspapers for which it paid subscriptions. The newspapers realized that a disaster, if it caused the deaths of many policyholders might have a crippling effect on their finances and a mutual arrangement was agreed upon to limit this form of artificial circulation. In World War II canvassing for circulation was forbidden and circulations were frozen at 1939 levels. There was, however, a renewal of some of this competition during the 1950s when inducements to purchase newspapers included gifts ranging from a racehorse to a public house. This practice is now forbidden by agreements between the national newspapers. The coming of broadcasting and television stimulated interest in news, and circulations of daily papers continued to mount steadily.

This increase in the circulation of individual newspapers was accompanied by a decline in their total numbers. Between 1953–63, 18 papers disappeared, either ceasing entirely or being absorbed by other publications. It is a feature of the British newspaper industry that the fortunes of any one newspaper are governed as much by the success or failure of its immediate competitors as they are by the skill and efficiency of its staff.

Most British newspapers gain the majority of their income, not from sales, but from advertising. As advertisers place their business where they know they can get the best value for money and as there is a limited amount of advertising to go round the paper with a relatively small circulation inevitably loses ground to its more powerful competitor; it is generally assumed that for a paper to remain viable in the 1960s it has to command a circulation which is at least half that of the most successful paper in its field. It was this situation that led to the closure of the *News Chronicle* (1,500,000) in 1960, killed by competition from such papers as the *Daily Express* (4,200,000) combined with rising production costs which cut profit margins to the minimum. The circulations of *The Times* and the *Guardian* were infinitely smaller but because their readers were drawn from the more affluent and influential sections of the community, companies with capital rather than consumer goods to sell were willing to pay their relatively high advertisement rates.

15. Newspaper Chains.—The second development that marked the period 1950–61 was the increasing concentration of the ownership of newspapers into fewer and fewer hands. In 1948 the three leading chains, Beaverbrook Newspapers Ltd., Associated

Newspapers Ltd. and the *Daily Mirror-Sunday Pictorial* group, controlled 43% of the total circulation of all daily and Sunday newspapers. By 1961 these combines had 65% of that circulation. The Westminster Press Provincial Newspapers, Ltd., owned 61 of the provincial papers in 1962, over two-thirds of the total number. In the early 1960s there was no town in England and Wales with more than one locally published morning paper and in only four towns outside London was there more than one evening newspaper.

16. Censorship.—With the outbreak of World War II the newspapers were brought under a system of voluntary censorship which had been worked out in advance by a committee representing the services and other government departments and the press. On the whole the system worked well, although in the early months there were some irritating delays and restrictions which were gradually smoothed out. No newspaper was compelled to submit its copy to the censorship department unless a definite embargo had been imposed upon a particular item of news. Comment was not restricted. The newspapers loyally accepted the system and any news which it was felt might give information to the enemy was submitted, for the newspapers realized that the fact that the copy had been passed by the censorship department would be a great help to them if, by any chance, proceedings were brought under the Official Secrets act. Contact between the government and the press was maintained by a system of defense notices and at the end of the war it was agreed that this machinery should be kept in being in case it might be needed again. During the war there were suggestions that the government was contemplating compulsory censorship but the idea was resisted vigorously by the newspapers.

17. The Royal Commissions on the Press.—In the years that followed the end of World War II controversy about the growing power of the newspaper chains and criticism about the alleged bad behaviour of a few individual journalists led to the setting up in 1947 of a royal commission which was charged "to inquire into the control, management and ownership of the newspaper and periodical Press and news agencies." In its report the commission decided "there was nothing approaching a monopoly in the press as a whole." It recommended the establishment of a general council of the press to safeguard the freedom of the press and to encourage a sense of public responsibility among journalists. In July 1953 a voluntary press council was established by seven organizations representing the proprietors, editors and working journalists. In 1963, acting on recommendation of the second royal commission (*see* below), the press council reformed its constitution. Its members were no longer entirely drawn from the profession; it was now headed by an independent chairman and 20% of its members were laymen.

In 1961, following the merger of Odhams and the *Daily Mirror-Sunday Pictorial* group, the government appointed a second royal commission to "examine the economic and financial factors affecting the production and sale of newspapers, magazines and other periodicals"; in particular they were to report whether the manufacturing and other costs, the efficiency of production and the advertising revenue (including that derived from television interests) tended to "diminish diversity of ownership and control or the number or variety of such publications, having regard to the importance, in the public interest, of the accurate presentation of news and the free expression of opinion."

A year later the commission reported that it had found "spectacular" movements toward concentration of ownership had taken place among periodicals and that the extent to which a few proprietors dominated the actual supply of news and opinion through the daily and Sunday press had greatly increased. The commission believed there was still a considerable range of choice in the national daily and Sunday press but the concentration of ownership carried with it the potential danger that variety of opinion might be stifled. It recommended that any acquisition by a purchaser who had, or who would acquire as the result of a transaction, the controlling interest of daily or Sunday newspapers with aggregate circulations exceeding 3,000,000 copies should come under the jurisdiction of a Press Amalgamation court whose consent would only be given if it could be established that such a transaction was not contrary to the public interest.

See also NEWS AGENCY; PRESS SYNDICATE.

(A. P. R.; S. P. A.)

III. GERMANY

It appears that not only was the first western printing from movable type done in Germany, but some of the earliest news pamphlets and perhaps the first regularly published newspapers were issued there. At any rate, there is a file of the *Avisa Relation oder Zeitung*, published at Augsburg in 1609, and one copy of the Strasbourg *Relation* of that year.

These papers were followed by others, such as the *Frankfurter Journal* of Egenolph Emmel in 1615 and the *Frankfurter Oberpostamtszeitung*, begun in 1616 and continued until 1866 under the shortened title of *Postzeitung*. In the course of the 17th century, most German cities supported newspapers; in the 18th century, despite the rigours of local and state censorship, the press multiplied throughout the country. Notable for its correspondence from abroad was the *Hamburgischer Correspondent*, founded in 1714 under the title *Holsteinische Zeitungs-Correspondenz*. The outstanding Berlin papers in the 18th century were two named, for their owners, *Vossische Zeitung* (1705) and *Spener'sche Zeitung* (1749); the latter was renamed *Berlinische Nachrichten* and lived until 1827. Under Napoleon censorship merely changed hands; the German press became Gallic and the newspapers echoes of the Parisian journals. But when Germany was liberated the old censorship reappeared. An 1819 resolution of the diet subjected the press to police supervision.

The greatest German newspaper in the first half of the 19th century was the *Allgemeine Zeitung*. It was founded at Tübingen by Johann Friedrich Cotta (later Baron von Cottendorf) in 1798. Censorship and other causes forced it to move successively to Stuttgart, Ulm, Augsburg and Munich. The revolutionary movements of 1830 and 1848 gave impetus to a new German journalism which, though most of the papers were short lived, brought in a new period of press enterprise. Many small papers were established throughout Germany and Austria, nearly all of them consistently partisan. Censorship varied in different states. Those best known throughout the nation, besides the *Allgemeine Zeitung*, were the *Augsburger Zeitung* (1689) and the *Kölnische Zeitung* (1804).

Bismarck had a high respect for the power of the press and kept a firm hand on its control. The press law under which the German newspapers operated 1874–1919 "guaranteed" freedom of the press but actually retained strong government controls. Even during World War I the government controlled a number of important newspapers. Following that war, besides owning Wolff's Telegraphic bureau, the leading news-gathering agency, the Prussian government secretly bought the *Deutsche Allgemeine Zeitung*, a Berlin paper founded in 1921 by Hugo Stinnes, and later sold it to the government of the *Reich*.

1. Under the German Republic.—Under the Weimar constitution of 1919, German newspapers enjoyed more freedom than they had ever known. In the years 1919–32 the *Gruppenpresse* (newspapers representing political, social and religious groups), though composed of papers of small individual circulations, maintained dominance in the country's journalism. During the 1920s, however, a *Massenpresse*, composed of large-circulation dailies designed for the masses rather than for parties or factions, grew up in Berlin and other large cities; these papers, though more objective in reporting and comment, were commonly partisan in control and thus had notable alignments with the *Gruppenpresse*.

By 1932 there were 4,700 newspapers in Germany, 70% of them dailies. More than 100 different parties or group ideologies were represented. The largest paper in this period was the *Berliner Morgenpost*, claiming 600,000 in 1932. It was founded in 1898 by the "house of Ullstein," which consisted of Leopold Ullstein and his five sons. The father had entered the newspaper field by purchasing the *Berliner Zeitung* in 1877 (later called *BZ am Mittag* and credited with 190,000 circulation in 1932). Other Ullstein dailies were the old "quality" *Vossische Zeitung*, acquired in 1913,

never a circulation leader; and *Tempo*, an evening paper started in 1930, which had 140,000 by 1932. Other large papers in Berlin were *Der Tag* (1900), claiming 100,000 in 1932; and *Berliner Nachtausgabe* (1924), with 180,000. These, with the *Lokalanzeiger*, were Scherl papers, backed by the Hugenberg *Konzern*. Alfred Hugenberg, leader of the Nationalist party, controlled the large Scherl dailies, as well as the weeklies and magazines of that chain. Besides the Ullstein and Hugenberg combines, Konzentrations A.G. controlled about 200 Social-Democratic papers and owned a news agency; Rudolph Mosse controlled the *Berliner Tageblatt, Volkszeitung* and *Morgenzeitung* in Berlin.

A number of large papers, regarded as belonging to the *Massenpresse* because they each had 100,000 circulation or more, had by 1932 grown up in other large cities besides Berlin. But some of the most influential papers in Germany had only about 60,000 circulation, such as *Frankfurter Zeitung* (1856), *Kölnische Zeitung, Nuremberg Fränkische Kurier* (1833) and *Hamburger Nachrichten* (1792). This quartette of famous old papers was long powerful in Europe. Oldest of all German papers, with only a few thousand circulation in 1932, was the *Hartungsche Zeitung* of Königsberg (1640).

2. The Hitler-Goebbels Press.—Adolf Hitler's first task in connection with the group which was soon to become the National Socialist party was the direction of a press and news bureau in the district army command at Munich in 1919. After the military *Putsch* of March 1920, sympathizers bought for Hitler the *Völkischer Beobachter*, which had been founded several years before World War I as a weekly gossip sheet. As the Nazi influence expanded in the 1920s, its newspaper effort broadened; but the *Beobachter* remained Hitler's personal organ, and for the elections of 1932 he established a Berlin edition. In connection with those elections, also, Hitler's party established or acquired about 130 other newspapers distributed throughout Germany.

When Hitler became chancellor in Jan. 1933, he immediately caused Pres. Paul von Hindenburg to invoke article 48 of the constitution in order to cancel the guarantee of freedom of the press. Some papers were stopped at once, and the press in general was muzzled. Within three months 200 papers had been suspended, including the venerable *Vossische Zeitung;* within a year 600 had been killed, the Deutsche Nachrichtenbüro (DNB) had been set up to supersede Wolff's Telegraphic bureau, and a journalists' registration system had been devised which made newspapermen "semiofficial public functionaries." Max Amman, publisher of the *Völkischer Beobachter*, became president of the *Reich* press chamber, a division of Josef Goebbels' ministry of public enlightenment and propaganda. Goebbels had founded the newspaper *Der Angriff* in 1927 and two years later became head of Nazi propaganda activities. Amman's duties were largely on the business side, though he shared with Otto Dietrich the veto on new papers. Dietrich was *Reich* press chief and had charge of editorial policies and personnel. Eher Verlag was set up to handle Nazi printing and publishing; operating chiefly in Berlin and Munich, it soon became the largest publishing concern in the world. It published the *Beobachter, Angriff, Schwarze Korps* (SS organ), *Arbeitsmann, Hitlerjugend* and other official newspapers and periodicals, as well as books and pamphlets.

Jewish newspaper owners—the Ullsteins, Mosse, etc.—were driven out. When Germany seized Austria in 1938 many of the old papers (including *Wiener Zeitung*, founded in 1703) disappeared, and the remainder of the Vienna papers were combined in one Nazi organ. The number of newspapers in Germany was reduced from 4,700 in 1932 to about 2,000, and the press became, to use Goebbels' famous figure, an organ on which the minister of propaganda could play his own tunes.

3. The Occupation Press.—World War II annihilated the German press. New papers were licensed by the occupation powers in their various zones. The Soviet military government established *Tägliche Rundschau* in Berlin; the U.S. military government set up *Die Neue Zeitung* in Munich; the British founded *Die Welt* in Hamburg; the French licensed *Der Kurier*, an afternoon Berlin paper. By mid-century there were 20 dailies in Berlin, of which the Soviet *Rundschau* had the largest circulation, said to be 800,000; while the British-licensed *Telegraf* and the U.S.-licensed *Tagesspiegel* each had around 500,000. The U.S. semiweekly *Neue Zeitung* was circulating more than 2,300,000 copies of each issue including Berlin and Frankfurt editions; and the British triweekly *Die Welt*, 700,000, also including a Berlin edition. Most papers outside Berlin were published only two or three times a week.

4. German Federal Republic and Western Berlin.—There were important developments in the press after the foundation of the German Federal Republic in Sept. 1949. The system of licences was abolished and a return made to free competition. Some newspapers founded by the occupation authorities disappeared (*Neue Zeitung*); others continued their existence as wholly independent undertakings (*Die Welt*); new journals were started or old ones reappeared (*Berliner Morgenpost* and *BZ* launched in western Berlin by the Ullstein group). In the early 1960s there were 535 dailies, many of them with subsidiary editions, with a circulation of over 15,700,000 and 13 weeklies with a circulation of 2,600,000. The provincial press increased greatly. Several hundred newspapers used the special articles supplied by a small number of centralized agencies (*Maternpresse*). Another characteristic of the postwar daily press was the reduction in the number of papers affiliated to political parties (about 10%).

In the early 1960s in the Federal Republic the highest circulation was held by *Bild-Zeitung* in Hamburg (3,716,200) followed by the *Westdeutsche Allgemeine Zeitung* of Essen (422,000). Among the most important papers by reason of their circulation or influence were the *Kölnische Rundschau* (Cologne), *Süddeutsche Zeitung* (Munich), *Die Welt* and *Hamburger Abendblatt* (Hamburg), *Stuttgarter Zeitung* (Stuttgart) and the dailies of Frankfurt, which became the centre of German journalism after World War II: *Frankfurter Allgemeine, Frankfurter Neue Presse* and *Frankfurter Rundschau.*

In western Berlin the highest circulation record was held by the dailies *Berliner Morgenpost* and *BZ*, both of which exceeded 200,000 circulation, while quality papers remained, notably *Der Taggesspiegel* and *Telegraf.*

In 1949 the national agency Deutsche Presse-Agentur (D.P.A.) was started with headquarters in Hamburg. It very soon became one of the largest in Europe.

5. German Democratic Republic.—After the proclamation of the German Democratic Republic in Oct. 1949, the press underwent a considerable change. Although the system of licensing permitted by the occupying power theoretically disappeared, strict supervision persisted but it was exercised by the *Presseamt* which itself received instructions from the Politburo of the Socialist (Communist) Unity party or S.E.D. Only the *Tägliche Rundschau* continued to be edited by the Soviet military commander, but it stopped publication in 1955.

In 1953 the authorities suspended the big circulation evening paper *Nacht-Express* which had been trying since 1945 to keep its public objectively informed.

In the early 1960s there were 39 dailies in the Democratic Republic. Largest was the *Neues Deutschland*, main organ of the S.E.D., with a circulation of about 500,000, while 60% of the other papers belonged to the S.E.D. party press. Total circulation for the country did not exceed 4,000,000. In East Berlin nine daily newspapers were published.

The agency Allgemeiner Deutscher Nachrichtendienst (A.D.N.) founded in 1946 and nationalized in 1953, had a monopoly.

IV. FRANCE

The French newspaper press from the first was characterized by a literary quality generally superior to that of the press of most other countries, by special attention to the arts and by alliances (sometimes amounting to subsidization) with political, social or literary groups. Parisian journalism frequently became a path to fame in both politics and literature.

1. Beginnings.—The first French newspaper was the *Gazette* (afterward called the *Gazette de France*), established in 1631 under the patronage and with the active co-operation of Cardinal Richelieu. The first editor and printer was Théophraste Renaudot. The first weekly number apparently appeared in May 1631.

much, at least, may be inferred from the date (July 4, 1631) of the sixth number, which was the first dated publication. Each number of the paper, which cost six centimes, consisted of a single sheet (eight pages) in small quarto, and was divided into two parts—the first simply entitled *Gazette*, the second *Nouvelles ordinaires de divers endroits*. It commonly began with foreign and ended with home news. Much of its earliest foreign news came direct from the minister, and often in his own hand.

In 1672 the *Mercure galant* was established by Donneau de Vizé. Its title was later changed to *Nouveau Mercure*, and in 1728 to *Mercure de France*, a designation retained, with slight modification, until 1853, when the paper finally ceased. It had many prominent contributors. In 1790 its circulation rose very rapidly and reached for a time 13,000 copies. Under Napoleon the organ of official information was the *Moniteur* (*Gazette nationale, ou le moniteur universel*), founded in 1789 under the same general management with the *Mercure*. The *Moniteur* kept step with the majority of the assembly, the *Mercure* with the minority.

The only other newspaper of a date anterior to the Revolution which need be noticed here is the first French daily, the *Journal de Paris*, which was started on New Year's day of 1777 and lived till 1819. Its period of highest prosperity may be dated about 1792, when its circulation is said to have exceeded 20,000. The *Journal des débats* was founded in 1789 by François Jean Baudouin and lasted until the beginning of World War II.

2. The 19th Century.—The cheap journalism of Paris began in 1836 with the journal of Émile de Girardin, *La Presse*, and *Le Siècle*, under the management of Dutacq, to whom, it is said—not incredibly—the original idea was really due. The first-named journal attained a circulation of 10,000 copies within three months and soon doubled that number. The *Siècle* prospered even more strikingly, and in a few years had reached a circulation (then without precedent in France) of 38,000 copies.

On July 16, 1850, the assembly passed what is called the *loi Tinguy* (from the name of the otherwise obscure deputy who proposed it), by which the author of every newspaper article on any subject, political, philosophical or religious, was bound to affix his name to it, on penalty of a fine of 500 fr. for the first offense and of 1,000 fr. for its repetition. Every false or feigned signature was to be punished by a fine of 1,000 fr., "together with six months' imprisonment, both for the author and the editor." The practical working of this law lay in the creation of a new functionary in the more important newspaper offices, who was called *secrétaire de la rédaction*, and was, in fact, the scapegoat ex officio. The *loi Tinguy* had a permanent influence on French journalism in the continued prevalence of signed articles, and the consequent prominence of individual writers as compared with the same class of work in other countries.

Moïse Polydore Millaud, creator of the French halfpenny press, made a fortune from *Le Petit Journal* and introduced a new era of cheap papers. In 1878 the paper had a circulation of about 650,000 compared with the circulation of *Le Figaro* (1826) of 70,000. At that period the total number of journals of all kinds in France was 2,200.

The newspapers of Paris, and similarly of France, practically doubled in number between 1880 and 1900. In 1880 there were about 120 Paris newspapers, in 1890 about 160 and in 1900 about 240. The total number of newspapers, as distinguished from periodicals, published in France during 1900 was 2,400, of which about 2,160 appeared in 540 provincial towns.

The French papers, of whatever party, took an increased interest during this period in foreign matters and much improved their organization for collecting news. *L'Eclair* gave less attention to the discussion of political questions from the party point of view than to the collection of news, and was followed by the *Echo de Paris* (1884) and *Le Matin*, which also dated from 1884, and which by an arrangement with the *Times* of London gave every day a translation of most of the telegrams published in that newspaper. The *journal d'information*, as these papers were called, took its place beside the *journal d'opinion*, more perhaps as a rival than as a complement. The natural result followed, and the more old-fashioned newspapers took steps to provide their readers with news as well as with leading articles, current and literary topics, society gossip, dramatic criticism and law reports. Nothing perhaps was so striking after 1890 as the demand of the French public for foreign and colonial news, or the readiness of the papers to supply it by means of special representatives independent of the news agencies.

In home matters the French press made greater progress still in the rapid and accurate collection of news, and in this respect the provincial press showed more enterprise and more ability than that of Paris. All the best provincial papers had Paris staffs reporting parliamentary proceedings and law cases. Being perfectly independent of purely Parisian opinion or even bias, the decentralization of the French provincial press became complete; it became also more independent politically than the Paris press. Several journals had national reputations: *La Dépêche* of Toulouse, with its 12 editions daily, *Le Progrès* of Lyons, *Le Petit Marseillais* and *La Petite Gironde* of Bordeaux.

3. The 20th Century.—During World War I French newspapers were under severe censorship. Many disappeared for a time because of shortage of paper or manpower. Changes in the French press as a whole were temporary, and prosperity returned after the war.

In 1930 Paris had 23 morning dailies of general circulation, and ten afternoons, while there were 140 dailies in the provinces. Circulation of *Le Petit Parisien* (1876) reached 1,000,000 in 1904; stimulated by its use of U.S. news methods, it distributed 1,700,000 copies daily by 1930. Next was *Le Journal* (1892) with 1,200,000, and third was *Le Matin*, just at the 1,000,000 mark. Characteristic of the popular press were two serial stories, or *feuilletons*, in each issue; front-page opinion articles, signed by well-known contributing editors; and modest sizes of four to ten pages. The better-known political papers were *Le Temps* (1861), the venerable *Journal des débats*, *La Liberté* (1864), *L'Oeuvre* (1893) and *L'Humanité*, founded in 1904 by Jean Jaurès as the Socialist organ but which became Communist in 1920. The main feature of the French press, especially after the Popular Front government (Blum cabinet) came into power in 1936, was its highly political character, newspapers tending to adopt extremes of a polemical nature, while every phase of politics was represented. A number of papers at this time, as before World War I, accepted financial support from foreign embassies and legations. *Le Temps*, however, achieved a peculiar equilibrium because, since it accepted financial help from the Quai d'Orsay, its editorial comment on foreign policy always supported the foreign minister, while its foreign correspondents were financed by foreign sources. It was clear that when Germany overwhelmed France in June 1940 the press bore no small part of the responsibility for the debacle that ensued.

The 25 Paris dailies of general circulation were reduced during the German occupation to half a dozen: *Le Matin*, *L'Oeuvre*, *Le Petit Parisien*, *Le Temps* (renamed *Les Nouveaux Temps* by the Germans), the *Paris-Midi* and *Le Cri du peuple*. They were not all published during the entire period of the occupation and were supplemented by several short-lived newcomers.

Meantime, an irregular underground press opposing both the Germans and their collaborationists grew up. Among leading underground papers were *Franc-Tireur*, *Combat*, *Résistance*, *Libération* and *Défense de la France*. Editorial and mechanical staffs were sometimes caught and executed; *Résistance* ended after about a year because its staff was shot by the Germans.

When France was liberated in 1944, the only prearmistice papers allowed to resume were four which had refused collaboration—*L'Humanité*, *Le Populaire* (Socialist), *Le Figaro* and *L'Aube* (Christian Democratic). The various resistance groups which had published outlaw papers during the occupation now had dailies to represent them in the Paris press, and all those named in the preceding paragraph became competitors for popular favour. Despite the paper shortage that limited each paper to two pages and kept circulations down to prescribed quotas, there was a great demand among French readers, resulting in a boom in the newspaper business and the establishment of more than a score of new dailies in Paris during the first year following the liberation. In July 1946

the size of the Paris papers increased to four pages. But two years later circulations had dropped, advertising had fallen off and costs had advanced alarmingly.

In the early 1960s there were in France 123 general daily papers while Paris had 13, as against 34 after the liberation; their total circulation was 11,500,000 copies of which 4,200,000 were in Paris. *France-soir* had the highest circulation (1,321,000) and used U.S. techniques in headlines, objective news, accent on crime and fresh feature material. It was closely followed from the point of view of circulation by *Le Parisien libéré* (900,000), *Le Figaro* (510,000) and *L'Aurore* (480,000). Although its circulation was around 225,000 copies, *Le Monde* enjoyed from 1945 a considerable reputation, as much in France as overseas for its news and reporting, but it was also criticized for favouring neutrality.

The provincial press after the war rose to heights it had never experienced before. The number of weeklies and periodicals (about 5,000 at the middle of the century) increased by the early 1960s to 15,000. Prominent among these was *Paris-Match* (1,500,-000) and *Jours de France* (515,000). None of the women's magazines exceeds a circulation of 2,000,000 copies.

The Havas News agency, founded by Charles Havas in 1835, achieved a virtual monopoly of foreign news by furnishing the most economical method for newspapers to obtain such news and by cultivating close relations with government. Auguste Havas, Charles's son, took over the Agence Havas in 1850 and six years later added an advertising agency, exchanging his news for advertising space. The agency gained in power during the ensuing 50 years, and in the 1920s absorbed several others. For the 75 years preceding World War II, Havas handled a very large proportion of French advertising, including *publicité d'influence* for government and finance. It handled large sums for the French government and also for certain foreign powers. In 1940 the Vichy government, having taken over the entire Havas business, divided the news and advertising services. The former was called Office Français d'Information; the latter, under the old name, became solely an advertising agency and continued after the liberation.

During the German occupation (1940–44) the Free French set up the Agence Française Indépendante, with headquarters in London, supported by Allied funds. After the liberation this became Agence France-Presse. In the early 1960s it distributed 70,000 words a day to 5,500 subscribers in 106 countries.

English-language journalism in Paris began with Sampson Perry's *Argus* (1809), a Napoleonic organ. This was followed by *Galignani's Messenger* (1814–1904). In 1887 James Gordon Bennett, Jr., founded in Paris the European edition of his *New York Herald*, which became the leading English-language paper on the continent. The *Herald* absorbed the European edition of the *Chicago Tribune* (1917–35) and in 1935 changed its name to *Herald Tribune* to conform with the title of the parent paper. In 1966 a leading Washington, D.C., daily bought into the enterprise, and the paper was renamed the *New York Herald Tribune-Washington Post International*. Demise of the New York paper (*see* above) in April 1967 was followed in May by merger of the Paris edition with the *New York Times*'s international edition (founded 1949; published in Paris from 1960) under the traditional name *Herald Tribune*.

V. OTHER WESTERN EUROPEAN COUNTRIES

1. Norway.—The Norwegian press apparently began with the founding of the *Norske Intelligenz Sedler* in Oslo in 1763, and two years later the *Efterretninger fra Addressecontoiret* in Bergen. The latter was a mercantile and labour bulletin which preceded the partisan political press that eventually came to be characteristic of Norway. Shortly after the union with Sweden in 1814, a number of political papers were begun in Oslo, of which the *Morgenbladet*, still published in the second half of the 20th century as a Conservative daily, became one of the best known. In the early 1960s there were 81 daily papers with a total sale of 1,691,000 copies. The *Aftenposten* of Oslo had the largest circulation—about 173,000 copies.

2. Sweden.—Though a newssheet called *Hermes gothicus* is known to have been published as early as 1624 in Strängnäs, and similar corantos were published in other Swedish towns, the first paper published with regularity appears to have been the *Ordinari post tijdender*, begun in 1645 and, in the second half of the 20th century, the oldest continuously published newspaper in the world, though little more than an official bulletin, under the title *Post och inrikes tidningar*. Its founder was Johan Beijer, Sweden's second postmaster general. It became a daily in 1820. The Swedish press has also the oldest legally protected guarantees of press freedom in the world in the press law of 1766.

The oldest continuously published newspaper in the early 1960s was the *Norrköpings Tidningar Östergötlands Dagblad* founded in 1758. In the early 1960s there were 186 daily papers with a total circulation of 3,809,300. This represented a sale of over 50 copies for every 100 inhabitants, one of the largest ratios in the world. Stockholm papers with large circulations were the liberal *Expressen* (384,000), an evening paper, followed by the liberal *Dagens Nyheter* (350,000) founded in 1864 and the Social Democratic *Stockholms-Tidningen* (144,300), with its evening associate *Aftonbladet* (197,000) founded in 1830, while the liberal *Götheborg-Posten* founded in 1813 had a circulation of 237,100. The conservative *Svenska Dagbladet* (published in Stockholm had a high reputation in and out of Sweden.

3. Denmark.—The first licence to publish a newspaper in Denmark was granted in 1634, and the oldest surviving newspaper is the *Berlingske Tidende*, which began publication, although under a different name, in 1749. Three newspapers have been published under their present name since the 18th century, *Aalborg Stiftstidende*, Aalborg (1767), *Fyens Stiftstidende*, Odense (1772) and *Aarhus Stiftstidende*, Aarhus (1794). They are all conservative newspapers with a circulation of 40,000–60,000.

The main liberal and social-democratic newspapers were founded in the later part of the 19th century. In the early 1960s the most recent addition to the Danish newspapers, the independent *Information*, grew out of clandestine papers of the resistance movement during World War II. Danish newspapers serve a geographical area and the close relations between newspapers and readership is an important characteristic of the Danish press. Morning papers are published seven days a week, usually with a much larger Sunday circulation. The number of dailies declined after World War II but there were 82 published (not counting a similar number of branch papers) in the early 1960s with certified net circulation (seven days a week) of approximately 1,650,000 copies, corresponding to 1.1 per household. Sixty smaller papers have ceased publication since World War II. Ten dailies are published in Copenhagen, selling together about 700,000 copies.

The leading conservative papers in the early 1960s were *Berlingske Tidende* (171,600), Copenhagen, and *Jyllands-Posten* (62,000), Aarhus, with the radical liberal *Politiken* (138,000), Copenhagen. The Social Democratic press published 11 newspapers with a joint circulation of 121,000 copies, the main one being *Aktuelt* (41,000) in Copenhagen. The leading liberal newspapers were *Vestkysten* (44,000), Esbjerg, and *Fyns Tidende* (36,-000), Odense. *Borsen*, Copenhagen, specialized in financial and commercial news. Popular mid-day papers were *B.T.* (162,000), and *Ekstrabladet* (82,000). The news agency Ritzaus bureau, created in 1866, is owned jointly by the Danish press.

4. Iceland.—Iceland had a monthly periodical as early as 1773. A weekly, *Thjodólfur*, was begun in 1848; and the first daily was *Dagskrá* (1896). The oldest surviving daily paper in the early 1960s was the Conservative *Visir* (1910), and the daily with the largest circulation was another Conservative paper, *Morgunbladid*, followed closely by the Progressive or Co-operative party's *Timinn*. The Social Democratic *Althýdubladid* and the Radical-to-Communist left *Thjódviljinn* were also dailies of importance.

5. Finland.—The first newspaper in Finland was published in the Swedish language in 1771, and the first in Finnish appeared in 1776. The oldest paper still published in the early 1960s was the *Åbo Underrättelser* (1824) of Turku, while the oldest in Helsinki, the capital, was *Uusi Suomi* (1847). Largest of the dailies was the *Helsingin Sanomat* (1889), with 270,000 circulation. There were 93 daily papers in the early 1960s of which 11% were printed in Swedish, the most important being *Hufvudstadsbladet*.

6. **Belgium.**—Some of the earliest newssheets in Europe were printed in Belgium. It has been claimed that Abraham Verhoeven's newssheets, authorized for publication as *Nieuwe Tydingen* in Antwerp in 1605, constitute the first occidental newspaper, though the earliest extant copy is one for 1621. Newspapers were, of course, under the control of the various national authorities which ruled what is now Belgium over the long period before the constitution of 1831 declared for freedom of the press. Under the liberal provisions of that document Belgium developed vigorous newspapers despite the competition afforded by the French press and the hardships suffered in two world wars.

In 1831 the 10 dailies in the country were all printed in French, and as late as 1848 there were 38 dailies, all in that language, but by 1860 there were 9 Flemish dailies. Most of the large Belgian papers had Sunday editions, and some published weekly illustrated supplements.

By the early 1960s there were 47 daily papers in Belgium, some of these being subsidiary or regional editions. Twenty-eight of these were in French, 18 in Flemish and 1 in German, though the combined circulation of the French papers was only slightly higher than that of the Flemish. The combined national circulation of dailies was roughly 2,500,000, of which half was edited in Brussels. Largest of the Brussels papers was *Le Soir* (1887) with 295,000, followed by *Het Laatste Nieuws* (1886) with 270,000, and *La Dernière Heure* (1906) and *La Libre Belgique* both at 170,000. The latter paper was founded in 1885 as *Le Patriote*, but took its present name when it went underground during the German occupation in World War I. The largest Antwerp paper was the *Gazet van Antwerpen* (1891) with a circulation of 167,000; in Ghent the *Het Volk* has a circulation of 210,000, and in Liege *La Meuse* one of 190,000. The national news agency was Belga.

7. **The Netherlands.**—Dutch printers were among the first Europeans to exercise the art, and such early printers as George Veseler, Broer Jonson and Adrian Clarke issued some of the corantos which were the forerunners of regularly published newspapers. Some such papers appeared in Amsterdam before 1620. In 1656 was founded what by mid-20th century was the oldest paper published in the Netherlands, the *Oprechte Haarlemsche Courant*, which became a daily in 1847.

The *Algemeen Handelsblad*, founded in 1828 as *Nieuwe Amsterdamse Courant*, was the first daily in the country. The paper with the largest circulation in 1964 was the Socialist *Het Vrije Volk* (308,700) with editions in 45 cities and towns. Next largest was *De Telegraaf* (281,000), founded in 1893 by H. M. C. Holdert. It was suspended after World War II for its collaborationist activities, but was allowed to resume in 1949. Other widely read papers were the Catholic *De Volkskrant* (162,000); the independent *Het Parool* (215,000); the independent *Algemeen Dagblad* (137,750), Rotterdam; the Catholic *Tijd de Maasbode* (92,500); and the antirevolutionary *Trouw* (100,000), Amsterdam.

The most famous paper outside Amsterdam was the *Nieuwe Rotterdamse Courant* (1843), Rotterdam, founded and conducted by the Nijgh family (circulation 56,000). In 1964 there were 93 newspapers including 10 national dailies. The circulation of the 83 regional dailies was 2,000,000 and that of the national dailies 1,400,000.

The news agency Algemeen Nederlandsch Persbureau was founded in 1934.

8. **Switzerland.**—Newssheets known as *Ordinari Wochenzeitung*, published at Basel in 1610, have been cited as constituting a newspaper and thus the beginning of the history of the Swiss press. Political and religious struggles, however, allowed little opportunity for the development of a regular journalism until the "period of regeneration," which began about 1830 and was followed by the federation of 1848. The federal constitution provided for liberty of the press which, except for short periods during World Wars I and II, was free of administrative control.

Of the 117 daily papers in the early 1960s, 84 were printed in German, 27 in French and 6 in Italian; there was no longer a daily in Romansh. The largest circulation was that of the *Tages-Anzeiger* (1893) in Zürich, with 158,000 daily circulation; all other papers had less than 100,000. However, some of them are well known outside Switzerland, including the *Neue Zürcher Zeitung* in Zürich (1780), the *Gazette de Lausanne* (1798) and the *Journal de Genève* (1826).

9. **Austria.**—At least three weekly newssheets are known to have existed in Vienna before 1620. Though limited in its development by the usual censorships of the 17th and 18th centuries, the Viennese press gained a wide reputation for good writing and criticism. The reign of Joseph II (1780–90) brought a helpful liberality in newspaper licensing, but the following reign and the rule of Metternich were less favourable. The revolutionary disturbances of 1848 brought a new severity into censorship and reduced the 200 papers then published in Austria-Hungary (90 of them dailies) by about half. Not until 1867 was there a relatively free press. Two newspapers which had been founded in Vienna within the first three years of the 18th century—*Posttägliche Mercurii Zeitung* and *Wiener Diarium*—were in 1780 combined as the *Wiener Zeitung*, long the government organ and serving in that capacity in the early 1960s.

Nearly all the existing Austrian papers had been founded since World War II. The chief exception besides the *Wiener Zeitung* was the *Arbeiter Zeitung* (1889), official Socialist organ, which with the *Österreichische Neue Tageszeitung* (1947), chief organ of the majority People's party, led the Vienna press. *Das Kleine Volksblatt* (1929), a tabloid, also represented the People's party. One of the leading Austrian papers in the early 1960s was the independent daily *Die Presse* while the *Neuer Kurier* had the largest circulation: 226,000 during the week and 296,000 on Saturdays. The provincial press increased in number and influence in the postwar period, partly because of the development of the party press; prominent among these were the *Salzburger Nachrichten* and the *Oberösterreichische Nachrichten* of Linz. Many papers were owned by political groups. In the early 1960s there were 35 dailies with a total circulation of 1,200,000.

10. **Spain.**—The history of the Spanish press is chiefly a history of censorship, with intermittent eras of relative freedom. The first authorized papers appeared only after the declaration for liberty of printing by the *Cortes* of Cadiz on Nov. 10, 1810; this was withdrawn in 1814, re-established in 1820 and then annulled 1823–34. The periods of authorized publication were too short to permit the development of important newspapers. Exceptions to the short-lived nature of newspapers before the constitution of 1869 were the government bulletin *La Gaceta de Madrid* (1661), begun as a monthly, later published weekly and made a daily in 1890; and *Diario de Barcelona* (1792), which, as the leading and semiofficial paper of Catalonia, was independent of Spanish censorship. Spanish papers were generally political, often in revolt against censorship and inadequately financed.

The civil war of 1936–39 reduced daily papers in Spain from 250 to fewer than 100. In the early 1960s there were 105 dailies with a total of around 3,000,000 copies. Control of the press in the second half of the 20th century was somewhat less strict than during the war, though the old system of the *editores responsables* approved by government, first set up in 1833 at the outbreak of the Carlist uprisings, was again in use. In 1962 newspaper censorship was officially alleviated but articles still had to be submitted to the censors and the real extent of freedom of the press was problematic.

Eight daily papers were published in the early 1960s in Madrid. The leading morning papers were *A.B.C.* (Conservative) and *Ya* (Catholic), each printing 175,000 copies, followed by *Arriba*, the political organ of the National movement, with 50,000 copies. Madrid evening papers consisted of *El Alcazar* (colour-engraved), the very popular *Madrid* and *Informaciones* and *Pueblo*, the organ of Syndicates and the largest, with a circulation of 100,000. Six daily papers were published in Barcelona; *La Vanguardia Española* had the largest circulation in Spain (180,000). Nearly all the Madrid and Barcelona morning dailies ran popular Sunday colour-engraved supplements, with a combined total of 200,000 copies.

Growing daily papers in provincial cities were *La Gaceta del Norte* (Bilbao), *El Heraldo de Aragon* (Saragossa), *Las Provincias* (Valencia) and *Ideal* (Granada).

Among weeklies *Siete Fechas* (250,000) was the most popular while *Gaceta Illustrada* had a high reputation.

There were four main national news agencies in the early 1960s, Cifra, Logos, Pyresa and Mencheta, while Efe supplied international coverage.

11. Portugal.—Successive governments of Portugal allowed scant and temporary liberty of the press. The constitutional provisions of 1911, separating church and state, provided for press freedom, but the dictatorship which developed under the constitution of 1933 was unfriendly to independence of the press. Thus no great newspapers have developed in this country.

In 1962 there were ten dailies in Lisbon, four in Oporto, three in Evora, two in Braga and one in Coimbra and Beja. About 150 weeklies, semiweeklies and triweeklies were published in the country. Largest of the Portuguese papers were *Diário de Notícias* (1864) with 120,000 circulation and *O Século* (1880), Lisbon, with 90,000.

12. Italy.—The name "gazette," which was for so long a more common generic designation of printed sheets or pamphlets of news than "newspaper," is believed to have been derived from *gazzetta*, a small coin used in Venice in the 16th century, which may have been the price of early *fogli d'avvisi* or the admission to a group which listened to the reading of such newssheets. Venice was a chief centre for the written newsletters of the middle ages, and weekly printed newssheets appeared in Florence as early as 1636, the work of Amador Massi and Lorenz Landi. The first Italian paper with a continuous title appears to have been *Sincero*, published in Genoa in 1645.

The press of Italy, always subject to more or less severe government controls, lent itself to reform and even revolutionary movements. Giuseppe Mazzini was an active journalist; and Count Cavour's *Il Risorgimento*, which he founded with Count Cesare Balbo in 1847, was the great organ of the national movement. The constitution of 1848 declared for freedom of the press, yet "special laws," it stated, would "punish abuses." Accordingly, a set of press edicts was issued which retained effective political controls and remained in use until the sterner censorship of the Fascist regime.

In 1920 there were 157 daily papers and 843 weeklies in Italy. Following Benito Mussolini's march on Rome in 1922, the national press regulations were adapted to the pattern of a totalitarian state, with very definite editorial policies prescribed for them almost day by day. Opposition papers were suppressed and their editors disposed of. Mussolini himself had been a journalist, editing the Socialist *Avanti* of Milan in 1912–14, and resigning that position to found his own *Il Popolo d'Italia*, which he edited until 1922. Under his dictatorship, Italian dailies were reduced to 50 or 60. Much the oldest of the survivors was the *Gazzetta di Venezia* (1787). *L'Osservatore romano* was founded as the papal organ in Rome in 1861.

The Agenzia Stefani was set up by Count Cavour in 1853 under the management of Wilhelm Stefani. It functioned as a government news agency in Rome under all changes and through the Fascist era. In 1945 a new national news agency was created under the name Agenzia Nazionale Stampa Associata (ANSA).

World War II put an end to many of the older newspapers but with peace came many new ventures, and in the early 1960s there were 95 daily newspapers published, 27 of which were evening papers and 4 sports papers; 3, including the *Daily American* in Rome and the German *Dolomiten* at Bolzano, were published in foreign languages. Of the daily papers 54 were published in northern Italy (12 in Milan) and only 7 in southern Italy (5 in Naples). Twenty dailies were published in Rome and nine in the islands. There were 102 periodicals with circulations of over 25,000.

The *Corriere della sera* (Evening Courier; 1876) of Milan had the largest circulation, 496,000; despite its name it was a morning paper with an evening associate *Corriere d'informazione*. *Il Giorno* (1955), owned by the Ente Nazionale Idrocarburi, was also published in Milan (330,000). *La Stampa* (372,000) was founded in Turin as *La Nuova Stampa* (1868). In Rome leading dailies were *Il Messaggero*, *Il Tempo*, the Communist party paper *L'Unità* (1945) and the Socialist party paper *L'Avanti*. The Rizzoli publishing house planned to open the first national daily *Oggi* in 1964, printing simultaneously in Milan and Rome.

A particular feature of Italian journalism was the *terza pagina* ("third page"), traditionally devoted to culture, book or theatre reviews and scientific discoveries.

13. Greece.—The first Greek papers were published in foreign capitals by refugees from Turkish rule and propagandists for Greek freedom. These appeared in Vienna, Paris and London from 1790 to 1820. The first Greek paper in the homeland appeared immediately after the beginning of the Greek war for independence—the *Salpinx Helleniki*, founded at Nauplia in 1821. An especially interesting journal was the *Hellenika Chronika*, edited 1824–26 at Missolonghi by a Swiss doctor, Jacques Mayer.

In the mid-1960s there were 95 daily papers published, of which 27 appeared in Athens. The largest of these was *Ta Nea* (118,000) and the second largest and oldest in the country was *Akropolis* (80,000) founded in 1881. The daily *Kathimerini* (1919) had a sale of about 40,000. The largest papers outside Athens were *Makedonia* (1908) with a sale of about 31,000 and *Ellinikos Vorras* with one of 22,000, both published in Salonika.

14. Turkey.—The earliest papers in Turkey were French journals published in the last decade of the 18th century. The first Turkish paper was *Takvime Vekayi* ("Calendar of Events"), a version of *Moniteur Ottoman*, begun in the same year (1831) by Alexandre Blaque. A period of severe repression followed the first press law in 1865 though the constitution of 1908 released a flood of new Turkish newspapers. The establishment of the republic in 1923 and the change from the Arabic to the Latin alphabet in 1928 enabled considerable development of the press. Press freedom was guaranteed by the 1961 constitution.

In the mid-1960s there were 836 daily publications and 817 periodicals being published. Of the newspapers and periodicals, 93 were published in foreign languages: 40 in English, 11 in Armenian, 15 in Greek, 11 in French, 5 in German and 4 in Italian. Total newspaper circulation was around 1,353,000, leading dailies being *Hürriyet* (about 500,000) and *Milliyet* (300,000), both published in Istanbul, the Turkish press centre. Of the leading dailies distributed all over the country, 13 of them were published in Istanbul and 8 in Ankara. These are mostly politically independent, although a few have party affiliations, such as *Ulus* (Republican People's party), in Ankara.

VI. EASTERN EUROPEAN COUNTRIES

1. The U.S.S.R.—The first Russian journal is said to have appeared in 1703, but the severe censorship imposed upon the press by the government prevented the development of a press adequate to the extent and population of the country. As newspapers developed in the 19th century, they came to emphasize literature and art and the political policies of government. Nicholas I permitted only 6 newspapers to be published at mid-19th century, but Alexander II allowed more than 60 to be started in the first decade of his reign, 1855–65. These papers soon developed a radical individualism (known as nihilism) which brought back strong repressive measures against the press, and these remained in effect past the end of the century. By 1913 there were 859 papers in all of Russia, approximately 50 of them dailies. A quarter of the daily papers were published in St. Petersburg. Among the latter were such famous papers as *Novoye Vremya* and *Ryech*.

Meantime, the revolutionary press, now regarded as the forerunner of the modern Soviet Union press, began with *Kolokol* ("Bell"), founded first as a monthly by the refugee A. I. Herzen in London in 1857; it was soon made a fortnightly and lived for ten years, exerting a considerable influence on reforms in Russia. Similar revolutionary journals were set up by refugees in other capitals, such as Geneva and New York, and in the 1880s and 1890s there were many illegal sheets in St. Petersburg. The first legal bolshevist paper was *Novaya Zhizn* ("New Life"), founded under Lenin's leadership in 1905. In 1910 *Zvezda* ("Star") was founded in St. Petersburg to combat other leftist groups, and two years later its place was taken by *Pravda* ("Truth"), which after the Revolution of 1917 became the leading Soviet organ and was published at Moscow.

In 1922 the periodical publications of the U.S.S.R. were placed in a carefully devised system which was enlarged to great proportions. Propaganda for the economic, political and social building and maintenance of the U.S.S.R. became the dominant function of the Soviet press.

Various central (All-Union) papers are published in Moscow including the party paper, *Pravda*, and that of the Soviets, *Isvestiya* (1917), those catering for special interests such as agriculture, business and culture as well as those of the social organizations such as the young communists, the trades unions, the union of writers and the sports organizations. At the republican level the papers tend to be joint publications of the party, state and government.

In the early 1960s there were 6,804 news publications in the U.S.S.R. with an aggregate print of 66,700,000. Twenty-five of these, with a total print of 23,524,000, were national newspapers, 180 were republican papers, 96 were regional papers and roughly 3,800 were local city papers. The rest were small, institutional papers, published at army installations, in schools and scientific institutions, and in factories and mills. In addition to these newspapers there were 2,740 collective farm newspapers printed in 17 languages, with a total print per issue of 1,900,000 copies. Newssheets pasted on walls were a regular feature of Soviet life in almost every factory, office, farm, school, college and army unit and some produce several, covering sports, arts and culture, etc. Many institutions also issued a regular mimeographed newssheet

Newspapers in the Soviet Union in the early 1960s were published in 60 languages, one-third of which did not exist as written languages before the Revolution. Of these newspapers 4,665 were in Russian; the other main groups were Belorussian, 154 papers; Uzbek, 112 papers; Ukrainian, 814 papers; Kazakh, 144 papers; and Georgian, 95 papers. Seven foreign language papers were also published.

Pravda was the leading party paper of the Soviet Union; it appeared every day of the year and tended to publish official statements in full. During World War II it was reduced to 2,000,000 but in the early 1960s it had one of the world's largest circulations, publishing 6,700,000 copies. Mats were sent by air to different parts of the U.S.S.R. where regional editions were printed. Leading party papers outside Moscow in the early 1960s included *Leningradskaya Pravda* (Leningrad), *Radyanska Ukraina* (Kiev), *Zvyazda* (Minsk), *Moldova Socialiste* (Kishinev), *Kommunist* (Tiflis), *Sovietakan Hayastan* (Yerevan), *Sotsialistik Kazakhstan* (Alma-Ata), *Kzyl Uzbekistan* (Tashkent), *Sovettik Kyrgyztan* (Frunze) and *Tajikistani* (Dushanbe).

Among leading Moscow papers was *Izvestia*, which had in the past tended to be an official gazette. In 1960 it was converted from a morning to an evening paper and its circulation in the early 1960s was 4,150,000. It published a Sunday supplement *Nedelya* (The Week). *Krasnaya Zvezda* was the daily organ of the armed forces. *Trud* (1,540,000) was published daily by the central council of trades unions and *Gudok* by the railways. Other papers were the building *Stroitelskaya gazeta* (thrice weekly), the agricultural *Selskaya Zhizn* (daily) and the business paper *Ekonomicheskaya gazeta*. *Sovetskaya Rossiya* (the Communist party and Russian Soviet Federated Socialist Republic government) printed 1,955,000 copies and *Sovetsky Sport* 850,000.

The central youth daily, *Komsomolskaya Pravda*, circulated 3,350,000 copies; *Pionerskaya Pravda*, published twice weekly for children, 4,050,000 copies.

Cultural papers published in Moscow were *Literaturnaya gazeta* thrice weekly and circulating 620,000 copies, *Sovetskaya Kultura* issued twice weekly by the ministry of culture and *Literaturnaya Rossiya* (weekly) started in 1963.

The official news agency Telegrafnoye Agentstvo Sovietskogo Soyuza (Tass) was founded in 1925 to collect foreign as well as domestic news for distribution to Soviet papers and after 1961 there was an unofficial agency *Novosti* which distributed news, feature articles and interviews, etc., to the foreign press as well as to the Soviet press.

2. The Baltic S.S.R.—There were Estonian newssheets as early as the 17th century, but the modern press of Estonia began with the foundation of the *Postimees* in 1857, which in 1939 had a circulation of 25,000. The *Päewaleht* (1905) and *Uus Eesti* (1934) had the largest circulations, each of about 50,000. In 1939 the country had 15 dailies, 12 of them in Estonian. The leading Communist dailies after 1945 were *Rahva Hääl* in Estonian and *Sovietskaya Estonia* in Russian.

The earliest Latvian newspaper was the daily *Latviešu Avīzes*, founded at Jelgava (Mitau) in 1822. The weekly *Mājas Viesis* was published in 1856, while in 1862 *Pēterburgas Avīzes* was published in St. Petersburg where censorship conditions were easier. *Baltijas Vēstnesis* (1868) and *Balss* (1878) were founded in Riga. The left-wing movement exerted a big influence with *Dienas Lapa* from 1886. The Riga paper *Jaunā Dienas Lapa* (1906) changed its name many times because of censorship. *Jaunākās Ziņas* (1911) was the biggest daily during Latvia's independence (200,-000). In 1939 there were 133 papers, 22 of them dailies. After occupation in 1940 all papers were stopped except *Cīņa*, the Communist party paper formerly printed in Moscow. In the 1960s *Cīņa* appeared 300 times a year and *Padomju Jaunatne* 256.

The first Lithuanian newspaper, the *Kurjer Litewski*, was founded at Vilnius (Wilno) in 1759 and was printed in Polish. The first paper in Lithuanian was *Aušra*, founded in 1883, which in 1889 was replaced by *Varpas*, both being published at Tilsit in what was then East Prussia. In 1905 the daily *Vilniaus Žinios* was founded at Vilnius. The *Lietuvos Aidas*, founded at Vilnius in 1917, was later transferred to Kaunas and in 1939 had a circulation of 17,000. There were more than 100 periodicals in Lithuania before 1940. After 1945 the two leading Communist dailies were *Tiesa* in Lithuanian and *Sovietskaya Litva* in Russian.

3. Poland.—The origins of the Polish press go back to 1661 when Jan Aleksander Gorczyn started to publish his *Merkuriusz Polski*, first in Cracow and later in Warsaw. The first newspaper in Warsaw was the *Gazeta Warszawska*, which started in 1774. The *Kurjer Warszawski* was founded in 1821. Before World War I there were important newspapers in all the three parts of Poland—Russian, German and Austrian—but only in the last named was the press free. After the restoration of Polish independence the press remained regional; with a few exceptions, none of the dailies had a national circulation. In 1937 there were 2,692 periodical publications, including 184 dailies. Among newspapers published in Warsaw the Roman Catholic *Mały Dziennik* had the largest circulation (125,000), followed by the *Kurjer Warszawski* (60,000) and the *Gazeta Polska* (30,000). The *Illustrowany Kuryer Codzienny*, founded in Cracow in 1906, had a circulation of 80,000 in 1937. In Poznan the largest circulation was that of *Kurjer Poznański* (40,000), founded in 1906. The Socialist daily *Robotnik* had a circulation of only 15,000 but it was famous for having been published from 1894 to 1918, clandestinely or abroad. Its first editor was Joseph Pilsudski.

The entire Polish press was closed down by the Germans in 1939. None of the pre-1939 newspapers was allowed by the Russians to reappear after 1945. By 1948 the press was under complete Communist control. From 1956 the Polish press fought for more objective reporting, better information and the supression of censorship. Compared with that of other Communist countries, the Polish press was readable, vivid and independent.

In the early 1960s, 53 daily newspapers were published with a combined circulation of 5,650,000. Ten dailies were published in Warsaw alone, among them *Trybuna Ludu* (300,000), the central organ of the Polish United Workers' party. Ten provincial towns published two or more papers. The most popular evening paper was *Expres Wieczorny* (465,000), published in the capital.

Among the periodicals with large circulations were *Przyjaciółka* (Woman's Friend), 1,850,000, and *Gromada-Rolnik Polski*, a farming paper, 550,000. Popular weeklies included *Przekrój* (Cross Section) and *Swiat* (World), as well as *Polityka* (Politics), a political and social weekly. After 1945 there was only one official news agency, PAP (Polska Agencja Prasowa).

4. Czechoslovakia.—The oldest Czech daily newspaper was the *Národni Listi* founded in Prague in 1860. It was followed by

the *Národní Politika* in 1883, by the *Lidové Noviny* (Brno) in 1893, the Social Democratic *Právo Lidu* in 1897, the *České Slovo* in 1909 and the Agrarian *Venkov* in 1917. After the creation of the republic the Communist *Rudé Právo* appeared in 1920. In 1937 the total number of periodical publications was about 3,500, including 1,200 in Prague alone. The largest circulations in 1937 were those of *Polední List* (120,000), *Národní Politika* (145,000) and *Právo Lidu* (118,000). In Slovakia the largest newspapers were the *Slovák* (45,000) and the *Slovenský Dennik* (40,000), both in Bratislava. There were also German, Magyar, Polish and Ukrainian newspapers. The *Deutsche Zeitung Bohemia*, founded in Prague in 1828, was the oldest daily newspaper published on Czech territory.

The Czechoslovak press was of high standard, both technically and in the manner of news reporting. It disappeared with the annexation by Germany in 1939. After 1945, of the pre-World War II newspapers, only *Rudé Právo* continued to appear, becoming the organ of the Communist party and having in the early 1960s a circulation of 1,000,000. There were, in the early 1960s, 19 dailies in Czechoslovakia of which 8 were published in Prague and 5 in Bratislava. Other dailies were: *Lidová Demokracie* (organ of the People's party), *Práce* (trade unions) and *Mladá Fronta* (Youth league). There was only one official news agency, ČTK (Československá tisková kancelář).

5. Hungary.—A Latin weekly sheet, *Nova Posoniensia*, founded in Pozsony (now Bratislava, Slovakia) by Matyas Bel in 1721, was the first Hungarian journal. The first periodical in Magyar was the weekly *Magyar Kurir*, founded by Samuel Decsy in Vienna in 1789. The first Magyar journal, circulated privately in Budapest under the title *Országyülési Tudositások*, consisted of the parliamentary reports of Lajos Kossuth (1832–36). In 1841 Kossuth became editor of the Liberal daily *Pesti Hirlap*, while Counts Aurel and Emil Dessewffy started the Conservative *Világ*. There was a remarkable development of the Hungarian press after 1867, with great latitude for free expression. The number of periodical publications increased from 80 in that year to about 2,000 in 1914. After World War I the Hungarian press was reduced in numbers; in 1937 it comprised about 1,200 publications, including 74 dailies. The *Függetlenség*, a daily newspaper founded in 1933 by Gyula Gombos, had the largest circulation (160,000). It was followed by the *Pesti Hirlap* (100,000), the Social Democratic *Népszava* (founded 1872; circulation 180,000) and *Az Est* (founded 1909; circulation 60,000). After 1945 the Hungarian press recovered much freedom, and by 1964 was not entirely Communist controlled (*e.g.*, *Népszava*, above, and *Magyar Nemzet*, organ of the Patriotic People's front, 120,000). *Szabad Nep*, the principal party organ, changed its name to *Népszabadság* (People's Freedom) after the rising of Oct.–Nov. 1956.

In the early 1960s, 26 dailies were published in Hungary, 4 of these, including *Népszabadság* (700,000), being published in Budapest. Total circulation was 1,635,000 compared with 1,078,000 before World War II. Numerous weeklies and periodicals were also published; *Szabad Föld* (Free Land), *Nök Lapja*, the illustrated weekly of the council of Hungarian women, and *Ludas Matyi*, a satirical paper, all have a wide circulation. Papers were also published for the German, Serbian-Croatian, Slovak and Rumanian population.

6. Rumania.—The first Rumanian political periodical was the *Curierul Românesc*, founded in Bucharest in 1828 by I. Eliade Rădulescu, while the first daily in Rumanian, the *Gazeta Transilvaniei*, appeared in 1838 in Brasov (Kronstadt), then in Hungary. The press developed after the union of the principalities (1859) and more so after the country's unification (1918). By 1937 there were 2,253 periodicals including 104 dailies. *Universul*, founded in 1882, had the largest circulation (140,000); it ceased publication in 1953. Other important newspapers were *Adeverul* (100,000), *Dimineața* (90,000), *România* (80,000) and *Argus* (30,000). The restored freedom of the press after World War II was quickly stifled and by 1948 strict Communist censorship prevailed. In the early 1960s there were 32 daily papers of which 19 were in the languages of national minorities. Their combined print total was 2,850,000. *Scînteia* (880,000) was the main Communist party daily organ, *Rominia Liberă* being the government's organ and *Munca* that of the trade unions.

7. Bulgaria.—The first political newspaper published in Bulgarian, the *Bulgarski Orel*, was founded in 1846 in Leipzig, Ger., by Ivan Bogorov. Two years later the Turkish government authorized the publication in Istanbul of the *Tsarigradski Vestnik*. The first daily published on Bulgarian soil was the *Balkanska Zora* founded in 1890 at Plovdiv. The first daily in Sofia was the *Vecherna Poshta*, founded in 1900. By 1914 there were 310 periodical publications. In 1937 there were 25 dailies in Sofia alone with *Utro* and *Zora* having the largest circulations (85,000 and 73,000 respectively). In the early 1960s there were 292 newspapers and periodicals published, including 70 provincial papers with a combined circulation of 1,700,000 and 8 daily papers in Sofia with a combined circulation of 1,500,000. The leading dailies were *Rabotnichesko Delo* (450,000), organ of the Central Committee of the Bulgarian Communist party, followed by *Otechestven Front* ("Fatherland Front"; 200,000) and the organs of the Youth union *Narodna Mladezh*, of the Agrarian union *Zemedelsko Zname* and of the trade unions *Trud*. Popular weeklies were the satirical journal *Sturshel* ("Hornet") and *Septemuriiche* for children. Papers were also published in several foreign languages.

8. Albania.—The first daily newspaper, the *Ora*, was founded at Tirane in 1930. From 1945 there were two daily newspapers: *Zëri i Popullit* ("The Voice of the People"), the Communist party organ, and *Bashkimi* ("Union"), the organ of the People's front.

9. Yugoslavia.—The first newspaper in Serbian, *Srpskija Novini*, was founded in 1791 in Vienna; later Serbian journals appeared in Budapest and Venice. The first newspaper published in Serbia was *Srbske Novine* (Kragujevac, 1834), the first in Croatia *Narodne Novine* (Zagreb, 1835), the first in Slovenia *Ljubljanske Novize* (Ljubljana, 1797). After the creation of independent Yugoslavia in 1918 the Serbian, Croatian and Slovene press developed considerably in numbers and quality. In 1937 there were 1,231 periodicals including 50 dailies; *i.e.*, 13 Serbian (mainly in Belgrade), 21 Croatian (mainly in Zagreb), 6 Slovene (mainly in Ljubljana) and 10 dailies published by the national minorities. In 1939, among the Serbian newspapers the *Politika* (1904) had a circulation of 100,000, the *Vreme* (1921) 65,000 and the *Pravda* (1904) 38,000; in Croatia the *Novosti* (1906) and in Slovenia the *Slovenec* (1871) had circulations of 30,000 each. The Croatian *Obzor*, the oldest existing Yugoslav daily (founded in 1860), in 1939 had a circulation of 7,000.

After World War II the number of papers increased. The most circulated papers were *Borba* and *Politika* (Belgrade). *Borba* was the organ of the Socialist Alliance of the Working People of Yugoslavia, and *Komunist* (issued weekly) was the official organ of the League of Communists of Yugoslavia. *Borba* was published in two editions, in Cyrillic for Serbia, Montenegro, Macedonia, Bosnia and eastern Hercegovina, and in Latin characters for Croatia, Slovenia, Bosnia and western Hercegovina. Other important papers in the early 1960s were *Vjesnik* (Zagreb), *Delo* published in Slovenian (Ljubljana), *Oslobodjenje* (Sarajevo), *Nova Makedonija* published in Macedonian (Skopje) and *Pobjeda* (Titograd). The official news agency, Tanyug, provided uniformity in all except regional and occupational news.

VII. COMMONWEALTH OF NATIONS

1. Canada.—The first Canadian newspaper was the *Halifax Gazette*, founded by John Bushell as a two-page weekly in 1751. In 1770 Anthony Henry combined this paper with his *Nova Scotia Gazette* and continued it for many years. First paper in Quebec was the *Quebec Gazette*, founded by William Brown and Thomas Gilmore in 1764 and printed in both English and French; it lasted for more than 100 years and was finally merged in the *Morning Chronicle* (1847) which, after a combination in 1926 with the *Telegraph* (1872), became known as the *Chronicle Telegraph*. First in Montreal was *La Gazette Littéraire*, founded in 1778 by Fleury Mesplet (a protégé of Benjamin Franklin) and Charles Berger; the modern *Montreal Gazette* is its descendant. First Ontario paper was Lewis Roy's *Upper Canada Gazette and American Oracle*, established in 1793.

By the early 1960s Canada had over 100 daily newspapers and about 900 weeklies, semiweeklies and triweeklies. Total daily newspaper circulation in Canada was about 4,200,000. Among the leading English-language papers were the *Toronto Daily Star* (1892) with the largest circulation in Canada, the *Toronto Evening Telegram* (1876), the *Toronto Globe and Mail* (1844), the *Vancouver Sun* (1886), the *Montreal Star* (1869), and the *Winnipeg Free Press* (1874). French language dailies included *La Presse* of Montreal (1884) and *Le Soleil* of Quebec (1880).

A feature in the Canadian newspaper industry in the 1960s was the trend towards consolidation of newspaper ownership. In 1963 when control of the *Vancouver Sun* passed into the hands of Free Press Publications Ltd. of Winnipeg, the Bell-Sifton interests controlled about half of the total western daily circulation of just over a million. Other leading newspaper groups were those of the Southam company and the Thomson company. Consolidation did not, however, extend to the largest of the eastern dailies which continued to operate separately.

Of the 112 daily newspapers in Canada, 101, including all the principal papers, are members of the Canadian Press, the leading national news service. The Canadian Press Ltd. was established in 1911 as a holding company for the Canadian rights to the news services of the Associated Press, until then held by the Canadian Pacific railway. In 1917 the four regional co-operative news associations set up in the previous ten years were merged into the national news co-operative association of daily newspapers which became known as the Canadian Press. It has sole rights to distribute in Canada the news reports of both the Associated Press and Reuters. After 1952 the CP news reports were made available in both French and English. Through subsidiary companies CP delivers news to the Canadian Broadcasting corporation and most privately owned radio and television stations.

2. Australia.—Australia's first newspaper was the *Sydney Gazette*, a weekly publication of four pages, which appeared in 1803. It was printed by George Howe, a convict, under the direction of P. G. King, then governor of New South Wales. Its policy was dictated by the government and thus the *Gazette* was the first of what has been called the "convict press." Other publications in this class included the *Derwent Star* (1810), the *Van Diemen's Land Gazette* (1814) and the *Hobart Town Gazette* (1816), all published in Tasmania. These publications, subservient to the requirement of official policy, were disliked by the growing number of free citizens in the penal colonies of New South Wales and Tasmania. The remainder of the century, therefore, saw the emergence of privately owned papers, hampered at first by censorship and repression, struggling for freedom of the press, and eventually reaching positions of great financial importance.

The tradition of family-controlled papers has been a feature of this press. In April 1831 three young men, two of them from the *Sydney Gazette*, combined to publish the *Sydney Herald*. It was later acquired by Charles Kemp and John Fairfax, the latter a member of a Warwickshire family who had been part-proprietor of a paper at Leamington, Eng. In 1853 the paper, which had changed its name to the *Sydney Morning Herald*, became the sole property of the Fairfax family, and it remained a family concern until 1956, when a public company was formed, which also acquired control of the *Sun*, a Sydney evening newspaper.

In Melbourne, Victoria, the *Argus*, established by William Kerr in 1846, was bought in 1848 by Edward Wilson. It remained a family-controlled paper, under the proprietorship of Messrs. Wilson and Mackinnon, until 1936, when ownership passed to a public company. Subsequently a controlling interest was acquired by Daily Mirror Newspapers, Ltd., London. Publication of the *Argus* ceased in 1957. Another Melbourne newspaper, the *Age*, which had been started in 1854, was acquired in 1856 by David and Ebenezer Syme, of Scottish origins. For a very long time it continued to be controlled entirely by the Syme family, later becoming a public company. David Syme came to exercise great political power.

The second quarter of the 20th century saw a decline in the number of papers published, both metropolitan and country, while the economic crises of the 1930s caused the closing of some publications. By the early 1960s, however, circulations had more than trebled since 1928. Sydney and Melbourne together had more than half of the circulation of Australian dailies.

There have never been national daily newspapers in Australia with circulations and influence extending throughout the country. This is due chiefly to the immense distances to be covered in delivery, the political division of Australia into six states and the concentration of population on the coastal perimeter of the continent. In the early 1960s the 15 metropolitan daily newspapers published in the six state capitals and Canberra all enjoyed considerable circulation and influence within their own state borders. The largest of these were two Melbourne papers, the *Sun News-Pictorial* (576,000) and the *Herald* (480,000), followed by the *Sydney Daily Telegraph* (327,000), the *Sydney Morning Herald* (304,000), the *Sun* (269,000) and the *Daily Mirror* (260,000). There are 35 dailies published outside the capital cities, combining coverage of world and national news with extensive local news, while nearly every town with a population over 20,000 has some form of local newspaper though only 33 centres support 2 or more, and all but 5 of these are in New South Wales or Victoria. About 3% are in foreign languages.

Magazines are published in all the capital cities, but only a few of them have national distribution. Largest of these is the Sydney *Australian Women's Weekly* (835,000). The Sydney *Bulletin*, a weekly founded in 1880 by J. F. Archibald and John Haynes, was still circulating in the early 1960s.

None of the main Australian dailies has any affiliation with the political parties. In the 1960s the only directly controlled Labour daily paper was the *Barrier Daily Truth* (Broken Hill), owned by the district Workers' Industrial union.

With the exception of the *Sydney Daily Mirror* all metropolitan and provincial daily newspapers take their basic world news through Australian Associated Press, Ltd. (formed in 1935), which is linked with the Reuters organization. The metropolitan newspaper groups, however, maintain their own staffs of correspondents in London, New York and elsewhere as occasion arises.

3. New Zealand.—Pioneer English and Scottish settlements in New Zealand made haste to establish newspapers, sometimes even before houses were built. The people were highly literate for the times, and weekly journals were begun, not so much to supply news as to give vent to political opinion, intended to exert pressure not only on the New Zealand authorities but on the British parliament as well. Thus the Wakefield expedition got out a paper, the *New Zealand Gazette* (Samuel Revans, editor), in London before it sailed in Sept. 1839, and published the second issue on arrival in April 1840. The paper survived at Wellington under various titles till 1868. In the north of the country, where Gov. H. Hobson arrived in 1840 to annex the country as a British possession, the *New Zealand Advertiser and Bay of Islands Gazette* (G. A. Eagar, editor) began publication on June 20, 1840, as a fierce opponent of the governor and his supporters. It ceased at the end of the same year. In Dec. 1840 the first official publication, the *New Zealand Government Gazette*, was printed at Paihia at the Church Missionary society's printing office. Each new settlement had one or more newspapers, many of which had very short lives. Communications were poor—the quickest way of sending news from Dunedin to Auckland was by ship to Sydney, Austr., and thence by ship to Auckland, a matter of 2,500 mi. The Devonshire settlers at New Plymouth founded the *Taranaki Herald* in 1852 and the *Taranaki News* in 1857. They both continue as dailies, the former being the oldest newspaper in New Zealand; the latter changed its name in 1959 to the *Daily News*.

In the early 1960s Auckland, with the largest urban population, had two daily papers, the morning *New Zealand Herald* (205,000) and the evening *Auckland Star* (135,000), with the largest circulations in New Zealand. The two surviving newspapers in the capital, Wellington, are the *Evening Post*, founded by Henry Blundell in 1865, with a circulation in the early 1960s of 94,500, and the *Dominion*, Wellington's morning daily, founded in 1907 by C. W. Earle, and edited by him until his death in 1950. Its circulation in the early 1960s was in excess of 94,000.

Christchurch journalism began with the *Lyttelton Times* which

was founded on Jan. 16, 1851, exactly one month from the day the Canterbury association settlers landed at the port. It had been planned in London, and Isaac Ingram, an Oxford printer, was the first publisher. The first editor was J. E. FitzGerald, a member of the committee of the Canterbury association, who, for the two years of his editorship, fought a continuing battle for self-government for the colony. The *Lyttelton Times*, under the editorship of Sam Saunders, became the leading Liberal paper of New Zealand, particularly in the days of the Seddon government (1893–1906). It was opposed by the *Christchurch Press*, founded in 1868 as a Conservative organ. In the same year the *Times* established an evening paper, the *Star*. Just before the outbreak of World War I, E. C. Huie began publishing another evening paper, the *Sun*. The depression years of 1930–35 found the four daily newspapers engaged in a bitter circulation war which ended with New Zealand Newspapers, Ltd., owners of the *Times* and *Star*, closing the *Times* and absorbing the *Sun*.

Thus Christchurch was left with two daily newspapers, the morning *Press* with a circulation in the early 1960s of over 64,000 and the *Christchurch Star* of over 65,000.

Like other cities, Dunedin had a number of newspapers in the 1860s, mainly induced by the discovery of gold in Otago. The two survivors are the *Otago Daily Times*, founded in 1861, with a circulation of 40,600 and the *Evening Star*, founded in 1863, with a circulation of 30,000.

None of the newspapers in the four main cities have a national circulation although, especially in the North Island, the two morning newspapers, the *New Zealand Herald* and the *Dominion*, have extensive circulations. There are also nearly 60 triweekly, biweekly or weekly newspapers published throughout the country, concentrating mostly on local news. Prominent national magazines include the *New Zealand Woman's Weekly*, the *Weekly News*, *New Zealand Truth* and the *New Zealand Listener*.

New Zealand has 42 daily newspapers who are all partners in the New Zealand Press association, which supplies them with home and overseas news. The Press association receives most of its overseas news through the Australian Associated Press and like A.A.P. is also a partner in Reuters. (A. P. R.; X.)

4. India.—Though printing from movable type was done in India in the 16th century, and there were written newsletters during the Mogul dynasty in that century, the first newspaper appeared Jan. 29, 1780. This was the *Bengal Gazette or Calcutta General Advertiser*, known as "Hickey's Gazette." James Augustus Hickey's attacks on the government and on private individuals resulted first in barring his paper from the post office and then in his arrest and imprisonment and the seizure of his paper. The second paper was Peter Reed's *Indian Gazette or Calcutta Advertiser*, begun later in 1780 and devoted largely to the business of the East India company; it lasted for more than 50 years. Bombay journalism began with the *Bombay Herald* in 1789; the first in Madras was the *Madras Courier* of 1785.

The first periodical in a vernacular language was the monthly *Digdarshan* of 1818, in Bengali, by J. C. Marshman, a Baptist missionary, which soon became a weekly newspaper with the title *Samachar Darpan* ("Mirror of News"). In 1829 it became bilingual, with local and foreign news in both English and Bengali.

In the early 1820s many vernacular papers appeared in Gujarati and Bengali, papers which were suspended under the John Adams press regulations. Active in this journalism was the religious and social reformer Raja Ram Mohun Roy, founder of the first Persian weekly, *Mirat-ul-Akhbar*, in Calcutta. Roy was later associated with *Banga Doot* ("Bengal Herald"), printed in Bengali, Persian, Hindi and English. Most famous of Bengali papers were *Ananda Bazar Patrika*, founded in 1878, and enjoying by the early 1960s one of the largest circulations among Indian dailies (102,000). This paper and the other leading daily in Bengali, *Jugantar* (founded in 1937), were both published in Calcutta.

The leading English-owned paper in India in the early 1960s was the *Statesman* of Calcutta (with a New Delhi edition), founded by Robert Knight in 1875, which absorbed the *Englishman* (1821) and *Friend of India*. Another English-owned paper, the *Pioneer* of Allahabad, founded in 1865, and famous for the service on its editorial staff of Rudyard Kipling for a few years in the latter 1880s, passed under Indian ownership in the 1930s.

Half-a-dozen leading Indian dailies in the English language were owned by Indians in the early 1960s. The *Hindu*, Madras, began as a mimeographed journal of the literary society, became a regular weekly in 1878 and a daily in 1889. The *Times of India* of Bombay (with a New Delhi edition), founded in 1838 as *Bombay Times*, was long regarded as the chief newspaper in India. The *Tribune of Ambala*, East Punjab, founded in 1881 and made a daily in 1960, became a modern and influential paper. The *Amrita Bazar Patrika*, founded in 1860 in a village near Calcutta, was in 1871 moved to that city and was made a bilingual paper. After the Vernacular Press act of 1878, it was made an English paper and became a leading newspaper in India. The *Free Press Journal* of Bombay was founded in 1930 by S. Sadanand, the outgrowth of a news agency. The *Hindusthan Times*, founded in 1923, was edited for a number of years by Devdas Gandhi, son of Mohandas Karamchand Gandhi. The daily with the largest combined circulation was the *Indian Express* (1953), published simultaneously in Bombay, New Delhi and three other cities.

The daily press in India in the early 1960s consisted of more than 300 papers with an aggregate circulation around 4,500,000: 75 in Hindi, 42 in Urdu, 33 in English, 26 in Malayalam, 24 in Tamil, the rest in other languages. In the matter of circulation, however, the English language dailies were at the top (1,150,000), followed by Hindi (745,000), Malayalam (499,000), Marathi (350,000). Of the nine dailies with a circulation of over 100,000, four were in English (*Indian Express*, *Times of India*, *Statesman*, *Hindu*), two in Tamil (*Thanthi*, *Dinamani*), one in Marathi (*Lokasatta*), one in Hindi (*Navbharat Times*) and one in Bengali.

Nearly 40% of newspapers and periodicals of all kinds were concentrated in Bombay, Calcutta, New Delhi and Madras.

Indian newspapers in 1948 formed their own co-operative news agency under the name of the Press Trust of India Ltd., taking over the 50-year-old Associated Press of India Ltd., which was a Reuters subsidiary. The Indian press at the same time joined those of the United Kingdom, Australia and New Zealand in the general management of Reuters.

5. Pakistan.—Following the birth of the new state in 1947, a number of new journals were established. Pakistan lost some of its papers by their removal to India, but gained its largest daily *Dawn*, which moved from Delhi to Karachi, where it continued to publish editions in several languages. Leading English-language papers were the *Pakistan Times* at Lahore, the *Times of Karachi* and *Morning News* at Dacca in East Pakistan and Karachi. In the early 1960s the country had 90 dailies: 70 in West Pakistan and 20 in East Pakistan. In West Pakistan they were printed mainly in Urdu, the most important being *Imroze* at Lahore and Karachi, but some were in Gujarati or Sindhi. In East Pakistan the language was mainly Bengali, the more important papers being *Azad* and *Ittefaq*, both published at Dacca.

6. Federation of Malaysia.—Singapore in the early 1960s had half-a-dozen daily papers published in English, Chinese and the Indian and Malay languages, circulating in the city and also in Malaya. The *Straits Times* (1845) had a special Malayan edition. The other leading papers were *Nanyang Siang Pau*, *Sin Chew Jit Poh* and *Nanfang Evening Post* (in Chinese).

Newspapers in Malaya were likewise in English, Chinese and the Indian and Malay languages. In the early 1960s the more important dailies were the *Straits Times* and the *Malay Mail* (in English), *Berita Harian* and *Utusan Melayu* (in Malay) and *New Life Daily News* and *China Press* (in Chinese).

In Sarawak in the early 1960s there were seven dailies, including six papers in Chinese and one in the English language.

7. Elsewhere in the East: *Ceylon.*—In the early 1960s there were nine dailies, four in English, three in Sinhalese and two in Tamil, totaling over 350,000 copies. Of these the more important were *Dinamina* and *Lankadipa* (in Sinhalese), the *Ceylon Daily News* (in English) and *Thinakaran* (in Tamil). The Sunday paper, *Silumina* (in Sinhalese), had the highest circulation (156,000).

Aden.—There were in the early 1960s four dailies. The leading paper was *Fatat-ul-Jezirah*.

Hong Kong.—There were in the 1960s nine dailies in Hong Kong. The leading papers were *Wah Kiu Man Po, Wa Kiu Yat Po, Ta Kung Pao* in Chinese, and *Hong Kong Tiger, Standard, China Mail* and *South China Morning Post* in English. (Jo. K. B.)

8. Africa: *Ghana.*—In the early 1960s four dailies were published, all in English. Their combined circulation of 200,000 represented 40 copies per 1,000 inhabitants. Seven nondailies and 15 periodicals were also published. *The Ghanaian Times* (Accra) and the *Evening News* (Accra) were financed by government funds. The largest paper, the *Daily Graphic* (Accra), was owned by the Mirror Newspapers, London, until 1962 when it was turned into a trust. The *Ashanti Pioneer* (Kumasi) ceased to be an opposition paper in Oct. 1962 as a result of official action. Press control was exercised both indirectly through government pressure and directly through the criminal code of 1960, which could require periodicals suspected of "systematic publication of matter calculated to prejudice public order or safety . . . to submit all future issues of the periodical to a specified authority to be passed upon before publication." Special significance was attached to *The Spark*, a weekly theoretical paper, published by the Bureau of African Affairs, launched in 1962.

Nigeria.—In the early 1960s, 14 dailies were published, all in English. Their total circulation of 260,000 represented 8 copies per 1,000 of the population. There were 34 nondailies and 32 periodicals. The *Daily Times* and *Sunday Times*, with the largest circulations (both 120,000), were owned by the Mirror Newspaper group. The federal government published the *Morning Post* and the *Sunday Post* (77,000). The largest indigenous group was Zik newspapers (started by N. Azikiwe) controlling five dailies, including the *West African Pilot* (Lagos), and supporting the National Council of Nigerian Citizens. The *Daily Express* (Lagos) supported the Action group, and the *Daily Mail* (Kano) supported the Northern Peoples congress. Except under emergency regulations there were no press laws and censorship.

Sierra Leone.—There was one daily in the early 1960s, the *Daily Mail* (Freetown) owned by the Mirror Newspapers (London). With a circulation of 15,000 it sold 6 copies per 1,000 inhabitants. There were also six nondailies and ten periodicals. There were no press laws or censorship.

Tanganyika.—In the early 1960s there were three dailies, the *Tanganyika Standard* (11,000), published in English, and *Mwafrika* (13,000) and *Ngurumo* (12,000), published in Swahili. Their combined sales reached 4.4 per 1,000 inhabitants. There were also 16 nondailies and 37 periodicals. Prominent Sunday newspapers were *Mwafrika Na Taifa* (30,000) and *Uhuru* (15,000), in Swahili, and *Sunday News* (10,600) and the *Sunday Nation* (8,000), in English. The governing party, the Tanganyika African National union (TANU), launched its own weekly *The Nationalist* in 1964. There were no press laws or censorship.

Zanzibar and Pemba.—In the early 1960s two dailies were published; with a combined circulation of 400 they sold 1 copy per 1,000 inhabitants. There were eight nondailies.

Uganda.—In the early 1960s three dailies were published, the *Uganda Argus* (13,300), *Uganda Eyogera* (12,000), published in Luganda, and *Taifa Empya*. They sold 6 copies per 1,000 inhabitants. Characteristic of the Ugandan press was the growth of indigenous and privately owned papers in many of the local languages.

Gambia.—There was one daily in the early 1960s with a circulation of 1,500 representing 5 copies per 1,000 inhabitants. There were also three nondailies and two periodicals.

Central Africa.—In the early 1960s, four dailies circulated with total sales of 112,000, representing 6 copies per 1,000 inhabitants. There were 36 nondailies and 40 periodicals. The Argus South African Newspapers, Ltd. controlled five of the largest papers, three dailies and two Sundays: the *Rhodesia Herald, Bulawayo Chronicle, Northern News* (Zambia), *Sunday News* and *Sunday Mail*. The largest group specializing in publications for Africans, Thomson Newspapers Rhodesia (Pvt) Ltd., included *Central African Daily News*, the *African Parade*, the *Popular Post* and Malawi's single daily. The Malawi party of H. Banda published a weekly *Malawi News* while the weekly, the *African Mail* in Lusaka, supported K. Kaunda's United National Independence party. A lively political monthly was the *Central African Examiner*.

Kenya.—In the early 1960s there were six dailies, three in English, one in English and Gujerati, one in Gujerati and one in Swahili. The largest of these were *East African Standard, Daily Nation* and *Taifa Leo* (Swahili), all published in Nairobi. The combined circulation of the six was 88,000 representing 7 copies per 1,000 inhabitants. There were 26 nondailies. East Africa Standard Ltd. owned *East Africa Standard* (weekly edition 42,000) and *Baraza* (39,000) published in Swahili. East African Newspapers Ltd. (with which were associated the Aga Khan and the Thomson Newspaper organization) owned the *Nation* (Sunday edition 31,000) and *Taifa* (weekly 59,000), published in Swahili. There were 40 periodicals, the government information service publishing 10 vernacular papers.

High Commission Territories.—In Basutoland there were four nondailies in the early 1960s with a combined circulation of 25,000 representing 28 copies per 1,000 inhabitants. There was also one periodical. Bechuanaland had one periodical, published by the government. In Swaziland, two nondailies with a joint circulation of 1,900 sold 8 copies per 1,000 inhabitants.

Mauritius.—There were nine dailies in the early 1960s with a circulation of 40,000, representing 68 copies per 1,000 inhabitants. There were also 11 nondailies and 15 periodicals. (Co. L.)

VIII. CENTRAL AND SOUTH AMERICA

1. Mexico.—A Mexican newssheet published in 1541 constituted the earliest printed news in the western hemisphere. It was published by Juan Pablos and was an account of the Guatemalan earthquake of the preceding year, entitled *Relación del terremoto de Guatemala*. The first regular newspaper came nearly two centuries later, *Gaceta de México* (1722). The first dailies were *Diario de México* and *Diario de Veracruz*, both begun in 1805. Arbitrary censorship was the rule and tradition in Mexico. The constitution of 1857 was liberal in language, but did not in practice afford any considerable freedom of the press. In the long presidency of Porfirio Díaz, however, economic stability was favourable to the development of the newspaper industry. The "insurgent press," beginning with *El Despertador Americano* (1810–11), from time to time played an important part in national affairs. Papers in Indian languages were established in the 1880s, as *Purepe* of Quiroga, in Tarascan; *Mor* of Tepoztlán, in Aztec; and others in Maya and Zapotecan in Yucatán and Oaxaca.

Daily newspapers in Mexico in the 1960s numbered more than 140, of which about 20 were published in the federal district. Nearly all had been founded after 1920 and many after 1940. The only important daily dating back to the 1880s was *El Correo de la Tarde* (1885) of Mazatlán. The largest papers in Mexico City were: the established and respected *El Universal* (1916), with its evening tabloid edition, *El Universal Gráfico* (1922); *Excelsior* (1917); *Novedades* (1932); and *La Prensa* (1928). These journals had large Sunday editions and affiliated radio stations. There was one paper owned and operated by the government, *El Nacional* (1929). Guadalajara and Monterrey, the next largest cities, had three and four dailies respectively. The circulation of Mexican dailies, regional rather than national, virtually doubled in the decade 1940–50 and continued to increase thereafter.

2. Central America.—The earliest printing in Central America was at Antigua, in the colony of Guatemala; but it was in the town of Guatemala that a monthly *Gaceta* was established in 1729. Of the dailies being published there in the 1960s, the oldest was *Diario de Centro America*, founded the year after the adoption of the constitution of 1879 as *El Guatemalteco; El Imparcial* (1922) and *Prensa Libre* (1951) had the largest circulations.

In Honduras the first paper was the *Gaceta de Honduras* (1830), in Comayagua; the first daily was *El Diario* (1897), in Tegucigalpa, the capital. In the 1960s Honduras had five dailies.

British Honduras had the *Belize Daily Clarion* (1897) and the *Belize Billboard* (1946).

Nicaragua's first paper was *El Telégrafo Nicaragüense* (1835) of León, and its first daily was the *Diario de Nicaragua* (1884)

of Granada. In the 1960s there were five dailies in Managua and one in León.

El Salvador had a paper at San Sebastian called *Liberal Guipuzcoano* in 1820. Of the dailies being published in the capital, San Salvador, in the 1960s *Diario Oficial* (1847), the government gazette, was the oldest, and *La Prensa Gráfica* (1915) and *El Diario de Hoy* (1936) foremost in circulation and influence. Sonsonate and Santa Ana each had one daily.

El Noticioso Universal, established by Joaquin Bernardo Calvo at San José in 1832, was Costa Rica's first newspaper. There were five Spanish-language dailies in that city in the 1960s, with circulation ranging from 10,000 to 40,000, and also one daily in English.

In what is now Panama, *Misceldnea del Istmo* was established in 1822, and short-lived political papers appeared from time to time; but modern Panamanian journalism began with the founding of the *Panama Star* by a group of American forty-niners bound for California but temporarily detained awaiting ship. Their main purpose appears to have been to publish an account of their celebration of Washington's birthday, and the paper was begun Feb. 24, 1849. The paper soon came into other hands, and when Panama seceded from the Colombian federation in 1853 it was made a daily and given a Spanish section, which eventually became a separate edition called *La Estrella de Panamá*. The *Panama Herald* (1851) was absorbed in 1854, and the English edition became *Panama Star & Herald*. The *Panama American* and its associate *El Panamá-America* began in 1925, and the *Nation* and *La Nación* in 1944.

3. Cuba.—Sporadic publication of printed newssheets goes back to 1707 with the appearance of *Disertación Médica Sobre las Islas de Barlovento*, a medical report on dietary conditions in the Windward Islands. In 1764 the Havana printer Olivos was ordered by the colonial authorities to issue a monthly *Mercurio*, and other official gazettes were published later. But the first general newspaper in the island was the *Papel Periódico de la Habana* (1790), issued under the enlightened administration of Captain General Luis de las Casas. Strict censorship was the rule under the colonial government.

After independence there was a rapid flourishing of the Cuban press, and some of the largest and more modern newspapers in the hemisphere were published in Havana in the late 1950s. Though government censorship or interference was only occasional, unofficial political subsidies accounted for considerable government influence in many newspapers. Before the Fidel Castro revolution there were about 48 dailies in the island, over 20 of them published in Havana. Among them were the *Diario de la Marina* (1832), oldest extant Cuban paper at the time, *El Mundo* (1901), *Información* (1933) and *Diario Nacional*, all of them morning dailies with circulations ranging between 25,000 and 75,000; *El País* (1921) and *Prensa Libre* (1941), both evening papers with circulations over 100,000. Among foreign-language dailies there were two in English, the *Havana Post* (1895) and the *Times of Havana* (1957), and three in Chinese.

After the accession of the Castro regime in 1959 mounting political pressure caused many Cuban newspapers to cease publication, among them some of the oldest and most respected. All others came finally under complete control of the government, exercised in many cases through the labour unions and, in others, by means of a direct government *interventor*. The three most important Cuban dailies being published in the 1960s were *Hoy*, traditionally the organ of the Cuban Communist party; *Revolución*, which in an earlier form had been the clandestine organ of Castro's revolutionary movement against Batista; and *El Mundo*.

4. West Indies.—The *Gazette du Cap*, of uncertain history, is said to have been Haiti's first paper. The *Gazette politique et commerciale d'Haiti* (1804) was the first government organ of the new republic. In the 1960s Haiti had six daily papers, all published at Port-au-Prince; the largest had a circulation of about 9,000. Larger in circulation were the dailies at Santo Domingo in the Dominican Republic, *La Nación* (1940), *El Caribe* (1947) and *El Listín Diario* (1893). The latter had been suppressed during the Trujillo dictatorship.

La Gaceta was founded as the official organ of the Spanish government of Puerto Rico in 1807 and continued until the occupation of the island by United States forces in 1898. In the 1960s there were two Spanish-language dailies in San Juan, *El Imparcial* (1917) and *El Mundo* (1919), which claimed more than 50,000 circulation each, and one English-language daily. There was one daily each in Ponce and Arecibo.

Robert Baldwin began the *Weekly Jamaica Courant* in 1718 at Santiago de la Vega, the capital of Jamaica until 1872. In the 1960s the morning *Daily Gleaner* (1834) was the chief paper of Kingston, and the evening paper was the *Star* (1951).

5. Colombia.—Manuel del Socorro Rodriguez, a Cuban *émigré*, was the publisher of the earliest papers issued in what was then called Santa Fé de Bogotá; they were the *Gaceta* (1785) and the *Papel Periódico* (1791–95). *El Tiempo* of Bogotá, largest paper in the country, suffered under the heavy hand of government censorship in the mid-1950s; in the latter years of the decade and in the 1960s government pressure on the press was markedly reduced. Largest paper outside the capital was *El Colombiano* (1912) of Medellín.

6. Ecuador.—The first known newspaper in Ecuador was the *Gaceta de Santafé* (1785) of Quito. No further paper was printed in the country until after the revolution of 1809, when the *Gaceta de la Corte de Quito* was begun. In the 1960s *El Comercio* (1906) was the most important of Quito's dailies; it also owned *Últimas Noticias* (1938), the capital's only evening paper.

7. Venezuela.—The first Venezuelan newspaper was the *Gaceta de Caracas* (1808). The oldest daily in Venezuela in the 1960s was *La Religión* (1890) of Caracas; those with the largest circulations were *El Mundo* and *El Nacional*, both of Caracas, each over 100,000.

8. Peru.—Probably the earliest newssheet printed in South America described the capture of the pirate Richard Hawkins off the Peruvian coast; it was issued by Antonio Ricardo at Lima in 1594. The first titled and numbered paper was *Gaceta de Lima* (1744). Peruvian newspapers, both under Spanish rule and after establishment of the republic in 1822–23, were firmly controlled by the government. Except for the government gazette *El Peruano*, which was founded in 1820, the oldest newspaper in the 1960s was *El Comercio* (1839) of Lima. Government control was the rule.

9. Bolivia.—In 1825, the year in which the name of Alto Perú was changed to Bolivia, the *Gaceta de Chuquisaca* and the *Cóndor de Bolivia* were founded in the capital, Chuquisaca, later renamed Sucre. Bolivian newspapers, chiefly owned by political factions, were unstable until some time after the adoption of the press law of 1925. The oldest daily in the 1960s was *El Diario* (1905) of La Paz. Under the Paz Estenssoro regime, which came into power in 1952, there was a severe censorship.

10. Brazil.—Brazil's first weekly newspaper was the official *Gazeta do Rio de Janeiro* (1808), which in 1823 became *Diario do Govêrno*. The country's oldest paper in the 1960s was *Diário de Pernambuco* (1825) of Recife. Founded in 1827 was *Jornal do Comercio* of Rio de Janeiro, which, though its circulation was less than those of most other papers in the capital in 1955, had long enjoyed a high reputation and influence as a conservative journal.

With the fall of the empire in 1889 there was a rapid development of newspapers, and in the next 20 years the number of papers and periodicals increased from about 600 to 1,000. By the 1960s there were well over 200 dailies.

The largest paper in Brazil in the 1960s was *O Globo* (1925) of Rio de Janeiro, which claimed a circulation of over 200,000 for its daily edition. Other leading Rio papers were *Jornal do Brasil* (1889), *Correio da Manha* (1901) and *O Jornal* (1919). Perhaps the outstanding paper in São Paulo was *O Estado de São Paulo* (1875). *Diários Associados* had become a strong group of 24 daily papers and 14 radio stations spread widely over the country and including such large papers as *Diário da Noite* (1929) and *O Jornal* in Rio, *Diário da Noite* (1925) in São Paulo and *Diário de Pernambuco* in Recife.

11. Argentina.—*El Telégrafo* (1801–02), the first newspaper

published in Argentina, came from the Buenos Aires press of Francisco Cabello y Mesa, a printer who had already engaged in journalism in Lima, Peru. It was followed by a few other papers in the first decade of the century and, after the first national government was established in 1810, by an official *Gaceta* (1810–21). The chaotic period which preceded the Juan Manuel de Rosas regime (1829–52) brought out many small, vituperative political sheets, but Rosas limited the regular Argentine press to a few papers which were forced to confine themselves to commercial news and official documents. Meantime, Argentine journalists took refuge in other South American countries, there to spread their doctrines of liberty and reform. After the fall of Rosas many of these men returned and renewed the conflicts of political journalism

The modern Argentine press began in the 1860s. *La Nación Argentina* was founded in 1862 but ceased publication in 1869. In 1870 one of its regular contributors, Argentine patriot and president Bartolomé Mitre, founded a new daily, *La Nación*, which eventually became one of the great South American newspapers. In 1869 José Clemente Paz founded *La Prensa*, which was to win similar fame. *La Capital*, begun in Rosario in 1867, completes the trilogy of great Argentine dailies still being published in the 1960s.

La Prensa, long considered one of the world's great newspapers, had the largest circulation (480,000) of any Spanish-language newspaper in the world in 1950. Still owned by the Paz family, it had become famous for its voluminous world-news reports, for its remarkable classified advertising section, for its editorial independence and for its special public services. In 1951, however, *La Prensa* was seized by the government, and was not returned to Alberto Gainza Paz, the publisher, until the fall of the Perón regime in 1955. *La Prensa*'s circulation in the 1960s was about 280,000.

La Nación also had strong international news coverage and gave much attention to technical and transportation problems. Its circulation in the 1960s was about 240,000 for the daily edition and about 300,000 for the Sunday edition. *La Razón* (1905) and *Crítica* (1913) were also important Buenos Aires dailies. There were more than 150 dailies published in Argentina, including a considerable foreign language press in Buenos Aires.

12. **Uruguay.**—The publication of Uruguay's first paper was occasioned by the brief British occupation of Montevideo in 1807; it was an English-Spanish sheet called *La Estrella del Sur*. Many papers, chiefly political, appeared during the troubled history of the country; probably the longest life was that enjoyed by *El Telégrafo* (1850–1931). José Batlle y Ordóñez founded *El Día* in 1886. The above-mentioned papers were published in Montevideo, where the greater proportion of daily papers in Uruguay were still situated in the 1960s. Leading morning papers were *El Día* and *El País* (1919), and the chief evening papers were *El Diario* (1923) and *El Plata* (1915), the latter affiliated with *El Día*. There was much government control.

13. **Paraguay.**—Journalism in Paraguay dates from the middle of the 19th century, though it was irregular until about 1898. There are fewer than ten dailies published in the country; the largest in the 1960s were *La Tribuna* (1925), *El País* (1923) and *Patria* (1946), all published at Asunción.

14. **Chile.**—The earliest of Chile's papers was *La Aurora de Chile*, issued in 1810 at Santiago. *El Mercurio* was founded at Valparaíso in 1825 and *La Unión*, another important paper. was established in the same city in 1885. In 1902 Agustín Edwards, owner of Valparaíso's *El Mercurio*, founded another morning paper of the same name in Santiago; this chain eventually came to include two evening papers in the capital and one in Valparaíso. The *Santiago Mercurio* had the largest circulation of the Chilean dailies (about 125,000 for the daily edition in the 1960s). *La Nación* (1917) was government owned. (F. L. Mt.; X.)

IX. ASIA

1. **The Middle East, Afghanistan and Nepal:** *Syria.*—There were 20 Arabic dailies published in Damascus in the early 1960s. The leading papers were *Al-Nasr, Al Ayamm, Sada Alam* and *Al Talia*. Among the provincial papers, the more important were *Al Watan* and *Barq al-Shemal* published in Aleppo.

Lebanon.—In the early 1960s there were 27 dailies published in Beirut of which 3 were in French and 2 in English. The leading dailies in Arabic were *Al Nahar* and *Al Jarida*, in French *L'Orient* and in English *Daily Star*.

Israel.—The first Hebrew daily paper in Palestine was E. B. Yehuda's *Haheruth* (1909–15). With the establishment of Israel in 1948, Tel Aviv became an active newspaper centre. In the early 1960s, there were 24 dailies, 14 in Hebrew and the rest in Yiddish, Arabic, German, English, French, Polish, Hungarian, Bulgarian and Rumanian. The largest of these papers (circulation 73,000) was a tabloid called *Ma'ariv* (1948). Oldest of them was *Ha'aretz* (circulation 39,000), founded in Egypt in 1915, moved the next year to Jerusalem and later to Tel Aviv. Two other leading papers were *Haboker* (1934) and *La-Merhav* (1954). The others were party papers, most important of which was *Davar* (circulation 40,000), a Socialist organ founded in 1925. The *Jerusalem Post* was the only English-language paper.

Jordan.—In the early 1960s there were six Arabic dailies, including two at Amman and four in Jerusalem. The leading papers were *Falastin, Al-Diffa* and *Al Jihad*. *Jerusalem Times* was a leading paper in the English language.

Iraq.—The first daily newspaper in the country was in English, the *Baghdad Times*, founded in 1914; in 1920 it became the *Iraq Times*. In the early 1960s there were 16 dailies. The leading Arabic dailies were *Al Zaman, Al Akhbar, Al-Belad, El Thawra, Al Ahd Al Jadid* and *El Mustaqbal*.

Iran.—Though there were earlier newssheets concerned with court events, the first regular newspaper in Persia was *Rúznáma*, an official gazette established in Teheran in 1851. With some changes in title, this journal continued for many years, and the modern official daily *Iran* may be said to be descended from it. The first Persian daily was *Khuldsatul-Hawádith* (1898), a two-page paper, printed on one side from type and lithographed on the other. Though typography had been introduced into Persia as early as 1817, it was superseded by lithography during most of the last half of the 19th century.

Many short-lived political papers were published during the chaotic World War II period, some of which continued after the re-establishment of the national sovereignty in 1947. In the early 1960s there were 38 dailies of which 23 were published in Teheran. The leading papers were *Ettela'at* (1924) with news editions in English and French, the *Kayhan* with an English edition *Kayhan International*. Other papers in English and French were respectively *Teheran Journal* and *Le Journal de Téhérán*.

Saudi Arabia.—There were two dailies, *Al Bilad* published in Jidda and *Um Al Quarah* in Mecca.

Afghanistan.—In the early 1960s there were 15 dailies. The papers with the largest circulation were *Anis* (30,000) and *Islah* (15,000). *Kabul Times* was the English language paper.

Nepal.—There were in the early 1960s five dailies in the Nepalese language: *Hal Khabar, Nepal Samachar, Samaj, Naya Samaj* and *Gorkha Patra*. Another daily, *Motherland*, was published in the English language.

2. **Southeast Asia:** *Burma.*—Only about a dozen daily newspapers were published in Burma before World War II, but that number had trebled by 1948. The oldest paper was *Hanthawaddy* (1889). The Burmese press was stimulated by national independence and, as a result of general instability prevailing elsewhere at the time, became concentrated in Rangoon where, in the early 1960s, there were 21 dailies. The leading newspapers were *Bama Khit* (36,000), *Hanthawaddy* (18,000), *Htoon Daily* (12,000), *Mandaing* (10,000) and *Rangoon Daily* (24,600). There were three dailies in English: the *Guardian* (5,500), the *Nation* (18,000) and the *Burman* (5,000). Other languages represented in the press were Chinese and the Indian languages Hindi and Tamil.

Thailand.—In the early 1960s there were 11 dailies, including 8 in the Thai language, 2 in English and 1 in Chinese. The largest of these papers (circulation 35,000) was the Thai paper *Sieng Ang Tong*. Other leading papers were *Pim Phai, Siam Rath,*

Sarn Seri, *Chaothai* in Thai language, *Bangkok Post* and *Bangkok World* in English and *Sin Sian Yit Pao* in Chinese.

Cambodia.—There were in the early 1960s five dailies, including one in the French language. The leading papers were *Kampuchea*, *Meatopum*, *Neak Cheat Niyun* and *La Dépêche du Cambodge.*

Laos.—There were in the early 1960s two dailies, *Pachaninhom* and *Siengmahason.* There was also a daily publication in French, *Bulletin Quotidien lao Presse.*

Republic of Vietnam.—In the early 1960s there were 28 dailies —16 in Vietnamese, 10 in Chinese, 1 in French and 1 in English. The leading Vietnamese papers were *Saigon Moi* and *Tieng-Chuong.* The paper in French was *Journal d'Extrême Orient* and in English, the *Times of Viet Nam.*

Democratic Republic of Vietnam.—The daily with the largest circulation was *Nhen Dan*, official organ of the ruling Lao Dang party. Two other leading papers were *Thu Do* and *Thoi Moi.*

Indonesia.—A newspaper called *Batavaise Nouvelles* was published in Batavia, Java, as early as 1744–46 as a small two-page weekly. Other government gazettes appeared as the colony passed from the French to the Dutch, and then to the English and back to the Dutch. The *Bataviasche Courant* was begun in 1816, changed to *Javasche Courant* in 1828, and continued for more than a century. Continuous struggles with censorship marked the development of the press in the Netherlands Indies.

During the first years of independence, the press developed quickly. In the early 1960s there were 103 dailies with a total of over 400,000 copies. Of these 22 appeared in Jakarta with a circulation of about 250,000. The leading papers were *Suluh Indonesia*, *Merdeka*, *Berita Indonesia*, *Harian Rakjat* of the Communist party and *Duta Masjarakat*, organ of the Islamic party, Nahadul Ulema. There were two dailies in English, *Indonesian Observer* and *Indonesian Herald* and one in Chinese, *Tay Kong Siang Poo.*

3. The Philippines.—The pioneer of the Philippine press was *Del Superior gobierno*, a sheet devoted to European news, published in Manila, 1811–12. The first daily was *La Esperanza* (1846–49). The government's official gazette was founded in 1848 as *Diario de Manila.* The leading paper for many years was *El Comercio* (1858–1925). After 1888 a greater liberality in the censorship and the development of political groups, chiefly nationalist in character, resulted in the establishment of a large number of papers, most of which were small and short lived. The first paper in the Tagalog language was *Patnubay Nang Catolico* (1890).

The *Manila Times*, first U.S. daily in the islands, was founded in 1898 and became a leading paper in circulation and influence. *La Independencia* (1898) became the leading organ of the Emilio Aguinaldo insurrection and was moved from place to place until captured by the U.S. forces.

In World War II all Manila newspaper plants were destroyed by the Japanese. Following the liberation and the establishment of the republic the Manila and provincial press was greatly expanded. In the earlier 1960s there were 12 dailies. Three were in Tagalog (the most important being *Taliba* and *Bagong Buhay*), seven in English (the most important being *Manila Times*, *Philippines Herald* and *Evening News*), *El Debatte* was in Spanish and *Fukien Times* in Chinese. The *Manila Times* had the largest circulation.

4. China.—The first newspaper in China and, if all the claims that have been made for it are accepted, the first newspaper in the world, was a court gazette which began during the T'ang dynasty (A.D. 618–906) and was used as a means of communication between officials. It was continued in the Sung dynasty (960–1279), and early in that period it began appearing at regular intervals and achieved a considerable circulation among Chinese scholars. For title it took the term *Ti-pao*, from *ti*, "palace," and *pao*, "report," a word which had been applied to the earlier bulletins; it was sometimes called *Ti-chan*, or "Court Reading-Matter." In the Ming dynasty (1368–1622) the title of this gazette was changed to *Tungchengsee.* In the last reign of the Ming dynasty, that of Zung Cheng (1628–44), the bulletins, which had hitherto been either handwritten or printed from blocks, began to be printed from movable wood type. During the Ch'ing dynasty (1644–1912) the bulletins were continued under the name *King pao* ("Peking Gazette"). The series was allowed to perish with the Manchus after 1912.

Similar official gazettes sprang up in the provinces under Manchu rule, and gazettes by the various ministries began in 1900. But newspapers for the general public, as apart from gazettes for officialdom, did not begin in China until the 19th century, and then they were translations or imitations of the English-language press which had been established in that country by commercial and missionary agencies.

James Matheson's *Canton Register* (1827–43) was the first English paper in China; when Hong Kong became British, it was transferred to that city and became the *Hongkong Register* (1843–59). Other papers were published in Canton and Hong Kong, and in 1845 the famous *China Mail* was founded in the latter city, with Andrew Shortrede as editor; it became a daily in 1876. The *North China Herald* was founded in Shanghai in 1850; in 1864 it was made a daily under the new title, *North China Daily News.* The *China Press* was founded in Shanghai in 1915 by a group of Americans, and was edited for a time by John B. Powell.

In 1858 Wu Ting-fang suggested Chinese translations of the *China Mail;* the result was the first Chinese paper for the general public, *Chung Ngoi San Pao.* The most important paper founded for the Chinese before the crisis of 1895 was *Shun Pao*, established at Shanghai in 1872 by Frederic Major, an Englishman. At the time of the Chinese revolution in 1911 it was sold to Sze Liang-zay, who made it prosperous and influential before his assassination in 1934. Sze also owned, after 1929, *Sin Wan Pao* (1893).

A period notable for the founding of many revolutionary journals representing various reform movements began in 1895, after the defeat of China in the Chino-Japanese War. These papers had much to do with bringing about the revolution of 1911. After that, the free speech guaranteed in the provisional constitution was an invitation to hundreds of young Chinese to start journals, many of which were short lived. The severe press laws of 1914 cut off most of the newspapers, but in the years 1918–20 the "literary revolution" and the "student movement" again gave rise to a multitude of journals. In 1921 it was reported that more than 1,000 publications were appearing in China, about half of them daily newspapers.

Sun Yat-sen's regime in Canton was especially favourable to development of the press, and the nationalist revolution of 1927 marked the beginning of another new era in the publication of newspapers in China. By 1948 there were, according to government estimates, about 1,800 newspapers, more than half of them dailies, in the entire country.

Aside from a few well-established and influential papers, most of the dailies were small in size and circulation. Many were party organs, often representing small groups. No little venality and unreliability existed among such papers. The press law of 1914 continued throughout Pres. Chiang Kai-shek's administration to impose a stern censorship; by 1948 it was almost equally severe on English-language and Chinese papers.

During World War II Japanese occupation of the coastal cities drove most of the great Chinese papers inland, but they were quick to recover in 1945–48. *Shun Pao* ("Shanghai Gazette") returned to Shanghai from Hong Kong; and its sister paper, *Sin Wan Pao* (the "News Gazette"), achieved an all-time Chinese circulation record of 350,000, largely through its commercial news. National circulations grew as never before, through the establishment of multiple-city editions. Thus the Kuomintang organ *Chung Yang Jih Pao* ("Central Daily News") was published in Nanking, Shanghai, Chungking and several other cities.

It was estimated that there were 36 dailies published in the early 1960s under the aegis of the Chinese People's Republic: the more important among them appearing in Peking and Shanghai. The most important was the *Jen Min Jih Pao* (People's Daily) published in Peking. The *Ta Kung Pao* (Impartial Gazette), was the founded in Tientsin in 1902 but now published in Peking,

only paper which survived the nationalist regime. It specialized in foreign affairs. *Sin Wan Jih Pao* and *Chieh Fang Daily News* were published in Shanghai. The *Hsin Hua* or New China News agency, which was the section of the ministry of information, had a monopoly in the collection and distribution of news.

5. **Japan.**—Newssheets called *yomiuri* appeared in Japan late in the 17th century. They were printed from blocks and were sold by vendors who attracted customers by reading the news aloud; hence the name, which means "selling by reading aloud," and which later became the title of one of the greatest of Japanese newspapers. The first newspaper was the English-language *Shipping List and Advertiser* (1861) of Nagasaki, which was soon moved to Yokohama to become the *Japan Herald*. Several other papers in English were begun in the 1860s. The first periodical in the Japanese language was a series of official translations of foreign news, issued monthly, of which the earliest was *Batavia Shimbun* (1862), derived from a Dutch paper in Java. The first Japanese newspaper for general circulation was the *Shimbunshi* (1864), established by Joseph Hikozo. This paper was followed by other Yokohama papers in Japanese, published by Englishmen and Americans.

But it was in 1868, the year of the Meiji restoration, that Japanese journalism really began. In that year 16 papers, in Tokyo, Osaka, Kyōto, Yokohama and other cities, were founded. This development continued despite strict censorship, many imprisonments of editors and occasional forcible suspensions.

The *Tokyo Nichi-Nichi* was founded in 1872, with the famous Genichiro Fukuchi, dramatist and educator, as its editor. In 1906 Hikoichi Motoyama, manager of one of the great industrial syndicates which were growing up in Japan, bought the *Nichi-Nichi* and made it an associate of the *Osaka Mainichi*, which he had owned for many years. The latter paper was founded as *Osaka Nippo* in 1876, but Motoyama rechristened it *Mainichi* when he bought it in 1888. These two papers set a great pace in enterprise, foreign correspondence and a degree of sensationalism. Each paper ran its circulation to more than 1,000,000 before World War II. Provincial papers were founded or purchased, including *Kyushu Mainichi* at Moji. In the war consolidations of 1942–43 these were all lost except the Kyushu paper. From the ordeal, however, the Tokyo and Osaka papers emerged with nearly 1,500,000 circulation each, and the one in Kyushu with more than 500,000.

The *Osaka Asahi* was founded in 1879 by Ryuhei Murayama, one of the greatest journalists of the Meiji era. It flourished, winning respect for its careful news coverage and progressiveness, and in 1888 the *Tokyo Asahi* was begun. Establishing connections with the *Times* of London, the *New York Times* and the Associated Press, these papers built up circulations of more than 1,000,000 each, covering the island of Honshu; in 1935 the Asahi company established the *Seibu* (Kokura) *Asahi* on the southern island of Kyushu. In the postwar period the Tokyo and Osaka papers each had about 1,500,000 circulation, and the Kyushu paper more than 500,000.

Founded in 1874, the *Yomiuri* of Tokyo had made a success in the 1930s by its emphasis on sports, finance and politics. In 1942 it was consolidated with *Hochi*, founded in 1872 by friends of Marquis Okuma and later owned by Seiji Noma, the "magazine king." In the war years it gained on its competitors, reaching nearly 2,000,000 circulation in 1944.

By 1937 the Japanese press, despite a period of stern repression preceding the constitution of 1889, had reached a very prosperous position. Beginning about 1889, it had largely changed over from the system of party journals to that of more or less independent mass-circulation papers. In 1937 there were 1,200 dailies and 600 weeklies in Japan. In the next two years, as the government tightened its control, there was a small decline; in 1940–41 came a reduction of 36% annually; in 1942, at government "suggestion," wholesale combinations were made which left one daily in each district outside the largest cities. This brought the total down to 53. After the end of the war in 1945, the number rose rapidly, and in early 1960s the Japan Publishers and Editors association (*Nihon Shimbun Kyokai*) reported a membership of 101 newspapers with a total circulation of 37,000,000.

Many newspapers suffered damage to their plant during the war. Under the administration of the supreme commander for the Allied powers (SCAP), newspaper management was "purged," and a precensorship set up which operated until July 1948.

Some papers have reduced the 9,000 ideographs known to the learned to fewer than 2,000 used in their columns, in order to bring their articles and editorials within the reading knowledge of the masses, using the syllable alphabet known as *kana* as an aid.

A distinctive feature of the Japanese press is that the leading newspapers are concentrated in Tokyo and Osaka. Approximately 45% of the circulation was accounted for by four national newspapers. *Asahi Shimbun, Mainichi Shimbun, Yomiuri Shimbun,* the "big three," and *Sangyo Keizai*, an economic daily, all centred in Tokyo. Counting the morning and evening editions separately, the "big three" alone had a combined circulation of around 12,000,000. They sold only about 5% of their copies on the street, while *Tokyo Shimbun* (representing a wartime consolidation of *Miyako Shimbun*, founded in 1884, and *Kokumin Shimbun*, founded in 1890) sold most of its nearly 500,000 circulation from pavement stands. Two other notable Tokyo papers were *Nippon Keizai Shimbun* (1876), the "Wall Street Journal of Japan," and *Japan Times* (1897), an English-language daily edited by Japanese. This paper, merged with *Japan Advertiser* (1890) as a wartime measure, was published for a time as *Nippon Times*. There were also English editions of *Asahi, Mainichi* and *Yomiuri*, *Mainichi's* English edition appearing in both Tokyo and Osaka.

Other leading newspapers were: *Chubu Nippon Shimbun*, Nagoya; *Nishi Nippon Shimbun* in Kyushu; and *Hokkaido Shimbun* in Sapporo, Hokkaido. Other dailies of interest were: *Kahoku Shimpo*, Sendai; *Shinano Mainichi Shimbun*, Nagano; *Niigata Nippo*, Niigata; *Kyōto Shimbun*, Kyōto; *Kobe Shimbun*, Kobe; *Sanyo Shimbun*, Okayama; *Chugoko Shimbun*, Hiroshima; *Kumanoto Nichinichi Shimbun*, Kumamoto; *Ehime Shimbun*, Matsuyama; and *Kochi Shimbun*, Kochi. The growing interest in sports was catered for by one daily devoted wholly to photo journalism.

The fact that four national newspapers accounted for nearly half of the total circulation has resulted in a unique pattern of news gathering and editing services. The *Asahi Shimbun* and *Mainichi Shimbun*, for instance, had four main offices in the three principal cities of Japan, Tokyo, Osaka and Nagoya, as well as in a city of northern Kyushu, and each of these main offices had its own editorial, business and mechanical facilities. This necessitated the employment of a large staff. The *Mainichi Shimbun* at the beginning of the 1960s employed more than 5,000 men, about a quarter of them on the editorial side. Employment on a newspaper was generally a lifetime position and newspaper labour unions were strong.

The leading news agency in the early 1960s was Kyodo Tsushin Sha (Mutual Wire-Service company), the descendant of the old government-subsidized Domei, founded in 1936. The Jiji Press, also a by-product of the defunct Domei, specialized in economic and financial matters.

6. **Other Countries:** *Republic of Korea.*—Of the 13 dailies at the beginning of the 1960s, the leading papers were *Dong-A-Ilbo*, and *Seoul Shin Mun*.

Democratic People's Republic of Korea.—There were seven principal dailies in the early 1960s—all connected with political groupings and government.

Formosa.—In 1961 there were 29 daily papers appearing at T'ai-pei and other towns in Formosa, *Hsing Sheng Pao* being the most important. There were two dailies published in English.

(A. P. R.; Jo. K. B.)

X. AFRICA

A UNESCO survey in 1961 established that there were 231 daily papers in Africa including British Commonwealth countries, with a total circulation of 3,000,000. This represented an average of 1.2 copies per 1,000 inhabitants, the lowest of any region in the world. The majority of all papers were concentrated in 14 countries: Algeria, Ethiopia, Ghana, Kenya, Morocco, Nigeria, Rho-

desia, Senegal, Sierra Leone, South Africa, Tanganyika, Tunisia, Uganda, United Arab Republic. In seven countries there were no daily papers other than sheets done by roneo, a process similar to mimeograph. In 15 countries, with a combined population of 12,000,000, there were no daily papers at all. Sub-Sahara territories accounted for only 125 dailies with a circulation of 900,000 copies.

There were in all territories 839 nondaily papers (including weeklies and bi- and tri-weeklies) and 1,395 periodicals. Sub-Sahara territories circulated 330 of the nondailies and 680 of the periodicals. In East, Central and South Africa the press was largely European- or Asian-owned; many of the papers in French-speaking Africa were owned by French companies. The trend in the 1960s was toward state-owned newspapers in newly independent countries, though this did not exclude privately owned papers except in a few countries. A large proportion of papers and periodicals were organs of political parties and trade unions. Religious missions owned several important periodicals; the *African Challenge* (Lagos), published in several languages by the Sudan Interior mission, had a monthly circulation of 115,700 copies throughout the continent; an illustrated Catholic monthly, *Présence Chrétienne* (Togo), and *The Truth*, a Muslim monthly published in English by the Ahmadiya Mission of Nigeria, were both widely distributed. Minority communities often provided their own papers.

In the 1960s there was a growing tendency toward producing papers for regional or continent-wide distribution. Outstanding examples in the field of reviews and magazines were *Jeune Afrique*, a Tunisian weekly; *Central African Examiner*, a Rhodesian monthly; *Afrique Nouvelle*, a Dakar weekly; the *Scribe* and the *Arab Review*, two Cairo official publications.

The most successful mass circulation papers were *Drum* (250,000), published in three regional editions; *Zonk*, published in Johannesburg; *Parade*, published in Central Africa; and *Bingo*, published in Dakar with three different editions for French-speaking Africa.

Although the big circulation papers were mainly published in European languages, the vernacular press was, in the early 1960s, becoming increasingly important. Of the 163 languages used by papers and periodicals, 145 were African; in one country more than 25 African languages were used. The most frequent language was Swahili with 60 newspapers and periodicals in 7 countries; Arabic was used in fewer papers but in 11 countries; Hausa was used in 6 countries.

1. United Arab Republic.—There were 21 dailies published in the early 1960s. Of these, 6 were in Arabic and had a circulation of 570,000, out of a total circulation of 652,000. There were also 27 nondailies, 13 in Arabic, and 31 periodicals, 20 in Arabic. The largest daily was *Al Ahram* (established 1875) with a circulation of 200,000 (300,000 on Fridays); *Al Akhbar* followed with 180,000, and *Al Gomhouria*, "the paper of the revolution," was third with 150,000. The largest evening paper was *Al-Messaa* (12,000), the leading political weekly was *Akhbar Elyom* (250,000), the biggest illustrated weekly *Al Mussawar* (40,000); the next biggest *Akher Saa* (30,000) appeared in co-operation with *Al Akhbar*. The most popular weekly, *Sabah El Kher* (50,000), appeared in co-operation with *Rose El Yousef* (50,000). There was also a woman's weekly, *Hawaa* (80,000). The *Arab Observer* and *Scribe* were both official magazines.

Under the law of 1958 no newspaper could be privately owned; all papers were transferred to the national union and were controlled by the staff. Half the profits went to the workers, the other half to future development. Censorship was abrogated under the law of 1958. Newspapers required a licence from the national union.

2. Other North African Countries: *Libya.*—The daily *Trablus el Gharb* was government-owned and published in Arabic, while the privately owned *Il Giornale di Tripoli* was published in Italian. Of the eight nondailies, two were government-owned and in Arabic, three privately owned and in Arabic and three in English and privately owned. Press laws were fairly stringent and suspension of papers occurred periodically.

Tunisia.—In the early 1960s two dailies were published in Arabic and two in French. Their combined circulation of 80,000 represented 20.8 copies per 1,000 inhabitants. There were also two nondailies, one in Italian and one in French, and five periodicals (four in Arabic, and one in French). The largest daily was the French *La Presse de Tunisie* (30,000). The government organ, *Al-Amal*, had a circulation of 20,000. *Jeune Afrique* (80,000), a French weekly, included all Africa in its scope.

Algeria.—Nine dailies were published in the early 1960s in French and Arabic; with a total circulation of 300,000, their sales averaged 30 per 1,000 population. Two nondailies and 192 periodicals were also published.

The Algerian press was greatly disrupted by the fight for independence from France, 1954–62, and its aftermath. Four dailies were published, *Alger Républicain*, *Le Peuple*, *Alger ce soir* and *La République* and a weekly *Révolution Africaine*. All supported the governing party, the National Liberation front (F.L.N.).

Morocco.—There were seven dailies in the early 1960s with a combined circulation of 112,500 representing 90 copies per 1,000 inhabitants. Among them was *Espana* (Spanish 35,000). *Le Petit Marocain* (French 30,000) and *La Vigie Marocaine* (French 30,000) were both published by the Mas group; *La Nation Africaine* (French 5,000) was published by the government; *Al Alam* (Arabic 5,000) was published by the Istiqlal party; *At Tahrir* (Arabic 5,000) was published by the National Union of Popular Forces. There were also 19 nondailies and 100 periodicals.

3. French-Speaking Countries.—Freedom of the press, based largely on the French law of 1881, was guaranteed in the constitutions of all African territories that are members of the French Community, though stringent penalties are generally provided. However, the press in the early 1960s was carefully watched over by the governments; indirect pressure was strong, and direct action was not unusual.

Except for papers and periodicals financed by a government or controlled by a political party, most were owned by companies in which Europeans held the major share.

Cameroon Republic.—There was one daily in French with a circulation of 10,000, representing 3 copies per 1,000 inhabitants. There were also five nondailies and 17 periodicals.

Central African Republic.—There was one daily in French with a circulation of 1,000 representing 9 copies per 1,000 inhabitants. There was also a nondaily.

Chad.—There were two dailies in French; their combined circulation of 1,200 represented 5 copies per 1,000 inhabitants. There was also a periodical.

Republic of Congo.—There were three dailies in French with a joint circulation of 1,100, representing 1 copy per 1,000 inhabitants. There were also a nondaily and three periodicals.

Dahomey.—There were two dailies in French; their joint circulation of 3,000 represented 2 copies per 1,000 inhabitants. There were also two nondailies and three periodicals.

Guinea.—The government published the only daily and the press was subject to direct government control. There were also a nondaily and three periodicals.

Ivory Coast.—There was one daily in French with a circulation of 9,400 representing 3 copies per 1,000 inhabitants. The government published a nondaily and there were also two periodicals. Press control was exercised through a law of 1959; it was invoked against local journalists and was also used to keep foreign papers out of the country.

Malagasy Republic.—There were 17 dailies with a combined circulation of 20,000 representing 4 copies per 1,000 inhabitants. There were also 28 nondailies and 16 periodicals.

Mali.—The government published a mimeographed daily bulletin. There were three dailies, the main one being *L'Essor* (4,500), the government party weekly. A statute of 1954 provided for press legislation.

Mauritania.—The government published a nondaily information bulletin in Arabic.

Niger.—There was one daily cyclostyled bulletin in French; its circulation of 1,000 represented 4 copies per 1,000 inhabitants. The press was controlled by a decree of 1959, which stipulated

that every issue of a paper should be deposited with the authorities 12 hours before publication.

Senegal.—There was one French daily, *Paris Dakar* (daily since 1935). With a circulation of 20,000, it sold 8 copies per 1,000 inhabitants. There were 7 nondailies and 41 periodicals, including information publications, government publications, party and trade union organs, etc.

Somaliland (French).—There were one nondaily with a circulation of 700 and one periodical.

Togo.—There were two dailies with a joint circulation of 1,650, one of them a government daily, *Togo Press;* the other was the *Togo Observateur.* There were also six nondailies and two periodicals including the Catholic monthly *Mia Holo* (1920). The press was controlled by a law of 1959 which included the stipulation that two copies signed by the editor must be deposited with the authorities two hours before publication.

Upper Volta.—The government published a cyclostyled daily bulletin with a circulation of 600, representing 6 copies per 1,000 inhabitants. They also published a weekly bulletin. The press was controlled by a law of 1959, based on the French law of 1881 but providing for stiffer penalties.

4. Portuguese Territories.—*Angola.*—There were in the early 1960s four dailies with a combined circulation of 23,000 representing 5 copies per 1,000 inhabitants. There were also seven nondailies including *Diario da Manha*, the official organ of the Portuguese National union. Seventeen periodicals were published, and a strict form of censorship was maintained.

Mozambique.—There were four dailies with a combined circulation of 20,000 representing 3 copies per 1,000 inhabitants. Five nondailies and 25 periodicals were published.

Guinea (Portuguese).—One daily was published; its circulation of 1,100 represented 1.9 copies per 1,000 inhabitants.

5. South Africa.—The South African press was in the early 1960s the largest and in many ways the most vigorous in the continent. Of the 19 dailies, 13, including those with the largest circulations, were in English and 6 in Afrikaans. Their combined circulation reached 897,000, representing 61 copies per 1,000 inhabitants. The combined sale of nondailies was 950,000; 25 periodicals were published. The largest newspaper group was the Argus S. African Newspapers Ltd., which controlled the *Star* (Johannesburg), *Cape Argus* (Cape Town), *Daily News* (Durban), *Friend and Goldfields Friend* (Bloemfontein) and *Pretoria News.* The other leading papers were the *Rand Daily Mail* (Johannesburg), *Cape Times* (Cape Town), *Natal Mercury* (Durban), *Evening Post* and *E. P. Herald* (Port Elizabeth). The leading Sunday papers were the *Sunday Times* and *Sunday Express* (both Johannesburg). A new paper, the *Sunday Chronicle* was launched in Johannesburg in 1964 by the Argus group.

The Afrikaans newspapers, though relatively small in circulation, were politically important. The prime minister sat on the boards that controlled all the major Afrikaans newspapers in the Transvaal: *Die Transvaler* and *Die Vaderland* (both dailies) and *Dagbreek* (Sunday). Other important Afrikaans papers supporting the government were *Die Burger* (Cape Town), *Die Volksblad* (Bloemfontein) and *Die Oosterlig* (Port Elizabeth).

Papers catering largely for Africans have assumed new importance particularly after the Republic was formed. The *World*, formerly a weekly, became the first African daily using both English and vernacular languages. The *Golden City Post*, a Sunday paper with a circulation approaching 100,000, was the companion paper to the illustrated monthly *Drum.*

Publication of the press commission report resulted, in 1962, in the Newspaper Press union agreeing to voluntary control through a board which has accepted its own code of conduct. In 1964 the press commission proposed official control but action on this recommendation was deferred. A dozen statutes affect the operation of the press; these include the Public Safety act, the Native Administration act, the Suppression of Communism act, the Official Secrets act, the Prisons act, the Riotous Assemblies act, the Publications and Entertainments act and the Criminal Law Amendment act ("the Sabotage bill"). A deposit of £10,000 was required by all new papers beginning publication.

6. Other Countries: *Liberia.*—The daily *Listener*, Monrovia, had a circulation of 2,000 while the twice-weekly *The Liberian Age* one of 3,000 and the Lorma weekly *Wuzi*, in the vernacular, one of 1,000. The first two of these papers were government subsidized. There were also three periodicals. In theory there was no press censorship.

Sudan.—In the early 1960s there were nine dailies in Arabic and three in English with a combined circulation of 30,000 representing 3.6 copies per 1,000 inhabitants; 13 nondailies and 5 periodicals were published. The press was subject to indirect control through the ministry of information.

Ethiopia.—In the early 1960s three dailies were published in Addis Ababa (two in English, one in French) and two in Asmara (one in Italian, the other trilingual: Arabic, Tigrinya, Amharic). Their combined circulation of 10,000 represented 5 copies per 1,000 population. There were 5 nondailies, including a French weekly in Addis Ababa, and 32 periodicals, among which the *Ethiopia Observer* was of special interest. Government press control was firmly maintained.

Somalia.—One daily was published in Arabic and Italian; its circulation of 2,000 represented 1.5 copies per 1,000 inhabitants. Five nondailies and three periodicals were also published.

Burundi and Rwanda.—Before these two countries received their separate independence in 1962, 7 nondailies were published with a combined circulation of 70,000, representing 15 copies per 1,000 inhabitants; 16 periodicals were also published.

Democratic Republic of the Congo.—In the later 1960s three dailies were published in Kinshasa (formerly Léopoldville), three in Lubumbashi (formerly Elisabethville) and one in Kisangani (formerly Stanleyville). Several weeklies and periodicals were also published. The most important papers were the *Courrier d'Afrique* and *Présence Congolaise* in Kinshasa.

The press was greatly disrupted by events following independence in 1960, and several papers were temporarily suspended by government action.

For African countries in the Commonwealth see *Commonwealth of Nations: Africa,* above. (Co. L.)

XI. THE NEWSPAPER OFFICE

Newspaper offices all over the world differ, just as newspapers differ: Spanish newspapers are more literary, French newspapers are more political than are U.S. newspapers. In the U.S. a big metropolitan daily newspaper office may be in a multistoried building; a small-town weekly newspaper may be in a one-story building with the combined editorial, advertising and business office in front and a print shop in the rear, and two men doing all the work. What follows here is a generalized account of a newspaper office of a metropolitan newspaper in the United States.

A newspaper is produced and distributed by an organization divided, generally, into three major parts: editorial, business and mechanical. The large newspaper is directed by, in addition to these basic operational divisions, or sides, an administrative group, and is aided by a promotion department. Thus the entire organization may be said to have five divisions.

1. Editorial Division.—This is the heart of the newspaper. Its function is the gathering and preparation of news, features and comment; indeed, the editorial side includes everything that goes into the paper except advertising.

Housing arrangements differ in the various offices, but the modern news room is big and inclusive. Prominent in it is the city desk, headquarters for local news coverage. There the city editor directs a corps of reporters and rewrite men; the latter prepare copy from news telephoned in, rewrite stories from earlier editions, etc. More or less under the direction of the city desk are a number of reporters and critics in special fields, such as the theatre, motion pictures, music, churches, schools, books, fashions, etc. These men are often called editors in their particular departments; on the largest papers theirs are full-time jobs, but on most papers they perform these special functions in combination or along with other assignments. Also under the supervision of the city desk is the picture editor, with the staff photographers to whom he gives assignments. Some papers have feature editors, whose duty is to

select from syndicated material or from pieces obtained from reporters attached to the city desk a supply of entertaining or instructive stories known as features. About-town columnists are often connected with the feature desk.

The sports editor may have a staff of several reporters, and perhaps special photographers and columnists are attached to that desk. The financial editor also has reporters for local news, as well as assistants to handle wire reports. The society editor and her staff of reporters deal with social events, meetings of women's clubs, etc. Most of the large papers also have woman's page editors, who produce, from the syndicates and other sources, matter of special interest to women. An increasing number of science editors write special articles on new developments in the sciences. In agricultural regions, many papers have full-time farm editors; and there are oil editors in districts where that industry is of great importance.

An immense volume of material is received by each department from the public relations offices of organizations, government departments and business concerns. Only a small percentage of public relations releases find their way into print, but all are scanned for newsworthiness.

The Sunday editor and his staff have charge of the planning and assembling of features for the Sunday edition. (In England all Sunday newspapers have separate staffs even though they may be owned by organizations possessing a daily.) Attached to his desk are the editors and staffs of any pictorial or feature supplements that originate in the newspaper office.

The editorial page staff is headed by a chief who is usually called editor of the editorial page (or section). The political cartoonist belongs to this staff, and the syndicated public affairs columns pass through their hands.

In the newsroom is located the copy desk, a great U-shaped table at which copy from reporters, feature writers and the teletypes is processed for the printers. This processing includes checking for facts, libelous statements, names, spelling, punctuation, paragraphing, tautology, etc., and the writing of headlines. The copy chief, or slot man, sits inside the "U," whence he can hand out incoming copy to the copyreaders "on the rim." Nearby is the desk of the telegraph editor, who handles the long strips of copy torn from the teletype machines, which receive the reports of the wire news agencies. Through the teletypes pours a stream of reports from abroad, from Washington, from the state capital and from news centres throughout the country. The telegraph editor has the responsibility of selecting from this mass of material the sections that his paper's readers will find most important and interesting.

It must be understood, however, that copy desk functions, like the organization of the newspaper office throughout, differ considerably from paper to paper. For example, the copy chief sometimes doubles as telegraph editor, even on large papers. Sports, society and so on may move their copy across a so-called universal copy desk; on the other hand, those departments (and even state news, city and telegraph in a few cases) may have separate copy desks.

Conveniently situated for the use of newsmen, copyreaders and editorial writers are the paper's reference library and morgue. In the latter are filed thousands of clippings, as well as the paper's own back numbers; innumerable photographs, engravings and mats, from which pictures may be reproduced; and other materials that may be drawn upon for the day's stories, whether the reported events are scheduled or unexpected.

2. Business Division: Advertising and Circulation.—The revenue division of the newspaper has two parts: the advertising department and the circulation department. The financial outgo is also considered as belonging to the business side, but in the organizational chart it comes under the administrative division, considered below.

The advertising department headed by the advertising manager, is divided into three subdepartments according to the types of advertising produced: local display, which sells space to local merchants and helps them prepare their copy; national display, which handles advertising from outside the local trading area, much of it obtained from agencies serving various regions or the whole country; and classified, which takes care of the small ads (wanted, for sale, etc.). The local (or retail) advertising manager directs a force of salesmen, who are assisted in providing attractive copy by a corps of copy writers and artists. The national (or general) advertising manager works with special advertising representatives in the large manufacturing centres and with the advertising agencies. The classified advertising manager directs street salesmen, correspondence salesmen and a group of telephone solicitors, as well as the office's own want-ad clerks. Attached to the advertising department in many newspaper offices is a research bureau, whose director is assisted by interviewers and a clerical force.

The circulation department is composed of several units. City distribution by truck and carrier is central in its duties; also there is distribution by truck in outlying districts, towns and cities, and by mail. Sales and collections are important; carrier boys are often useful in these activities. The circulation manager of a large paper may have under him such supervisors or managers of various divisions, as a city circulation manager, country circulation manager, mail circulation manager and Sunday circulation manager. District and branch supervisors oversee delivery to street salesmen, newsstands, local carriers, motor route carriers and outside country dealers. There are also street and telephone solicitors and subscription agents, as well as collectors, etc. The mailing room superintendent directs a force of mailers.

3. Mechanical Division.—This department has four chief units: (1) the composing room, where copy from the newsroom (or rooms), editorial room and advertising desks is set into type, mainly by Linotype, and made up into page forms; (2) the engraving room, which takes photographs and drawings and makes engravings (cuts) for printing; (3) the stereotyping room, where plates for the presses are cast in molten metal from the page forms; and (4) the pressroom, where the papers are printed, folded, trimmed, counted and delivered to the mailing room for bundling for the trucks and wrapping and addressing for the post office.

A mechanical superintendent usually oversees and co-ordinates this four-part operation. A composing room foreman supervises the force of Linotype operators (or compositors); the machinists who care for the Linotypes; the compositors who assemble the Linotype slugs, hand-set type, cuts, etc., that make up the ads; the proofreaders and correctors of both news galleys and ads; and the make-up men, who put the pages together in forms and who work under the direction of a make-up superintendent. The engraving room has its own foreman, with such assistants as are necessary to process the cuts for news stories, features, advertising and the editorial page. The superintendent of the stereotyping room has a force of stereotypers, who make mats from each form to be placed in the casting mold; the plates from this mold are curved so that they may be locked on the cylinders of the presses. The pressroom foreman directs a group of pressmen, who not only fix the plates on the cylinders but also by accurate mechanical means take care of the necessary feeding of paper and ink to produce a well-printed paper.

4. Administrative Division.—An organization as complicated as that which produces a daily newspaper must be efficiently co-ordinated. This requirement is met by an administrative group that varies greatly in its composition and in the terminology of its personnel from one newspaper office to another. In general, however, it includes the president, publisher, executive editor, managing editor, circulation manager, advertising manager, mechanical superintendent and business manager.

At the head of these is the president of the publishing company or the board of directors. He sometimes carries the title of publisher, or there may be both a president and a publisher. These positions represent the ownership, and the men occupying them generally direct the policy of the paper. Ordinarily there is a large degree of autonomy allowed the editors and managers on the lower levels. The term editor in chief is no longer in common use. Editor is a title often given to the chief of the entire editorial division, though a few papers retain the older custom of calling the editor of the editorial page editor of the paper; indeed, some papers combine the two functions. In a number of instances the

publisher also carries the title of editor. Publisher is the title of the active executive head, however, and the man filling that position keeps in constant touch with all the administrative heads named above.

Under the editor are the executive editor, the managing editor and the news editor. Usually a paper does not have all three of these positions. When it has an executive editor, he is chiefly occupied with the management of the personnel of the editorial division, and then the managing editor has general oversight of the flow of news and features. If there is no executive editor, the managing editor usually works mainly with personnel and a news editor with planning the news and feature program of the day. A news editor commonly has a desk adjacent to the copy desk, so he can keep tab on the copy that is coming in. He is in constant consultation with the city and telegraph editors as well; and, with the make-up editor, he is continually planning and replanning the pages of the next edition as events develop.

The business manager is in charge of all financial outgo. He and his staff attend to payroll and to purchases of paper, ink, metal and other supplies. With the custodian, he takes care of maintenance of the building; with the mechanical superintendent, he keeps up the equipment of machinery. The accounting department may be headed by the treasurer of the publishing company or by the cashier or controller. Here are the auditor and a staff of bookkeepers and clerks. The business manager himself is sometimes called assistant publisher, and he keeps in close contact with all departments and operations of the newspaper office.

5. Promotion Division.—The division devoted to promotion and advertising of the paper to the public works closely with the circulation department, but it also serves other departments. It gives support to the paper's community service projects, striving to create good will and understanding. It is headed by a promotion manager, who may be assisted by copy writers, script writers and photographers or, at any rate, by workers who can help in the preparation of newspaper and direct-mail advertising, radio and television shows, exhibits, etc.

6. The Story of a Story.—It may help to clarify the activities of the newspaper office to trace a news story for an afternoon paper throughout its course from assignment to lockup in its page form.

Reporter Jones receives from his city editor in the morning an assignment to cover a bar association meeting at which, it has been rumoured, Judge X may announce his candidacy for the governorship. Jones is back by 11 o'clock. "He's going to run," he tells the city editor, who then instructs him as to how long his story may be. As Jones pounds it out on his typewriter, it is brought by a copy boy to the desk of the city editor, who looks it over and perhaps calls Jones over to consult about some points in it. Then he places it in a box, from which a copy boy soon carries it to the news editor, who glances over it and hands it to the copy chief, with a few words about the position and display he plans to give it in the next edition.

The copy chief then marks Jones's story with an identifying name, "Judge X," and a number indicating the kind of headlines it is to carry, in conformity with the "play" suggested by the news editor, and turns it over to one of his copyreaders for checking and head writing. After the copy has been edited and the head written and attached, it is sent by pneumatic tube down to the composing room. There the copy cutter, because the deadline for the first home edition is approaching, divides the copy into two "takes" for two of the Linotype operators. Soon the slugs, each carrying in relief letters from which a line is to be printed, and now still warm from the machines, are delivered to the galley bank, together with the original copy. The bank man pulls a proof, which he sends, with copy, by tube to the proofroom. After the proofreaders return the marked proof to the composing room, lines in which errors have occurred are reset, and the new slugs are substituted for those that carried the errors, in a process called correcting the galleys.

Meanwhile, in the newsroom upstairs, the first home edition is taking form under the supervision of the news editor, who must decide on space, position and display of news. The ads have already been in place on the make-up tables downstairs for hours; and the sports, society, editorial and stock-market pages are being made up separately by their own departments. The news editor is assisted by his make-up editor, who is working with dummy sheets for pages on which space allotted to various ads is crossed off. They have an earlier mail edition as a starting point from which to lay out the home edition. In conferences around the news and make-up desks, city, state, telegraph and picture editors have pointed out the stories that could be discarded from the earlier edition and those that are in process for later editions, thus keeping the news editor informed on a constantly changing news picture.

Today a European political crisis, an airplane disaster and the proceedings of a congressional committee are the big stories; but the news editor points out a position on page one below the fold for Judge X's announcement, and the picture editor has dug up a single-column cut of the judge from the morgue to go with it.

At one o'clock the completed dummies of the main news pages are taken down to the composing room by the make-up editor. There the make-up men are bending over rows of steel-topped tables on which lie the page forms to which they now transfer from the galleys the slugs carrying the various stories. The news editor himself comes down to oversee the last phases of the make-up of page-one form, shortening a story here and there to make it fit, with the assistance of a Linotype operator. At last everything is exactly in place, and the sound of the planer and mallet on the form marks the end of the editorial work on page one, with Jones's story of Judge X's announcement. The form is ready to be wheeled to the stereotyping room, and in a matter of minutes it will be on the presses. (F. L. MT.)

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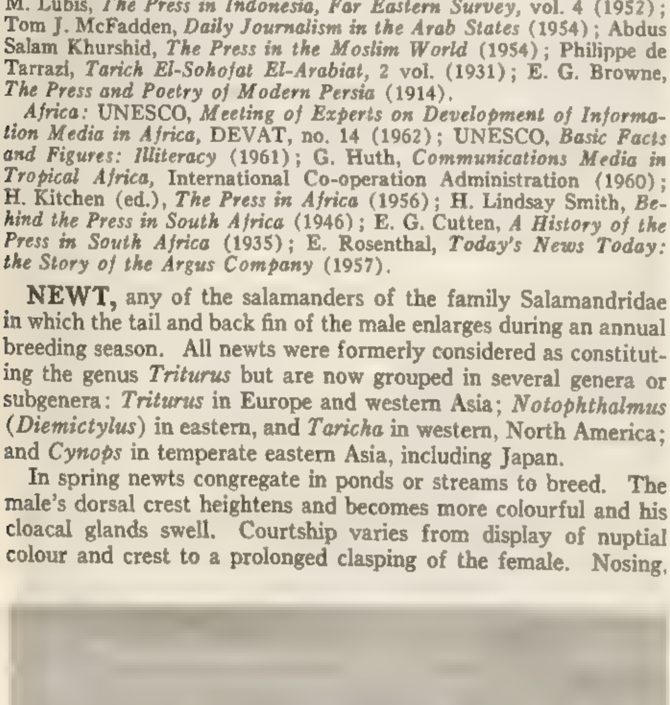
NEWT, any of the salamanders of the family Salamandridae in which the tail and back fin of the male enlarges during an annual breeding season. All newts were formerly considered as constituting the genus *Triturus* but are now grouped in several genera or subgenera: *Triturus* in Europe and western Asia; *Notophthalmus* (*Diemictylus*) in eastern, and *Taricha* in western, North America; and *Cynops* in temperate eastern Asia, including Japan.

In spring newts congregate in ponds or streams to breed. The male's dorsal crest heightens and becomes more colourful and his cloacal glands swell. Courtship varies from display of nuptial colour and crest to a prolonged clasping of the female. Nosing, rubbing and the release of scents presumably stimulate the female to pick up the spermatophore that the male deposits at the mating climax. The spermatophore consists of a large basal gelatinous part and a detachable sperm capsule top that the female removes with her cloacal lips. The sperms free themselves and lodge in glandular folds of the female's cloaca, where the eggs are fertilized a few days later as they are laid.



ISABELLE HUNT CONANT

RED-SPOTTED NEWT (NOTOPHTHALMUS V. VIRIDESCENS)

The female of most newts lays 200 or more eggs, attaching them singly to vegetation, sticks or stones in the water; *Taricha* lays 5–30 eggs, mostly in clumps. The eggs hatch in three to five weeks, and the larvae usually transform at summer's end. Although neoteny (prolongation of the aquatic larval stage) is known, most young newts lead a completely terrestrial life. In the eastern U.S. they are called efts or red efts at this stage. When two to four years old, newts mature and begin their annual or permanent return to the ponds. During the autumn, partial courtship may occasionally take place.

Newts eat earthworms, insects, snails and other small animals. In the water they also ingest amphibian eggs, including their own. They are favourite aquarium animals and are also much used in experimental studies. *See* also AMPHIBIA; SALAMANDER; and references under "Newt" in the Index. (G. B. R.)

NEW TESTAMENT: *see* BIBLE.

NEW THOUGHT, a term used to characterize an important religio-metaphysical healing movement which received its first impulse from Phineas Parkhurst Quimby (*q.v.*), the first person, certainly in America, to have arrived at the conclusion that all illness is basically a matter of the mind, of mistaken belief. His healings were therefore accomplished by correcting the patient's wrong belief. Many came to him for healing, among them, in the early 1860s, four persons who themselves became famous healers.

One of these was Mary Baker Eddy (*q.v.*), who later founded Christian Science. Just how much of her teaching she derived from Quimby is a moot question; according to Christian Science belief her *Science and Health* was divinely revealed personally to her. Warren Felt Evans (1817–89) became the first articulate exponent of the Quimby point of view, contributed to its further development, and spread it through his several widely read and influential books; but he left no organization.

It was Julius A. Dresser and Annette Seabury, later his wife, who first gave organized form to what may be called New Thought as over against Christian Science. This has since taken many forms, all loosely recognized as New Thought in general belief and practice but differing widely one from another at points. Among these have been Divine Science, Unity (*q.v.*) School of Christianity, Home of Truth, Church of the Truth, Religious Science and others, most of which have been at one time or are now united in a rather loose federation known as the International New Thought Alliance.

Differing rather widely in some respects, they agree in general in emphasizing the primacy of mind in the universe; the immanence of God, usually thought of as being nonpersonal, though with definite personal qualities; a clear distinction between the historic Jesus and the Christ; the supremacy of good, if not always the unreality of evil; the essential goodness of human nature, man being thought of as divine; the possibility of healing through mental or spiritual means; and usually also the availability of abundance or prosperity to all men.

See Charles S. Braden, *Spirits in Rebellion: the Rise and Development of New Thought,* with extensive bibliography (1963).
(C. S. B.)

NEWTON, ALFRED (1829–1907), English zoologist, a specialist in the study of birds and one of the founders of the British Ornithologists' Union, was born at Geneva, Switz., on June 11, 1829. In 1854 he was elected to the Drury travelling fellowship of Magdalene college, Cambridge, and from then until 1863 he visited Lapland, Iceland, the West Indies, North America and Spitsbergen, studying chiefly ornithology. In 1866 he became the first professor of zoology and comparative anatomy at Cambridge, a position he retained till his death on June 7, 1907. His services to ornithology and zoogeography were recognized by the Royal society in 1900, when it awarded him a royal medal, having

elected him a fellow in 1870. He was also given the gold medal of the Linnaean society in 1900. He was editor of the ornithological journal *The Ibis* (1865–70) and *The Zoological Record* (1870–72). His books include *Zoology of Ancient Europe* (1862), *Ootheca Wolleyana* (1864–1902) and a *Dictionary of Birds* (1893–96), an amplification of the numerous articles on birds that he contributed to the ninth edition of the *Encyclopædia Britannica*.

NEWTON, SIR CHARLES THOMAS (1816–1894), British archaeologist, recognized for his discoveries in Asia Minor and as exponent of the systematic study of classical antiquities, was born at Bredwardine, Herefordshire, on Sept. 16, 1816, and educated at Shrewsbury school and Christ Church, Oxford. He entered the British museum as an assistant in the department of antiquities in 1840. He left it in 1852 to become vice-consul at Mytilene (on the island of Lesbos) with the object of conducting an archaeological reconnaissance of the islands and coasts of Asia Minor. Encouraged by financial assistance from Lord Stratford de Redcliffe, at that time British ambassador in Constantinople, Newton made notable discoveries of inscriptions on the island of Calymnos, off the coast of ancient Caria (*q.v.*). In 1856–57 he identified the remains of the mausoleum of Halicarnassus, one of the seven wonders of the ancient world. At Branchidae he discovered the statues that in ancient times had lined a sacred way, and at Cnidus, R. P. Pullan, working under Newton's direction, found a colossal lion now in the British museum. Together they published *A History of the Discoveries at Halicarnassus, Cnidus and Branchidae*, two volumes (1862–63).

Newton was the first (1862) to hold the position of keeper of Greek and Roman antiquities in the British museum. He secured considerable new material for the department. First Yates professor of classical archaeology in University college, London, from 1880 to 1888, he did much to promote Hellenic studies in Britain. Created knight commander of the Bath in 1887, Newton died at Margate, Kent, on Nov. 28, 1894.

See also CNIDUS. (J. M. WI.)

NEWTON, SIR ISAAC (1642–1727), English physical scientist and mathematician, one of the greatest figures in the entire history of science, was born at Woolsthorpe, near Grantham in Lincolnshire, on Dec. 25, 1642. His father had died the previous October. In 1645 Newton's mother remarried, moved to her new husband's home and left her son in the care of her mother. Newton was an indifferent scholar until a successful fight with another boy seems to have stimulated him and he became the best student of the school.

When Newton was 14 years old (1656), his mother became widowed for the second time, returned to Woolsthorpe and brought the boy home from school to run the farm. He proved to be an absentminded farmer, occupying himself with mathematics instead of attending to his work. His uncle, William Ayscough, rector of Burton Coggles, was a member of Trinity college, Cambridge, and in 1660 by his advice Newton was sent back to school to prepare for Cambridge. On June 5, 1661, he matriculated as a subsizar at Trinity college. Three years later he was elected as scholar and in Jan. 1665 took the B.A. degree. In 1667 he was elected a fellow of the college. In the autumn of 1665 the spread of the Great Plague caused the closing of the university. Until its reopening in the spring of 1667 Newton remained at Woolsthorpe. During those 18 months he laid the foundations for his famous discoveries in mathematics and physical science.

Early Basic Discoveries.—During the first of these months at Woolsthorpe, Newton developed what is now called the binomial theorem (*see* BINOMIAL THEOREM), and soon thereafter the method of fluxions, an early form of the differential calculus, the most important single mathematical innovation made since the time of the ancient Greeks. In May of 1666 he related, "I had entrance into the inverse method of fluxions," or the principle of the integral calculus, the method of calculating areas under curves and the volumes of solid figures.

These advancements alone would have entitled him to one of the highest places in the history of the sciences. But they were accompanied by two others, each of unusual significance. One was an analysis by experiment of the composition of white light and the nature of colours. The other was the discovery of the gravitational force holding the moon in its orbit, though nothing of this was published for almost 20 years (see *Work on Gravitation and Astronomy*, below). Newton later said that during those two years, "I was in the prime of my age for invention, and minded Mathematics and Philosophy [*i.e.*, science] more than at any time since."

Newton returned to Cambridge and to Trinity college in 1667, but did not publish his discoveries. Yet his teacher, Isaac Barrow—a man who distinguished himself in the fields of optics, mathematics and theology—recognized the superiority of his gifted pupil and resigned his chair, the Lucasian professorship of mathematics, so that Newton, at the age of 26, might succeed him. In a book on optics published in that year, Barrow recorded his indebtedness to Newton, calling him a "man of quite exceptional ability."

Work on the Telescope and Optics.—At this time the subject of optics was Newton's chief scientific interest. He worked at the problem of grinding lenses with nonspherical surfaces and continued to experiment with prisms. One result of his research was a new type of telescope, called the reflecting telescope because its principal light-gathering component was a mirror rather than the lens system of the refracting telescope. News of this invention came to the Royal society of London. Newton constructed a telescope and sent it to the society, to which he was elected a fellow. A week later, he suggested that he would like to present an account of the scientific discovery that had led him to design the new instrument, a discovery, in his words, "being in my judgment the oddest, if not the most considerable detection, which has hitherto been made in the operations of nature."

The main points of Newton's discovery were these. He found that if a narrow beam of white light, *e.g.*, sunlight, is allowed to pass through a slit into a prism, it will be dispersed into light of many colours covering the visual spectrum. He separated any narrow sector from that spectrum, as by placing a board with a slit in the path of the light leaving the prism, and allowed the monochromatic light to pass through a second prism. The result was that that beam bent but its hue was unchanged. Hence, those were wrong who had argued that the production of a spectrum by a prism arose from a "staining" action of the prism. Rather, as Newton's experiments showed, all light is bent or refracted as it goes from one medium to another (save in a direction perpendicular to the interface between two such media). Newton showed that white light is a mixture of light of all colours and that the prism separated the mixture into its component parts because the light of each colour is refracted by the prism at a different angle. But if light of a single colour were to be separated out in the spectrum, its colour would not change as it passed through another prism since it would not be a mixture but would be (to use Newton's own phrase) "homogeneal."

Knowing that white light is a mixture of light of all colours, and the prism separates light into these component colours, Newton could then explain many colour phenomena. For instance, a piece of white paper when illuminated with light of a single colour (say, red, green or yellow) will no longer appear to be white (but rather red, green or yellow). The colours of objects thus are related to the light by which they are seen, because "natural bodies . . . are variously qualified to reflect one sort of light in greater plenty than another." On this research are founded the science of colour and the technique of spectrum analysis.

In one set of experiments Newton studied the phenomenon known now as chromatic aberration. Since the prism experiments had shown that each colour has its own index of refraction, Newton concluded that the image of a body illuminated by white light (as sunlight) will not be sharp, there being a different focus for each colour. Thus an ordinary biconvex lens forms an image with an edge coloured like a miniature rainbow. Newton concluded erroneously from experiments that no one could ever make a lens system free of these colour fringes—free of chromatic aberration. He claimed to have shown by experiment that there is such a relation between the bending of light and dispersion into colours that no system of lenses could ever give an image without these effects.

In this he was mistaken; prisms and lenses can be made of different kinds of glass in pairs so that there is no dispersion although there is a net deviation or bending of light rays from their original paths. (*See* TELESCOPE.)

In order to prevent chromatic aberration from spoiling the quality of the telescopic image, Newton devised a telescope in which the principle element was a concave or magnifying mirror. Yet, as Christiaan Huygens pointed out, the full potentialities of Newton's reflecting telescope could not be realized until there was a method of grinding parabolic mirrors. (The most powerful telescopes at Mount Wilson and Palomar observatories are reflecting telescopes.) The telescope Newton made for the Royal society, one of their most prized possessions, is nine inches long and has a two-inch mirror.

When Newton sent his paper on light and colours to the Royal society, a committee was appointed to study the question further. One committee member, Robert Hooke, the originator of a theory of light and colour of considerable merit, had written a book, the *Micrographia* (1665), dealing in part with the same type of phenomena Newton had studied. Hooke admitted the accuracy of Newton's experiments, but doubted Newton's conclusions. Huygens also held to his own theory of colour, and as E. N. da Costa Andrade has explained, "he failed to understand . . . that Newton was not arguing about the nature of colour, about matters of doctrine, but describing experiments to show how white light and coloured light behaved, to show what were the measurable properties." Other critics arose; some misunderstood the experiments, but for the most part they disagreed on Newton's theory. Three of Newton's comments explain his position clearly: ". . . the Theory, which I propounded, was evinced by me, not inferring 'tis thus because not otherwise, that is, not by deducing it only from a confutation of contrary suppositions, but by deriving it from Experiments concluding positively and directly." "For the best and safest method of philosophising seems to be, first to enquire diligently into the properties of things, and of establishing these properties by experiment, and then to proceed more slowly to hypotheses for the explanation of them." As to "certain properties of light, which, now discovered, I think easy to be proved, . . . which if I had not considered them as true, I would rather have them rejected as vain and empty speculation, than acknowledged even as an hypothesis."

Discussions about Newton's paper were still going on in 1675. In December of that year he wrote, "I was so persecuted with discussions arising out of my theory of light that I blamed my own imprudence for parting with so substantial a blessing as my quiet to run after a shadow."

One effect of the controversy was that Newton was led to investigate other effects of colour, to inquire how light was produced and to develop the emission or corpuscular theory of light, according to which light is the product of emission by a luminous body of a host of tiny particles traveling in empty space with a speed of about 186,000 mi. per second; the laws of reflection and refraction were developed on mechanical principles, aided only by a supplementary hypothesis as to how, when falling on a transparent surface, some of the particles are reflected—bent back into the medium from which they have come—and others are refracted, along a new path inclined to the old, into the medium toward which they are traveling. It is in verification of this theory that light travels more slowly in a dense medium such as glass than in air. The theory was also applied to explain the colours seen when light is reflected from a thin film, a soap film or the thin layer of air between a convex lens of large radius and a flat reflecting surface on which it rests; in this case, when viewed in reflected light of a definite colour a series of dark and light rings circling round a central black spot is seen. Newton determined the law connecting the radius of a bright ring and the colour of the light. Since the radius depends on the colour, the bright rings for the various colours, when white light is used, will be different and the observer will see a series of coloured rings surrounding the black central spot. This phenomenon is now known as Newton's rings. (*See* LIGHT: *The Age of Newton and Huygens.*)

Hooke was again a critic; in his *Micrographia* he had adopted a kind of wave theory of light, according to which light consists of a series of pulses transmitted through a medium pervading space, the universal ether, and had endeavoured to explain rectilinear propagation, reflection and refraction as well as dispersion and the colours of thin plates. Newton, in his explanation of optical phenomena indicated that corpuscles of light might be guided by waves in an ethereal medium; yet he thought little of Hooke's attempts at explanation. From the work of Thomas Young in 1804 and the brilliant work of the French genius Augustin Fresnel a few years later came description in terms of wave theory covering the phenomena of light as then observed. Young drew on Newton's concepts of waves as well as on the views of Christian Huygens.

Newton rejected a simple wave theory of light because it could not account for rectilinear propagation or for polarization. As Newton demonstrated, all wave phenomena—for instance, sound—carry the disturbance into the region of shadow, or around obstacles. It never occurred to him that the waves of light might be exceedingly small. Yet in studying the colours of thin plates, Newton provided much of the necessary information for the later wave theorists. Thomas Young showed that Newton's careful measurements led to an accurate determination of the wavelength of the several colours. In his early papers, and later on in his *Opticks* (first edition 1704) Newton advanced an explanation of optical phenomena that was neither a pure corpuscular theory nor a pure wave theory. According to Newton it seemed probable that light consists of a series of corpuscles emanating from luminous bodies. These corpuscles give rise to waves as they travel through the ether and many optical phenomena (such as the colours of thin plates) arise from the properties of both waves and corpuscles. This explanation fell from favour during the 19th century, when the wave theory of light was fashionably accepted. But since A. Einstein wrote of photons of 1905, many writers have called attention to a similarity between Newton's views and those of the 20th century, in which there is a fusion of elements of both wave and corpuscular theories of light.

Work on Gravitation and Astronomy.—Since the early years at Woolsthorpe, Newton had been considering the main problem of motion: what force is it that keeps the planets moving about the sun in the Copernican system? Newton proposed that one and the same force of universal gravitation causes the planets to revolve about the sun in elliptical paths according to Kepler's laws. Furthermore, this force, which loses effect with the square of the distance, keeps the moon in motion about the earth and causes objects to fall to earth.

Newton related that the occasion of this discovery was the fall of an apple. What did he mean? If the moon moves in an orbit around the earth, and does not fly off in a straight line along a tangent to the orbit, there must be a force directed to the earth, a centripetal force pulling the moon to the centre of the earth. The situation is similar to that of a ball whirling in a circle at the end of a string; if the string breaks, the centripetal force ceases to be exerted, and the ball flies off along a tangent. Expressed differently, the moon is continually drawn away from its rectilinear tangential path by a force; this force causes the moon to fall continually away from a straight line and to follow its observed orbit. Newton computed the distance the moon must fall in each second. If the force that makes the moon fall varies inversely as the square of the distance, then, since the moon is at a distance of 60 earth radii from the earth's centre, the earth's force on the moon is $\frac{1}{60\times 60}$, or $\frac{1}{3,600}$ of what it would be if the moon were at the earth's surface. Hence, assuming that the force of gravity keeps the moon in its orbit and that this force varies inversely as the distance, Newton could predict the rate of fall of an object to the earth. This proved to be approximately what is observed: as Newton expressed it, the observation agreed "pretty nearly" with the theory. He also was able to show that Kepler's laws implied a central force that varied inversely as the square of the distance. Conversely, by assuming a single force exerted between sun and planets proportional to the masses of the sun and the planet involved and inversely proportional to the

square of the distance between them, one could derive Kepler's laws and show that one and the same force acted between the planets and the sun, between any planet and its satellite, between the oceans and sun and moon (so as to produce the tides) and, in general, between any two bits of matter in the universe.

In London there were great debates about planetary motions and about the orbits that would result from specified types of forces. Discussions went on at the Royal society or in the houses of the members—Sir Christopher Wren, Hooke, Edmund Halley and others who were active in the society—until one Wednesday in Jan. 1684 Halley met Wren and Hooke and the latter declared "that he had demonstrated all the laws of the celestial motions." Halley confessed his ignorance and Sir Christopher "to encourage enquiry said he would give Hooke or me"—the quotation is from a letter of Halley to Newton—"two months to bring him a convincing demonstration." Sir Christopher offered to give "a book of 40 shillings" to the one who first found the solution. So it remained until August, when Halley visited Newton at Cambridge and questioned him concerning the trajectory of a body moving under the action of a central force which varied as the inverse square of the distance from the centre. Halley wrote that Newton knew the answer and "had brought this demonstration to perfection." Newton promised to look for the old proof but could not find it, "and not finding it did it again." Halley returned to Cambridge and persuaded Newton to put his work in form for the Royal society. On Dec. 10, 1684, Halley informed the society that he had lately seen Newton, who had showed him a curious treatise, *De Motu*, which, upon Halley's desire, was sent to the society to be entered on their register.

Newton then attacked and solved a major problem. Hitherto his calculations had proceeded on the assumption that the sun and the planets could each be treated as though they were points, with all their matter concentrated at their respective centres. But was this true or was it merely an approximation resulting from the fact that the planetary distances were so immense that even a great sphere like the sun could in comparison be treated as a point?

Newton proceeded to work this out, on the assumption that each particle of the sun attracted an external particle with a force proportional to the product of the masses of the two and inversely proportional to the square of the distance between them. Thus he showed that if the sun were of uniform density the resultant force on the external particle would be the same as that which would be exerted if the whole mass of the sun were concentrated at the centre (*see* MECHANICS).

Some scholars have held that it was the difficulty of solving this problem that had caused Newton in 1665 to lay aside his astronomical calculations. Others agree with H. Pemberton's remark that a crude value for the earth's radius was responsible for the delay. In any event, the calculations were resumed with a more precise knowledge of the moon's distance.

The writing of the *Principia* was begun in March 1686. Entitled *Philosophiae Naturalis Principia Mathematica*, or "Mathematical Principles of Natural Philosophy," the work was first published in the summer of 1687. At that time the Royal society was in difficulties as to funds and Halley took the whole cost on himself. Hooke, when the book was first presented, claimed that he had anticipated Newton in part of it, and in the correspondence that followed Halley did all he could to smooth over the difficulties and persuade Newton to continue his work.

The *Principia* set the seal to Newton's reputation. It explained for the first time the way in which a single mathematical law could account for phenomena of the heavens, the tides and the motion of objects on the earth. The whole development of modern science begins with this great book. For more than 200 years it reigned supreme; popular theories of cosmology were based on the principles laid down by Newton. His mechanics guided astronomers and men of science in their search for natural knowledge.

Religious Beliefs.—Newton was profoundly interested in religious matters. He studied carefully the writings of the Church Fathers, the early writers on Christianity, and sought evidence to bolster his own principles of faith, which were anti-Trinitarian. John Maynard Keynes, who studied Newton's writings on esoteric and theological matters, concluded that Newton was "a Judaic monotheist of the school of Maimonides." Very likely this was the reason that Newton refused Holy Orders and had to be given a special dispensation to hold his professorship. He kept his religious convictions, like his experiments on alchemy, secret. Ultimately, the amount of time and energy that he devoted to alchemy probably rivaled that given to physics or to mathematics. So well did Newton keep his secret that his activities in these two realms are not generally and fully known.

Middle and Later Life.—In 1687 James II tried to force the university to admit as a master of arts Father Alban Francis, a Benedictine monk, without taking the oaths of allegiance and supremacy. Newton was one of those who led the resistance to the royal action, and appeared before Lord Jeffreys to argue the case for Cambridge. In the end the deputies were reprimanded and John Peachell, the vice-chancellor, was deprived of his office. Newton's share in the affair led to his being elected member of parliament for the university in 1689, retaining the seat till the dissolution next year. He was elected again in 1701, but he never took any prominent part in politics.

Upon the dissolution of parliament in 1690 he returned to Cambridge and continued for a time his mathematical work; this was interrupted in 1692–94 by a serious illness. He was suffering from insomnia and nervous trouble. There was a report that he was going out of his mind. In June 1694 Huygens wrote to G. W. Leibniz, "I do not know if you are acquainted with the accident to the good Mr. Newton, namely, that he has had an attack of phrenitis which lasted eighteen months and of which they say his friends have cured him by means of remedies and keeping him shut up." For some time his friends had been anxious to obtain some recognition of his work; this came in 1695. Charles Montague, later earl of Halifax, a former fellow of Trinity who was chancellor of the exchequer, offered him the post of warden of the mint. This he accepted and four years later became master. In the same year he was elected one of the eight foreign associates of the French Academy of Science.

In 1696 John Bernoulli addressed a letter to the mathematicians of Europe, challenging them to solve two problems and giving six months for the solution. On Jan. 26, 1697, Newton received from France two copies of the printed paper containing the problems and the following day sent the solutions to the Royal society. They were transmitted anonymously to Bernoulli, who, as he said, recognized the lion by his talon, *"tanquam ex ungue leonem."*

As warden of the mint Newton had retained his Cambridge offices, but soon after his appointment as master he named a deputy, and in 1701 resigned his professorship and the fellowship at Trinity. He had moved to London, where he continued his duties as master with marked efficiency until his death in 1727. In 1703 Newton became president of the Royal society and was re-elected annually until his death. Queen Anne visited Cambridge in 1705 and on this occasion Newton was knighted. About the same time the controversy with Leibniz as to the invention of the differential calculus began. It is now generally recognized that Leibniz invented the calculus independently of Newton and that Newton's claim that Leibniz was a plagiarist had no foundation. Early in 1727 Newton was taken seriously ill; he died on March 20, 1727, and was buried in Westminster abbey on March 28.

Published Works.—Since the first issue of the *Principia* in 1687 (*see* above), there have been many editions. In 1709 Newton consented to have Roger Cotes, a fellow of Trinity, help him prepare a second edition, which was published in 1713; a third edition made with the aid of Henry Pemberton appeared in 1726. This third Latin edition was reprinted in Geneva in 1739–42 with an excellent commentary by two friars, Le Sueur and Jacquier; often reprinted, this is known incorrectly as the Jesuits' edition. An English translation first published by A. Motte as *Mathematical Principles of Natural Philosophy* (1729) was revised and republished (1803), revised again by Florian Cajori and reprinted together with Newton's *System of the World* (1934).

The *Opticks*, first published in 1704, went through three editions in Newton's lifetime; a modern edition appeared in 1952.

The scientific papers published by Newton in his lifetime are collected in *Isaac Newton's Papers and Letters on Natural Philosophy*, edited by I. Bernard Cohen (1958). The most recent edition of Newton's writings, edited by S. Horsley in five volumes under the title *Opera quae extant omnia* (1779–85), is not complete.

Correspondence of Scientific Men of the 17th Century, etc., From the Originals in the Collection of the Earl of Macclesfield, edited by S. P. Rigaud (1841), and *Correspondence of Sir Isaac Newton and Professor Cotes, Including Letters of Other Eminent Men* (1850), edited by J. Edleston, contain many of Newton's letters, and the latter volume contains a synopsis of his life. A selection of Newton's writings on religion is contained in H. McLachlan (ed.), *Theological Manuscripts* (1950); earlier published religious writings were *Chronology of Ancient Kingdoms Amended* (1728), and the *Apocalypse of St. John* (1733).

The Royal society has undertaken an edition of *The Correspondence of Isaac Newton*, of which the first three volumes (1959–61), were edited by H. W. Turnbull and J. F. Scott.

For information on the impact of Newton's work on scientific thought, *see* SCIENCE, HISTORY OF: *Determinism and Postdeterminism*. For further information on his major scientific contributions, *see* CALCULUS, DIFFERENTIAL AND INTEGRAL; CELESTIAL MECHANICS; GRAVITATION; MOTION, PRINCIPLES AND LAWS OF. *See* also references under "Newton, Sir Isaac" in the Index.

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L. T. More, *Isaac Newton* (1934). The most readable account of Newton's life and achievement is E. N. da Costa Andrade, *Sir Isaac Newton* (1954); still useful for the amount of quoted material is *Memoirs of the Life, Writings, and Discoveries of Sir Isaac Newton*, by Sir David Brewster, 2 vol. (1855; reprinted 1860). Valuable critical commentaries are to be found in Augustus de Morgan, *Essays on the Life and Work of Newton*, edited with notes and appendices by P. E. Jourdain (1914). A brief account of Newton's life and works is given in S. Brodetsky, *Sir Isaac Newton* (1928). Of great value to students of Newton is the *Catalogue of the Portsmouth Collection of Books and Papers Written by or Belonging to Sir Isaac Newton* (1888), which describes the great mass of Newton's papers which came at his death into the hands of Conduitt. Among general commentaries may be mentioned: H. Pemberton, *A View of Sir Isaac Newton's Philosophy* (1728); Colin Maclaurin, *An Account of Sir Isaac Newton's Philosophical Discoveries* (1748); F. Rosenberger, *Isaac Newton and seine Physikalische Principien* (1895); Léon Bloch, *La Philosophie de Newton* (1908); I. Bernard Cohen, *Franklin and Newton* (1956).

Of great importance for the controversy with Leibniz is the report drawn up by order of the Royal Society, published under the title *Commercium Epistolicum* (1712), of which editions appeared in 1722 and 1725. *See* also S. P. Rigaud, *Historical Essay on the First Publication of Sir I. Newton's Principia* (1838); W. W. R. Ball, *Essay on Newton's Principia* (1893); J. W. L. Glaisher, *Bi-Centenary of Newton's Principia* (1888); *Isaac Newton, 1642–1727*, ed. by W. J. Greenstreet, a memorial volume (1927); History of Science Society, *Sir Isaac Newton, 1727–1927* (1928); W. Stukeley, *Memoirs of Sir Isaac Newton's Life, 1752* (1936); H. W. Turnbull, *Mathematical Discoveries of Newton* (1945); Royal Society of London, *Newton Tercentenary Celebrations, 15–19 July, 1946* (1947). (R. T. GL.; I. B. C.)

NEWTON, JOHN (1725–1807), one of the leaders of the Evangelical revival and friend of the poet William Cowper (*q.v.*), was born in London on July 24, 1725. He had little formal education and served from 1736 to 1742 on the ship in the Mediterranean trade of which his father was master. Early in 1744 he was impressed on board a man-of-war, the "Harwich," where he was made midshipman. For an attempt to escape while his ship lay off Plymouth he was publicly flogged and degraded. After this experience he joined another vessel bound for Africa, where he took service under a slave dealer. Then in 1747 he returned to the sea, and for a time became captain of a slave ship. Newton, known previously for his unbelief and blasphemy, underwent conversion during a storm at sea in 1748. He finally gave up seafaring in 1755 and was appointed tide surveyor at Liverpool where he came to know George Whitefield and John Wesley. He now began to study Greek and Hebrew and in 1758 applied to the archbishop of York for ordination. This was refused him, but having been offered the curacy of Olney, Buckinghamshire, in April 1764 he was ordained by the bishop of Lincoln. In Oct. 1767 William Cowper settled in the parish. The two men became close friends and they published together the *Olney Hymns* (1779). Newton's contribution included, among many other hymns, the well-known "How Sweet the Name of Jesus Sounds!" and "Glorious Things of Thee are Spoken." The most important of his works was *Cardiphonia, or the Utterance of the Heart* (1781), a series of devotional letters. It was through his letter writing that Newton made his greatest contribution to the Evangelical movement. In 1779 he left Olney to become rector of St. Mary Woolnoth, London. There he exercised an important ministry, influencing many, among them William Wilberforce, the future leader in the campaign for the abolition of slavery. Like Cowper, Newton held Calvinistic views, although his evangelical fervour allied him closely with the sentiments of Wesley and the Methodists. He died in London on Dec. 21, 1807.

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NEWTON, JOHN (1823–1895), U.S. army officer and engineer, was born in Norfolk, Va., on Aug. 24, 1823, and graduated from the U.S. Military academy at West Point, N.Y., in 1842. From 1842 to 1861 he was engaged in the construction of coast defense works and in improving waterways. He was assistant professor of engineering at the U.S. Military academy from 1843 to 1846, became a captain in 1856 and was chief engineer in the Utah expedition of 1857–58. He served in the Virginia campaign of 1861 at the start of the American Civil War. He distinguished himself in the Seven Days' battle and at Antietam and after the battle of Fredericksburg was made major general, U.S. volunteers. In the Chancellorsville campaign Newton took part in the storming of Marye's heights at Fredericksburg, on May 3, 1863, and at the battle of Gettysburg he was for a time in command of the I corps. Later he took part in the Atlanta campaign as a division commander in Gen. W. T. Sherman's army. For gallant conduct at Peachtree creek he was made brevet brigadier general, and at the close of the war was made brevet major general, U.S. army. In 1884 he became chief of engineers, and held this position until his retirement in 1886. One of his notable engineering achievements was the successful blasting of an obstruction in New York harbour in 1885 with 250,000 lb. of dynamite. In 1887–88 he was commissioner of public works in New York, and from 1888 until his death on May 1, 1895, was president of the Panama Railroad company.

NEWTON, a suburban, residential city of Middlesex county in eastern Massachusetts, U.S., is located on the south bank of the Charles river, immediately west of Boston (*q.v.*) and Brookline. Settled in 1639 as part of Cambridge, it was separated in 1688 and incorporated as New Towne, changing its name to Newton in 1691. During the 19th century farming was the principal occupation although the upper and lower falls areas of the Charles were busy industrial centres. Newton's growth as a residential suburb was given impetus by the opening of the Boston and Worcester railroad in 1834. Newton was incorporated as a city in 1873.

With a population (1960) of 92,384, Newton is part of the Boston standard metropolitan statistical area. Despite its size Newton has kept the flavour of a small suburban town, being divided into 14 individual villages, and containing a number of parks, playgrounds and other recreational facilities. Industries, limited by zoning laws, manufacture electronic tubes, electric signalling systems, textiles, rubber goods and plastics. Situated within the city are Newton Junior college (1946); Boston college (Roman Catholic, 1863); Newton College of the Sacred Heart (Roman Catholic, 1946); and the Andover-Newton Theological school formed by a merger of Andover Theological seminary (Congregational, 1808) and Newton Theological institute (Baptist, 1825). (M. R. F.-S.)

NEWTON ABBOT, a market town in the Totnes parliamentary division of Devon, Eng., 16 mi. S.S.W. of Exeter by road and near the head of the Teign estuary. Pop. (1961) 18,060.

has a Wednesday cattle and general market; it is also a shopping centre and railway junction with various light industries. The two parish churches, St. Mary's in Wolborough and All Saints' in Highweek, are Perpendicular in style. The Jacobean Forde house (1610) was visited by Charles I and William of Orange, who first read his declaration to the people of England at Newton Abbot market cross. The 15th-century Bradley manor belongs to the National trust. The portion of Newton Abbot in the parish of Highweek was formerly a separate town known as Newton Bushel. There is a racecourse on the opposite bank of the Teign. Newton Abbot rural district council (area 144.8 sq.mi.; pop. [1961] 25,963) embraces 22 parishes and extends from Dartmeet (central Dartmoor) on the west to Dawlish and Teignmouth urban districts on the east.

NEWTOWNABBEY, an urban district of County Antrim, N.Ire., lies on the shores of Belfast lough, adjoining the northern boundary of the city and county borough of Belfast. Pop. (1961) 37,440. The third largest town in Northern Ireland, it was constituted by private act of parliament in 1958, when seven former village communities were amalgamated to form the new urban district, which includes a civic centre and about 160 ac. of municipal playing fields and public parks. The basic textile industries have been supplemented by the establishment of two central government factory estates. (A. R. Ma.)

NEWTOWNARDS, a municipal borough of County Down, N.Ire., lies at the northern end of Strangford lough, 10 mi. E. of Belfast by road. Pop. (1961) 13,090. The town was founded by Sir Hugh Montgomery in 1608, at the site of a Dominican friary founded in 1244 by Walter de Burgh (ruins of which survive), and was incorporated in 1613. It is heavily industrialized, and as well as the spinning and weaving of linen its industries include the manufacture of hosiery, aircraft components, sheet-metal work and draftmen's instruments, fabric printing and rayon weaving.

Immediately to the northeast of the town is Movilla (Magh Bhile) with remains of a 6th-century abbey church attributed to St. Finian. (Hu. S.)

NEW TOWNS. In order to decentralize population and industry from London and other big towns in Great Britain, a New Towns act was passed in 1946. Following this, 12 New Towns were designated in England and Wales and 3 in Scotland, each with its own development corporation financed by the government. Relatively undeveloped sites were usually chosen and the New Towns were to be self-contained and locally governed. Each was to have an admixture of population so as to give it a balanced social life. Final population figures ranged from about 30,000 to 80,000 or more in England and Wales (70,000 in Scotland). The 12 New Towns designated in England and Wales were Aycliffe and Peterlee in County Durham, Bracknell in Berkshire, Corby in Northamptonshire, Crawley in Sussex, Cwmbran in Monmouthshire, Basildon and Harlow in Essex, and Hatfield, Hemel Hempstead, Stevenage and Welwyn Garden City in Hertfordshire. The three Scottish ones were Glenrothes in Fife, East Kilbride in Lanarkshire and Cumbernauld in Dunbartonshire.

By the early 1960s half a million people lived in the 15 New Towns but pressure on the big cities remained acute. Accordingly additional New Towns were designated at Skelmersdale in Lancashire, Livingston partly in West Lothian and partly in Midlothian, Dawley in Shropshire, Redditch in Worcestershire, Runcorn in Cheshire, Washington in Durham and Risley, near Manchester.

The New Towns act, 1959, provided for the establishment of a New Towns commission which was to take over the assets and properties of the New Towns as each was substantially completed. Early in 1962 Crawley and Hemel Hempstead were handed over to the commission.

See HOUSING: *Great Britain: Town Planning after World War II.*

See also F. J. Osborn and A. Whittick, *New Towns: the Answer to Megalopolis* (1963), which contains a full bibliography.

NEWTOWN ST. BOSWELLS, a village of Roxburghshire, Scot., lies 40 mi. S.E. of Edinburgh by road, on the main Edinburgh-Carlisle railway and main Edinburgh-Newcastle road. Pop. (1961) 1,050. Until 1929 the village was mainly populated by employees of the old North British Railway company, for it was an important railway junction; by the mid-1960s, however, all branch lines had been closed. The county buildings were erected there in 1929 and it is now an important administrative centre with the offices of the Edinburgh and East of Scotland College of Agriculture and a branch of the department of agriculture for Scotland. A livestock market holds weekly sales.

Dryburgh abbey (1¼ mi. E.), founded in 1150 for Premonstratensians by Hugh de Morville and financed by David I, is one of the prime attractions of the border country. Sir Walter Scott and Field Marshal Earl Haig of Bemersyde and members of their families are buried there.

St. Boswells, a residential village, lies 1 mi. E.S.E. of Newtown St. Boswells. (J. R. Fr.)

NEW WESTMINSTER, a city of British Columbia, Can., located on the estuary of the Fraser river, 15 mi. from its mouth, on the steep north bank at a bridging point of the Trans-Canada highway and the Canadian National and Great Northern railways. Pop. (1961) 33,654. The city is an integral part of metropolitan Vancouver. It is a freshwater port with berthing and cargo handling facilities for deep-sea ships which load timber, lead, zinc, fertilizer, apples and grain. Gov. James Douglas incorporated the city in 1860 and until 1866 it was the capital of the mainland colony of British Columbia. It is a trading and manufacturing centre with one of the largest concentrations of the forest products industry in the province. The processing of lumber, Fraser river salmon and fruit and vegetables from the adjacent farming district are among the principal manufacturing industries. (G. A. W.)

NEW WINDSOR, often called simply WINDSOR, a royal borough of Berkshire, Eng., stands on the south bank of the Thames opposite Eton, Buckinghamshire, 23 mi. W. of London by road. Pop. (1961) 27,126. Despite several references to it in Domesday Book, it is called New Windsor because further downstream lies Old Windsor, which was a royal manor in Saxon times.

The dominating feature of the town is Windsor castle, standing on a great outcrop of chalk. William the Conqueror built his fortress there but its only visible remains now are the mound where the Round tower stands. Great gray walls surround the castle, rising high above the Thames valley and also above Thames street which climbs steeply from Windsor bridge to High street, one of the highest parts of the town. On the way up, Curfew tower with its clock protrudes above the walls and dominates the approach. (*See* WINDSOR CASTLE.)

Farther along High street, passing Market Cross house, juts out the Guildhall, designed by Sir Thomas Fitz who superintended its erection from the laying of the foundation stone in 1687 till his death in 1689. Under the Guildhall, almost forming part of the street, is the old Corn market. The pillars—which only appear to support the Guildhall above, for they have never touched the beams—were erected by Sir Christopher Wren because, as tradition has it, members of the corporation feared the floor would collapse under their weight. It is said that Wren also supervised completion of the building. On its end walls statues of Queen Anne and her husband, Prince George of Denmark, face respectively toward the Thames and the Long walk. The Guildhall has a collection of paintings, including a portrait of Queen Elizabeth II, presented to the corporation by successive sovereigns; it also contains an exhibition of manuscripts, pictures, plans and objects showing the history of Windsor from early times to the present day. The council still meets in the Guildhall as do its committees, but the administrative offices of the corporation are now at Kipling Memorial building in Windsor.

The corporation is an ancient one which had its first known charter in 1277. Since then it has had other charters, the last one being dated 1685. Near the Guildhall is the parish church of St. John the Baptist where the corporation on civic occasions attends divine service. The church has, among other treasures, a painting of "The Last Supper," attributed to Franz Cleyn (d. 1658). Holy Trinity parish church has many regimental memo-

rials, for it is attended by the military units stationed at Windsor.

Primarily a residential town with many of its inhabitants working on the trading estate in nearby Slough or in London, New Windsor is served by both the western and southern regions of British railways.

The principal industries are light engineering, optical works, printing and the making of scientific instruments. The town is fortunate in being almost surrounded by Windsor Great park, a royal domain which contains the famous Long walk (of about 3 mi.) and stretches southward to Virginia water. Part of the Home park is also open to the public and there are playing fields and other open spaces. Windsor has a racecourse and an annual horse show. Pleasure boats ply up and down the river during the summer and great numbers of people visit the town.

Roman coins have been found at St. Leonard's hill, and Saxon remains at Old Windsor, the second largest town in Berkshire at the time of Domesday and excavated in the 1950s. For hundreds of years from Saxon times onward kings hunted in Windsor forest. On the Long walk Henry VIII listened to the sound of the gunfire announcing the execution of Anne Boleyn; Nell Gwyn lived there; George III raised Merino sheep in the park; and at Frogmore in the castle grounds Queen Victoria erected for the prince consort the mausoleum in which she also was later buried. (J. E. S.)

NEW YEAR'S DAY, the first day of the year. New Year's festivals, among the oldest and most universally observed, generally include rites and ceremonies expressive of mortification, purgation, invigoration and jubilation over life's renewal. The earliest-known record of a New Year's festival dates from about 2000 B.C. in Mesopotamia, where the year began with the new moon nearest the spring equinox (mid-March; Babylonia) or nearest the autumnal equinox (mid-September; Assyria). The year began for the Egyptians, Phoenicians and Persians with the autumnal equinox (Sept. 21) and for the Greeks, until the 5th century B.C., with the winter solstice (Dec. 21). By the Roman republican calendar the year began on March 1; after 153 B.C. the official date was Jan. 1, and this was confirmed by the Julian calendar (46 B.C.).

For the Jewish religious calendar the year begins with the first day of the month of Tishri (Sept. 6–Oct. 5; *see* JEWISH HOLIDAYS: *Rosh Hashana*). In early medieval times most of Christian Europe regarded March 25 as the beginning of the year, though for Anglo-Saxon England New Year's day was Dec. 25. William the Conqueror decreed that the year start on Jan. 1, but later England began its year with the rest of Christendom on March 25. Jan. 1 was restored as New Year's day by the Gregorian calendar (1582), immediately adopted by Roman Catholic countries. Other European countries followed suit: Scotland, 1660; Germany and Denmark, about 1700; Russia, 1706; England, 1752; and Sweden, 1753.

See also CALENDAR; FEAST AND FESTIVAL.

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NEW YORK, one of the original 13 states of the United States, ranks 30th in area among the states, but first in population, trade and manufacturing. Its land area is 47,939 sq.mi. and the area of inland waters is 1,637 sq.mi. The state has a triangular outline, with a breadth from east to west of 322 mi. and from north to south, on the line of the Hudson river, of 312 mi. In addition, Long Island thrusts about 118 mi. eastward from New York bay.

New York is bounded on the north by Lake Ontario, the St. Lawrence river and Canada; on the east by Vermont, Massachusetts and Connecticut; on the south by the Atlantic ocean, New Jersey and Pennsylvania; and on the west by Pennsylvania, Lake Erie and the Niagara river.

Because of its great wealth and the concentration of business and industry, New York has come to be known as the "Empire state." The state capital is Albany and the state ratified the federal constitution on July 26, 1788, the 11th of the colonies to do so. The sugar maple has been adopted as the state's official tree and the rose as the official flower. The state flag has a blue field upon which is imprinted the state coat of arms with the motto "Excelsior" inscribed on a white ribbon beneath it.

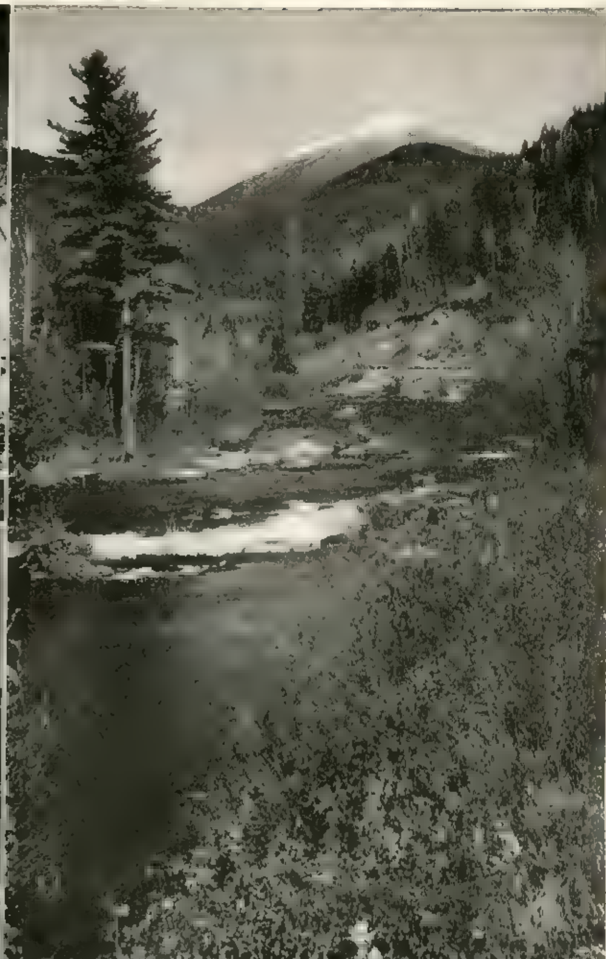
PHYSICAL GEOGRAPHY

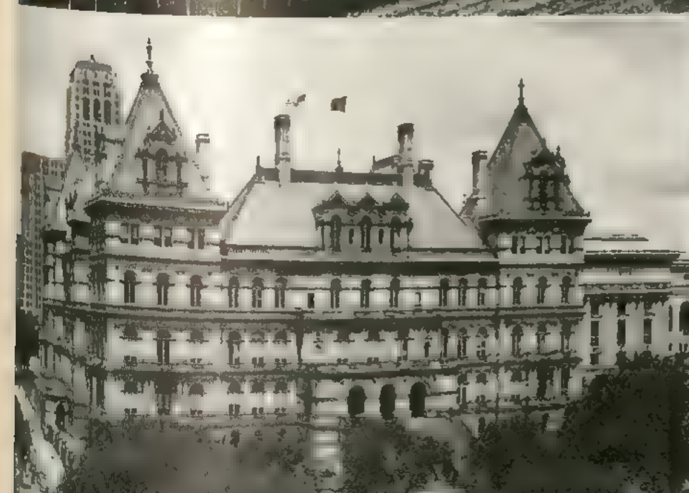
Physical Features.—The most notable topographical feature of the state is the circular Adirondack mountain area in the northeast. This ancient mountain mass of Pre-Cambrian rocks resembles more the Laurentian mountains of Canada than the Appalachians. The highest peak is Mt. Marcy (5,344 ft.). Other peaks range from about 2,000 ft. to about 5,000 ft. Even the highest summits are worn and rounded and are largely forest covered. The Adirondack area proper, and much of the surrounding ring of younger sedimentary rocks is too rugged and the soil is too thin for agriculture. Because of the beautiful scenery, this is a favourite recreational centre. In summer, visitors hunt, fish, swim and climb; in winter, they skate and ski. Small factories have developed, partly to utilize the products of forest, mine and farm and partly to use the extensive water power.

South of the Mohawk river and west of the Hudson river rises a high level plateau which extends westward to the Pennsylvania border. There the sedimentary strata are essentially horizontal and of the Paleozoic age, mainly Devonian. This plateau area, which comprises more than half of the state, has much variety. The elevation decreases toward the north by means of a series of "steps," the lowest elevation being on the Ontario plain which skirts the southern shore of Lake Ontario for a width of about 35 mi. The fertile and level lands along the shores of Lake Ontario and Lake Erie have attracted many farmers especially fruit growers. The large lakes have a moderating effect on the climate and lengthen the growing season. The plateau surface becomes more rugged toward the south and the east. Elevations of about 1,500 and 2,000 ft. are common from Chautauqua lake to the Catskill mountains. The plateau is cut by many streams which have created deep valleys. The valley walls rise to undulating and often fairly level uplands which provide excellent pasturage for dairy cows. In southeastern New York, near the Appalachians the plateau becomes much higher, reaching its culmination in the Catskills. Summit elevations of from approximately 3,000 to 4,000 ft. are common, the highest point being Slide mountain (4,185 ft.). Like the Adirondacks, this region is largely forest covered and is famous as a site of summer and winter sports. The Helderberg mountains are really an escarpment facing the lower Mohawk and the Hudson rivers south of Albany, where there is a downward step in the plateau. The steeply rising face of the plateau is the result of the resistance of a durable layer of limestone, known as the Helderberg limestone. The most notable escarpment in western New York is the Niagara which extends eastward from Canada, forming the Niagara falls, and creating a sharp drop at Lockport.

South of the Catskills there are a number of different topographical features which are caused by the belts of differing rock structure that cross the state from southwest to northeast. The most pronounced of these upfolded strata form the low Shawangunk mountains, which descend to a lowland region of folded strata of limestone, slate and other rocks in Orange and Dutchess counties. This lowland area is a continuation of the great valley of the Appalachians and extends northeast into Vermont and southwest across New Jersey, Pennsylvania, Maryland and Virginia. It is bounded on its southeast side by the highlands, a belt of crystalline rocks which merge into the Taconic range, or Berkshires. The Hudson river has cut a deep gorge through the highlands. South of the highlands is a belt of Triassic sandstone which, because of its peculiar columnar jointing, has developed the famous Palisades of the lower Hudson. Long Island, a northeast extension of the coastal plain, has few heights of more than 200 ft. High hill, the highest point, is only 410 ft. above sea level.

The continental glacier covered the entire surface of New York with the exception of a very small area in the extreme western part. It broadened and deepened many of the valleys, rounded the hills, turned aside many streams, causing changes in drainage giving rise to innumerable waterfalls and rapids, and formed the





BY COURTESY OF (TOP LEFT, TOP RIGHT, BOTTOM LEFT) NEW YORK STATE DEPARTMENT OF COMMERCE; PHOTOGRAPHS, (CENTRE LEFT) H. ARMSTRONG ROBERTS, (BOTTOM RIGHT) EWING GALLOWAY

VIEWS OF NEW YORK STATE

Top left: Hasbrouck House at Newburgh built in 1750. George Washington used it as his headquarters in 1782–83

Top right: Whiteface mountain (4,872 ft.), part of the Adirondack range, with the Ausable river in the foreground

Centre left: Ore and grain boats on Buffalo creek. Buffalo has been a leading port and industrial centre of the United States since the opening of the Erie Canal in 1825

Bottom left: The state capitol at Albany, completed in 1898, which took more than 30 years to build

Bottom right: The Administration building at West Point, the U.S. Military academy

NEW YORK (STATE)

BY COURTESY OF (TOP LEFT) NEW YORK STATE THRUWAY AUTHORITY, (TOP RIGHT, CENTRE RIGHT, BOTTOM LEFT) NEW YORK STATE DEPARTMENT OF COMMERCE, (BOTTOM RIGHT) STANDARD OIL CO. (N.J.)

SCENES IN NEW YORK STATE

Top left: New York State thruway, principal traffic artery between Buffalo in the northwest and New York city in the southeast. The photograph shows the road as it runs parallel to the Mohawk river near Fort Plain

Top right: Surf-casting for striped bass at Hampton Bays on the south shore of Long Island

Centre right: Fort Niagara, overlooking Lake Ontario at the mouth of the Niagara river. The first fort on this site was built by the French in 1678, the present structure in 1725–26

Bottom left: A dairy farm near Syracuse. Milk and dairy products provide more than half of the total annual farm income of New York state

Bottom right: Tanker passing through the Erie canal at Waterford, near the junction of the Champlain and Erie divisions of the New York State Barge canal system which is about 525 mi. long

thousands of lakes which dot the state. As the ice receded, it halted at various points where it formed moraines and other glacial deposits.

Drainage.—New York is drained by streams running in various directions. The St. Lawrence river system receives most of the runoff, mainly from short streams from the plateau and from the Adirondacks. A small part of the state, in the west, is drained toward the Ohio river. A much larger area drains into the Susquehanna river and into Chesapeake bay. A part of the Catskills, and the region farther south, drains into Delaware bay through the Delaware river. The Hudson is by far the most important river within the state, being navigable for 151 mi. from the sea. It is noted for its remarkable scenery, especially where it crosses the highlands.

There are about 8,000 small, glacial lakes and ponds in the state. The largest lake apart from Lakes Erie and Ontario is Lake Champlain into which Lake George drains. The largest lake entirely within the state is Oneida lake. In the central part of the state is a series of elongated lakes called the Finger Lakes; the six largest are Cayuga, Seneca, Keuka, Canandaigua, Owasco and Skaneateles. In the extreme western part of the state is Chautauqua lake. New York has many falls and rapids, the largest of which is the cataract of Niagara which is about 1 mi. wide and 167 ft. high. The U.S. fall is entirely within New York, but the Canadian boundary line passes down the centre of the Horseshoe or Canadian fall.

Climate.—New York has a wide variety of climate because of its topography and location between the Atlantic ocean and the Great Lakes. The average mean annual temperature in the state is about 45° F. (about 7° C.), though it varies from 52.3° F. in New York city to less than 40° F. in the Adirondacks. The mountain and plateau regions have heavy snowfalls and extreme changes in temperature. Daytime temperature is often high, but the nights are decidedly cool because of the rapid loss of heat. In contrast, Long Island has light snowfall and fairly constant temperature because of the moderating effect of the ocean. Similarly, the area adjoining the Great Lakes, and to a lesser extent the Finger Lakes, has long, mild autumns and winters much less severe than the uplands a few miles away.

There is a wide variation in the annual precipitation, though the greatest amount falls during the growing season. The average annual precipitation in New York city is 42.11 in.; in Syracuse 35.31 in.; in Binghamton 34.41 in. The average annual snowfall ranges from 31.3 in. in New York city to 87.0 in. in Oswego and 126.6 in. at Lake Placid. New York lies within the northeastern cloud belt and therefore receives less sunshine than the central or western states.

Soil.—The soil is mostly glacial drift, with the depth and composition often varying greatly even within small areas. The most widely distributed soil, especially in the eastern half of the state is clay formed by the glacial pulverizing of limestone and shale. The most fertile soil is found along the shores of the lakes and in the river valleys where alluvium has accumulated.

Plants and Animals.—A dense forest covered the state during the colonial period except for a few natural clearings in the Genesee valley but only in the recesses of the Adirondacks are there tracts of the original forest. There are 149 kinds of trees, of which 116 are native. Spruce, pine and hemlock are the commonest trees in the Adirondack and Catskill mountains. The evergreens provide a rich background for the maples, birches and beeches. Oak, short-leaf pine, maple, hickory and gum trees are the principal ones on Long Island. Oak, hickory, chestnut and elm are the most predominant trees in the Hudson–Mohawk valley, the Lake Ontario plain and the deeper valleys of the plateau.

New York also has thousands of varieties of plants and ferns. In the forests there are wild sarsaparilla, Solomon's-seal, trillium and many other kinds of wild flowers. Buttercups, clover, violets, wild roses and rushes are common throughout the state.

Both northern and southern animal types are found in New York. The wild turkey, panther, elk, moose, wolverine and timber wolf have been killed off but protective measures have saved the beaver, otter, mink and black bear from extinction. Deer, foxes, muskrats, raccoons, rabbits and squirrels are common in most parts of the state.

About 265 kinds of birds inhabit the state during some portion of the year. In the summer there are the robin, wood thrush, catbird, bluebird, wren, barn swallow, meadow lark, red-headed woodpecker and oriole among others. Year-round types include the English sparrow, crow and various kinds of woodpecker and hawk. The state protects game birds such as partridge, pheasant, ruffed grouse, varieties of wild duck, snipe and woodcock. There are a great many types of fish in New York's waters despite pollution and disturbance of the balance of nature through the stocking of streams. The kinds common in most watersheds are darters, yellow perch, suckers, bullheads, sunfish, small-mouthed bass, rock bass, shiners, dace, brook trout and blunt-nosed minnows. Long Island is noted for its shellfish: lobsters, oysters, clams and scallops. Its fishermen seek out the pollack, flounder, mackerel, bluefish, striped and sea bass in the ocean waters.

Parks and Reservations.—The state conservation department supervises 98 parks which vary in size from 6 ac. (Sackets Harbor) to 59,600 ac. (Allegany state park). The state council of parks which is composed of the chairmen of the various regional park commissions acts as a central advisory agency. The nine park commissions are Niagara frontier, which preserves the beauties of Niagara falls and gorge; Palisades interstate; Genesee, which oversees Letchworth park; Finger Lakes, which includes Watkins glen and Taughannock falls; Thousand Islands; Taconic state, which supervises 9 park areas on the east bank of the Hudson; Central New York; Long Island, which supervises 17 parks including Jones beach; and Allegany state. In addition, the state owns the Adirondack forest preserve, a virgin wilderness embracing 2,252,970 ac. In 1964 the Fire Island National Seashore, comprising 25 mi. of beach, was established.

Following the colonial practice, New York in 1784 made a treaty with Chief Joseph Brant and the six nations of the Iroquois, and assumed responsibility for the Indians residing within its borders. In 1960 about 7,000 Indians lived on seven reservations. They are the Allegany, Cattaraugus, Tonawanda and Tuscarora in the western part of the state; the St. Regis, the most populous, near Massena; the Shinnecock, on Long Island; and the Onondaga, south of Syracuse. Indian agents are appointed by the state board of social welfare and are directed to provide care and relief for needy Indians.

Historic Sites and Museums.—New York has many museums, notable buildings and historic sites. The New York State Historical association operates two museums at Cooperstown: Fenimore house, its headquarters, with historical and art collections and the Farmers' museum with its 19th-century village. Nearby is the National Baseball Hall of Fame and Museum. The Adirondack museum at Blue Mountain lake has exhibits of logging equipment, boats and early resorts. Other important historical museums are the Albany Institute of History and Art, the Buffalo Historical museum, Oneida Historical society in Utica, the Rochester Historical Society museum and the Suffolk County Historical Society museum at Riverhead. New York city has several important museums. Perhaps the most interesting historically are the Museum of the City of New York and that of the New York Historical society. Local societies throughout the state have collected Indian relics, newspapers, diaries, tools, firearms, china and furniture.

The state has acquired more than 20 historic houses and sites. Three Revolutionary War battlefields—Oriskany, Saratoga, Bennington (Walloomsac)—are marked by monuments and parks. In Kingston stands the senate house where the first state senate met on Sept. 10, 1777. Three historic places in the Newburgh area are associated with the last two years of the American Revolution. They are Washington's headquarters, Knox's headquarters and Temple hill where General Washington appealed to his rebellious officers to remain patient and loyal. Across the Hudson river are the Clinton house at Poughkeepsie, Philipse manor at Yonkers and the John Jay homestead at Bedford. The national government administers a library at Hyde Park, the home

and graves of Franklin D. Roosevelt and his wife, as a national historic site. The Albany area has three state-administered houses or museums: the Schuyler mansion, Ft. Crailo in Rensselaer and the state museum attached to the state library in Albany. The state museum specializes in Indian material and collections of the animals, flowers and minerals of the state. Johnson hall in Johnstown, Guy Park in Amsterdam and Ft. Johnson in Fort Johnson were built by Sir William Johnson, an early Indian trader and builder. The Schoharie County Historical society has its museum in the Old Stone fort in Schoharie. Near Little Falls stands the Herkimer home where the hero of the battle of Oriskany, Nicholas Herkimer, died in 1777. Three colonial forts have been reconstructed. They are Ft. Ontario at Oswego, Ft. Niagara at Lewiston and Ft. Ticonderoga. Three memorials commemorate the campaign by Generals John Sullivan and James Clinton against the Iroquois in 1779. They are the Sullivan monument near the south end of Conesus lake, the Boyd-Parker monument near Geneseo, and the Newton battlefield near Elmira. Theodore Roosevelt's home, Sagamore Hill, at Oyster Bay, L.I., and his birthplace in New York city became national historic sites in 1963. Two outstanding industrial museums are the George Eastman House of Photography in Rochester and the Corning Glass museum in Corning.

HISTORY

The Indians.—The Iroquois Indians had an important influence in New York not only on provincial development, but also on the imperial struggles between the Dutch, British and French. The five tribes (Mohawk, Oneida, Onondaga, Cayuga and Seneca) of central and western New York formed the confederacy of the Five Nations about 1570. This confederacy or league, which admitted the Tuscarora in 1722, reached the height of its influence about 1700 when it held the balance of power between England and France. The league's power rested on its commanding position on the strategic waterways, its control of the fur trade between the seacoast traders and the tribes of the interior, its unity and its skill in warfare. The various Algonkian tribes in the lower Hudson valley and Long Island were much less important.

Discovery and Exploration.—New York bay and the Hudson river were discovered by Giovanni da Verrazano in 1524. For many years after that, French vessels occasionally ascended the Hudson to trade with the Indians. Henry Hudson and Samuel de Champlain penetrated deep into the heart of New York in 1609. The Dutch East India company employed Hudson, an Englishman, to find a new water route to the far east. After a vain effort to sail around northern Europe, Hudson turned westward and finally entered New York harbour. Hudson sailed up the "river of the mountains" to a point near the site of Albany. His reports on the fertile land, furs and friendly Indians aroused much interest among Dutch merchants. The East India company sent out more sea captains to explore and trade. Adriaen Block in 1613–14 explored the shores of Long Island sound from Manhattan Island to the present state of Rhode Island. Late in 1614 or early in 1615 a stockaded trading post called Fort Nassau was erected on Castle Island within the present limits of Albany.

Settlement.—In 1621 the states-general, the ruling council of the Dutch republic, granted a charter to the Dutch West India company which gave it a monopoly of trade for 24 years along the shores of the Americas and in the Atlantic below the Tropic of Cancer. The company's directors drew up in 1624 a provisional order for administering a colony to be established in the recently designated (1623) province of New Netherland. It provided for company control of trade and for a director general. The same year it sent out about 30 families, mostly Walloons, and 18 of these families founded the first permanent settlement at Fort Orange (Albany). Three more vessels arrived in 1625 and Willem Verhulst replaced Cornelis Jacobsen May as director or governor. In 1626 the company appointed as governor Peter Minuit who purchased Manhattan Island from Indian chiefs for 60 guilders (about $24) in trinkets and built a fort at the lower end of the island. This settlement, known as New Amsterdam, became the seat of government and trade. The village grew slowly having only about 1,000 inhabitants by 1650 and about 1,500 in 1664.

In 1629 the company adopted the charter of freedoms and exemptions in order to spur colonization and agriculture. With company permission individuals could take possession of as much land as they could cultivate. Thus began the system of individual development and private ownership of land. Members of the company who peopled their tracts with 50 adult settlers in four years could acquire huge estates along navigable rivers. Only one of these patroonships proved successful, however, that of Kiliaen Van Rensselaer, a diamond merchant of Amsterdam, who developed his estate, which covered most of modern Albany and Rensselaer counties, by sending out colonists, craftsmen and supplies. His practice of leasing his land encouraged the system of farm tenancy which the English landlords later expanded.

The Dutch Period.—Governor Minuit was recalled in 1631 for granting privileges to the patroons at the expense of the company. His successor, the corrupt Wouter van Twiller (1633–38) constructed forts on the Connecticut and Delaware rivers in order to protect the fur traders. Willem (William) Kieft began his nine-year rule in 1638 when the company gave up its monopoly of trade. Two years later it permitted those who transported five settlers to the colony to receive 200 ac. and it also began to allow manufacturing. These inducements encouraged immigration from the homeland and from New England and Virginia. The activities of irresponsible traders and the mismanagement of Indian affairs by Governor Kieft, however, provoked the Algonkians to attack the Dutch settlements (1641–45). Out of this warfare arose an organized movement for a government in which the colonists would have a voice, but in 1642 Kieft refused to accept reforms which were recommended by an unofficial board of 12 leading colonists. The next year he clashed with another board of eight men over the issue of taxes and this board's request to the states-general for the recall of Kieft was granted.

Peter Stuyvesant (*q.v.*), his successor, arrived in May 1647. He agreed to the establishment of a board of nine men, the first permanent board of officials in the colony, but he rejected the board's recommendations. The grant of municipal rights to New Amsterdam in 1653 encouraged the towns on Long Island to demand more self-government. The leading men from the province met in a diet and demanded a share in the enactment of the laws and in the election of officials. Stuyvesant dismissed the meeting but the Long Island towns kept up their demands until in 1663 they secured the right to elect their own magistrates at town meetings. They also won a memorable victory for religious liberty. Stuyvesant, a zealous Calvinist, was especially angry at the rebellious town of Flushing which permitted Quaker meetings. His order forbidding Flushing to harbour Quakers led 26 freeholders to sign a remonstrance in 1657 calling for liberty of conscience. The imprisonment of one of the leaders did not stop the Quaker activities in Flushing and in 1662 Stuyvesant arrested John Bowne for allowing meetings in his house. Bowne was jailed and deported but the directors of the company urged Stuyvesant to end his persecution and eventually Bowne returned to New Netherland a free man.

Stuyvesant had more success in conducting foreign affairs. In 1655 a fleet of seven ships and 650 men which he had dispatched captured the Swedish settlements on the Delaware river founded by the New Sweden company in 1637. The English threat was potentially more dangerous. The English government claimed the whole region held by the Dutch, citing the discoveries of John Cabot (1498), the patent of the London and Plymouth companies (1606) and the patent to the council of New England (1620). Most threatening of all was the invasion of the Connecticut valley, the land along the sound and Long Island by English settlers. Realizing the weakness of New Netherland, Stuyvesant was forced in 1650 to sign the humiliating treaty of Hartford with the New England confederacy by which Long Island was divided. The English obtained the part east of a line drawn south from Oyster bay and also secured the rest

west of the Connecticut river although they agreed not to settle within 10 mi. of the Hudson river.

Trade regulation, however, led to the final conflict between England and Holland. The Dutch traders constantly interfered with the enforcement of the acts of trade and navigation. Then, on March 22, 1664, Charles II of England granted to his brother James, duke of York and Albany, all of the land from the west side of the Connecticut river to the east side of Delaware bay, including Maine, Long Island, Martha's Vineyard and other islands. Col. Richard Nicolls was appointed commander of a fleet to capture New Netherland. Stuyvesant surrendered in September without fighting and Nicolls replaced him as governor.

English Rule.—The transition from Dutch to English rule and institutions was accomplished smoothly. The duke of York assumed sole power to make laws, regulate trade, grant land and fix taxes. Completely autocratic rule, however, was limited by several factors such as the great distance from England, demands by inhabitants for home rule, the willingness of governors to make concessions in order to secure co-operation and the requirement in the duke's charter of 1664 that all laws must harmonize with those of the homeland. Governor Nicolls began in 1665 by creating an English county named Yorkshire out of Long Island, Staten Island and Westchester and promulgating a code of laws known as the "duke's laws." This code gave the freeholders of each town a voice in town government through the election of a board of eight overseers and a constable. It also guaranteed religious freedom and jury trial. The code soon was extended to the rest of the province. The duke of York had reduced his holdings in 1664 by granting New Jersey to Lord John Berkeley and Sir George Carteret and Governor Nicolls recognized Connecticut's claims to its present borders. Nicolls was succeeded in 1668 by Col. Francis Lovelace who, as governor, continued the policy of conciliation.

In Aug. 1673, Holland and England being at war, a Dutch fleet surprised and captured New York and restored Dutch authority and names. The treaty of Westminster in Feb. 1674 reaffirmed the treaty of Breda (1667), and in November the English again took possession in the person of Gov. Edmund Andros. The merchants strenuously resisted Andros' efforts to levy import duties and while he was in England to answer unfounded charges of dishonesty the citizens renewed their demands for a representative assembly. The unrest led the duke in 1683 to send a new governor, Thomas Dongan, with orders to call the desired assembly. It met in New York city and passed 15 acts, the most important of which was a charter of liberties and privileges that provided for an assembly elected by the freeholders and freemen. This assembly had the power to approve or reject all taxes. When the duke became king of England as James II in 1685, he withdrew his approval of the charter and instructed Dongan to resume full legislative powers. In 1688 he consolidated New York, New Jersey and the New England colonies into the Dominion of New England under the viceregal authority of Andros as governor general.

The news that the British parliament had dethroned James and that Boston's citizens had jailed Governor Andros led to a popular uprising in New York under the leadership of Jacob Leisler (*q.v.*). Leisler called an assembly which proclaimed James' successors, William and Mary, as monarchs and formed a committee of public safety to rule. Leisler surrendered the colony on March 29, 1691, to Henry Sloughter, the new governor. The landlord-merchant aristocracy hated Leisler for his democratic tendencies and they persuaded Sloughter and his council to bring charges of treason against Leisler who was tried, convicted and hanged. The Leisler rebellion, besides sharpening class cleavages, helped preserve New York's separate existence. It also resulted in a permanent bicameral legislature since Leisler's assembly was made a permanent elected unit and the old council became the upper house.

The rise of the assembly and of provincial home rule were the most striking developments in the political history of New York in the 18th century. The extravagances of Gov. Edward Cornbury (1702–08) caused the assembly in 1706 to demand and win the right to appoint its own treasurer when it needed to raise "extraordinary supplies" beyond the normal budget. In 1715 Gov. Robert Hunter (1710–20) agreed unofficially to spend the budget according to a system specified by the colony's leaders. Gov. George Clinton (1743–53) clashed repeatedly with the assembly, which tried to strip him of his powers even over military affairs. Finally a compromise was arranged whereby Clinton could initiate money bills but had to accept a one-year appropriation bill which named officials and fixed salaries. The great landlords of the upper Hudson, led by the Livingston family, organized a new faction in the 1750s to challenge Lieut. Gov. James De Lancey, who had agreed to a tax on land in order to raise revenue for the French and Indian War (1754–63). During the next 20 years the Livingston group in alliance with the Presbyterians, lawyers and artisans tended to challenge the royal prerogative and eventually became the patriots of the American Revolution whereas the De Lancey group, supported by the Anglican Church and the most important merchants of the city, tended to oppose radical measures and they became the Tories (Loyalists) in 1775.

The famous libel suit against John Peter Zenger (*q.v.*), who had established the *New York Weekly Journal* in 1733, advanced the freedom of the press and to some extent the independence of the judiciary. Gov. William Cosby arrested Zenger in Nov. 1734 for printing criticisms of his administration. At his trial, the jury released Zenger because it held his statements were true and therefore not libelous. In 1805 New York, after the urging by Alexander Hamilton, enlarged the freedom of the press by admitting truth as a defense in libel cases.

The northern frontier of New York was a crucial area in the long conflict between England and France for the domination of North America—thus the colony was often a battleground in the four Anglo-French wars between 1689 and 1763. Between 1713 and 1740 relative calm was maintained on the New York frontier. The French, however, built Ft. Niagara (1726) and Crown Point (1731) on Lake Champlain and Gov. William Burnet countered by building Ft. Oswego in 1727. Gov. George Clinton favoured vigorous action against the French but the assembly would vote him no money. He made William Johnson, a famous Indian trader, the Indian agent for New York but Johnson was able to win support only from the Mohawk tribe. The Iroquois complained that the land speculators stole their lands and that the government did not protect them from French attacks. To meet this dissatisfaction the colony's board of trade directed Governor De Lancey to call a colonial congress at Albany in 1754, at which Benjamin Franklin advanced his plan for colonial union. The congress adopted the plan with modifications, but the plan was ultimately disapproved by all of the colonies. The congress was partly successful, however, in placating the Iroquois.

The British plans for 1755 called for attacks on Ft. Niagara and Crown Point. Neither campaign succeeded although at the battle of Lake George the British defeated the French forces of Baron Ludwig Dieskau. In 1756 the French general Montcalm took Oswego and the following year Ft. William Henry on Lake George. Ticonderoga, Crown Point and Niagara were eventually taken from the French and Montreal fell in 1760. The final British victory in 1763 meant the end of the French threat but it also marked the decline of Iroquois power. Furthermore, it set in motion the forces which led the colonists to seek home rule and finally independence.

The Revolutionary Period.—Victory brought perplexing problems to Great Britain. Among them were a large debt, heavy taxes, the administration of new territories and the necessity of reorganizing the imperial trade. In wrestling with these problems cabinet ministers advanced solutions which encroached upon the home rule of the colonists. The Sugar act of 1764 with its provision for vigorous enforcement provoked the merchants who were suffering from the postwar depression and a currency shortage. Irritation became anger when parliament in 1765 passed the Stamp act, which imposed a tax on legal documents, licences, commercial instruments, newspapers, pamphlets, etc. The New York assembly authorized a committee to correspond with committees in other colonies and to attend a Stamp Act congress which met in

New York city in 1765. The Sons of Liberty, a radical group of artisans led by lawyers and merchants, rioted, boycotted British imports and threatened stamp officials. The good feeling caused by the repeal of the Stamp act in 1766 turned to dismay when Gov. Henry Moore prorogued the assembly in late 1766 until it should provide for quarters and supplies for British soldiers. The Townshend acts of 1767, designed to raise further revenue, stirred merchants to sign a nonimportation agreement. Finally, in 1770 parliament repealed the duties except the tax on tea.

Tension relaxed until 1773 when the Tea act was passed. This act annoyed most merchants because it gave the British East India company the right to sell tea through its own agents. Following the example of Boston, a band of men disguised as Indians were dispatched to dump tea into New York harbour. When parliament passed the "Intolerable acts" in retaliation, the New York assembly appointed a committee which approved the calling of a continental congress. The first continental congress in Oct. 1774 adopted the "association," an agreement not to import from or export to Britain until American rights were respected. A committee was to be set up in each town, city and county in each of the English colonies in North America to enforce the association by punishing violators. (*See* CONTINENTAL CONGRESS, THE.) This action disturbed the conservative majority in the assembly who refused to choose delegates to the second continental congress, but the radicals asked county committees to send representatives to a provincial convention which met on April 20, 1775, and appointed the delegates.

News of the battle of Lexington on April 19, 1775, led to the collapse of royal government in New York. The radicals formed a committee of 100 which in effect governed New York until the second provincial congress met on May 22.

There was never a majority of New Yorkers who favoured severing the imperial tie. Loyalist sentiment was perhaps stronger in New York than any other state. Traditional ties of family, church and trade were reinforced by the fear of radicals and the destruction of trade by the association. Real power, however, passed to the third provincial congress which met in May 1776 and called for a new government. This congress refused to permit the New York delegates to the second continental congress to sign the Declaration of Independence on July 4, but the fourth provincial congress, meeting at White Plains, approved the famous document July 9.

Nearly one-third of all the engagements of the Revolutionary War took place in New York. George Washington came to New York city on April 13, 1776, to prepare against an attack. Britain's Sir William Howe landed with 10,000 men on Staten Island on July 5. He ousted the Americans from Brooklyn and occupied New York city on Sept. 15. Gen. John Burgoyne with 7,700 British and German troops took Ft. Ticonderoga on July 6, 1777, but surrendered his forces at old Saratoga (Schuylerville). Meanwhile, the British colonel Barry St. Leger led an auxiliary force from Oswego against Ft. Stanwix (Rome). On Aug. 6 he fought one of the bloodiest battles of the war at Oriskany, where the American commander Nicholas Herkimer was mortally wounded. Deserted by his Indian allies, St. Leger retreated to Oswego. Sir Henry Clinton, who had been left in charge by Howe, led a small expedition up the Hudson, broke through the highland barrier and burned Kingston. When he learned of Burgoyne's imminent defeat, Clinton decided to withdraw to New York city. The failure of the British campaign not only saved upstate New York and New England, but it persuaded France to enter the war as an American ally. Frontier attacks by Tories and Indians caused much damage in the Mohawk and Schoharie valleys. As a result in 1779, the American generals John Sullivan and James Clinton advanced through the Finger Lakes region to the Genesee valley where they burned about 40 Iroquois villages. The closing episode of the war as far as New York was concerned was the discovery of Benedict Arnold's attempt in 1780 to betray West Point and other posts on the Hudson to the British. Washington established his headquarters at Newburgh after the British surrender at Yorktown in 1781. The British left New York city on Nov. 25, 1783, but did not give up their posts on Lake Ontario until 1795 after the signing of the Jay treaty in 1794. (For further details, see AMERICAN REVOLUTION.)

Early Years of Statehood.—John Jay was the principal author of New York's first constitution. The structure of government was quite similar to that of colonial New York although the power of the governor was curtailed. Both Jay's appointive and veto power had to be shared with councils which included senators. These councils worked badly and the constitutional convention of 1821 abolished them. In 1777 George Clinton became the state's first governor and held the office for the next 18 years. He was a champion of the patriots against the Tories, of states' rights against central government and of small farmers against the landed aristocrats. The conservatives wanted a strong government and their leader, Alexander Hamilton, helped call the Constitutional convention in 1787 and he alone of the New York delegation signed the federal constitution which the convention adopted. Nevertheless, his opponents composed about two-thirds of the delegates to the state convention called to ratify the federal constitution in 1788. A bare majority for ratification was obtained as the result of Hamilton's arguments, the ratification by New Hampshire and Virginia, a promise of a bill of rights and the threat of secession by New York city. All New Yorkers supported Washington for president and were pleased by the choice of New York city as the temporary national capital.

The friends and foes of the federal constitution continued their rivalry under the designations of Federalists and Antifederalists (Clintonian Republicans). Most of the aristocracy, except for the Livingston family, backed Hamilton whereas a majority of the farmers supported Clinton. Aaron Burr transformed Tammany hall from a fraternal association into an arm of the Republican (future Democratic) party. The Federalists easily elected Jay as governor in 1795. Jay reformed the criminal code and pushed through a law in 1799 providing for gradual emancipation of slaves. The Federalists, however, lost popular support because of their attempts to prosecute Jedediah Peck and other critics of Pres. John Adams under the federal Sedition act.

The return of Clinton as governor in 1801 inaugurated a period of factional strife among his Republican followers. His nephew De Witt Clinton, challenged Aaron Burr's political control of New York city and became mayor in 1803. Burr in 1804 ran for governor as an independent with Federalist backing. Hamilton's advice to his friends not to vote for Burr added to Burr's hatred of Hamilton and this enmity led to a duel between the two men in which Hamilton was killed. Thereafter, the Federalists declined although the party experienced a temporary revival when the Embargo act and the War of 1812 injured trade and shipping.

Gov. Daniel D. Tompkins (1807–17) proved an exceptional war leader during the War of 1812. Tompkins surmounted such difficulties as the poorly trained militia, obstructive tactics by the Federalist majority in the assembly and incursions by the British. Many of the war's battles were fought along the state's borders. The American plan for an attack on Niagara and Montreal ended ingloriously largely because the state's militia refused to advance beyond the state's borders. British raids on Plattsburgh and Buffalo and the American burning of York (Toronto) occurred in 1813. The next year Capt. Thomas Macdonough defeated a larger British fleet on Lake Champlain and prevented an invasion.

De Witt Clinton's speech in 1815 demanding canals between the Hudson river and Lakes Erie and Champlain met such an enthusiastic response the legislature was forced to make Clinton the head of a canal commission.

Power Politics.—In 1817 Clinton became governor by an almost unanimous vote and, largely through his efforts, the Erie canal was built. About this time, Martin Van Buren and other Republicans such as William L. Marcy and Silas Wright organized a powerful political machine known as the Albany Regency. This group favoured low taxes, fiscal economy and no government interference with business. At the constitutional convention of 1821 Van Buren reflected the democratic spirit of the day by extending the vote to all white males over 21, but his group refused to give Negroes the vote unless they could meet high property qualifications. The Regency elected Joseph C. Yates in 1822 and ousted

Clinton from the canal commission in 1824. This blunder enraged public opinion and Clinton was swept back into the governor's office in 1825 just in time to open the Erie canal that year.

New York politics was especially complicated in the period from 1825 to 1865. The two-party system tended to break down because of the almost continuous splits within the major parties and the emergence of several new parties. The principal issues were the role of government toward canals and railroads, the extension of slavery to the territories, prohibition of liquor, immigrants and the chartering of banks. Thurlow Weed and William Seward used the Antimasonic party (*q.v.*) to attack the Albany Regency, which had granted many bank charters to its friends. Weed finally cemented an alliance between the Antimasons and most of the followers of De Witt Clinton. This alliance became known as the Whig party and was the main opposition to the Democratic party between 1834 and 1855.

Seward became the first Whig governor in 1838. The Whig program called for the enlargement of the Erie canal and more aid for education. A piece of significant legislation was the Free Banking act of 1838, under which individuals or associations could engage in banking without any special charter provided they had a paid-up capital of $100,000. The Democratic party was split between the "Hunkers" or conservatives and the "Barnburners" or radicals. The conservatives urged the use of canal revenues to complete the canals while the radicals wanted to pay off the state debt. The Barnburners opposed the extension of slavery into the territories, but the Hunkers co-operated with the southern Democrats who often controlled the presidency and the national congress. In 1848 the Barnburners created the Free-Soil party and chose Martin Van Buren to run for president. The Democratic split guaranteed a Whig victory for Hamilton Fish as governor and Zachary Taylor as president. But the slavery issue also split the Whigs and the factional fight within the party led to its collapse by 1855. The mortal blow came with the Kansas-Nebraska act of 1854, which led to the formation of the Republican party. Weed, William Seward and Horace Greeley were three of the prominent Whigs who joined the Republicans along with several Barnburners and Free-Soilers. The Republican party attracted upstate farmers and small businessmen and in 1856 elected John King as governor.

The national crisis of 1860–61 bewildered New Yorkers, but under the able direction of Republican Gov. Edwin Morgan the state provided supplies, money and almost 500,000 soldiers for the ensuing Civil War. The unfair provisions of the draft act and its clumsy administration were the causes of the draft riots of July 1863 in New York city.

New York citizens took the leadership in the humanitarian movement that characterized the period between 1830 and 1860. The state supplied several leading reformers—Thomas Eddy, Gerrit Smith, Susan B. Anthony, Theodore Weld—in such fields as penology, mental care, temperance, women's rights and antislavery agitation. Washington Irving and James Fenimore Cooper established the state's literary reputation before 1825, after which New England authors marched to the fore. Walt Whitman and Herman Melville after 1850 re-established the leadership of New York in literary affairs. In music, art and the theatre, New York city became pacesetter for the nation.

New York became the "Empire state" by 1830 when it was first in population, agriculture, foreign trade, manufacturing and transportation facilities. The influx of hundreds of thousands of Yankees meant the rapid clearing of forests, stimulation of trade and the growth of factories. The most significant developments in the land history of the state were: the treaty of Hartford of 1786 by which Massachusetts gave up its claims to western New York in return for the land west of Seneca lake plus ten townships near Binghamton; the purchase of land titles from the Indians by Massachusetts and New York agents; the sale of huge tracts to such speculators as Robert Morris, the Holland Land company and the London associates; the rapid distribution of land into the hands of small farmers; the collapse of the old leasehold system; and the rise of speculation in urban real estate from New York city to Buffalo.

"Boss" Rule and Corruption.—During the decade following the Civil War, "boss" rule and corruption characterized government operations on the state, county and city levels. Postwar demoralization, the antiquated government structure, the pressure of business interests for franchises and contracts, the strengthening of political machines such as that of Boss William Tweed were the major causes of corruption. The Democratic party generally controlled the governorship between 1875 and 1895 under such important leaders as Samuel Tilden (1875–76), who broke up the "canal ring" (*see* TILDEN, SAMUEL JONES), Grover Cleveland (1883–84) and David B. Hill (1885–91). During these years the Republican party was divided by factional strife with the leader Roscoe Conkling quarreling with Republican presidents Rutherford Hayes, James Garfield and Chester Arthur, for control of patronage especially in the New York custom house. The governorship passed to Republicans between 1895 and 1910 because the public charged the Democrats with corruption and responsibility for the depression of 1893 and because the Republicans were ably led by Theodore Roosevelt and Gov. Charles Evans Hughes. Hughes (1907–10) brought about the regulation of insurance and utility companies, introduced many labour reforms, including the first workmen's compensation law, and took steps to conserve forest and water resources. The split between the progressive followers of Theodore Roosevelt and the conservative Republicans gave the state to the Democrats in 1910 and 1912. An intraparty fight between Democratic Gov. William Sulzer and Boss Charles Murphy of Tammany hall led to the impeachment of Sulzer in 1913. He was found technically guilty of perjury, misrepresentation of campaign expenditures and concealment of evidence. More important than these quarrels were the labour laws passed after the diastrous Triangle shirtwaist factory fire in New York city in 1911. Robert Wagner, with the aid of Alfred E. Smith, made a thorough examination of labour conditions and their recommendations were enacted into legislation. Among the laws passed was the Widowed Mothers Pension act.

Modern Times.—The Democratic party usually controlled the governor's office from 1918 to 1942 because of the ability of its able leaders such as Smith, Wagner, Franklin D. Roosevelt and Herbert H. Lehman to attract the votes of the foreign-born and their children in the cities. Most immigrants preferred the Democratic party because of its traditional hospitality to immigrants as opposed to the nativistic tendencies of the Federalist-Whig-Republican group; its opposition to prohibition; its sympathy toward labour; and its willingness to use government agencies to combat the depression of 1930.

The structure and scope of New York's government has been transformed, especially since 1922. Governor Smith (1919–20; 1923–28) left an impressive record despite the obstructive tactics of the Republican-controlled legislature. Smith aroused public opinion to force through his program including the consolidation of 187 bureaus into 18 departments; the executive budget; "home rule" for cities; more state aid to localities for roads, health and education; the expansion of the park system; the eight-hour day; the retention of public power sites; and the expansion of the mental hygiene program. Gov. Franklin D. Roosevelt (1929–33) continued Smith's policies despite the onset of the economic depression in 1930. He arranged for work relief for the unemployed and started a system of old-age pensions. In 1932 Roosevelt succeeded in removing James Walker, colourful mayor of New York city, whose administration was tainted with corruption. The Smith-Roosevelt experiments in social legislation anticipated much of the federal New Deal legislation of the 1930s.

Among the policies of Governor Lehman (1933–42) were more stringent regulation of public utilities, low-cost housing projects, minimum wages for women, close regulation of the dairy industry, the extension of the merit system to practically all government departments, a liberal welfare program and a balanced budget. In 1942 Thomas E. Dewey, a Republican lawyer who had made a reputation prosecuting rackets in New York city, became governor, a position which he held until Jan. 1, 1955. Dewey continued Lehman's efforts to expand agricultural and industrial production for defense during World War II. The state division of commerce sought and secured many government contracts for

New York firms. More than 1,000,000 workers were trained and the state and federal labour boards were successful in settling almost all labour disputes. A special war council co-ordinated efforts to solve such problems as the shortage of farm labour, feed and gasoline, civilian defense, vocational training and food conservation. The Ives-Quinn act of 1945, the first state law of its kind, forbade discrimination in employment. Its chief purpose was to educate employers to hire the best qualified candidates. The five-man commission established by the act was given authority, however, to issue cease and desist orders against violators of its orders. Another achievement was the creation of the state university in 1948, which consolidated the existing state institutions of higher learning and also encouraged the establishment of new two-year community colleges. Under Dewey the health services were greatly expanded and in 1948 the thruway was begun. His administrations won for Dewey national attention, but he failed in his two campaigns for the presidency.

W. Averell Harriman, a Democrat, barely defeated Republican senator Irving Ives in 1954. Harriman's administration continued the policies begun by Smith, Roosevelt and Lehman and continued by Dewey. Harriman lost his bid for re-election in 1958 to Nelson Rockefeller, who won office by more than 500,000 votes and was re-elected in 1962 and again in 1966. His program continued the enlargement of social services and tax reforms.

GOVERNMENT

New York has been governed under five constitutions which were adopted in 1777, 1821, 1846, 1894 and 1938 respectively. The constitution of 1938 has 20 articles, including a bill of rights. It grants the vote to all citizens of 21 years or over who have resided within the state for 1 year, in the county for 4 months and in the election district for 30 days. Voters must also be able to read and write English. The constitution provides for revision in two ways. Every 20 years the voters are given the opportunity to approve or reject the convening of a constitutional convention. Any changes by a convention must receive the approval of the voters in the next election. The more frequently used method of revision, however, is passage of legislation by two consecutive sessions of the legislature after which the proposed changes are submitted to popular referendum.

The governor of New York is a strong executive whose prominent position often makes him a presidential possibility. He is elected for a four-year term along with a lieutenant governor, comptroller and attorney general. Among the duties and powers of the governor are the construction of the budget, the appointment and removal of many officials, law enforcement, the approval or veto of legislation and the command of the state militia and police. In the event of the death, impeachment, resignation or absence of the governor, the lieutenant governor becomes the chief executive.

A constitutional amendment of 1944 added a department of commerce to the state's organization; an amendment in 1959 added the department of motor vehicles. The other state departments are those of audit and control, taxation and finance, law, state, public works, conservation, agriculture and markets, labour, education, health, mental hygiene, social welfare, correction, public service, banking, insurance and civil service. In addition there is an executive department directly under the control of the governor.

The legislative power is vested in a senate of 58 members and an assembly of 150 members, each chamber elected biennially. Both senators and assemblymen are elected from single districts. Republican control of the legislature and the constitutional conventions of 1894 and 1938 has led to the apportionment of seats in such a way as to favour upstate and rural counties over New York city. The legislature meets each year. Most of the work is done by committees whose chairmen have great power in determining what bills will receive approval. Bills approved by both houses are sent to the governor for his signature or veto. The governor has 30 days to study any bills sent within the last ten days of a session, but a bill must have his signature to become law.

The court structure defied systematic reorganization from 1846 until 1962 when, under a constitutional amendment adopted in 1961, centralized administration by a five-man board of the state highest judges was established, a family court was created and courts in New York city, reorganized in 1959, were consolidated. Most judges are elected, usually for a 14-year term. The court of appeals, the state's highest court, consists of a chief justice and six associate justices elected from the state at large. This court reviews only questions of law except in cases in which the death penalty is involved.

The state is divided into eleven judicial districts each of which has several supreme court justices. The supreme court has general jurisdiction in law and equity, including both civil and criminal actions. There are four judicial departments in which appellate divisions of the supreme court are established. These courts review cases from the supreme and inferior courts. The governor selects the justices who sit on the appellate division. The court of claims consists of six judges appointed by the governor and approved by the senate for nine-year terms. It hears and determines private claims against the state.

Each of the 62 counties (unless wholly included in a city) has its own officials. The voters elect the more important officials such as the county judge, surrogate, sheriff, district attorney, clerk, treasurer and coroner. A board of supervisors which has one supervisor from each town and city ward has executive, legislative and financial powers. The five counties within New York city (*q.v.*) operate under a different pattern and a few counties such as Nassau and Westchester have created the elective position of county executive. Towns provide government for those citizens living outside the borders of cities. Within the towns are villages whose government is organized according to which one of the four classes they belong. Second class towns (generally those under 10,000 population), the most numerous, are governed by a board consisting of the supervisor, two councilmen and two justices of the peace. Cities range in size from Sherrill with about 2,000 people to New York city. Most cities are administered by a mayor and a city council or board of aldermen.

Finance and Taxation.—The state is financed through the general fund which is divided into two subsidiary funds; the local assistance fund from which appropriations are made in support of units of local government and the state purposes fund from which appropriations are made for the operation of state departments and for debt service. The state's capital construction is provided for through the capital construction fund.

The constitution requires that on or before Feb. 1 of each year the governor shall submit a budget to the legislature. The budget contains a complete plan of expenditures for the next fiscal year and also the year's estimated revenues. State expenditures and revenues rose sharply after World War II. The budget for the fiscal year beginning April 1, 1946, called for the expenditure of about $600,000,000; 15 years later the figure was about $2,000,000,000 of which local governments received over $1,000,000,000. State aid for local education increased from about 24% of the total budget to about 33% for the same period. New York spent more money per pupil than any other state. At the same time the state government spent almost 35% of the total budget for its own departments. The largest expenditure was for mental hygiene followed by public works and correction. In addition, about $300,000,000 annually was appropriated from the separate capital construction fund, most of which was assigned to highways, parkways and grade crossings.

In 1959 the legislature raised taxes on gasoline and on cigarettes and the income tax was placed on a withholding basis and the maximum rate raised to 10% on taxable income over $15,000. The chief kinds of taxes in New York are individual income taxes, corporation net income taxes, motor fuels taxes, motor vehicle and operators licences, tobacco products taxes, alcoholic beverage taxes and property taxes. New York ranked after Connecticut and Delaware in size of per capita income. In the 1960s it was about $3,000.

The state banking department was created in 1851. It is required to examine every bank, trust company and other financial institution within the state but not the national banks. In the second half of the 20th century there were about 500 banks

*New York: Places of 5,000 or More Population (1960 Census)**

Place	Population 1960	1950	1940	1920	1900
Total state	16,782,304	14,830,192	13,479,142	10,385,227	7,268,894
Albany	129,726	134,995	130,577	113,344	94,151
Albion	5,182	4,850	4,660	4,683	4,477
Amityville	8,318	6,164	5,058	3,265	2,038
Amsterdam	28,772	32,240	33,329	33,524	20,929
Arlington	8,317	5,374	—	—	—
Auburn	35,249	36,722	35,753	36,192	30,345
Babylon	11,062	6,015	4,742	2,523	2,157
Baldwin	30,204	—	—	—	—
Baldwinsville	5,985	4,495	3,840	3,685	2,992
Batavia	18,210	17,799	17,267	13,541	9,180
Bath	6,166	5,416	4,696	4,795	4,994
Beacon†	13,922	14,012	12,572	10,996	9,480
Bellmore	12,784	—	—	—	—
Bethpage-Old Bethpage	20,515	—	—	—	—
Binghamton	75,941	80,674	78,309	66,800	39,647
Brentwood	15,387	2,803	—	—	—
Briarcliff Manor	5,105	2,494	1,830	1,027	—
Brockport	5,256	4,748	3,590	2,980	3,398
Bronxville	6,744	6,778	6,888	3,055	579
Buffalo	532,759	580,132	575,901	506,775	352,387
Canandaigua	9,370	8,332	8,321	7,356	6,151
Canton	5,046	4,379	3,018	2,631	2,757
Catskill	5,825	5,392	5,429	4,728	5,484
Cedarhurst	6,954	6,051	5,463	2,838	—
Centereach	8,524	—	—	—	—
Cheektowaga-Northwest	52,362	—	—	—	—
Cheektowaga-Southwest	12,766	—	—	—	—
Cohoes	20,129	—	—	—	—
Colonie	6,992	2,068	1,407	10,196§	7,035§
Commack	9,613	—	—	—	—
Copiague	14,081	—	—	—	—
Corning	17,085	17,684	16,212	15,820	11,061
Cortland	19,181	18,152	15,881	13,294	9,014
Croton-on-Hudson	6,812	4,837	3,843	2,286	1,533
Dansville	5,460	5,253	4,976	4,631	3,633
Deer Park	16,726	—	—	—	—
Depew	13,580	7,217	6,084	5,850	3,379
Dobbs Ferry	9,260	6,268	5,883	4,401	2,888
Dunkirk	18,205	18,007	17,713	19,336	11,616
East Aurora	6,791	5,962	5,253	3,703	2,366
East Hills	7,184	2,547	343	—	—
East Massapequa	14,779	—	—	—	—
East Meadow	46,036	—	—	—	—
East Northport	8,381	3,842	—	—	—
East Rochester	8,152	7,022	6,691	3,901	—
East Rockaway	10,721	7,970	5,610	2,005	739
Eggertsville	44,807	—	—	—	—
Ellenville	5,003	4,225	4,000	3,116	2,879
Elmira	46,517	49,716	45,106	45,393	35,672
Elmira Heights	5,157	5,009	4,829	4,188	1,763
Elmira Southeast	6,698	—	—	—	—
Elmont	30,138	—	—	—	—
Endicott	18,775	20,050	17,702	9,500	—
Fairport	5,507	5,267	4,644	4,626	2,489
Fairview	8,626	1,721	—	—	—
Farmingdale	6,128	4,492	3,524	2,091	—
Floral Park	17,499	14,582	12,950	2,097	—
Franklin Square	32,483	—	—	—	—
Fredonia	8,477	7,095	5,738	6,051	4,127
Freeport	34,419	24,680	20,410	8,599	2,612
Fulton	14,261	13,922	13,362	13,043	5,281
Garden City	23,948	14,486	11,223	2,420	—
Garden City Park-Herricks	15,364	—	—	—	—
Geneva	17,286	17,144	15,555	14,648	10,433
Glen Cove	23,817	15,130	12,415	8,664	—
Glens Falls	18,580	19,610	18,836	16,638	12,613
Gloversville	21,741	23,634	23,329	22,075	18,349
Great Neck	10,171	7,759	6,167	—	—
Greenlawn	5,422	1,000	—	—	—
Hamburg	9,145	6,938	5,467	3,185	1,683
Hamburg-Lake Shore	11,527	—	—	—	—
Hastings-on-Hudson	8,979	7,565	7,057	5,526	2,002
Haverstraw	5,771	5,818	5,909	5,226	5,935
Hempstead	34,641	29,135	20,856	6,382	3,582
Henrietta Northeast	6,403	—	—	—	—
Herkimer	9,396	9,400	9,617	10,453	5,555
Hicksville	50,405	—	—	—	—
Hornell	13,907	15,049	15,649	15,025	11,918
Horseheads	7,207	3,606	2,570	2,078	1,901
Hudson	11,075	11,629	11,517	11,745	9,528
Hudson Falls	7,752	7,236	6,654	5,761	4,473
Huntington	11,255	9,324	31,768‖	13,893	9,483‖
Huntington Station	23,438	9,924	31,768‖	13,893	9,483‖
Ilion	10,199	9,363	8,927	10,169	5,138
Inwood	10,362	—	—	—	—
Irvington	5,494	3,657	3,272	2,701	2,231
Ithaca	28,799	29,257	19,730	17,004	13,136
Jamestown	41,818	43,354	42,638	38,917	22,892
Jericho	10,795	—	—	—	—
Johnson City‡	19,118	19,249	18,039	8,587	3,111
Johnstown	10,390	10,923	10,666	10,908	10,130
Kenmore	21,261	20,066	18,612	3,160	318
Kings Point	5,410	2,445	1,247	—	—
Kingston	29,260	28,817	28,589	26,688	24,535
Lackawanna	29,564	27,658	24,058	17,918	—
Lancaster	12,254	8,665	7,236	6,059	3,750
Larchmont	6,789	6,330	5,970	2,468	945
Lawrence	5,907	4,681	3,649	2,861	558
Levittown	65,276	—	—	—	—
Lindenhurst	20,905	8,644	4,756	—	—
Little Falls	8,935	9,541	10,163	13,029	10,381
Lockport	26,443	25,133	24,379	21,308	16,581
Locust Grove	11,558	—	—	—	—
Long Beach	26,473	15,586	9,036	282	—
Lynbrook	19,881	17,314	14,557	4,371	—
Malone	8,737	9,501	8,743	7,556	5,935
Malverne	9,968	8,086	5,153	—	—
Mamaroneck	17,673	15,016	13,034	6,571	—
Massapequa	32,900	—	—	—	—
Massapequa Park	19,904	2,334	488	—	—
Massena	15,478	13,137	11,328	5,993	2,032
Mechanicville	6,831	7,385	7,449	8,166	4,695
Medina	6,681	6,179	5,871	6,011	4,716
Merrick	18,789	—	—	—	—
Middletown	23,475	22,586	21,908	18,420	14,522
Mineola	20,519	14,831	10,064	3,016	—
Monticello	5,222	4,223	3,737	2,330	1,160
Mount Kisco	6,805	5,907	5,941	3,944	1,346
Mount Vernon	76,010	71,899	67,362	42,726	21,228
Newark	12,868	10,295	9,646	6,964	4,578
Newburgh	30,979	31,956	31,883	30,366	24,943
New Hyde Park	10,808	7,349	4,691	—	—
New Rochelle	76,812	59,725	58,408	36,213	14,720
New York City	7,781,984	7,891,957	7,454,995	5,620,048	3,437,202
Niagara Falls	102,394	90,872	78,029	50,760	19,457
North Bellmore	19,639	—	—	—	—
North Merrick	12,976	—	—	—	—
North New Hyde Park	17,929	—	—	—	—
North Pelham	5,326	5,046	5,052	2,385	684
Northport	5,972	3,859	3,093	1,977	1,794
North Syracuse	7,412	3,356	2,083	—	—
North Tarrytown	8,818	8,740	8,804	5,927	4,241
North Tonawanda	34,757	24,731	20,254	15,482	9,069
North Valley Stream	17,239	—	—	—	—
Norwich	9,175	8,816	8,694	8,268	5,766
Nyack	6,062	5,889	5,206	4,444	4,275
Oceanside	30,448	—	—	—	—
Ogdensburg	16,122	16,166	16,346	14,609	12,633
Olean	21,868	22,884	21,506	20,506	9,462
Oneida	11,677	11,325	10,291	10,541	6,364
Oneonta	13,412	13,564	11,731	11,582	7,147
Ossining	18,662	16,098	15,996	10,739	7,939
Oswego	22,155	22,647	22,062	23,626	22,199
Owego	5,417	5,350	5,068	4,147	5,039
Patchogue	8,838	7,361	7,181	4,031	2,926
Peekskill	18,737	17,731	17,311	15,868	10,358
Pelham Manor	6,114	5,306	5,302	1,754	1,571¶
Penn Yan	5,770	5,481	5,308	4,517	4,650
Plainedge	21,973	—	—	—	—
Plainview	27,710	—	—	—	—
Plattsburgh	20,172	17,738	16,351	10,909	8,434
Pleasantville	5,877	4,861	4,454	3,590	1,204
Port Chester	24,960	23,970	23,073	16,573	7,440
Port Jervis	9,268	9,372	9,749	10,171	9,385
Port Washington	15,657	—	—	—	—
Potsdam	7,765	7,491	4,821	4,039	3,843
Poughkeepsie	38,330	41,023	40,478	35,000	24,029
Rensselaer	10,506	10,856	10,768	10,823	7,466
Riverhead	5,830	4,892	8,922§	5,753§	4,503§
Rochester	318,611	332,488	324,975	295,750	162,608
Rockville Centre	26,355	22,362	18,613	6,262	1,884
Rome	51,646	41,682	34,214	26,341	15,343
Roosevelt	12,883	—	—	—	—
Rotterdam	16,871	—	—	—	—
Rye	14,225	11,721	9,865	5,308	12,861§
Salamanca	8,480	8,861	9,011	9,276	4,251
San Remo	11,996	—	—	—	—
Saranac Lake	6,421	6,913	7,138	5,174	2,594
Saratoga Springs	16,630	15,473	13,705	13,181	12,409
Scarsdale	17,968	13,156	12,966	3,506	885§
Schenectady	81,682	91,785	87,549	88,723	31,682
Scotia	7,625	7,812	7,960	4,358	3,010♀
Sea Cliff	5,669	4,868	4,416	2,108	1,558
Seaford	14,718	—	—	—	—
Seneca Falls	7,439	6,634	6,452	6,389	6,519
Sidney	5,157	4,815	3,012	2,670	2,331
Sloan	5,803	4,698	3,836	1,791	873
Solvay	8,732	7,868	8,201	7,352	3,493
South Farmingdale	16,318	—	—	—	—
South Huntington	7,084	1,274	—	—	—
South Westbury	11,977	—	—	—	—
Spring Valley	6,538	4,500	4,308	3,818	—
Stony Point	8,739§	5,485§	4,898§	3,211§	4,161§
Suffern	5,094	4,010	3,768	3,154	1,619
Syracuse	216,038	220,583	205,967	171,717	108,374
Tarrytown	11,109	8,851	6,874	5,807	4,770
Tonawanda (city)	21,561	14,617	13,008	10,068	7,421
Tonawanda	83,771	—	—	—	—
Troy	67,492	72,311	70,304	72,013	60,651
Tuckahoe	6,423	5,991	6,563	3,509	—
Tupper Lake	5,200	5,441	5,451	2,508	3,045δ
Uniondale	20,041	—	—	—	—
Utica	100,410	101,531	100,518	94,156	56,383
Valley Stream	38,629	26,854	16,679	—	—
Vernon Valley	5,998	—	—	—	—
Wantagh	34,172	—	—	—	—
Waterloo	5,098	4,438	4,010	3,809	4,256
Watertown	33,306	34,350	33,385	31,285	21,696
Watervliet	13,917	15,197	16,114	16,073	14,321
Waverly	5,950	6,037	5,450	5,270	4,465

(Continued)

*Populations are reported as constituted at date of each census. †Fishkill Landing and Matteawan villages consolidated and incorporated as Beacon since 1910. ‡Name changed from Lestershire since 1910. §Township. ‖Huntington township, which includes the population of Huntington and Huntington Station. ¶Pelham township, which includes the population of Pelham Manor. ♀Glenville township, which includes the population of Scotia. δAltamont township, which includes the population of Tupper Lake.

Note: Dash indicates place did not exist during the reported census, or data not available.

New York: Places of 5,000 or More Population (1960)—(Continued)*

Place	Population				
	1960	1950	1940	1920	1900
Wellsville	5,967	6,402	5,942	4,996	3,556
Westbury	14,757	7,112	4,524	—	—
West Elmira . . .	5,763	3,833	—	—	—
West Haverstraw . .	5,020	3,099	2,533	2,018	2,079
West Hempstead-Lakeview	24,783	—	—	—	—
West Seneca . . .	23,138	—	—	—	—
White Plains . . .	50,485	43,466	40,327	21,031	7,899
Williamsville . . .	6,316	4,649	3,614	1,753	905
Williston Park . . .	8,255	7,505	5,750	—	—
Woodmere . . .	14,011	—	—	—	—
Yonkers	190,634	152,798	142,598	100,176	47,931

*Populations are reported as constituted at date of each census.
Note: Dash indicates place did not exist during the reported census, or data not available.

the state with total assets of more than $75,000,000,000. At the same time the assessed value of property subject to state and local government tax was more than $35,000,000,000.

POPULATION

The population of New York remained scanty and scattered throughout the colonial period. In 1664 there were fewer than 10,000 inhabitants of whom about two-thirds were Dutch; the others were divided between Swedes, French, Germans, Negroes and English. It is estimated that the population was about 19,000 in 1700 and about 75,000, 50 years later. The figure was about 170,000 at the time of the American Revolution and included approximately 20,000 Negroes. Practically all of these persons lived within a few miles of the Hudson river or the Atlantic ocean. The emigration of more than 25,000 Loyalists (Tories) during and after the Revolution was more than offset by the great influx of New Englanders after 1783. The first federal census of 1790 revealed New York had 340,120 inhabitants. This made it fifth among the 18 states and territories that then composed the union. Approximately one-half of the white population in 1790 was of English descent with the large families of Connecticut as important a source of English blood as the United Kingdom itself. Long Island east of Brooklyn was a Yankee stronghold; the Dutch element, less than one-fifth of the total, was strong in Albany and in Ulster county. Germans from the Palatinate district along the Rhine were scattered through the Schoharie valley, the upper reaches of the Mohawk river and the Hudson valley. The small French contingent settled in New York city, New Rochelle and New Paltz. Scots from northern Ireland and Scotland were numerous in Orange and Ulster counties and in the Cherry Valley region. The Negro minority, the largest among the northern colonies, became relatively less important after the American Revolution, when immigration from New England and Europe increased.

More than half of the 1,372,812 inhabitants of New York in 1820 were of New England descent. At that time, fewer than 15% of the people lived in urban centres of more than 3,000 persons. New York became the nation's most populous state in 1820 and has remained so ever since. Another wave of immigration flooded New York between 1840 and 1860 when great numbers of Irish and Germans poured into the state. In 1855 persons born in Europe constituted more than one-fourth of the people of the state and nearly one-half of the population of New York city. In 1860, just before the Civil War, the population was 3,880,735, nearly two-fifths of which was centred in urban places.

The Irish and Germans provided the largest number of immigrants until about 1890 at which time the influx of Italians, Russians, Poles and Greeks increased rapidly until World War I. The restrictions placed on immigration by congress during the 1920s checked the number of immigrants and the economic depression of the 1930s brought immigration to a virtual standstill.

In 1960 New York had a population of 16,782,304, an increase of 1,952,112 or 13.2% over 1950. The population per square mile in 1960 was 338.5, as compared with 49.6 for the U.S. as a whole. The percentage of persons 65 years old or over was increasing, being 10.1% in 1960. The percentage of the population 14 years old and over that was in the labour force (56.5% in 1960) was steadily increasing, the result of prolonged schooling for that age group. Foreign-born whites numbered 2,181,868 in 1960 with the Italians (430,843) and English (406,128) in the lead. In 1960 New York city with about half of the state's population had more than 67.1% of the foreign-born white residents in the state. About 48.6% of the city's residents were foreign born or of foreign or mixed parentage. Comparable figures for other centres were 48.1% for Yonkers; 37.8% for Rochester; 35.4% for Buffalo.

In 1960 seven standard metropolitan statistical areas—Albany-Schenectady-Troy (Albany, Rensselaer, Saratoga, Schenectady counties), Binghamton (Broome county), Buffalo (Erie, Niagara counties), New York (*see* NEW YORK [CITY]), Rochester (Monroe county), Syracuse (Madison, Onondaga, Oswego counties) and Utica-Rome (Herkimer, Oneida counties)—had a combined population of 14,352,693. In 1963 Tioga county (pop. [1960] 37,802), N.Y., and Susquehanna county, Pa. (33,137) were added to the Binghamton SMSA and Livingston (44,053), Orleans (34,159) and Wayne (67,989) counties were added to the Rochester SMSA.

EDUCATION

Historical and Administrative.—A majority of the children in colonial New York never saw the inside of a schoolroom. In New Amsterdam schools were established under church auspices and with government support beginning in 1638. Under the British the Society for the Propagation of the Gospel in Foreign Parts set up a few schools for the children of the Indians and the poor. Middle-class families often employed tutors or sent their children to private schools. The few youths preparing for the ministry or the law attended college usually at Yale or Princeton (then the College of New Jersey). The Anglicans founded King's college (later Columbia university) in 1754. During the Revolutionary War most of the schools were closed.

In 1784 the legislature established a system of education which was supervised by a board of regents and was authorized to establish secondary schools and colleges. Later the board's functions were extended to include the jurisdiction of the professional, scientific and technical schools, the administration of laws relating to the admission to the professions, the charge of the state library at Albany, the supervision of local libraries and the custody of the state museum. Although the regents proposed a public-school system in 1787, little was done until 1795 when the legislature granted money for five years to elementary schools under county sponsorship. In 1812 the legislature provided for a permanent system of public schools with school districts in each township. By 1828 schools had been established in more than 8,000 districts. These schools received funds from the state, the locality and the parents of the children attending them. As many parents could not or would not pay the fees there was a movement for free public schools. The legislature in 1851 granted $800,000 for schools but it was not until 1867 that all the elementary schools became free.

Secondary schools called academies were founded by private groups with some financial assistance from the regents. Such schools charged tuition and prepared students for college. During the 1850s a few cities began to set up free public high schools. After the Civil War the movement swept across the state and most academies were taken over by the public high schools. The larger church groups founded colleges principally as a place where they could train young men for the clergy.

The legislature in 1904 reorganized the educational system. While the regents kept authority over colleges and universities, a commissioner of education was made responsible for elementary and secondary education. The commissioner became the chief officer of the whole educational system.

Among the major educational trends in the 20th century have been expanding enrollments; broader curriculums; consolidation of district schools into centralized schools; increase in state aid to localities; and expansion of publicly supported colleges and universities. The consolidation or centralization of school districts has proceeded rapidly until fewer than 10% of the original districts remained in the second half of the 20th century. This trend was encouraged by a law of 1925 which granted additional state aid

districts setting up centralized schools.

The State University of New York, established by the legislature in 1948, comprises the university centres, two medical centres, the Graduate School of Public Affairs, two-year and four-year state colleges and locally sponsored two-year community colleges. The university offers programs in liberal arts and science engineering, home economics, industrial and labour relations, veterinary medicine, ceramics, agriculture, forestry, maritime service, teacher education, law, pharmacy, medicine, dentistry, social work and business administration. Two-year programs are offered in a variety of fields, liberal arts and technical courses in agricultural, industrial, health and service areas. Several of its colleges offer graduate programs. The university is governed by a board of trustees appointed by the governor. Each college is locally administered. Units of the university include State university at Albany, State university at Buffalo, State university at Stony Brook and State university at Binghamton; Downstate Medical centre at Brooklyn and Upstate Medical centre at Syracuse; Graduate School of Public Affairs at Albany; colleges at Brockport, Buffalo, Cortland, Fredonia, Geneseo, New Paltz, Oneonta, Oswego, Plattsburgh and Potsdam; College of Forestry at Syracuse university; Maritime college at Fort Schuyler (New York city); College of Ceramics at Alfred university; and four colleges at Cornell university (agriculture, home economics, veterinary medicine and industrial and labour relations). Two-year agricultural and technical institutes are at Alfred, Canton, Cobleskill, Delhi, Farmingdale and Morrisville. Two-year community colleges under the university are located throughout the state.

The City University of New York (formerly College of the City of New York) comprises the municipal four-year colleges administered by the board of higher education of the city of New York. The colleges are City college (1847), Brooklyn college (1930), Hunter college (1870) and Queens college (1937). Under federal control are the United States Military academy at West Point, founded in 1802 and the United States Merchant Marine academy at Kings Point, founded in 1938. Columbia university (*q.v.*) in New York city, one of the nation's most famous schools, was founded in 1754 as King's college. Its activities suspended during the Revolutionary War, it was reopened in 1784 as Columbia college under a charter granted by the state of New York. By an act of the state legislature the name of the institution was changed in 1912 to Columbia University of the City of New York. Barnard college (1889) in New York city is the undergraduate college for women of Columbia university.

Among the other notable privately controlled colleges and universities in New York are Colgate university (Hamilton, 1819); Cooper Union (1859), founded by Peter Cooper; Cornell university (Ithaca, branches at New York city, Geneva and Buffalo, 1865), especially noted for its agricultural and medical schools; Fordham university (New York city, Roman Catholic, 1841); Hamilton college (Clinton, 1793); New York university (New York city, 1831); Sarah Lawrence college (Bronxville, 1926), for women; and Vassar college (Poughkeepsie, 1861), for women. Other privately controlled colleges and universities in the state include, in New York city: College of Mount St. Vincent (Roman Catholic, 1910), Finch college (1900), Jewish Theological Seminary of America (1887), Juilliard School of Music (1905), Manhattan college (Roman Catholic, 1853), Manhattan School of Music (1917), Mills College of Education (1909), New School for Social Research (1919), Pace college (1906), Yeshiva university (Jewish Orthodox, 1886); in Brooklyn: Long Island university and C. W. Post college (Brooklyn and Greenvale, 1926), Polytechnic Institute of Brooklyn (1854), Pratt institute (1887), St. Francis college (Roman Catholic, 1884), St. John's university (Roman Catholic, 1870), St. Joseph's College for Women (Roman Catholic, 1916); in Buffalo: Canisius college (Roman Catholic, 1870), D'Youville college (Roman Catholic, 1908), Mount St. Joseph Teachers college (Roman Catholic, 1937), Rosary Hill college (Roman Catholic, 1947); in Rochester: Nazareth college (Roman Catholic, 1924), Rochester Institute of Technology (1829), St. John Fisher college (Roman Catholic, 1948), University of Rochester (1850). Among other New York schools are Adelphi university (Garden City, 1896); Alfred university (1857); Bard college (Annandale-on-Hudson, 1860); Clarkson College of Technology (Potsdam, 1895); College of New Rochelle (Roman Catholic, 1904); College of St. Rose (Albany, Roman Catholic, 1920); Elmira college (1855); Good Counsel college (White Plains, Roman Catholic, 1923); Hartwick college (Oneonta, related to United Lutheran Church, 1928); Hobart and William Smith colleges (Geneva, Hobart, an affiliate of Episcopal Church, 1822); Hofstra university (Hempstead, 1935); Houghton college (Wesleyan Methodist, 1883); Iona college (New Rochelle, Roman Catholic, 1940); Ithaca college (1892); Keuka college (Keuka Park, affiliate of American Baptist Church, 1892); Le Moyne college (Syracuse, Roman Catholic, 1946); Manhattanville College of the Sacred Heart (Purchase, Roman Catholic, 1841); Maryknoll Teachers college (Roman Catholic, 1931); Niagara university (Roman Catholic, 1856); Notre Dame College of Staten Island (Roman Catholic, 1931); Rensselaer Polytechnic institute (Troy, 1824); Russell Sage college (Troy, 1916); St. Bernardine of Siena college (Loudonville, Roman Catholic, 1937); St. Bonaventure university (St. Bonaventure, Roman Catholic, 1859); St. Lawrence university (Canton, 1856); Skidmore college (Saratoga Springs, 1911); Syracuse university (founded by Methodist Church, 1870); Union college and university (Schenectady and Albany, 1795); Utica college (1946); Wagner college (Staten Island, related to the United Lutheran Church of America, 1883); Webb Institute of Naval Architecture (Glen Cove, 1889); and Wells college (Aurora, 1868).

HEALTH, WELFARE AND CORRECTIONS

Until the latter part of the 19th century private charity or the almshouse were the chief means of caring for the unfortunate but gradually public agencies expanded their scope of activities to include suitable care to dependent children, the mentally ill, the aged and infirm and the destitute. Local, state and federal governments participate and co-operate in the administration and financing of welfare services.

Public health services in New York are handled largely through the department of health and the department of mental hygiene. The latter has the largest staff and budget of all of the state's departments and cares for more than 100,000 mental patients in 18 hospitals. It also administers six state schools for mental defectives, one colony for epileptics, one psychiatric institute for research in New York city and one psychiatric hospital for observation in Syracuse. The department of health is responsible for the administration and enforcement of the public health laws and state sanitary code. It supervises all the local health agencies except those of New York city. Despite spectacular progress in diminishing the death rate from tuberculosis, the department, in the second half of the 20th century, still operated sanitoriums at Oneonta, Ray Brook and Mt. Morris. The department also sponsors research in the treatment and care of cancer at the Roswell Park Memorial institute in Buffalo and the Rehabilitation hospital at West Haverstraw. The five regional health offices of the state, located at Albany, Buffalo, Syracuse, Rochester and White Plains carry out programs in their regions and aid local agencies.

The welfare services offered by New York are administered by many departments. For convenience, however, public welfare functions are understood to mean the services controlled by the department of social welfare established in 1867 although under a different name. This department in 1873 received authority to visit and inspect all charitable and correctional institutions whether supported by state, local government or private funds. In the second half of the 20th century it supervised nearly 2,500 agencies including about 600 hospitals and dispensaries, more than 400 homes and orphanages and more than 100 child-placing organizations. At the same time, it supervised more than 60 local public welfare districts, granting them financial aid for such programs as old-age assistance, aid to the disabled, assistance to the blind, home relief, veteran aid, foster care of children and other programs.

The change in title from prison department to department of correction in 1925 indicated a significant change in attitude toward

offenders. The main concern was no longer to punish but to restore prisoners to a useful position in society. New York has pioneered in penology as is shown in the development of the Auburn system (*see* PRISON: *Silent System*) and the establishment of the first state reformatory. Six prisons are of the maximum security type: they are Attica, Auburn, Green Haven, Clinton prison at Dannemora, Great Meadow at Comstock and Sing Sing at Ossining. Wallkill prison and Westfield state farm at Bedford Hills are medium security prisons. Reformatories for boys and young men are those at Elmira and the vocational institute at West Coxsackie. Other special institutions are located at Albion, Woodbourne and Napanoch. The state hospitals for the criminal insane are Matteawan at Beacon and Dannemora.

New York has had a department of labour since 1901. It enforces laws designed to protect the health and safety of employees; to improve working conditions; to establish minimum wages; to provide benefits to workers eligible for unemployment insurance, workmen's compensation and disability benefits; and to promote peaceful labour relations.

THE ECONOMY

Living Conditions.—New York state residents have one of the highest standards of living in the world. In the second half of the 20th century wages and salaries accounted for 68% of all income flowing to New Yorkers, a substantial increase over the 56% for 1929. Property income in the same period fell, however, from 30% to 15%. Proprietors' income was 9%, a figure lower than the national average because of the lesser role played by agriculture in the economy of the state. Other income, including transfer payments and fringe benefits, have tripled since 1929 and accounted for 5.7% of the total.

Income and living conditions improved substantially after World War II. Median income per family reached $5,500 ten years after the war. New York differed from the rest of the U.S. in that there was a much higher percentage of residents engaged in clerical and sales work and a much lower percentage engaged in farming. Nearly 10% of the employed persons in the U.S. lived in New York.

Housing standards in New York are markedly higher than the national average. By the second half of the 20th century more than 83% of the dwelling units had private baths, toilets and hot water; about 90% had mechanical refrigeration and about 82% had central heating. Approximately 11.1% of the houses dated from 1940 or later; almost 53% were built before 1919. Since 1950 a large number of one-family units have been built in the suburban areas.

Agriculture.—Good soil, excellent transportation facilities and nearby markets have kept New York an important agricultural state. The value of farm products totaled more than $800,000,000 in the second half of the 20th century.

The economy of colonial New York was based on agriculture, which supported more than 80% of the people. The colonial aristocracy acquired an unusually large share of the land because of close relations with the governors. Most of the landlords rented their lands for perpetuity or for the lives of the two or three persons named in the lease. Westchester county had six manors which covered more than half its total acreage. Scarsdale, Cortlandt Manor and Philipse Manor included about 400 sq.mi. Livingston Manor, the seat of one of the most distinguished families in New York history, included 160,000 ac. while Van Rensselaer Manor covered about 750,000 ac. surrounding Albany. Tenants owed the Van Rensselaer family 10 to 14 bu. of wheat for each 100 ac., four fat hens and one day's service with a team. When the tenant sold his farm he had to pay an alienation fee of from one-tenth to one-third of the sale price.

This land system retarded the development of upstate New York since few immigrants wished to become tenants when freehold farms were obtainable in Pennsylvania, New Jersey and New England. The tenants, resentful of their economic and political inferiority, rose up in revolt on several occasions. In the 1760s antirent agitation swept through the leasehold areas on the east bank of the Hudson but the governor sent troops to put down the rebellion. The tenants, however, won some victories. The confiscation of loyalist (Tory) estates during the Revolution broke up the manors and estates along the lower Hudson, but the farmers in Albany, Rensselaer, Columbia, Schoharie and Delaware counties had to wait until the 1840s for an end to the leasehold system.

The rise of commercial farming came hard on the heels of the conquest of upstate by pioneer farmers. At first, wheat was the main cash crop, but by 1850 dairying had advanced to first place. The amount of land cultivated reached its peak in 1880 after which much marginal land was allowed to revert to brush, forest or pasture.

The number of farms fell from about 160,000 in 1930 to 80,000 in a generation (35 yrs.); these farms comprised about 14,000,000 ac. During the same period the average size of farms rose from 112 ac. to about 150 ac. and the value per farm from $6,180 to more than $20,000.

Dairying is by far the most important source of farm income, providing about one-half of the total. Other important sources of farm income are poultry and eggs, livestock products, fruit, vegetables and field crops. The state raises a variety of horticultural specialties including nursery products, crops grown under glass, flower bulbs and seed and competes with Vermont in the production of maple sugar. The fruit and vegetable farms supply the large food-processing industry with such products as apples, cherries, peaches, currants, berries, tomatoes, peas, beans, sweet corn and cabbage.

Manufacturing.—In New York manufacturing developed slowly as artisans in small shops took care of most local needs. Workingmen, in colonial days, belonged to one of four groups: free labour, apprentices, indentured servants and slaves. Bound labour gradually declined since it was less efficient than free labour.

By 1840 New York city won top rank among the cities of the nation in manufacturing. A chain of commercial and manufacturing centres grew up along the Erie canal and New York Central railway. The Industrial Revolution progressed fairly slowly, however, and as late as 1850 most goods were made by hand in the home or in the shops of craftsmen. The textile industry had started during the War of 1812 when British imports were unobtainable. Small textile factories grew up along the streams of Oneida, Columbia and Dutchess counties. The clothing manufacturers employed the largest number of workers by 1860, with New York city and Rochester as the main centres of the industry. The processing of foodstuffs—brewing, milling, meatpacking—gradually moved from small local establishments that used water power to larger concerns in the cities where coal was the source of power.

New York has ranked first among the states in the value of its manufactures since 1830. The exceptional transportation facilities, the commercial supremacy of New York city, the location of the state near the great trade routes, the influx of millions of immigrants both skilled and unskilled, the ample financial resources and the availability of power were the major factors stimulating the industrial development of the Empire state.

New York's pattern of manufacturing activity has been distinctive in several respects. For decades the nondurable goods industries employed more than 60% of all the state's manufacturing workers, a percentage considerably higher than that for the nation. Since World War II, however, the durable goods industries have grown rapidly offsetting the drop in employment in textiles, clothing and other nondurable goods. Similarly, an unusually large percentage of employed workers were engaged in the service trades. The apparel trades accounted for 21% of all manufacturing employees compared with only 6% for the rest of the United States. The ten leading industries in 1860 were flour, men's clothing, sugar refining, leather, liquors, lumber, printing, boots and shoes, machinery and oil; in 1960 they were apparel, printing and publishing, food, machinery, electrical machinery, chemicals, transportation equipment, instruments, fabricated metal products and primary metals. In 1860 most of the industry was engaged in the processing of the products of farm or forest

but by mid-20th century heavy goods such as machinery, metals and transportation equipment were very important to the economy of New York.

In the second half of the 20th century, New York state led all of the others in the number of persons employed in the apparel, printing and publishing, paper and paper products, instruments and furniture industry groups. The state produced approximately 50% of the country's total output of women's dresses, coats and blouses, 90% of the women's furs and 35% of men's and boys' tailored clothes. It produced about 70% of the value of photo equipment manufactured in the nation. The total value added to manufactures, rising steadily each year, exceeded $19,000,000,000 in the 1960s.

In upstate New York there are six metropolitan areas that are leading industrial centres. They are Buffalo, Rochester, Albany-Troy-Schenectady, Syracuse, Utica-Rome and Binghamton. The Buffalo area has the largest steel-producing plants in the state and great aircraft and chemicals plants. Rochester is famous for its manufacture of cameras and scientific instruments. The state's electrical machinery industry is centred in the Schenectady, Utica and Syracuse areas. Syracuse also is famous for china, chemicals and machinery. The Binghamton region specializes in the manufacture of business machines, photographic supplies and shoes. Also, tremendous industrial expansion has taken place on Long Island since 1945, especially in the making of aircraft and instruments. The construction of the St. Lawrence power project has led to the construction of many new factories particularly aluminum plants.

Minerals.—New York produces more than 30 mineral substances. Among them are cement, iron ore, stone, sand and gravel, coke, clays, gypsum and zinc. Deposits of petroleum and natural gas are found in the southwestern part of the state. New York is a leading producer of salt (about 20% of U.S. total) for domestic, industrial and chemical uses. Minor minerals such as talc, emery, garnet and titanium are mined in the Adirondack region. The state ranks about 18th among the states in the value of its mineral output—more than $200,000,000.

Iron and lead have been mined in New York since colonial days. Troy became a steel-processing centre and steel processed there was used in the construction of the "Monitor" in 1862. Until about 1880 the state remained an important centre of iron mining, but thereafter the industry declined steadily in importance until World War II. Following the war, however, there was an increase in the mining of lead, zinc and titanium. For many years, New York was the only producer among the states of emery and it has been a leader in the production of talc, soapstone and pyrophyllite.

Commerce and Finance.—New York is by far the leading state of the union in wholesale and retail trade and employs over one-fifth of the total persons employed in these occupations. Commerce has been significant to the economy of New York from its earliest history. The export of breadstuffs increased so rapidly that the flour barrel was placed on the official seal of New York city in 1682. Most trade, at that time, consisted of the exchange of foodstuffs and furs for manufactures from England and for sugar and molasses from the West Indies. Shipowners often ignored the navigation acts by trading with the planters in the French and Spanish West Indies. The port of New York became the leader in foreign trade between 1810 and 1820, and by 1840 had achieved unquestioned supremacy. During the next century it controlled roughly one-half of the nation's foreign commerce, measured in terms of value. It ordinarily handled more than half of the nation's imports and over a third of its exports. The rapid expansion of population and industry in the Gulf states and on the Pacific coast since 1920 has gradually reduced New York's relative share of the nation's commerce, but in the second half of the 20th century it still handled 35% of imports and 27% of exports (by value). The three northern customs districts (Buffalo, Rochester and St. Lawrence) handle almost 30% of all United States trade with Canada, the nation's largest customer. One-half of all passengers to and from foreign countries overseas pass through the port of New York.

New York city is the world's financial centre because of its stock exchanges, banks and other financial institutions. Upstate cities also have important financial resources. It has been estimated that about 20% of the total liquid savings in the United States, including time deposits, life insurance equities, savings bonds, saving and loan shares and postal savings are held by residents of New York. New York city banks in the 1960s granted nearly 30% of all commercial and business loans in the United States and handled about three-fourths of the financing of the nation's foreign trade. At the same time, investors transacted on the New York stock exchange and the American stock exchange 93% (based on value) of all security transactions reported on all exchanges. More than 20 life insurance companies, including three of the first four in assets, have their headquarters in New York city. The city also dominates the marine-insurance field.

Transportation.—New York has one of the finest harbours on the North Atlantic coast, the best route through the Appalachian barrier and an excellent system of waterways, both natural and man-made. The success of the Erie canal, opened in 1825, led to the construction of several lateral canals and the enlargement of the Erie between 1836 and 1862. The steam railways, however, began to challenge the canal especially after 1850. The first railroads began operations about 1831. During the 1850s the eight short lines across the state began to take freight away from the canal. The establishment of the New York Central railroad in 1853 dramatized the fact that the railroads had become large corporations. In 1851 New York city was linked with Greenbush across the Hudson from Albany by the Hudson River railroad and the Harlem railroad, and it was indirectly connected with Lake Erie by the Erie railroad (now the Erie-Lackawanna railroad) which had a line from Piermont on the Hudson to Dunkirk on the lake. Cornelius Vanderbilt got control of the Hudson River railroad and in 1869 took over the New York Central. This system subsequently acquired connections with Chicago, Montreal and Boston, leased the West Shore railroad in 1886 and purchased several feeder lines. Other important railroads in New York were the Lehigh Valley; the Pennsylvania in the central and western part of the state; the Delaware and Hudson; the Boston and Maine in the east; and the Long Island Rail Road. Railroad mileage in 1960 was about 7,000.

Transportation by water, highway and air challenged the supremacy of the railroads in the 20th century. In 1903 the voters approved the construction of a new Barge canal partly because they wanted to punish the railroads for granting lower through rates from Chicago to Philadelphia and Baltimore than from Chicago to New York city. The New York State Barge Canal system, which was not completed until 1918, included 522 mi. of canal with branches to Oswego, Lake Champlain, Seneca lake and Cayuga lake. The Barge canal normally carries about 4,000,000 tons of goods a year, more than half of which are petroleum products. (*See* also ERIE CANAL.) The taxpayers subsidize the canal system since the shippers do not pay tolls.

In the second half of the 20th century New York had about 100,000 mi. of roads which ranged from dirt roads to multilane parkways. In 1948 the state Thruway authority began the construction of a 550-mi. superhighway connecting New York city with Buffalo and the Pennsylvania line. The last link of the thruway from Albany eastward to Massachusetts was opened in 1958. Airlines connect the various cities and the state as a whole with the rest of the country and the world. In the 1960s New York had more than 250 airports, including the huge John F. Kennedy International airport (formerly the New York International airport) at Idlewild on Long Island. *See* also references under "New York" in the Index.

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(D. M. El.)

NEW YORK (CITY), the largest city in the U.S., is situated at the mouth of the Hudson river, there sometimes called the North river. The five boroughs comprising the city are: the Bronx (Bronx county), 54.4 sq.mi., on the southernmost part of the mainland adjacent to and below Westchester county and separated from the borough of Manhattan by the Harlem river (a canalized waterway connecting the Hudson and East rivers); Manhattan (New York county), 31.2 sq.mi., on Manhattan Island between the Hudson and East rivers; Queens (Queens county), 126.6 sq.mi., on Long Island adjoining and to the west of Nassau county and separated from the Bronx and Manhattan by the East river; Brooklyn (Kings county), 88.8 sq.mi., adjoining and to the south of Queens at the western end of Long Island; and Richmond (Richmond county), 64.4 sq.mi., on Staten Island in New York bay, southwest of Brooklyn and separated from it by the Narrows (a strait connecting Upper and Lower New York bays) and from the mainland of the state of New Jersey by tidal estuaries known as Kill van Kull and Arthur Kill. The total area of the city is 365.4 sq.mi. The greatest width of the city, from the eastern boundary line of Queens to the western border of Richmond, is 25 mi.; from the same point in Queens to the western end of 23rd street at the Hudson river in Manhattan, is 16.5 mi. The greatest over-all length, north to south, is 36 mi.

The city's more important small islands are: North and South Brother, Rikers, City, Hunter, Hart, Governors (occupied by a U.S. military reservation, Ft. Jay), Welfare (formerly Blackwell's), Ward's, Randall's (latter three occupied by state and city institutions) and numerous islands in Jamaica bay. Liberty Island (name changed from Bedloe's Island June 29, 1960; the site of F. Bartholdi's Statue of Liberty) and Ellis Island, where the federal government formerly maintained the best-known and most active immigration station, are in Upper New York bay, within the bounds of New Jersey.

The total water front within New York city is 578 mi., of which Manhattan has 43 mi.; Brooklyn, 201 mi.; the Bronx, 80 mi.; Queens, 197 mi.; and Richmond, 57 mi. The two flanking rivers, the Hudson and the East, are not true rivers. The former, up to Troy, is a tidal arm or narrow inlet of the sea; the latter, a 16-mi. tidal strait, connects New York bay with Long Island sound.

HISTORY

Discovery and Exploration.—New York bay and the Hudson river were apparently first discovered by Giovanni da Verrazzano, a Florentine navigator, on April 17, 1524. The first conclusive exploration of New York bay and the Hudson river, however, was made by Henry Hudson, an Englishman sailing for the Dutch East India company, in the "Half Moon" during Sept. and Oct. 1609. Unable to reach the orient around the north of Siberia by way of the ice-packed Arctic ocean, instead of returning to Holland Hudson sailed westward and ultimately into New York harbour. Beginning in 1610, Dutch captains such as Adriaen Block, Hendrick Christiaensen and Cornelis Jacobsen May voyaged to Manhattan. The fur trade was the primary attraction. Block explored New York harbour, Long Island sound, the Connecticut river as far as present-day Hartford and discovered Block Island in 1614. On March 27, 1614, the states-general of the Netherlands granted a general charter to 13 shipowners whose five vessels were trading in the New York area; they were required to make four voyages by Jan. 1, 1618; and were given a monopoly of trade in New Netherland. When their charter expired in 1618 the Dutch government declined to renew it. Instead, seeking a western counterpart for their Dutch East India company, the government chartered the Dutch West India company in 1621. This powerful trading corporation was granted a monopoly of trade throughout the western hemisphere.

Dutch Period.—In 1624, 30 Protestant Walloon families were sent by the company to augment the few trading post settlers already there. Only about eight men remained on Manhattan. The next year more colonists came, and when the first director, Cornelis May, was succeeded by director Willem Verhulst in 1625, the colony numbered almost 200 persons. The government of New Netherland province was vested in a director-general and council. These officers, though formally appointed by the company, were subject to the approval of the states-general. The first director-general, Peter Minuit, arrived with additional colonists in 1626, purchased Manhattan Island from the local Algonkian Indians with pieces of bright cloth, beads and other trinkets to the value of 60 guldens, or about $24, erected Ft. Amsterdam at the lower end of the island and changed the name of Manhattan to New Amsterdam and made it the seat of government. Recalled by the company in 1631, Minuit was replaced first by Bastiaen Jansen Krol and then by Wouter van Twiller in March 1633 who in turn remained until March 1638, when he was recalled because of his mismanagement. He was succeeded by Willem Kieft, an Amsterdam merchant, whose Indian policy proved disastrous to the colony. He levied a tax on the Algonkian tribes for the presumed purpose of protecting them from the neighbouring fierce Iroquois, but declined to assist them after the Iroquois attacked. The result was four years of intermittent but savage warfare between the Dutch and Algonkins. Kieft's one great virtue was his tolerance of freedom of worship.

Peter Stuyvesant (*q.v.*), last of the Dutch governors, was appointed in 1646 and administered the colony until the English conquest in 1664. He defied colonists and company alike. Grudgingly, under the company's specific orders, he was compelled to grant the first municipal charter to New Amsterdam on Feb.

In the foreground (centre) is the Empire State building, tallest skyscraper in the world, 1,250 ft. above street level, exclusive of its television aerial.

At left in the background is the Chrysler building. Oblong building at right, on the edge of the East river, is the headquarters of the United Nations

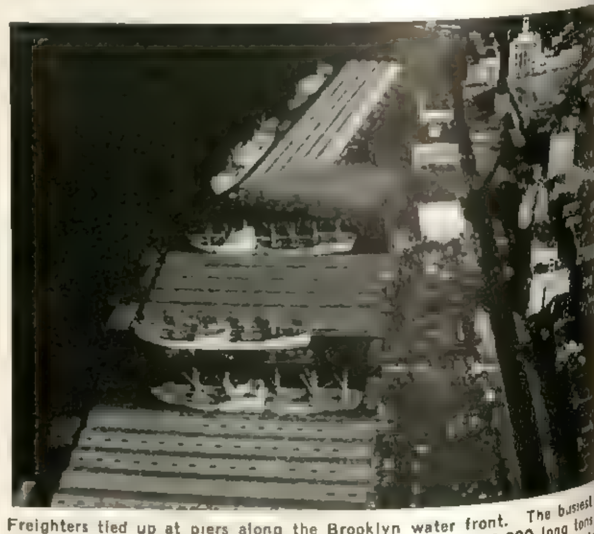
MIDTOWN NEW YORK

BY COURTESY OF AMERICAN AIRLINES

NEW YORK (CITY)

View to the south from above Manhattan. In the foreground is the edge of Central Park. In the bay may be seen Governor's Island (centre) and the Statue of Liberty (right)

Three of the bridges crossing the East river. From top to bottom, Williamsburg, Manhattan, Brooklyn. The Brooklyn bridge, the first to span the river, was opened for traffic in 1883



Freighters tied up at piers along the Brooklyn water front. The busiest ... the U.S., the port of New York handles more than 25,000,000 long tons of bulk cargo annually through its water front, which has a developed frontage of about 460 mi.

NEW YORK FROM THE AIR

BY COURTESY OF (BOTTOM RIGHT) THE PORT OF NEW YORK AUTHORITY (BOTTOM LEFT) CITIES SERVICE COMPANY, PHOTO BY FRITZ HENLE; PHOTOGRAPH, (TOP) FAIRCHILD AERIAL SURVEYS

Looking north along the Hudson river. Right, apartment houses of upper Manhattan; centre, Henry Hudson parkway (West Side drive) and Riverside drive, major traffic arteries to the city; left, a section of the George Washington bridge to New Jersey

Cluster of skyscrapers at the southern tip of Manhattan (the Battery). The area is the centre of the city's financial operations, including banks and trust companies, the New York Stock and American Stock exchanges and other product and commodity exchanges

NEW YORK FROM THE AIR

BY COURTESY OF (TOP) NEW YORK STATE DEPARTMENT OF COMMERCE; PHOTOGRAPH, (BOTTOM) FAIRCHILD AERIAL SURVEYS

Gilded bronze statue of Prometheus by Paul Manship, in the plaza of Rockefeller Center. The eight-ton statue is 18 ft. high; it was installed in 1934

Washington arch, a memorial to the first president at the foot of Fifth avenue in Greenwich Village. The arch was designed by Stanford White and erected in 1895. The Empire State building may be seen in the distance

The New York Stock exchange, Wall street. At right is a statue of George Washington on the steps of the Federal Hall memorial (formerly the subtreasury building) where he took his oath of office as the first president of the U.S.

FAMILIAR LANDMARKS IN NEW YORK CITY

"Cleopatra's Needle," an Egyptian obelisk of about 1500 B.C., in Central park, behind the Metropolitan Museum of Art. Installed in [illegible]

Winter view of the cemetery of Trinity church, in the heart of the financial district at Broadway and Wall street. The original church was established in 1697

PHOTOGRAPHS, (TOP LEFT) AUTHENTICATED NEWS, (TOP RIGHT) JOSEF MUENCH, (CENTRE LEFT, BOTTOM RIGHT) A. DEVANEY, (BOTTOM LEFT) UNITED PRESS INTERNATIONAL

Busts of famous U.S. cit[illegible] the colonnade of the Hall of Fame for Great Americans, on the campus of New York university

The New York Public library, in midtown Manhattan, one of the world's great libraries with a collection of almost 6,000,000 volumes and more than 50 branches

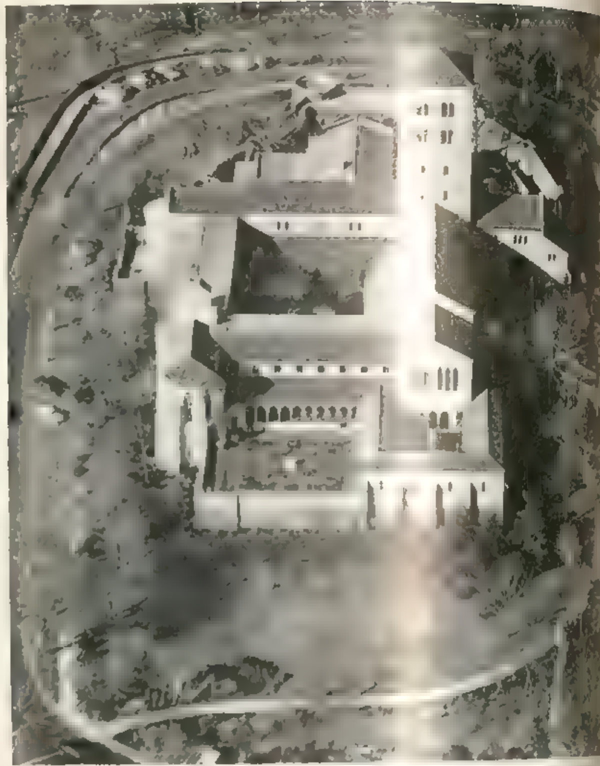
POINTS OF INTEREST IN NEW YORK CITY

Scene in Central park, an 840-ac. tract in the middle of the city from 59th to 110th street, between Fifth and Eighth avenues

St. Paul's chapel, the oldest church edifice in the city, was built in 1766; the spire was added in 1794

PHOTOGRAPHS, (TOP LEFT) SAMUEL HERSCH FROM A. DEVANEY, (TOP RIGHT) A. DEVANEY, (BOTTOM LEFT) D. JORDAN WILSON—PIX FROM PUBLIX, (BOTTOM RIGHT) WAYNE ANDREWS

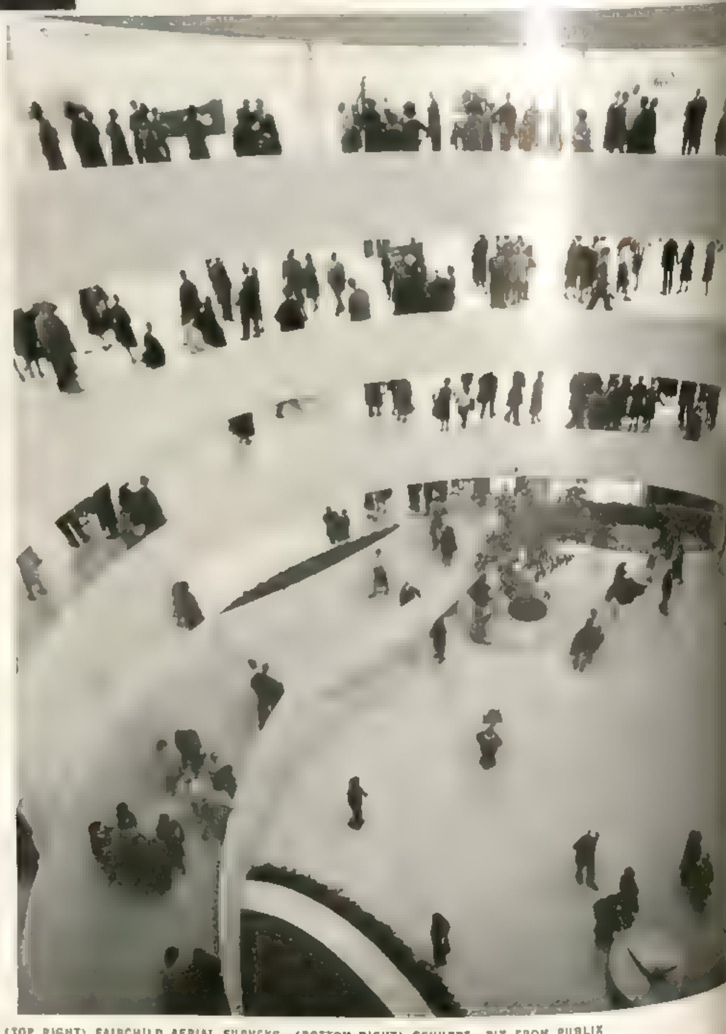
Sidewalk exhibition of paintings in Greenwich Village, home of many of the city's artists. Such exhibitions are frequent throughout the warm months of the year



The Cloisters, medieval art museum located in Fort Tryon park. The building incorporates sections of several European monasteries and a complete Romanesque chapel. Collection includes many famous Gothic tapestries

Egyptian statuary at the Metropolitan Museum of Art, Central park. The Metropolitan houses the largest collection of art objects in the U.S., including painting, sculpture and decorative arts of all ages and cultures

ART AND MUSEUMS IN NEW YORK CITY



View of the spiral ramps which serve as the galleries of the Solomon R. Guggenheim Museum of Non-Objective Art. The last major public building to be designed by Frank Lloyd Wright, the Guggenheim was completed in 1959, the year of Wright's death. Collection includes painting, sculpture and drawings

PHOTOGRAPHS, (TOP LEFT, CENTRE LEFT) D. JORDAN WILSON—PIX FROM PUBLIX, (TOP RIGHT) FAIRCHILD AERIAL SURVEYS, (BOTTOM RIGHT) SCHUPPE—PIX FROM PUBLIX

1653, but kept the city under such close supervision the new municipal powers were virtually nullified. In view of Stuyvesant's shortcomings and the feeling that they were employees of an indifferent corporation rather than Dutch nationals, it was inevitable that the populace declined to obey the governor and resist the English ultimatum for the surrender of the province. Accordingly, Stuyvesant was compelled to capitulate on Sept. 8, 1664, to Col. Richard Nicolls without the firing of a shot. The English flag was raised over the fort, which was renamed Ft. James, after the new proprietor, James, duke of York, and New Amsterdam became New York.

English Rule.—The rights of the Dutch settlers were carefully maintained at first, and established institutions changed only gradually. The English reorganized the city government (1665) with a mayor, five aldermen and a sheriff to be appointed by the governor of the province for a term of one year, and also extended the city limits to include all of Manhattan Island. The third Anglo-Dutch War broke out in 1672, and on Aug. 8, 1673, New York was recaptured by the Dutch. Capt. Anthony Colve became the governor-general until the treaty of Westminster ended the war in 1674, and Colve turned the city over to Sir Edmund Andros, the new English governor, who restored the English form of city government.

The next century was a continuous struggle for control of the city government between the Tory-supported royal governors and the largely Whig populace. The first serious manifestation of American resistance came with the refusal of the merchants of New York and other parts of the province to pay certain duties exacted by the "duke's laws" which had been promulgated in 1665, and which were essentially a code of laws and a constitution for the newly created county of Yorkshire (Westchester, Long Island and Staten Island). (*See* also NEW YORK [state]: *History.*)

Gov. Thomas Dongan, one of the colony's ablest governors, arrived in 1683 with instructions to call a general provincial assembly for which the colonists had been petitioning. Accordingly, the first general assembly met on Oct. 17, 1683, in Ft. James, consisting of Dongan, 10 councilors and 17 representatives elected by the free citizenry. The new assembly on Dec. 8, 1683, divided the city into six wards, each to choose one alderman and one assistant alderman; these 12, together with the mayor and the recorder (a new judgeship of the mayor's court for trying criminal cases) were to comprise the new common council. All former rights and privileges were confirmed; the city was given eminent domain; it could sue and be sued; it could acquire and grant lands; and it could grant and regulate franchises and rights. Freemen could also elect constables and assessors. All these rights were now legally confirmed by Dongan's formal grant of a municipal charter, the first under English rule, on April 27, 1686. In addition, the charter provided for sources of income for the city and conveyed to it the proprietorship of the city hall, the market houses, bridges, wharves, docks, cemeteries, ferries, unoccupied lands and the waters within the city. The city seal presented to the corporation the same year is that which it now employs except that an eagle was substituted for the royal crown in 1784.

One of the most important occurrences in this period was Leisler's rebellion (1689–91), the local counterpart of the revolution in England which had dethroned James II. Jacob Leisler (*q.v.*), loyal to the new monarchs, William and Mary, seized the local government in their name, and was appointed by the local committee of safety as the equivalent of the first popular governor of New York province. In turn, he obtained the election of Peter de Lanoy as the first popular mayor of the city, a privilege that was to lapse until 1834. William's and Mary's new governor, Col. Henry Sloughter, persuaded by Leisler's foes that he was a traitor, had him and his son-in-law hanged in 1691, the only persons ever hanged in the province or state for treason. In 1695 parliament exonerated them and two years later restored the martyrs' property that had been forfeited by the provincial court.

Governor Sloughter appointed as mayor Abraham DePeyster, who was effective in conciliating the warring factions for the time and responsible for many public improvements. The old "rattle watch" or police of the city was reorganized by DePeyster in 1697 and placed again under civil control. DePeyster built new wharves, provided the first system of poor relief and instituted improvements in sanitation. The incompetence of governors Benjamin Fletcher, Lord Cornbury and Francis Lovelace increased resentment against English government; and appointed mayors, though in the main men of good standing and usually merchants, were so frequently changed that few made noticeable impressions upon municipal affairs. An exception was William Peartree (1703–07), who established the first free grammar school and a school for Negro slaves and also improved the jail and provided a debtors' prison in the city hall. Gov. Robert Hunter (1710–20) was one of the ablest administrators in America. In 1710 he endeavored to settle about 3,000 German Palatines in the Hudson valley to produce naval stores, but the attempt failed. Between April 7–21, 1712, an insurrection of Negroes took place but was promptly suppressed by Hunter. Nine white men were slain and many more wounded; in retaliation, 21 Negroes were convicted and executed, some most barbarously, and many others were imprisoned. Twenty-nine years later, on Feb. 28, 1741, the alleged Negro conspiracy to burn the city was uncovered, and between then and Oct. 22, 1742, 14 Negroes were burned at the stake and 18 were hanged; 71 were transported out of the colony, and 3 whites were also executed. In 1730 New York received the Montgomerie charter from Gov. John Montgomerie which increased the municipal power by enabling the mayor to appoint subordinate officers with the advice and consent of the common council, and permitted the mayor with a majority of the common council to enact or repeal any by-laws or ordinances they saw fit.

Of especial significance was the trial of John Peter Zenger in the New York city hall in Aug. 1735 on the charge of printing libelous statements in his *New York Weekly Journal* about Gov. William S. Cosby. Zenger was acquitted in what proved to be a tremendous victory for freedom of the press.

The Revolution.—By the middle of the 18th century New York city was regarded as the focal point of resistance to the royal authority. Causes of resentment against English rule were soon forthcoming. One was the impressment of New York sailors onto British men-of-war in the harbour of the city. The merchants of the city reacted vigorously in 1764 and 1765 in protest against the Sugar act of 1764. When New York learned of the passage of the Stamp act on April 11, 1765, the citizenry was stunned and indignant. The Stamp Act congress was convened in the city hall from Oct. 7–25, 1765, with 27 delegates from nine colonies. A Declaration of Rights and Grievances, and additional protests, were dispatched to the British government. The Sons of Liberty commenced perhaps the earliest committee of correspondence in New York city in 1765. While the congress was still in session, a British vessel arrived loaded with stamps, but in the face of popular passion the stamps were secretly landed at night and placed in Ft. George for safekeeping. On Nov. 1, 1765, the date of the act's inception, a crowd proceeded to the fort and to Bowling Green, where Lieut. Gov. Cadwallader Colden was hanged in effigy. Mayor John Cruger, Jr., finally induced Colden to turn the stamps over to the city corporation, but the Sons of Liberty and the merchants were firm in their resistance to the enforcement of the Stamp act and it was finally repealed on March 18, 1766.

Rioting between the Sons of Liberty and the British soldiery became an almost daily occurrence. The first serious bloodshed occurred on Aug. 11, 1766, when the Sons of Liberty were erecting a liberty pole; the soldiers charged the citizens with drawn bayonets, wounding several, including their leader Isaac Sears. On Jan. 2, 1769, Gov. Henry Moore dissolved the assembly for failing to co-operate with the provisions of the Quartering act. In Jan. 1770 another liberty pole was cut down by soldiers resulting in the "battle of Golden hill" (John and William streets) on Jan. 19, about six weeks before the Boston Massacre. Several patriots and soldiers were badly wounded, none fatally, but "much blood was spilt." Frays continued in the days following, and finally Mayor Whitehead Hicks issued a proclamation forbidding soldiers to leave their barracks unless accompanied by a noncommissioned officer. Rumours in early 1774 that tea ships were on their way to New York to carry out Lord North's program of taxa-

tion by means of the Tea act of 1773 kept public indignation at high pitch. The "London" arrived in April 1774 and a party of Sons of Liberty boarded it and dumped 18 cases of tea into the harbour. The closure of the port of Boston in punishment for the Boston Tea Party was the signal for the calling of a meeting at Fraunces' tavern and the election of a committee of 51, which issued the call for the first intercolonial congress. The committee of 51 was dissolved with the election of a new committee of observation of 60 to enforce in New York the Nonimportation act of the first Continental Congress.

When the news of Lexington and Concord reached New York on April 23, 1775, a crowd took possession of city hall and seized the munitions stored there; two British ships in the harbour were seized and their cargoes unloaded. The committee of 60 called for the election of a new committee of 100 to arrange for the calling of a war congress of deputies from all New York counties. This provincial congress met in New York and declared its obedience to the Continental Congress. On April 4, 1776, New York was placed under military rule by Gen. Israel Putnam and Washington later moved his headquarters there. On July 12, British Adm. Richard Howe appeared with his fleet in the harbour, but it was not until Aug. 22 that British troops were landed at Gravesend bay. On Aug. 27 the British took Brooklyn heights. Washington withdrew his troops from Long Island (*q.v.*) and reorganized in New York on Aug. 29. The British then landed at Kips bay on Sept. 15, threw the Americans back and next endeavoured to cut off the American army by throwing a line of troops across Manhattan at about present-day 34th street. The Americans slipped through to Harlem heights, where Washington again reorganized. On Sept. 16 the British attacked unsuccessfully at Harlem heights. On Sept. 21 a fire broke out near Whitehall slip and almost completely destroyed the lower part of the city. Trinity church was burned but St. Paul's and King's college were saved by a shifting of the wind. The following day Nathan Hale, a young spy for the American army who had been condemned by Gen. William Howe, was hanged at a spot near present-day 45th street and First avenue.

New York was held by the British troops for the remainder of the war. It was used largely as a prison camp, and as a gathering place for loyalists (Tories). Churches, warehouses, jails and stores were packed with men sick and well. On the site of the fire, a village of huts and tents had sprung up which was called "Canvas Town." A second disastrous fire on Aug. 3, 1778, destroyed another 60 houses and many stores. Robberies were a daily occurrence and citizens could expect no help from the British soldiers. In Wallabout bay, on the East river, an old hulk, the "Jersey," was used by the British as a prison ship and there more than 11,000 men died. The city was in desperate straits for want of supplies, and sickness ravaged the people. There was no government except military rule and the oppression of civilians by the soldiery was the cause of frequent riots. The revenues of the city were appropriated by the military for their private uses. After the surrender of Lord Cornwallis at Yorktown, Sir Guy Carleton succeeded the intolerant Sir Henry Clinton in May 1782 and immediately undertook the restoration of law and order. By the time of the British evacuation, Nov. 25, 1783, confidence in British government had partially returned.

Formative Years.—The parting of Washington from his troops came on Dec. 4, 1783, at Fraunces' tavern. After the departure of Washington on Jan. 21, 1784, the state legislature began its sessions in New York's city hall, and the city remained the state capital until 1797, when it was permanently removed to Albany. From 1785 to 1790 the federal congress also met in the city hall, and thus the city was for a time both the national and state capital. James Duane was appointed by Gov. George Clinton the first American mayor of New York on Feb. 5, 1784; on Feb. 22 the "Empress of China," sailing from New York, was the first American vessel to enter Asiatic waters; on March 15 the second bank in the U.S., the Bank of New York, was organized with Alexander Hamilton as one of its directors, and on May 15, by act of legislature, King's college became the state university and its name was changed to Columbia college. Several events foreshadowed the important shape of things to come in the city: in 1786 the city's population was 23,614; on June 15, 1787, the Mutual Assurance Co., the city's first fire insurance company, was organized; on Oct. 27, 1787, the first number of the *Federalist Papers* appeared, an effort sponsored by Hamilton and John Jay, both New Yorkers, and James Madison, to ensure the ratification of the constitution by the state; and in 1789 the Tammany society was founded.

On April 30, 1789, Washington was inaugurated president at Federal hall at the corner of Broad and Wall streets. The rise of commerce and wealth drew many people to New York and it began to take on the appearance of a metropolis. Washington made his last official visit to Federal hall on Aug. 12, 1790, and then went to the new capital, Philadelphia. New streets and public utilities were laid out. Bellevue hospital, originally established as the Alms house in 1736, was located on its present site in 1794 for the treatment of contagious diseases. Collect pond, later the site of the Tombs (city prison), was the scene of the first trials of John Fitch's steamboat in 1796. The New York Historical society was founded in 1804. With the help of De Witt Clinton, who served as mayor for ten years between 1803 and 1815, there was organized, in 1805, the Society for Establishing a Free School in the City of New York. Under Clinton, schools were built and Columbia college improved, philanthropic organizations increased in number and arts and letters were stimulated. In 1807 there were 19 newspapers, of which 8 were dailies. Although the Embargo act of 1807 struck New York trade a serious blow, it was not without benefit in stimulating domestic industries. The new city hall was completed in 1812, and there was at this time a considerable advance both in architecture and building construction. Many new buildings, including churches, were built, new streets were graded and swamps filled in along the water front. Collect pond was filled in and the hills and valleys of lower Manhattan were rapidly leveled for homes and other structures.

In the midst of this prosperity, war was declared against Great Britain on June 18, 1812. The commerce of the city suffered from blockade, and the city was put in a posture of strong defense, with additional forts built. On Feb. 11, 1815, the ship "Favorite" arrived in New York under a flag of truce with British and American messengers and the peace treaty of Ghent. Under Mayor Jacob Radcliff (1815–17), the common council appropriated $1,000 for free vaccination against smallpox, which periodically ravaged the city. Mayor Cadwallader D. Colden (1818–21) likewise advanced governmental and private services for public welfare. By 1820 the city's population had reached 123,700, for great numbers of immigrants from Europe were arriving. The problems of dealing with this influx of newcomers were taxing the city and its facilities to the limit. Yellow fever broke out in 1819, 1822 and 1823, and hundreds died daily; another epidemic occurred ten years later and smallpox and malaria also took their toll. Yet, the city continued to grow. The opening of the Erie canal on Nov. 4, 1825, ushered in an even more important phase of New York's commercial history.

By 1830 the population of Manhattan Island was 202,589; mass transportation became a problem only partly solved by the horse-drawn stages and the later horse cars. On Dec. 16, 1835, the "great fire" broke out and destroyed nearly 700 buildings in the heart of the city and virtually wiped out the last vestiges of the old Dutch city that had survived the fires of 1776 and 1778. Croton water was furnished the city on July 4, 1842. Blackwell's (now Welfare) Island, purchased in 1828 for $50,000, was made the site of the city's correctional institutions and hospitals. The *New York Sun* was begun in 1833 by Benjamin H. Day. The *Herald* of James Gordon Bennett appeared in 1835, the *Tribune* of Horace Greeley in 1841 and Henry J. Raymond's *Times* in 1851. On May 7, 1847, the state legislature authorized the city's board of education to charter a free academy, and the academy (later the College of the City of New York; now the City University of New York) was established at Lexington avenue and 23rd street in Jan. 1849. Beyond Union square, which was a residential centre, there was little but open fields at the middle of the 19th century. The World's fair at the Crystal palace on Murray hill was the outstanding event of 1853; in 1856 Central park was purchased. The panic and depression of 1857 paralyzed business

thousands were without employment, more than 900 merchants failed and riots and disturbances of all kinds ensued.

The Civil War Years.—That same year the state legislature actively stepped into the political picture in New York city. Mayor Fernando Wood (1855–58; 1860–62), in the manner of Aaron Burr, had converted Tammany Hall from a political organization into a personal political machine. To weaken his control, the Republicans at Albany reduced his second term from two years to one, and created a metropolitan police board to take over the control of the city's police from Wood's municipal police board. Wood resisted the enforcement of these and other acts and precipitated a riot. Just before the outbreak of the American Civil War, in his message of Jan. 6, 1861, to the common council, Mayor Wood, opposed to the war and a leader of the Copperheads (*q.v.*), favoured the establishment of New York city as a separate state. It was in New York that Abraham Lincoln strengthened his claim to the Republican nomination in 1860 by his Cooper Union speech on Feb. 27 of that year.

With the coming of the Civil War, the city, recovered from the financial panic of 1857, boomed by supplying military needs. It authorized a loan of $1,000,000 for the defense of the Union, and hundreds of thousands of dollars more were privately pledged. New York was again filled with soldiers. On April 19, 1861, its 7th regiment entrained for Washington, and a week later a mass meeting in Union square pledged loyalty to the Union cause. George Opdyke defeated Wood in the election for mayor. The city's war effort was marred by the draft riots of July 13–16, 1863, a protest against conscription and the $300 bounty system for obtaining substitutes. More than 1,000 persons were killed or wounded and property damage exceeded $1,000,000. Mayor Opdyke reported in 1863 that the people of New York had contributed up to that time $300,000,000 for war purposes and had furnished more than 80,000 men to the Union army.

The Brooklyn bridge was begun in 1870, and sanitary conditions, which in 1865 had been thoroughly studied by a citizens' committee and found to be deplorable, were on their way to betterment. The old volunteer fire department was replaced in 1865 by a Metropolitan Fire district that included both New York and Brooklyn, and which possessed a paid, uniformed and trained force. In May 1867 the first tenement house law was passed to regulate the growing number of tenements. The American Museum of Natural History was incorporated in 1869 and in that same year the Metropolitan Museum of Art and the future Hunter college were founded.

Boss Rule And Corruption.—At this time the urban political machine appeared, led by the "boss." The chief prototype of this leader was "Boss" William Marcy Tweed (*q.v.*), who by 1868, as master of Tammany Hall, had manipulated control of the city and county of New York, and enjoyed a virtual stranglehold upon the state as well. He had moved John T. Hoffman into the governorship and A. Oakey Hall into the mayoralty. Together with other officials, these constituted the "Tweed ring." The ring stole from between $75,000,000 to $200,000,000 during its time of power. Ultimately, the disclosures of this graft by the *New York Times* in 1871, the biting cartoons of Thomas Nast in *Harper's Weekly* and the unrelenting campaign of the reform-minded committee of 70 brought about the downfall of the Tweed ring and the imprisonment of some of its members, including Tweed who died in prison in 1878. The next Tammany chieftain was "Boss" John Kelly (1874–86), who fought against political reform.

In 1874 the corporate limits of the city were extended to include about 13,000 ac. across the Harlem river taken from Westchester county and formed into the lower Bronx; and on June 6, 1895, the state legislature further annexed about 20,000 ac. including several incorporated villages in Westchester, thereby rounding out the present boundaries of the Bronx. Following Kelly as leader of Tammany was Richard Croker (1886–1902). Reform movements and investigations complicated his regime and in 1894 William L. Strong became Republican mayor and headed a reform administration. Col. George Waring was made commissioner of street cleaning and inaugurated the modern system of street cleaning and refuse collection. Theodore Roosevelt made an enviable reputation as a member of the board of police commissioners. On Jan. 1, 1898, Greater New York city came into being by a charter passed by the state legislature and plebiscites by the communities absorbed. Kings, Richmond and parts of Queens counties were annexed to Manhattan and the Bronx. Croker had led Tammany to a Democratic victory in a bitter four-cornered mayoralty campaign in 1897 and thus the first mayor of the enlarged city was his candidate Robert A. Van Wyck. The Republican party has failed to win a single mayoralty campaign in the greater city's history. Tammany's defeats have been by fusion movements combining reform, anti-Tammany organizations and sometimes the Republicans. Thus, in 1901, Seth Low, fusion candidate, defeated Tammany's Edward M. Shepard because of investigations disclosing Tammany graft and complicity in police corruption. In 1903, Low, however, was defeated by George B. McClellan, Jr., Tammany's candidate.

Tammany and Reform Movements.—Tammany was in power for approximately 18 out of the next 30 years, and between 1902 and 1924 was led by "Boss" Charles Francis Murphy, whose skill permitted him to survive many defeats that would have deposed a lesser leader. He persisted despite a falling out with Mayor McClellan during the latter's second administration (1905–09); he was repudiated by Mayor William J. Gaynor (1910–13); and he was badly shaken by the victory of perhaps the most able of the city's mayors, John Purroy Mitchel (1914–17).

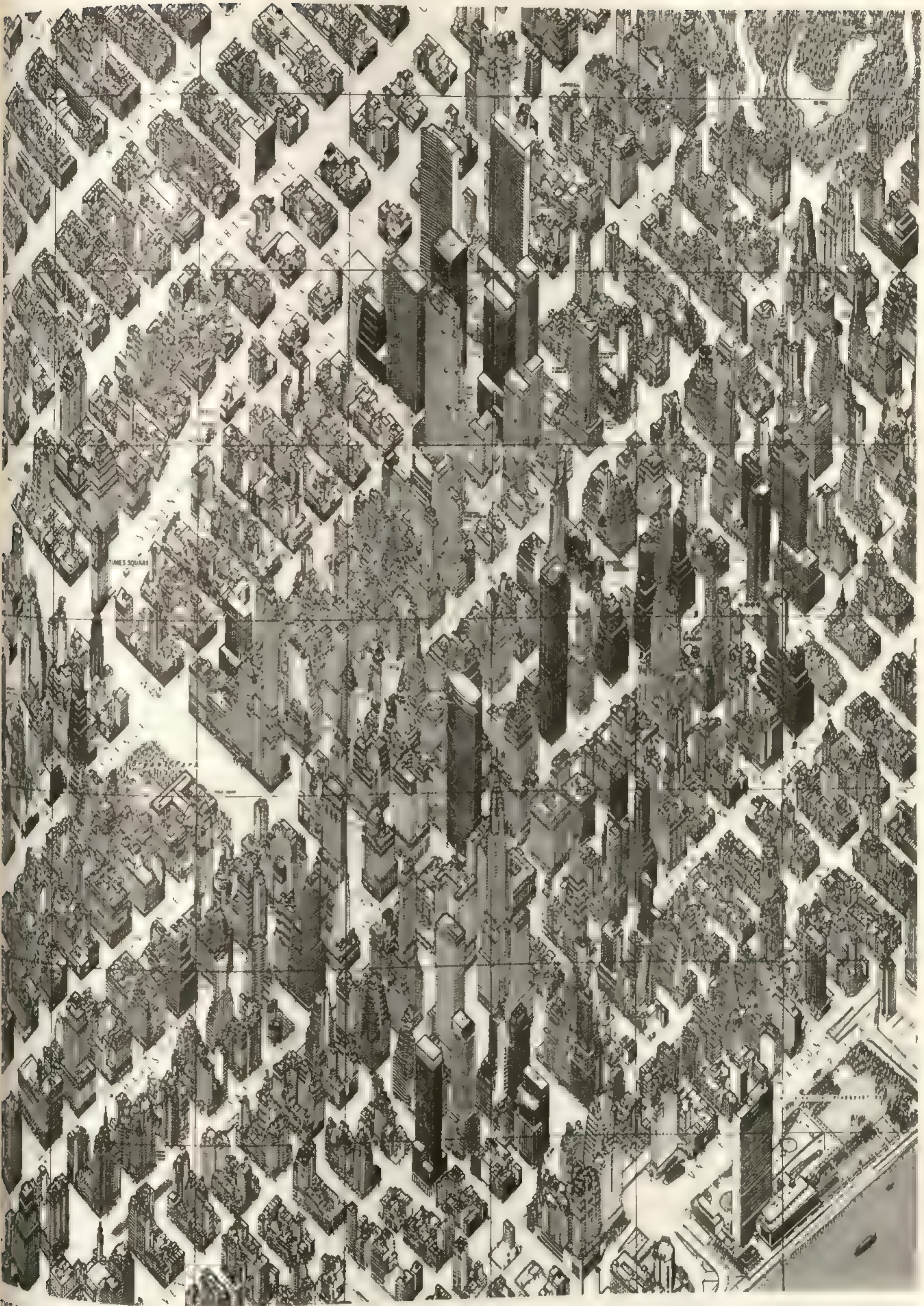
In McClellan's second term Mitchel had been appointed special investigator after a citizens' civic group published a report on irregularities in the administration of the offices of borough President John F. Ahearn of Manhattan and borough President Lewis F. Haffen of the Bronx. Mitchel secured sufficient evidence of these irregularities to warrant Gov. Charles Evans Hughes's removal of both Ahearn and Haffen. In 1912 District Attorney Charles S. Whitman's exposure of police corruption under Mayor Gaynor helped to make Whitman governor in 1915; Gaynor, wounded in an attempt upon his life, died Sept. 10, 1913. The police scandals during Gaynor's administration, although not of his making, swung popular sympathy against Tammany, and Mitchel, candidate for mayor on a fusion ticket, was elected in 1913. In Sept. 1914 a special aldermanic committee of investigation undertook a complete survey of police administration and methods. The facts finally disclosed furnished clear evidence of police incompetency and corruption. Mayor Mitchel's administration was regarded as exceptionally efficient because of the administrative reforms which he instituted.

In the election of 1917 Mitchel was defeated by an overwhelming vote in a four-candidate race, mainly by the combined forces of Murphy, William Randolph Hearst and "Boss" John H. McCooey of Brooklyn. The victor was John F. Hylan, who held office for two terms (1918–25). Hylan was refused party support for a third term. The Tammany leaders selected James J. Walker in 1925. Walker defeated the Republican candidate, Frank D. Waterman. The great issues of the Hylan administration—rapid transit and subway fares—continued paramount under Walker. In 1932 Walker was summoned before Gov. Franklin D. Roosevelt to answer charges of graft brought by Samuel Seabury, counsel for the Hofstadter legislative committee, and, failing to halt proceedings for his removal, resigned Sept. 1, 1932. After an interim under president of the board of aldermen Joseph V. McKee (Sept. 1–Dec. 31, 1932), surrogate John P. O'Brien succeeded in a special election to fill Walker's unexpired term throughout the year 1933.

The combination of the Seabury disclosures of widespread Tammany graft and corruption throughout the city government and the serious financial difficulties of the municipality put Fiorello H. LaGuardia into city hall as the fusion victor in the election of 1933. He won re-elections in 1937 and 1941. The LaGuardia administration was noted for the unification of the transportation system under municipal operation; the completion of the Triborough bridge and the Lincoln and Queens Midtown tunnels; the development of the Delaware water supply system; and the World's fair of 1939 and 1940. The wave of civic regeneration begun by the Seabury investigations was carried on by District Attorney

PICTORIAL MAPS, INC., NEW YORK CITY

AN ISOMETRIC PROJECTION OF NEW YORK CITY SHOWING MANHATTAN BETWEEN 22ND STREET OR



THE SOUTH, THE HUDSON RIVER ON THE WEST, CENTRAL PARK ON THE NORTH AND THE EAST RIVER

Thomas E. Dewey and his staff, and by John H. Amen, with a series of political and gangster prosecutions and convictions.

LaGuardia did not run for re-election in 1945, and William O'Dwyer, a Democrat, was elected mayor. The notable achievements of his administration included an extensive building program, with emphasis on schools, hospitals, traffic speedways and public housing. The mayor also instituted a far-reaching program of administrative reform, creating the division of analysis in the bureau of the budget; corresponding methods analysis units in 24 of the major city departments; and the mayor's committee on management survey.

Among the major political issues of the period were the abolition by popular referendum in 1947 of proportional representation as a means of electing the 25 city councilmen and the consequent reduction of the opposition and reform element of the council to a minority of one. Other notable political decisions involved the adoption of a ten-cent fare for the transit system (July 1948), the acceptance of collective bargaining with the subway unions, the refusal to deal with so-called Communist unions, the transfer of the city's airports to the Port of New York authority on a 50-year lease and the sharp increase in salary rates for the top elected officers.

O'Dwyer was re-elected in 1949, but resigned on Sept. 1, 1950, to accept the assignment of U.S. ambassador to Mexico. After his departure the reputation of his administration suffered with the conviction of James J. Moran, former first deputy fire commissioner, for income tax evasion, perjury, conspiracy and extortion. In Nov. 1950 Vincent R. Impellitteri, a Democrat running on the independent Experience party ticket, handed Tammany (now known officially as the New York County Democratic committee) a setback by his surprising defeat of its candidate, Ferdinand Pecora, in a special election to fill the vacancy resulting from O'Dwyer's resignation. Instead of building up the Experience party into an anti-Tammany organization the mayor tried to wrest control of the regular organization from its leader Carmine de Sapio, but without success.

Impellitteri did not run for re-election in 1953 and Robert F. Wagner, Jr., was nominated as the Democratic candidate. Wagner defeated both Rudolph Halley and Harold Riegelman in the election. Four years later, Wagner went on to defeat Robert K. Christenberry, the Republican candidate, and he was elected for a third term in 1961. Among Mayor Wagner's achievements were the completion of the removal of the elevated transit lines from Manhattan; the opening of the great exhibition hall, the Coliseum; the renovation of city hall; and the start of the great Lincoln Square cultural and art centre. A world's fair was opened in New York city in 1964.

POPULATION CHARACTERISTICS

New York had fewer than 200 inhabitants in 1625, and about 1,000 in 1656 and about 16,200 in 1755. Around 1783 New York began its rapid growth as the leading port of the nation. The first federal census in 1790 showed the city's population at 33,131; by 1796, the population nearly doubled over 1786; in 1850, it was 515,394; in 1870, the first post-Civil War census indicated a population of 942,292; and, in 1890, the figure had risen to 1,441,216. In 1898 the present five boroughs were united by the state to form the city of Greater New York and its total population in 1900 was 3,437,202. In 1950 the figure was 7,891,957. The 1960 population was 7,781,984 and divided as follows: Manhattan, 1,698,281; Bronx, 1,424,815; Brooklyn, 2,627,319; Queens, 1,809,578; and Richmond, 221,991. The New York standard metropolitan statistical area (New York city and Nassau, Rockland, Suffolk and Westchester counties) had a population of 10,694,633 in 1960.

Almost every national and racial group in the world is represented among the inhabitants of the city. The location of the United Nations in the city adds a diplomatic cosmopolitanism comparable to the ethnic diversity.

The Negro population in 1960 was 1,087,931, constituting the largest Negro community in the country, and representing a gain of 45.5% over the 1950 figure of 747,608. Negroes between World Wars I and II had increasingly made Manhattan's Harlem their centre, both residentially and culturally, bounded generally between 110th street on the south and 155th street on the north, Third avenue on the east and Amsterdam avenue on the west. The increase of their population and migration from the south after 1940, coupled with the sharp influx of Puerto Rican immigrants into the east Harlem and Bronx areas, led to the expansion of the original Harlem area and encouraged Negro movement into other neighbourhoods in other boroughs with formerly small Negro populations. Negro population by boroughs, as of 1960 was: Bronx, 163,896; Manhattan, 397,101; Brooklyn, 371,405; Queens, 145,855; and Richmond, 9,674.

Puerto Rican immigrants constitute the city's newest marginal economic and social group. The Chinese quarter is in the neighbourhood of Chatham square, on Mott, Pell and Doyers streets. The city of New York has the largest Jewish population of any city in the world.

The foreign-born population, as revealed by the 1960 census, was distributed by native language as follows:

Foreign-Born Population as of 1960 Census

Mother tongue of foreign-born population	Total	Bronx	Brooklyn	Manhattan	Queens	Richmond
English	237,918	53,541	60,344	68,102	51,299	4,632
Norwegian	17,893	517	12,527	1,353	1,452	2,016
Swedish	12,445	1,884	4,1[illegible]5	2,911	2,843	652
Danish	4,479	389	1,668	1,081	1,118	225
Dutch	5,805	590	1,1[illegible]1	2,170	1,758	156
French	32,623	3,262	5,505	14,310	9,049	49[illegible]
German	202,519	31,957	28,502	62,163	77,061	2,8[illegible]
Polish	81,125	16,981	31,879	15,363	15,955	94[illegible]
Czech	11,469	1,576	1,506	4,083	4,194	[illegible]
Slovak	7,456	1,279	1,293	2,207	2,501	[illegible]
Hungarian	39,752	10,205	8,442	11,278	9,569	[illegible]
Serb-Croatian	5,419	707	784	1,899	1,906	[illegible]
Slovenian	1,118	111	205	252	546	[illegible]
Russian	74,715	17,881	27,017	17,744	11,666	[illegible]
Ukrainian	13,289	1,403	2,606	6,686	2,412	[illegible]
Lithuanian	6,381	363	2,961	678	2,351	[illegible]
Finnish	4,637	1,112	1,125	1,723	511	[illegible]
Rumanian	9,730	2,936	3,148	2,068	1,551	[illegible]
Yiddish	254,262	68,353	132,853	27,776	24,900	[illegible]
Greek	33,701	3,640	6,784	11,399	11,572	[illegible]
Italian	275,697	53,657	117,081	36,606	59,923	[illegible]
Spanish	77,447	11,375	16,210	36,260	12,989	[illegible]
Portuguese	3,957	534	1,134	1,345	885	[illegible]
Japanese	3,497	370	299	1,563	1,211	[illegible]
Chinese	19,375	1,451	2,5[illegible]1	13,058	2,262	[illegible]
Arabic	5,556	136	3,885	992	514	[illegible]
All other	42,416	8,494	12,160	11,707	9,703	[illegible]
Not reported	73,979	11,825	28,564	17,921	13,922	[illegible]
Total foreign born	1,558,690	306,592	516,349	374,698	335,623	25,428

Source. U S Department of Commerce, Bureau of the Census, 1960 Census of Population.

The population decline in Manhattan accentuates the continuing application of choice Manhattan real estate to skyscraper and other commercial, office and service usage and the fact that the island is increasingly becoming an area of extremes, of either very high-rental units or low-income and slum units. Manhattan is increasingly the borough of employment and livelihood for millions from the outside. Urban renewal has been unable to keep pace with slum blight.

The Bronx and Brooklyn do not reflect the extremes and pressures of Manhattan, but a slight exodus already was apparent in their demographic data, accelerated to some degree by the uncontainable population thrust of the Negro and Puerto Rican families. This is less true of Queens. That borough's continued progress makes it one of the fastest growing counties in the nation, because of realty development within an area greater by far than that of any of its sister boroughs, together with a growing native birth rate and in-migration by all strata of the economic spectrum. Staten Island, also growing slightly in numbers, has room to accommodate a great population increase.

The New York-Northeastern New Jersey standard consolidated area includes the New York, Jersey City, Newark and Paterson-Clifton-Passaic standard metropolitan statistical areas and the New Jersey counties of Middlesex and Somerset for a total of 17 counties in New York and eastern New Jersey. This area had a 1960 population of 14,759,429. In addition to New York city it includes such important centres of industry and population as Newark, Paterson, Elizabeth, Bayonne, Hoboken, Passaic, Union City, East Orange, Perth Amboy, Orange and New Brunswick in New Jersey; and Yonkers, Mount Vernon, New Rochelle and White Plains in New York. For comparative population figures for New York city *see* table in NEW YORK (state): *Population*.

GOVERNMENT AND SERVICES

Administrative Organization.—The city's basic form of government was inaugurated by the charter passed by the state legislature that created Greater New York on Jan. 1, 1898. It provided for a mayor elected at large, 5 borough presidents, a board of aldermen of 65 elected members with a president elected at large. A comptroller, elected at large, was head of the department of finance.

A new city charter providing generally for a strong mayor-council type of government was adopted by popular referendum on Nov. 3, 1936, and became effective on Jan. 1, 1938. It provided for a 25-member city council, elected by a system of proportional representation. This system of election was abolished by popular referendum in 1947 and, under a new law, councilmen were elected by simple majority vote with one from each of the state senatorial districts wholly within the city.

On Nov. 7, 1961, New York city voters overwhelmingly approved adoption of another new city charter, providing for the first major reorganization of the city government since 1936. The new charter, effective on Jan. 1, 1963, was designed to increase the executive power of the mayor; to invest the city council with sole legislative power, subject to the mayor's veto; to deprive the board of estimate of its legislating authority and confine it to passing, along with the council, on the mayor's expense and capital budgets and in approving or disapproving major mayoral changes in the budget during the fiscal year; to transfer from the comptroller to the mayor the power to make the final estimate of general fund revenues for budget-making purposes; to convert the expense budget from a line-item to a program budget; to transfer highway and sewer work from the control of borough presidents to city departments; and to eliminate local assessments for local improvements.

The city council was also made more representative by voter approval of a second question providing that in the election of 10 additional councilmen-at-large, each party or independent group may nominate only one candidate in each of the five boroughs and that voters may vote for only one of them, the two candidates receiving the highest votes to be declared the victors; thus, increased minority representation was guaranteed. The first such councilmen-at-large were elected in November 1963, 5 Democrats and 5 Republicans.

The city council may pass a law over the mayor's veto by a two-thirds vote within thirty days; it may reduce or increase the budget but the mayor has the power to veto any changes; and it may call for an investigation of the conduct and administration of any city department or agency or of any county within the city. Besides the 10 new borough-wide councilmen, the original 25 councilmen are divided as follows: 9 from Brooklyn, 6 from Manhattan, 5 from Queens, 4 from the Bronx and 1 from Richmond. All councilmen are elected for four-year terms.

The board of estimate may add to or subtract from the budget, subject also to the veto of the mayor. The board retains control over zoning, franchises, pier leases, and the leasing and assignment of property; continues as head of the New York city employees' retirement system; and makes recommendations to the mayor or the council on matters of city policy. No franchise granted by the board may be for more than 25 years, except a tunnel-railroad franchise, which may not exceed 50 years. The board is a nonelective body; its membership consists of the mayor, the comptroller and the president of the city council, who each may cast four votes; and the five borough presidents, who each may cast two votes.

With an even stronger mayor-council type of government, the mayor became the responsible directing head of the city. He is the chairman of the board of estimate, recommends legislation, and appoints and may dismiss the city administrator, the city construction co-ordinator, the corporation counsel, the commissioner of investigation and the director of the bureau of the budget. He can organize and reorganize the executive office of the mayor and the city departments. Thus, he appoints the commissioners or executive heads of the police, fire, health, hospitals, welfare, correction, sanitation, public works, markets and 18 other municipal departments, of 16 boards and commissions and of 3 agencies operating from his offices, as well as many lesser officials.

Civil service regulations apply to all officers and employees of the city except to those who are elected, to legislative officers and to staffs of those educational institutions which have special professional standards. In 1920 the city employees' retirement system was put into effect. All persons in city service became eligible for the benefits of this retirement system, except those entitled to share in the police pension fund, the fire department relief fund, the teachers' retirement system or the department of street cleaning relief and pension fund.

An amendment to the state constitution, approved by the voters in Dec. 1935, provided for a reform of the county government within the city of New York. There are five county governments within Greater New York, namely, New York, Bronx, Kings, Queens and Richmond. The officers of the five different counties function almost independently of the city officers. Under the amendment the city has the theoretical power through the enactment of local laws to abolish any county office within its limits except that of judge, county clerk or district attorney; or it may reassign the functions of county officers, with certain exceptions, to city or other county officials or to the courts. The county clerks are appointed and removable by the appellate division of the supreme court in the judicial department in which their respective counties are located.

Finance and Taxation.—The annual expense budget of New York city in the second half of the 20th century amounted to more than $2,000,000,000 or nearly double the amount ten years previously. Approximately 18% was allocated to education; 12% to welfare; 7% to police protection; 7% to hospitals; 4% to fire protection; 4% to sanitation; 17% to debt service; 9% to pensions; and 22% was allocated to all other purposes. To meet this expense budget, the city received revenues as follows: approximately 45% from real estate taxes; 34% from the general fund; and 21% from other funds. The general fund included sales taxes, general business and financial taxes, other special taxes, water charges and other charges, local assistance from the state and "carry-over" funds. Grouped under "other funds" were state aid, federal aid, sewer charges, parking meter revenue and all other sources. Since the nation's beginnings, New York city has contended that it has been required to supply more revenue for the state's needs proportionately than have other areas of the state, but that generally it has received less benefits, services or aid proportionately. Many of the generally Democratic-controlled city's financial difficulties have been blamed upon the discriminatory treatment by the generally Republican-controlled state legislature. It occasioned more than ordinary interest, therefore, when Republican governor Nelson A. Rockefeller and Democratic mayor Wagner on March 26, 1960, agreed upon a fiscal program whereby the city would gain substantial state aid.

Expenditures for capital improvements are considered separately. The so-called capital budget does not include capital expenditures to be paid for by special assessments. Expenditures for capital improvements are allocated among the board of education; the transit authority; public works; gas, electricity and water supply; docks and piers; health, hospitals and sanitation; the parks, libraries and museums; and other recipients.

The assessed valuation of all taxable real estate in the city in the second half of the 20th century aggregated more than $27,000,000,000. Three independent agencies enjoyed revenues of their own. They were the New York city transit authority, the New York city housing authority and the Triborough Bridge and Tunnel authority.

The comptroller is the chief financial officer of the city government. It is his business to advise the mayor, council, and board of estimate; to approve the disbursement of funds; to estimate annually general fund revenues; to audit the accounts of the city departments and agencies; to install a uniform accounting system for all city funds; and to manage the sale and retirement of the city's securities. Aside from the office of comptroller and the bureau of the budget there is a department of finance, headed by the treasurer (formerly the city chamberlain), appointed by the

mayor. This department includes the bureau of city collections and the bureau of receipts and disbursements. Four agencies handle the tax and licence work of the city: the tax department, the board of assessors, the board of revision of assessments and the department of licences. The financial organization of the city also includes a department of purchase which has sole authority for the purchase of supplies and equipment for all departments and agencies of the city government with the exception of the institutions and offices of the board of higher education and the department of education.

Courts.—The judicial system of the city is composed of the following courts: civil; criminal; a division of the state-wide family court; surrogates (estates of infants and deceased persons); and the small claims courts in each borough for cases involving claims of $100 or less. For changes in the court structure of the state *see* New York (state): *Government.*

Police.—The total police force of the city of New York, including patrolmen, detectives, the safety division, emergency, harbour and helicopter personnel, the youth division including the juvenile aid bureau, and plainclothesmen numbered more than 27,000 in the second half of the 20th century. In addition, there were about 1,200 part-time school crossing guards employed by the city. There were about 90 station houses, more than half of them in Manhattan and Brooklyn. A significant feature of the police department is its academy of training, through which all recruits must pass.

Fire.—A fire commissioner heads the fire department, which in the second half of the 20th century had more than 13,000 employees. Under an intensified campaign of specialized inspection and education two school inspections annually have been the rule since Jan. 1, 1959; there are factory-loft inspections; fire wardens receive fire-prevention instruction, as do building superintendents and school custodians; and a new centralized training school was established on Welfare Island.

Health.—Within the department of health is the board of health which consists of the commissioner and four other members, two of whom must be physicians. The department operates offices, health centres and health stations in each borough.

The board of health is responsible for matters of public health policy and for drafting the city's sanitary code. The department exercises sanitary supervision of food supplies and regulates sanitary conditions in establishments that manufacture, handle or store food or patent medicine products.

In the second half of the 20th century the department has been particularly active in the identification of virus diseases, the control of radiological hazards, case finding campaigns against tuberculosis and diabetes, immunization against poliomyelitis, research into the causes of coronary heart disease, a transport service for premature infants and the development of techniques for the early detection of cancer. The New York City Health Research council was created in 1958. That year marked the 50th anniversary of the founding of the maternal and child health services; in that half-century there was a reduction of 77% in the city's infant mortality rate. A considerable number of voluntary health agencies operate in the city and co-operate with the health department.

Hospitals.—The department of hospitals was established in 1930 by the consolidation of the general and special hospitals of the departments of health and welfare, and Bellevue and allied hospitals. Among the chief private general hospitals are Mount Sinai, St. Luke's, Presbyterian, New York, Roosevelt, Lenox Hill and Post Graduate, all in Manhattan. In the Bronx are the Montefiore and Misericordia hospitals. In Brooklyn are the Long Island college hospital, Jewish, Brooklyn and Methodist Episcopal hospitals. Of the private special hospitals for women and children, the Lying-in, Sloane Maternity and Woman's are the largest. Other special hospitals of note are the Joint Diseases, Special Surgery, New York Eye and Ear infirmary, Manhattan Eye, Ear and Throat hospital, Skin and Cancer clinic and Neurological institute. The larger municipal hospitals, each providing 1,000 beds or more, are Bellevue, Kings county, City, Metropolitan, Sea View and Triboro.

Among the events of interest in connection with the private hospital services of the city have been the establishment of the Columbia-Presbyterian Medical centre and the New York Hospital-Cornell Medical centre. In upper Manhattan are clustered the buildings of five separate units: the Presbyterian hospital (including the Presbyterian hospital, the Sloane hospital for women, the Vanderbilt clinic, the Squier urological clinic, the Stephen V. Harkness private patient pavilion and the Presbyterian hospital school of nursing); the Columbia university group (including the college of physicians and surgeons, the school of dental and oral surgery, the school of oral hygiene and the DeLamar Institute of Public Health); the Babies' Hospital of the City of New York; the Neurological Institute of New York; and the New York State Psychiatric institute and hospital. The New York Hospital-Cornell Medical centre includes the New York hospital, the Payne Whitney Psychiatric clinic, the New York Hospital-Westchester division for mental diseases at White Plains, N.Y., the Cornell University-New York hospital school of nursing and the Cornell university medical college.

Public Assistance.—The objectives of the department of welfare are to grant financial aid to those in need who are eligible to receive it, and also to return recipients and their families to self-support as soon as possible. The forms of public aid from city, state and federal funds administered by the department are: home relief; veteran assistance; old-age assistance; blind assistance; aid to dependent children; aid to the disabled; shelter care; child welfare; day care; custodial care; and hospitalization.

In 1941 the work of various independent city agencies were made a part of the larger central welfare agency. The private relief agencies of the city offer a great variety of services for family welfare and institutional care. The more important ones are affiliated with the Welfare council of New York city, which seeks to co-ordinate the efforts of the individual agencies and carries on special research and informational services in the interest of all agencies and the general public. Mention should be made also of the Jewish Board of Guardians, the many Catholic charities and the Community Service society of New York. The latter was formed by the merger in 1939 of the Association for Improving the Condition of the Poor (1848) and the Charity Organization society (1883).

Correction.—The department of correction has a threefold goal: to relieve acute overcrowding in all penal institutions as a result of the steady increase in the number of prisoners since World War II; to close obsolete prison buildings; and to separate inmates properly in order to promote rehabilitation and academic and vocational training. The department administers the city institutions for the care and custody of criminals and misdemeanants and for the detention of persons awaiting trial. In 19[illegible] the correction academy was established to provide essential training for the department's personnel. In 1958 an agreement was reached whereby self-committed narcotics addicts would no longer be dealt with as prisoners, but as patients to be cared for by the department of hospitals. Apart from the department of correction, the city magistrates' courts, the courts of domestic relations, the courts of special sessions and the county courts provide an extensive system of probational investigation and supervision. There is also a city parole commission whose jurisdiction extends to prisoners given indeterminate sentences by the city courts and the parole officer assigned to each offender retains supervision for three years. A large number of private agencies also deal with correctional problems.

Public Water Supply.—In the early years, the water supply of New York was derived from wells, streams and ponds. In 1[illegible] the Manhattan company was incorporated ostensibly to supply the city with water but, under a clause in its charter, devoted itself primarily to the banking business. In 1834 the legislature authorized the city to begin the necessary works to bring water from the Croton watershed more than 30 mi. N., and the first Croton water was delivered to the city in 1842 through the Croton aqueduct. In 1883 a new Croton aqueduct was authorized and thus additional water became available in 1890. In 1905 the board of water supply was created and work was begun on a new system to bring

water from the Catskill mountains, more than 100 mi. N. This commission developed an additional water supply from the Esopus and Schoharie watersheds with a total dependable yield of about 500,000,000 gal. daily flowing through the Catskill aqueduct which delivers its water just north of the city line into Hill View reservoir in Yonkers, having a storage capacity of 900,000,000 gal. A new construction program to draw water from the Delaware river, begun in 1936, was planned by the board in three stages. The first stage, comprising the Rondout and Neversink reservoirs and the Delaware aqueduct, began contributing to the city's water supply in 1944. The second stage began to contribute its water in 1955. The third stage of the Delaware system commonly is known as the Cannonsville project. The three stages together were planned to yield an additional 920,000,000 gal. daily. A drainage area of 1,700 sq.mi., greater than the entire land area of Rhode Island, is required for the city's water-supply system.

Sanitation.—A department of sanitation was created in 1929, consolidating five separate borough departments into one division of street cleaning. In 1933 the three-member sanitation commission was replaced by a single commissioner. In Oct. 1955 the city undertook its largest crusade against litter. In 1958 a related drive against "litterbugs" was begun which used both education of the public and a rigorous enforcement of the sanitary code. The department, aided by other departments and agencies, summoned violators.

Public Works.—The department of public works also is directed by a commissioner. The department has charge and control of planning, construction and repair work of all structures, buildings and other public works paid for wholly or in part by city funds and is charged with maintaining and operating them. It also has charge of sewers and sewage-disposal plants. Under its jurisdiction are public buildings of every description, including city hall, bridges, court buildings, hospitals, health centres, parking facilities and libraries. The city has been engaged in a vast sewage-disposal program to eliminate the pollution of its harbours for many years. An engineering bureau was established in 1930 to tackle this problem and in 1938, under the new charter, it came under the department of public works. The early bureau commenced work on the Ward's Island plant, and completed the Coney Island plant, giving the city its first modern sewage-disposal plant in 1935. Within five years three additional plants had been completed and put into operation: Ward's Island plant, Tallmans Island plant and a part of the Bowery bay plant. In 1948 this program was given additional impetus when the Interstate Sanitation commission stipulated that all sewage pollution of waters within its jurisdiction should end by Dec. 1959. The department has undertaken a refuse-disposal program in conjunction with the sanitation department which involves the construction of new incinerators, new marine transfer stations, marine unloading stations, the modernization of older incinerators and the improvement of transfer stations.

Postal Services.—The post office of New York city in 1827 was located in a small two-story frame building on Garden street (now Exchange place) and the entire force consisted of about eight clerks and six letter carriers. In 1869 the city hall post office at Park row and Broadway was the main post office. It was razed in 1939. In 1914 a new general post office building was opened on Eighth avenue from 31st to 33rd streets, containing 500,000 sq.ft. of floor space. The transportation of mails is expedited by means of an underground pneumatic-tube system consisting of 27 mi. of double-line eight-inch tubes with a carrying capacity of approximately 200,000 pieces of mail per hour.

City Planning and Zoning.—The Greater New York charter adopted in 1898 provided that the responsibility for laying out street systems should be primarily vested in the borough presidents, with specific approval resting on the board of estimate and apportionment and independent approval by the mayor for changes in plan. In 1903 the board of aldermen created an improvement commission; in 1913 a heights-of-buildings commission was created. The latter led to the building zone resolution of 1916 which regulated the height and bulk of buildings thereafter erected and the boundaries for trades and industries. The charter adopted in 1936 provided for a city planning commission. This body was charged with the preparation of a master plan for the future development of the city. It is responsible for completing and maintaining the city map; zoning changes; the preparation of a capital budget and a five-year capital improvement program; the approval of assessable improvements; and the selection and acquisition of land for streets and sites for large public improvements. In 1958 the commission initiated plans for urban renewal and in 1960 the stage was set for the final plan for the West Side Urban Renewal project.

Public Markets.—The department of markets supervises and controls public markets, pushcarts, indoor and outdoor street markets and terminal markets to assure adequate distribution of food, purity of content and protection from profiteering and fraud; it issues market and pushcart permits; it supervises the manufacture and sale of ice; it inspects weights, measures and scales; and it provides consumers with price information.

The city's chief wholesale markets are the Bronx terminal, the New York city live-poultry terminal in Queens, the Gansevoort market meat centre, the Peck Slip in Manhattan and the Brooklyn terminal markets. In addition, there are a few pushcart or street markets, a picturesque remainder and feature of the city's congested foreign districts.

COMMERCE AND INDUSTRY

Harbour.—During the second half of the 20th century the port of New York was the busiest in the U.S., averaging more than 25,000 ship arrivals and departures annually. New York's harbour is naturally divided into several parts. At the entrance from the Atlantic is the outer harbour (about 122 sq.mi.), known as Lower bay. Raritan bay lies adjacent to the Lower bay on the west and the Raritan river and the Kill van Kull flow into the west side of Raritan bay. The Ambrose channel is the chief of several channels crossing the broad bar at the entrance to the outer harbour. It leads northwestward and then northward into the inner harbour through the Narrows, a neck about 1 mi. wide between Long Island and Staten Island. The inner harbour consists of the Upper bay, 4 mi. long and 4 mi. wide, the lower Hudson river, the East river, Long Island sound and tributary waterways. Anchorage channel, an extension of Ambrose channel, extending through the Upper bay to the mouth of the Hudson river at the Battery, affords a depth of 40 ft. at mean low water for a width of 2,000 ft. Within the port are 42 channels, from 38 to 45 ft. deep.

The port of New York has a total length of developed frontage measured around piers and shore lines of about 755 mi., with about 460 mi. in New York and 295 mi. in New Jersey. The harbour has two northern entrances: the northeast entrance from Long Island sound by the East river, principally used by New England coasting vessels; and the North (lower Hudson) river, by which the inland water-borne traffic of the Hudson river and Erie canal is brought to the port of New York. There are nearly 400 vessel berths in the port. In the second half of the 20th century the ocean-borne foreign trade passing through the port, in terms of general cargo, was more than 13,000,000 long tons and in terms of bulk cargo, more than 27,000,000 long tons annually.

In 1921 the states of New Jersey and New York adopted the principles under which the Port of New York authority was established; its purpose was to co-ordinate the terminal, transport and other facilities of commerce in and about the port of New York. This agency and the department of marine and aviation operate most of New York city's port facilities. Most of the docks are controlled by the latter; most terminal, transport and other facilities are controlled by the former. The area of the port of New York district within the jurisdiction of the port authority is about 1,500 sq.mi., extending from below Sandy Hook on the south to Tarrytown on the north. The Holland vehicular tunnel, opened in 1927, was brought under the port authority's control in 1930. The Lincoln vehicular tunnel was opened in 1938. (*See* also PORT.)

Banking, Exchange and Insurance.—New York city, the headquarters of major enterprises and of professional, executive

and managerial personnel, is the nation's executive capital. At the same time, it is the financial capital of the world. From the beginning of the city's history, the financial district of New York has been at the end of Manhattan Island, below Fulton street. The largest banks and trust companies, the exchanges and many insurance headquarters are there as are the New York Stock and American Stock exchanges, the Coffee and Sugar exchange, the New York Cocoa exchange, the New York Cotton exchange, the Maritime exchange, the New York Produce exchange and the Commodity exchange. In 1784 Alexander Hamilton wrote the constitution for the Bank of New York, the first to be established in the city and in operation five years before the U.S. constitution was adopted. The first bank of the United States was established in 1791, and a branch known as the office of discount and deposit was opened in New York in the same year. The Bank of the Manhattan company, in which Aaron Burr was interested, was the third bank to be organized in the city and its charter is notable as being the first to enable a public utility company to engage in banking.

The subtreasury of the United States, formerly on Wall street, was abolished in 1914. On Feb. 21, 1940, it became a national monument—Federal Hall memorial. A part of the functions of the subtreasury is carried on by the U.S. assay office at 32 Wall street. The New York clearinghouse, located on Cedar street, was established in 1853. Bank clearings in the second half of the 20th century have been exceeding more than $600,000,000,000 annually. New York is the centre of federal reserve district no. 2. The New York Stock exchange has more than 1,300 members. The American Stock exchange was formerly an open-air market for unlisted securities. It is now housed in its own building at 78 Trinity place, completed in 1921. In Jan. 1953 the exchange took its present name and dropped its former title of New York Curb exchange.

Wholesale Trade.—New York city, the largest wholesale trade centre in the U.S., employs more than 300,000 persons in wholesale establishments. The total wholesale trade conducted amounted to more than $45,000,000,000 annually in the second half of the 20th century.

The clothing industry is chiefly centred in Manhattan, between Washington square and 42nd street, and in cross streets between Seventh avenue and Broadway. Silk establishments have two principal centres, one bounded roughly by 23rd and 34th streets and Third and Fifth avenues; the other, on or adjacent to Broadway between Canal and Eighth streets. Fur establishments are sharply localized between Broadway and Eighth avenue and 26th and 30th streets. The millinery business has moved to a centre between Broadway and Fifth avenue above 34th street. Boot and shoe establishments are almost exclusively in lower Manhattan between Broadway and West Broadway below Canal street. Jewelry, formerly concentrated in and about Maiden lane, later became distributed in smaller groups between Maiden lane and 50th street along Broadway and Fifth avenue, with large and growing centres at and about the intersection of Canal street and the Bowery and on 47th street between Fifth and Sixth avenues. Fruit and produce markets are centralized in Manhattan between Canal and Cortlandt streets and West Broadway and the North river. The fish, butter, egg and cheese markets are highly concentrated on the lower west side between Harrison and Greenwich streets and meat establishments centre at West 14th street and the North river. The coffee, tea and spice markets are mainly in a small area on the lower east side about Water and Front streets. Hardware houses are west of Broadway, between Houston and Fulton streets; paper and stationery are much more widely scattered than formerly, largely because of the uptown movement of printing and publishing establishments, one great centre being at or near Park row and the other in the neighbourhood of the main post office about 34th street. Drug establishments are chiefly in lower Manhattan, while leather dealers are just below Brooklyn bridge.

Retail Trade.—The retail trade has followed the northward movement of the population. In 1850 it was at Canal street and by 1880 at 14th street. By mid-20th century it was between 31st and 59th streets, and Third and Eighth avenues. Fifth avenue was formerly exclusively residential but later was given up to retail trade as far north as 60th street. Beyond that a zoning ordinance reserved Fifth avenue for residence. Some of the largest department stores are on 34th street and the greatest volume of trade is done there. But the northward trend of the residential section affected the character of the trade, and the more expensive shops, including some of the oldest retail firms, are farther up Fifth avenue. Madison avenue, because of its situation between Park and Fifth avenues, rapidly took on the aspect of the latter, and is lined with shops from 42nd street to 84th street. The art and antique dealers are on 57th and adjacent streets and also on Madison and Lexington avenues. There are a number of small antique shops on Eighth street. Automobile houses are near Columbus circle and up Broadway from 55th street for more than ten blocks. Brooklyn and the Bronx have important shopping and financial districts of their own. The growth and decentralization of population precipitated a trend among large department stores toward building branches of their stores in suburban areas of the city and in many cases in the neighbouring counties. In the second half of the 20th century retail trade establishments had an annual sales volume of more than $9,000,000,000.

Building Construction.—More than half of the city's homes and apartments were less than 50 years old and were built in three great waves of housing construction since 1921. Vast projects, such as Stuyvesant Town, Cooper Village, Parkchester, Fordham Hill and Fresh Meadows, have been constructed with funds supplied by large institutional investors. In addition, two large-scale urban renewal projects for the development of municipally sponsored modern industrial parks to aid industry have been undertaken on former slum sites. From 1958 there has been a marked increase in private-enterprise housing built with the aid of federal, state or city government.

Modern building construction in New York dates from the erection of the ten-story Tower building in 1889. The loftiest building in the world, the Empire State building on Fifth avenue at 34th street, rises to a height of 1,250 ft. from the street level and has 102 stories. Rockefeller Center, the largest privately owned business and amusement centre in the United States, begun in 1931 and completed in 1947 with the addition of a new building to the group completed before World War II, covers almost 13 ac. between Fifth and Sixth avenues from 48th to mid-51st streets. There are 15 separate buildings and the 5 edifices of the western section of the centre comprise Radio City. From the end of World War II, New York city has experienced a phenomenal building boom resulting in nearly 150 new office buildings. Manhattan's midtown area especially has been the centre of this commercial office and skyscraper building renascence, with the downtown area assuming the secondary role. Several commercial offices and skyscrapers built after World War II include: Chase Manhattan (60 stories), Union Carbide and Carbon (52), Time & Life (48), National City Bank (43), Socony Mobil (42), Equitable Life (42), International Telephone and Telegraph (33), Produce Exchange (33) and Pfizer (32).

Laws affecting building in the city date back to 1647 and they dealt primarily with fire prevention. In 1867 a law dealing with fire prevention and ventilation was passed; in 1879 this law was amended so that no new tenement could occupy more than 65% of the lot and there had to be at least 600 cu.ft. of air space per person per room; in 1899 a new building code was adopted; in 1901 a tenement house law was enacted. In 1916 the city's first zoning ordinance was adopted regulating use, height and percentage of lot; and in 1929 the Multiple Dwelling law was passed superseding the act of 1901.

Manufacturing.—New York city is the leading manufacturing city in the U.S., a position it has held since 1824. In the second half of the 20th century the metropolitan area accounted for more than a fourth of the industrial production of the country's dozen largest industrial areas. At that time there were more than 35,000 manufacturing establishments in the city which employed nearly 1,000,000 persons. The ten leading manufacturing industries in terms of the number of workers employed were appar-

and other finished products; printing, publishing and allied industries; food and kindred products; electrical machinery; chemicals and allied products; fabricated metal products; textile products; machinery, excluding electrical; leather and leather products; and paper and allied products. Nearly 80% of the total manufacturing employment was in these industries.

TRANSPORTATION AND COMMUNICATION

Rapid Transit.—The problem of transportation and communication in New York city is unique not only because of the extraordinary concentration of people in certain areas at a given moment but also because of the narrow and elongated shape of Manhattan, and of the rapid growth and shifting areas of population that must be served.

The vast 237 route-mile city-owned rapid-transit system had its beginnings with the primitive steam locomotives that pulled cars along the Ninth avenue elevated railway, which opened in 1871 and extended slightly more than 3 mi. from Battery place near the southerly end of Manhattan to 30th street. The next decade witnessed its growth to 32.5 route-miles of track, forming four separate transit lines extending north and south on Manhattan. These lines were entirely private enterprises operated under perpetual franchises granted by the state legislature. For the next 20 years there were no extensions to the rapid transit lines on Manhattan, but some progress was made in other boroughs—the Third avenue "L" in Manhattan was extended into the Bronx across the Harlem river as far as 169th street in 1888, to 177th street by 1891, to Fordham road by 1901 and to its terminus at Bronx park by 1902. In Brooklyn the first elevated, the Lexington avenue line, was opened in 1885. This line was extended and other lines built until by 1900 the Brooklyn system had a route length of 62 mi. In 1902 the motive power of these elevated lines was changed from steam to electricity. In 1900 the first subway was planned and finally extended from the Bronx through Manhattan and under the East river to Brooklyn. This rapid transit system was a municipal undertaking. Between 1908–10 two tubes under the Hudson river connecting Manhattan with Hoboken and Jersey City and a connecting tube which extends up Sixth avenue from Cortlandt street to 33rd street were completed. In 1913 a new Lexington avenue line and the extension of the west side subway down Seventh avenue to lower Manhattan and then under the East river to Brooklyn were begun. A four-track subway on Broadway and Seventh avenue, Manhattan, extending through tunnels to Brooklyn and Queens was authorized at about the same time. In 1925 the city began building an independent subway system, the main unit of which, the Eighth avenue line, commenced operation in 1932. During the La-Guardia administration, many more miles of track were opened on the Independent subway and the new Sixth avenue line was completed. The Sixth avenue "L" was razed and buses rapidly replaced surface cars. Unification of the transit system of the city was accomplished in June 1940; through condemnation proceedings the city acquired title to "L" lines in Brooklyn and Manhattan which, with the exception of a part of the Third avenue line in the Bronx, were abandoned.

The New York City Transit authority administers the largest municipally owned transit system in the U.S., comprising a total mileage of nearly 800 mi. The subway division is divided into three systems; the Interborough Rapid Transit, the Brooklyn-Manhattan Transit and the Independent system.

Railroads.—The New York Central and the New York, New Haven and Hartford railroads have a common terminal in Manhattan (Grand Central terminal), at 42nd street and Park avenue; and the Pennsylvania has its terminal at 32nd street and Seventh avenue, with tunnels to Long Island and New Jersey. The Pennsylvania terminal is used also by the Long Island railroad, which has its own terminal at Atlantic and Flatbush avenues in the borough of Brooklyn. The other railroad terminals are on the New Jersey bank of the Hudson and are reached either by tunnel, ferry or subway.

Streets.—The first comprehensive street plan was the Randel plan, drawn up by John Randel, Jr., in 1807. By 1811 the plan was in effect, and with a few changes, notably the laying out of Madison avenue, midway between Fourth and Fifth avenues, north of 23rd street, and Lexington avenue between Third and Fourth avenues, north from 21st street, this is now the street plan of Manhattan as far north as 155th street. The 120,000 population at that time was concentrated south of Houston street. The plan provided straight line "avenues," with a uniform width of 100 ft. extending longitudinally along the island and separating block lengths ranging from 610 to 920 ft. At right angles thereto, "streets," usually 60 ft. wide, were laid out separated by a block depth of 200 ft. The plan included the extension of Broadway, which has a general direction diagonally across Manhattan to 79th street, whence it parallels the other avenues. The rapid growth of the city and the ever-increasing use of motor vehicles produced serious traffic congestion in many sections of the city and this necessitated extensive street widening and the development of new thoroughfares.

The Port authority operates the bus terminal, plus two motor truck terminals, one in New York and the other in Newark, and the Union Inland terminal in Manhattan.

Notable accomplishments in the city's highway system have been the West Side highway, a 13-mi. nonstop drive from one end of Manhattan to the other that connects directly onto the Henry Hudson parkway in the Bronx and finally with the Westchester county parkway system in Yonkers; the Franklin D. Roosevelt (East river) drive, a nonstop drive from the Battery to 125th street and then into the Harlem river drive; and the Major Deegan expressway that runs the length of the Bronx and connects the Triborough bridge with the New York State thruway. Other improvements have been the 3-mi. viaduct on the Jersey side of the river, leading from the Holland tunnel to the main highway to Trenton; the extension of the Hutchinson river parkway, the Henry Hudson parkway and the Bronx river parkway, extending for 15 mi. through Westchester county; the bridges and highways in the Triborough bridge project, opened in 1936; and the Belt parkway, primarily a three-lane superhighway, which from the Brooklyn-Manhattan tunnel rims the boroughs of Brooklyn and Queens for a distance of more than 40 mi.

The more notable streets include Wall street, on lower Manhattan, the centre of the financial district; Fifth avenue, with its fine shops, clubs, library and museum; Riverside drive, overlooking the Hudson; Park avenue, which continues as Fourth avenue above 32nd street to the Grand Central terminal and then from 45th street to the Harlem river, and is lined with fine apartment houses and office buildings in the middle section up to 96th street; the Bowery, which runs diagonally through the east side of lower Manhattan from the Brooklyn bridge to meet Fourth avenue at Eighth street; and Broadway, which extends more than 18 mi. from the southern tip of Manhattan to the northern limits of the city. In its middle part, from 10th to 79th streets, Broadway cuts through the heart of the business and amusement district. From 34th street to Columbus circle at 59th street it forms the centre of the automobile, theatre, moving picture, restaurant and nightlife sector.

Bridges and Tunnels.—There are eight bridges spanning the East river. One, completed in 1951, links the east Harlem area with a large playground and park on Ward's Island. The Brooklyn, Manhattan and Williamsburg bridges are suspension bridges and connect Manhattan with Brooklyn. The Brooklyn bridge, the first to span the East river, was opened in 1883. The Williamsburg bridge was opened in 1903, the Queensboro bridge in 1909 and the Manhattan bridge the same year. The Hell Gate bridge over the East river is exclusively for railroad traffic. The Triborough bridge over the East river, opened in 1936, actually consists of three bridges connected by several long viaducts over land, its arms extending into Manhattan, the Bronx and Queens. The vertical lift bridge between Randall's Island and Manhattan is one of the largest of that type in the country. The Bronx-Whitestone bridge, opened in 1939, connects the Bronx with Queens, as does the Throgs Neck bridge, opened in 1961.

The George Washington bridge, crossing the Hudson river, extending from a point near 178th street, Manhattan, to Fort Lee,

N.J., was opened in 1931 and is one of the longest suspension bridges in the world. A second deck below the original deck was opened to traffic in 1962.

The two-deck Verrazano-Narrows bridge between Brooklyn and Staten Island was opened in 1964.

The Harlem river is traversed by 13 bridges of various types and designs. The most notable is the famous High bridge (1848), which carries an aqueduct of the city's Croton water supply, and which was rebuilt in 1928 to remove impediments to navigation.

Transportation of passengers by rail between the boroughs of Manhattan, Brooklyn, the Bronx and Queens and New Jersey is provided by means of tunnels constructed below the beds of the East, Hudson and Harlem rivers. Vehicular transportation between Manhattan and Jersey City was made possible by the opening of the Holland vehicular tunnel in Nov. 1927. In Dec. 1937 the Lincoln tunnel, connecting 39th street in Manhattan with Weehawken in New Jersey, was opened. A third tube was added to this tunnel in 1957 making it the only triple underwater tunnel in the world. The Queens Midtown tunnel, finished in 1940, connects Manhattan on the east side at 36th and 37th streets with Long Island city. The Brooklyn-Battery tunnel was opened in 1950. This twin-tube 11,000-ft. structure was the longest underriver ventilated vehicular tunnel in the country at the time of its completion. It connects the southern tip of Manhattan with Gowanus parkway, which branches into the Belt system or into downtown Brooklyn. The Pennsylvania railroad has four tubes across the East river and two across the Hudson, and the Hudson and Manhattan railroad has two systems, each comprising two single-track tubes from Jersey City. The Brooklyn-Manhattan Transit system has six rapid-transit tubes under the East river, laid in pairs, and the Interborough Rapid Transit system also has three pairs of transit tubes leaving Manhattan.

Practically all of the railroad and rapid-transit tunnels were completed between 1900 and 1920. In connection with the Independent subway system, the board of transportation designed five new tunnels, four of which were opened for service in 1933 and one in 1936.

Ferries.—There were 11 ferries operating from New York city in the early 1960s. Four operated from City Island, the Bronx, to Hart Island; from the Battery, Manhattan, to St. George, Staten Island; from East 134th street, the Bronx, to North Brothers and Rikers islands; from 69th street, Brooklyn, to St. George. Others were operated by railroads, private companies and the federal government. The Staten Island ferry ride is one of the city's recreational features, offering a ten-mile, one-hour round trip through the New York harbour, and affording a view of the city's sky line, the Statue of Liberty and Governors Island.

Airports.—In 1947 four major airports in the metropolitan area were combined into a single integrated air-terminal system under the control of the Port of New York authority. These were the LaGuardia airport in Queens; the New York International airport at Idlewild in Queens, renamed the John F. Kennedy International airport in 1963; Newark airport in Newark, N.J.; and Teterboro airport in Teterboro, N.J. In addition, the authority operates the West 30th street heliport which was opened in 1956.

Telephone and Telegraph.—Between 1950 and 1960, the number of telephones in the city increased by more than 1,000,000 to make a total of more than 4,000,000. The volume of telegraph traffic is so great that the company operating the system designated the New York city area as a separate division. There are approximately 115 mi. of cable under the streets of Manhattan, used to speed distribution of local telegraph traffic. These cables are all concentrated in a relatively small area of 3 sq.mi. and there are entrances to approximately 1,000 buildings in the financial and midtown area.

International communications services are provided by coaxial and conventional underwater cables and landlines, radiotelegraph circuits, radiotelephone circuits and ship-to-shore radiotelegraph.

EDUCATION AND CULTURAL ACTIVITIES

Public-School System.—The public-school system is administered by a department of education of nine persons appointed by the mayor. The chief executive officer is the superintendent of schools, who is elected by the board for a term of six years.

The board of education has created the "600" schools for maladjusted students and those presenting disciplinary problems and has pioneered in the education of the gifted. Serious problems include the absorption of the numerous Puerto Rican children into the schools and the integration of Negro pupils into predominantly white schools.

Higher Educational Facilities.—The city provides higher educational facilities through the City University of New York (formerly College of the City of New York), which comprises City college, Hunter college, Brooklyn college and Queens college. City college was established as the Free academy in 1847. A modern structure in lower Manhattan houses its business school. Hunter college was founded in 1870 as the "normal and high school." In addition, New York is the seat of Columbia university (*q.v.*) and New York university, which was founded in 1831. In 1835 it moved to Washington square and in 1891 added a site of about 48 ac. on University heights in the Bronx. Fordham university was founded in 1841 as St. John's college. In 1846 it was turned over to the Jesuits and incorporated. The name was changed to Fordham in 1907. It is situated in the Bronx. Long Island university is in Brooklyn. In 1928 Yeshiva university (Jewish) was opened and it occupies buildings of ancient Semitic architecture in upper Manhattan. Among the professional schools are: the General Theological seminary (Protestant Episcopal); Union Theological seminary (Presbyterian); Jewish Theological Seminary of America; Cornell university medical college; Brooklyn law school; the Institute of Public Administration; the New School for Social Research; and the professional schools of the various universities. The chief technical institutions are the Mechanics institute, founded in 1820; Cooper Union (*q.v.*); and Pratt and Polytechnic institutes, both in Brooklyn. The State University of New York Maritime college is at Fort Schuyler in the Bronx.

In 1956 New York city and New York state combined to establish the Staten Island Community college offering either a two-year course in the liberal arts or a two-year program in varied categories of technical training. The Bronx Community college was founded in 1957 and the Queensborough Community college opened its doors in 1960. These three colleges are sponsored by the New York city board of higher education under the program of the State University of New York. Under the related city-state community college plan are two two-year colleges, the Fashion Institute of Technology and the New York City Community College of Applied Arts and Sciences.

Libraries.—The first public library in New York was the New York Society library, founded in 1754 in the city hall. It remained at the city hall until 1795 and was the library of congress when New York was the nation's capital. Other libraries are the Columbia university library (1754), that of the New York Historical society (1804) and the Mercantile library, founded in 1820 by merchants' clerks. The municipal library system consists of the New York Public library, serving Manhattan, the Bronx and Richmond; the Brooklyn Public library and the Queens Public library. There are also numerous college, university and important special libraries in the city.

Art and Architecture.—Augustus Saint-Gaudens is represented by his "Peter Cooper," the equestrian statue of Sherman, the Admiral Farragut statue, the bronze relief of the Rev. Henry W. Bellows and other works; John Quincy Adams Ward, by the "Pilgrim," "Shakespeare," "Indian Hunter" and a monumental bronze "Washington"; Frederick W. MacMonnies, by his "Nathan Hale," "Civic Virtue," "Horse Trainers and a Quadriga"; Daniel Chester French, by the "Alma Mater"; George Grey Barnard, by a fountain at Columbia; Karl Bitter, by "Abundance" and an equestrian statue of Franz Sigel; Anne Hyatt, by "Jeanne D'Arc"; Bartholdi, Kirke Brown, by an equestrian Washington; F. Auguste Bartholdi, the French artist, by "Lafayette"; H. P. Proctor, by a bronze group of panthers; and Edward Kemeys, by "Still Hunt." On the front of the Public library is a statue by Paul Bartlett. A group by Albert Weinter depicting the purchase of Manhattan Island is in the city hall of records. On Liberty Island the Statue of Liberty

by Bartholdi, a gift of France on the 100th anniversary of American independence, rises 305 ft. above the harbour. (*See* LIBERTY, STATUE OF.) Modern U.S. sculpture is well represented by the works of such men as William Zorach, Jo Davidson and Isamu Noguchi.

The largest collection of art objects in America is in the Metropolitan Museum of Art. Other museums of importance are the Whitney Museum of American Art, which exhibits works of U.S. artists, the Museum of Modern Art, and the Solomon R. Guggenheim museum, housed in a building designed by Frank Lloyd Wright.

Aside from the public museums, among the important art galleries is that of the Associated American Artists. The Cloisters in Fort Tryon park, a branch of the Metropolitan Museum of Art, was a gift of John D. Rockefeller, Jr. It contains an outstanding set of Gothic tapestries, "The Hunt of the Unicorn."

A few striking examples of 18th and early 19th-century architecture remained in the 1960s, notably St. Paul's chapel, designed by MacBean and built in 1764; the old church of St. Mark's-in-The-Bouwerie, completed in 1799; and city hall, the work of Joseph F. Mangin and John McComb, Jr., completed in 1812. James Renwick designed the Gothic Grace church, completed in 1845, and St. Patrick's cathedral, which was built between 1858 and 1879. After the Civil War Richard M. Hunt, a graduate and teacher in the Paris School of Fine Arts, began his American career. Among his first works were the Astor and Gerry houses and the old *Tribune* building. Charles F. McKim, William R. Mead and Stanford White were designers of the old Madison Square Garden, the Washington arch and the Metropolitan club. R. H. Robertson is known for his work on the American Tract Society and United Charities buildings. John Carrère and Thomas Hastings planned the National Academy of Design and the New York Public library; H. I. Hardenburg, the Waldorf, Savoy and Manhattan hotels and the American Fine Arts building; and Ernest Flagg, the Singer building, St. Luke's hospital and the Scribner building.

Since 1945 there has been an office building boom. Several of these structures and skyscrapers have been innovational from an architectural point of view. Conspicuous among these have been the United Nations group, the Seagram, 260 Madison Avenue and Manufacturers Trust Company (with its unbroken glass façade) buildings, Lever and Canada houses and the New York coliseum.

Music.—In the first quarter of the 19th century, the Park theatre became a famous stage for dramatic and musical art. In the 1840s and 1850s the musical centre was Tripler hall on lower Broadway, which became Metropolitan hall in 1854 and then, following its destruction by fire shortly afterward, was rebuilt and rechristened the New York theatre and Metropolitan Opera house. Later its name was changed to the Winter Garden. The present Metropolitan Opera house was built in 1883. In the latter half of the 19th century several other large halls for musical recitals were opened, notably, Steinway, Chickering, Hardman and Carnegie halls.

In the 20th century there has been a growth of interest in all forms of musical activity. Typical of this were the Lewisohn Stadium concerts, performed by the New York Philharmonic-Symphony orchestra and distinguished soloists before large audiences in the City college stadium. Besides the Metropolitan Opera company, opera was represented in New York city by the New York City Opera company at the City centre. Ground was broken in 1959 for the Lincoln Centre for the Performing Arts, part of the Lincoln Square development, and its Philharmonic hall was dedicated in 1962.

Literature.—Cadwallader Colden, author of the *History of the Five Nations* (1730), was perhaps the first New York author of general reputation. The first authors' club, the Ancient Club of New York, was founded in the latter part of the 18th century and later included among its members Washington Irving, Fitz-Greene Halleck, James Kirke Paulding and Joseph Rodman Drake. A little later John James Audubon, Richard Henry Dana, James Fenimore Cooper, Edgar Allan Poe, William Cullen Bryant, Herman Melville, John Bigelow, Julia Ward Howe and Robert Bonner were members of New York's literary life. In the 19th century the Bread and Cheese club brought together a most creditable group of writers. In the early 1920s Greenwich Village (*see* below) became the centre of American letters. During this period Edna St. Vincent Millay, Eugene O'Neill and Theodore Dreiser, among many, made this part of New York their headquarters.

The chief society of authors having headquarters in New York is the American Academy of Arts and Letters. Other notable literary organizations are the Authors' guild, Grolier club and Century association.

Theatres.—The first dramatic performances in New York were probably those given in a building on Pearl street by a company of actors from London in 1732. Another company from London came to New York in 1749. The real beginning of the permanent theatre in New York was, however, in 1750, when a company under the management of Thomas Kean and Walter Murray came from Philadelphia and established themselves in a house on Kip street (now Nassau), between John street and Maiden lane. Lewis Hallam arrived in 1753 from Virginia and erected a theatre in Nassau street, the first building constructed for theatre purposes, and opened it in 1753 with *The Conscious Lovers* and *Damon and Phelleda*. The first performance of *Romeo and Juliet* in New York was given at this theatre in 1754 with Mrs. Hallam as Juliet. This theatre was abandoned the same year and was converted into a church by a society of Calvinists. The next theatre was at Crugers wharf on the East river and was opened by David Douglass in 1758 with *Jane Shore*. Douglass also opened another theatre at the corner of Nassau and what is now Beekman street in 1761 with *The Fair Penitent* and later gave the first performance of *Hamlet* in New York; he also established the John Street theatre in 1767. In 1789, the first professional play by an American playwright, *The Contrast*, by Royall Tyler, was produced there.

In 1798 a three-story stone theatre, the Park, was built between Ann and Beekman streets on Park row, for Hallam and John Hodgkinson. This building was magnificent for its time, costing about $180,000. In 1837 New York had five theatres: the Park, Bowery, Olympic, Chatham and Richmond Hill. Palmer's Opera house was built in the 1840s as was the Astor Place Opera house, where the Astor Place riot occurred as the result of a dispute between friends of the U.S. actor Edwin Forrest and his English rival William Macready. Twenty-two persons were killed and 36 were wounded by the militia called to quell the disturbance. In 1850, P. T. Barnum brought Jenny Lind to the U.S. for a series of concerts which began at Castle Garden at the Battery. Similar "pleasure gardens" as Niblo's, the New York, Cold Springs, East River, Vauxhall and Ranleagh were utilized for concerts and other performances for which the capacity of theatres was inadequate. The Crystal palace at Sixth avenue and 42nd street was also a great amusement centre in the early 1850s.

By the middle of the 19th century the theatrical district was well established in the neighbourhood of Union square. The Academy of Music, the Union Square, Irving Place and Wallack's were the chief theatres in this area. By 1870, 23rd street had become the upper limit of the theatrical centre, with the Fifth Avenue theatre and Booth's. Ten years later the theatres had invaded the lower 30s with Daly's, the Standard, Wallack's and the Casino. In 1883 the erection of the Metropolitan Opera house at 39th street started an invasion of the 40s and by the end of the century, 42nd street had become the real centre of the theatrical district.

The modern theatre district comprises roughly a strip of Manhattan extending from 41st to 53rd streets, and from Fifth to Eighth avenues.

Scientific Collections and Learned Societies.—Chief of the scientific collections is that of the American Museum of Natural History. The Hayden planetarium is a part of this museum. The zoological park in Bronx park is under the control of the New York Zoological society. The botanical garden in Bronx park occupies about 400 ac. The museum contains a library, collections with about 1,800,000 specimens and research laboratories. The Brooklyn Institute of Arts and Science maintains another large botanical garden.

The Hispanic Society of America, founded by Archer M. Hunt-

ington, maintains an excellent museum of Spanish and Portuguese paintings, manuscripts, maps, coins and antiquities. Other interesting collections are in the museum of the American Numismatic society and the American Museum of Safety (industrial safety appliances).

The New York Historical society, the Long Island Historical Society of Brooklyn, the New York Genealogical and Biographical association, the Museum of the City of New York, the New York Academy of Medicine and the Academy of Political Science also deserve mention.

(For New York city press data *see* NEWSPAPER. For foundations *see* FOUNDATIONS, PHILANTHROPIC, etc. For museums *see* MUSEUMS AND GALLERIES.)

Clubs.—Club life in New York is less significant in the second half of the 20th century than in the earlier part of the century. The first social organizations of importance were the authors' Bread and Cheese club (1824) and the artists' Sketch club (1829). It was not until 1836, however, that club life in New York really began with the founding of the aristocratic Union and Hone clubs. The Knickerbocker (1871) was popular among the descendants of original New York settlers. The St. Nicholas was formed a little later for those whose ancestors were early residents of the colonies.

The Metropolitan (1891), with its costly house, was in fact a protest against the exclusiveness of many of the older clubs. The Union League (1863) was established for the purpose of aiding the Union, and its first work was the organization of regiments of Negro troops. To offset this Republican influence, the Manhattan was organized in 1864 to advance Democratic ideals.

The chief sport and athletic clubs are the New York Yacht (1844), the New York Athletic (1868) and the Racquet and Tennis. Other important clubs with more or less specialized interests are the Camera, Century, City, Colony, Engineers, Explorers, Harvard, Lambs, Yale, Lawyers, Lotos, Players and Salmagundi clubs.

Churches.—The Dutch Reformed church (1628), the first church in the city, is known as the Collegiate Church of New York city. The Presbyterians organized there as early as 1638 and were tolerated by the Reformed Church, but it was not until the English occupancy that they made their influence felt. In 1719 the first Presbyterian church was built in Wall street. It was not until 1847 that a Congregational church attained prominence in New York, when the Plymouth church of Brooklyn was founded with Henry Ward Beecher as pastor. In 1664 the Lutherans obtained permission from the English governor Richard Nicolls to establish a church. The first Lutheran church, at Broadway and Rector street, was destroyed in the fire of 1776. The Protestant Episcopal Trinity church was built in 1697 at Broadway and Wall street where Trinity church (1846) now stands. St. Paul's chapel (1766) at Broadway and Vesey street is the oldest church edifice in the city; Grace, St. Thomas', the Church of the Transfiguration, familiarly known as "The Little Church Around the Corner," and the Cathedral of St. John the Divine, at 110th street and Morningside avenue, are other notable Episcopal churches. The first Methodist church (1768) was erected in John street. The Baptists had built their first church on "Golden Hill," on John street between William and Nassau streets by 1728. St. Peter's (1785) was the first Roman Catholic church and in 1808 New York was made the seat of an Episcopal see. In 1858 the present St. Patrick's cathedral at Fifth avenue and 51st street was begun, and in 1879 it was dedicated.

PARKS AND RECREATION

The department of parks has two long-range objectives: the construction and rehabilitation of recreation plants and facilities, and the expansion of park acreage through reclamation. A consolidated department was established in 1934 and is directed by a commissioner appointed by the mayor. In all, in the second half of the 20th century, the park system consisted of more than 34,000 ac. Also under the jurisdiction of the department are public beaches, swimming pools and other recreational facilities ranging from archery to football fields and yacht basins.

Central park extends from 59th to 110th streets, between Fifth and Eighth (Central Park West) avenues. It was purchased in 1856 for about $5,500,000, and laid out and developed by architects Frederick Law Olmsted and Calvert Vaux. Van Cortlandt, Pelham bay and Forest parks are the largest generally devoted to outdoor sports and recreation. In Van Cortlandt park is the Van Cortlandt mansion, built in 1748 and now maintained as a museum. The Bronx park is noted for its zoological and botanical exhibits, the African veldt, opened in 1941, being one of its major attractions. Riverside park, in Manhattan, extends along the east bank of the Hudson river from 72nd to 129th streets, a distance of about three miles. City Hall park constitutes a part of what was called the "fields," or "commons," in the middle of the 17th century. Roger Morris park is the site of the Jumel mansion, the home of Mme Jumel, wife of Aaron Burr, and there Gen. George Washington made his headquarters during the battle of Harlem heights. In Audubon park was the home of the naturalist John James Audubon. Poe park, in the Bronx, is the site of the Edgar Allan Poe cottage, moved from its nearby original location.

Indoor recreation centres have been constructed with indoor pools; "golden age" centres are especially designed for older people; and a dance and concert schedule in the city's parks has been instituted; the Shakespeare workshop functions in Central park and the Wollman memorial alternates between square dancing and ice skating.

GREENWICH VILLAGE

Bounded on the north by 14th street, on the south by Spring street, running west from Broadway, Greenwich Village is a roughly triangularly shaped segment of New York city perhaps most commonly thought of as a home of American arts and letters. It is often associated with Bohemianism, radicalism, struggling artists and exotic night clubs and restaurants maintained chiefly for visitors. This atmosphere was a carry-over from the period before and after World War I, when the "Village" was locally considered the centre of the American literary and artistic renaissance. The Village has never relinquished its important role in the development of the experimental theatre and the off-Broadway theatre. The sidewalk art shows still persisted into the second half of the 20th century, and many artists still lived and worked in the Village, but the area was losing its uniqueness and early character before the impact of modern urban transformation. Some parts, however, still retained their former quaintness and charm. Southwest of Sheridan square and in the area west of the Avenue of the Americas was a maze of winding streets where could be found the age-worn dwellings erected by the burghers in the late 18th and early 19th centuries.

Elsewhere in the Village, other buildings were giving way to huge modern apartments and developments typical of a hundred other neighbourhoods. Houses and mews—converted stables with their interior gardens—that gave the Village its old-world look were rapidly being torn down. Washington square, at the foot of Fifth avenue, dominated by Washington arch, erected in 1892, was the last vestige of the dignity and taste of the early wealthy settlers who built there when Washington square was the centre of high society. Even the square, however, was gradually succumbing to the advances of the skyscraper apartments and New York university. In 1950 and 1951 the Rhinelander mansion and other fine old buildings along the northern border of the park were torn down. On the southern side of the park, "genius row," including the homes of some of the country's best-known artists and writers, had also disappeared.

See also references under "New York (City)" in the Index.

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NEW YORK, STATE UNIVERSITY OF, was established in 1948 to provide an adequate program of higher education for qualified youth of the state. It comprises about 50 separate, locally administered colleges throughout the state, almost half of them locally sponsored community colleges. *See* New York: *Education.*

NEW YORK FERN (*Dryopteris noveboracensis*), a beautiful North American fern of the shield-fern group, useful in the shady wild garden. While named after New York, it is native to a much greater region, occurring in moist woods from Newfoundland to Minnesota and southward to Georgia and Arkansas. The delicate pale green fronds, one to two feet high, rise on slender stalks (stipes) from widely creeping rootstocks. For general features of these and other ferns, *see* Fern.

NEW ZEALAND, an independent monarchical state and a constituent member of the Commonwealth of Nations, consisting of a series of islands in the southwest Pacific. New Zealand proper consists of the North Island (44,281 sq.mi.), the South Island (58,093 sq.mi.), Stewart Island (670 sq.mi.) and the Chatham Islands (*q.v.*; 372 sq.mi.). Within the political boundaries designated in 1842 and reaffirmed in 1863—from 33° S. to 53° S. and from 162° E. to 173° W.—are also: Campbell Island (44 sq.mi.); the islets of Snares, Solander and Bounty; Antipodes Island (24 sq.mi.) and Auckland Islands (*q.v.*; 234 sq.mi.); sometimes referred to as the minor islands or Subantarctic Islands. Off the North cape of the North Island are the Three Kings (3 sq.mi.). The Kermadec Islands (*q.v.*), annexed in 1887, lie 600 mi. N.E. of New Zealand.

The island territories administered by New Zealand comprise: (1) the Cook Islands (*q.v.*), which lie 2,100–2,800 mi. N.E. of New Zealand and include Niue, which is separately administered; these came under New Zealand control in 1901; (2) the Tokelaus (4 sq.mi.), which lie about 300 mi. N. of Western Samoa and in 1948 were declared to form part of New Zealand; they had a population in 1964 of 1,835. In addition, the Ross dependency (160,000 sq.mi.), that segment of Antarctica south of latitude 60° S. and between 160° E. and 150° W. longitude, was in 1923 brought under New Zealand jurisdiction. Western Samoa (1,097 sq.mi.) was administered by New Zealand from 1914 until it became independent in 1962. Together with the United Kingdom and Australia, New Zealand shares the trusteeship of Nauru Island.

Excluding the island territories and the Ross dependency, New Zealand has an area of 103,736 sq.mi. Territorial and administrative responsibilities extend from the south pole almost to the equator. Penrhyn, the most distant atoll in the Cook Islands, lies almost half way from Wellington (the New Zealand capital) to the North American continent.

This article consists of the following sections and subsections:

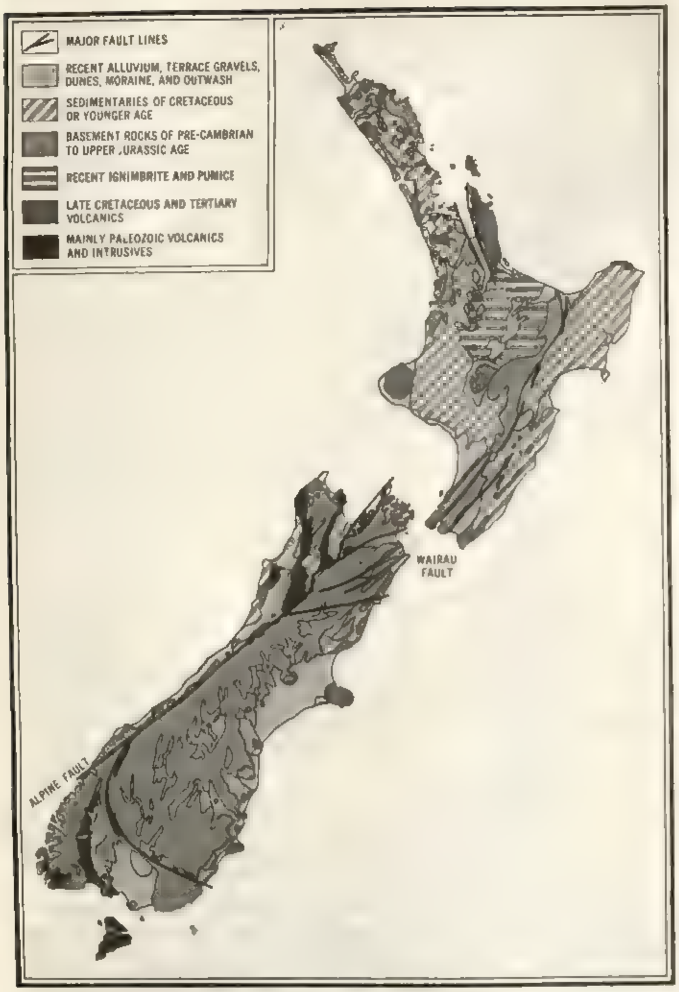
I. PHYSICAL GEOGRAPHY

1. Structure, Geology and Land Forms.—Structurally New Zealand is a section of the circum-Pacific mobile crustal belt, and forms the crest of a giant and unstable arcuate earth fold rising sharply from the ocean floor and paralleled closely eastward by a deep trough—the Hikurangi trench—which extends northeast into the Kermadec and Tongan deeps. The main islands are of youthful structure and recent origin. They assumed their present form and mountainous character as a result mainly of late Pliocene and Pleistocene diastrophism and mountain building. Contemporary earthquakes and active volcanism in New Zealand may represent the final stages in this relatively recent and catastrophic disruption of the Pacific's southwestern rim.

This period of mountain building followed prolonged, though interrupted, sedimentation dating from the late Cretaceous. The diastrophic disturbance began with gentle folding in the Oligocene, mounting gradually to a climax which, in some areas, was as early as the Miocene and elsewhere as late as mid-Pleistocene. The later phases of this "Kaikoura orogeny" were characterized by deformation and uplift through massive and widespread block faulting which, with the attendant volcanism, left a profound impression on the land forms and landscapes, creating what has been termed "a concourse of earth blocks." Active subsequent denudation has not destroyed, nor effectively masked, the structural and tectonic land forms created in a period of late Cretaceous, Tertiary and Quaternary diastrophism.

Rocks of varied age and composition occur in remarkable range and variety. But while the North Island lacks metamorphic and plutonic rocks and sedimentaries older than Permian, the South Island has a remarkable variety of metamorphic and intrusive rocks and a suite of sedimentaries ranging from possible Pre-Cambrian to Quaternary, though it lacks the North Island's spread and variety of younger volcanic rocks, ash and pumice.

The "undermass" consists of the stratified rocks of Jurassic or greater age, generally strongly folded and widely metamorphosed; the more altered rocks being unfossiliferous and their age uncertain. All were strongly folded between the Jurassic (a period of widespread deposition) and the upper Cretaceous, and were deeply eroded. The covering strata were deposited on the



K. B. CUMBERLAND

GENERALIZED GEOLOGY AND STRUCTURE OF NEW ZEALAND

eroded surface of the undermass and consist of weak sedimentaries of from upper Cretaceous to upper Tertiary and Quaternary age. Crustal deformation accompanied the deposition of the cover, intensifying until the Plio-Pleistocene peak of the Kaikoura orogeny. Both younger rocks and the undermass beneath them were first folded, later violently faulted and subsequently eroded. Much of the surface is now occupied by later accumulations—unconsolidated post-Tertiary gravels, sands and clays, volcanic ash and pumice sands. Taken as a whole, New Zealand derives its distinctive and varied scenery largely from the youthfulness of the structure, geology and land forms.

There are sharp contrasts between the two main islands. In the North Island, where hill country is much more characteristic than mountain landscapes, the surface most commonly consists of deep sandstones, siltstones and mudstones of late Cretaceous and Tertiary origin, much of it blanketed with late Quaternary volcanic debris. In the South Island, with its rugged and dominantly mountain terrain, the undermass is widely exposed.

The North Island.—Most of the North Island is hilly, its surface consisting of weak sedimentaries of the cover and later marine, alluvial and volcanic accumulations. Mountain landscapes and exposure of the island's old and hard skeleton are largely confined to the narrow, much fault-margined axial ranges extending northeastward from Cook strait in the Rimutaka, Tararua, Ruahine, Kaimanawa, Kaweka, Huiarau and Ikawhenua ranges toward the Bay of Plenty. Of Lower Mesozoic greywackes, these form a sharp divide between east and west. To the east, extending from Cape Palliser to East cape and including the structurally complex Raukumara peninsula, is the largest remaining accumulation of Upper Jurassic, Cretaceous, Tertiary and Quaternary sediments, consisting of greywackes, sandstones, siltstones, massive mudstones, bentonitic clays, thin limestones and conglomerates. In the late Tertiary the region was strongly folded on a northeast-southwest axis and the folds cut across by transcurrent (strike-slip, or lateral) faults still active; earthquakes there are as frequent as anywhere in New Zealand. Except for the gravel-floored Wairarapa lowland trough, the small alluvial Ruataniwha and Heretaunga plains (Hawke's Bay) and the Waipaoa flats in Poverty bay, the region is hill country, most of it steep and broken, much of it unstable and often affected disastrously by soil erosion and man-induced mass movement.

The other mountains in the North Island are the isolated Quaternary andesite cone of Mt. Egmont (8,260 ft. and active only 250 years ago) and the clustered active cones of Tongariro National park (Ruapehu 9,175 ft.; Ngauruhoe 7,515 ft.; and Tongariro 6,548 ft.). Between them, and extending from northern Taranaki to the western foot of the Tararua-Ruahine ranges, is steep and broken hill country deeply dissected by a close net of dendritic streams fed by heavy and regular rainstorms and cut into a great depth of near-horizontal blue-gray mudstones ("papa") and yellow-brown sandstones.

In the centre of the North Island is the volcanic plateau, or thermal belt, with the greatest expanse of Recent and Pleistocene volcanic materials in New Zealand and, between Tongariro National park and White Island, a concentration of contemporary volcanic activity. The underlying greywackes and the faulted structure of the undermass are hidden beneath great ignimbrite sheets of 2,000 cu.mi. estimated volume. The ignimbrite, or welded tuff, was probably formed by the consolidation and welding of hot rhyolitic fragments suspended in gas clouds from catastrophic Pleistocene eruptions in the Lake Taupo area. The faulted and dissected mesa-like surface of the ignimbrite is buried under layers of pumice which blanket and soften the surface over wide areas now widely planted with introduced forest trees.

From the rim of the volcanic plateau, the North Island projects northwestward in the North Auckland and Coromandel peninsulas. There the rocks and land forms are diverse and varied. Deformation is mainly the result of faulting and block tilting but several broad folds with north-south axes are discernible. The Hauraki gulf and Thames-Piako lowland are part of a fault-defined trough. The northern peninsulas have exposures of the greywacke basement and pocketed patches of Jurassic, Cretaceous and Tertiary sediments and Tertiary and Quaternary volcanics. The latter are often basaltic, as in the lower Waikato valley, on the Auckland isthmus and at Kerikeri. The volcanic rocks constituting the Coromandel peninsula and Great Barrier Island are largely andesites, dacites and rhyolitic lavas and tuffs of Miocene and Pliocene age. Both peninsulas have an irregular drowned coastline (with wide shallow embayments like the Manukau, Kaipara and Hokianga harbours) although in the north at Ninety Mile beach the sweeping west coast is smoothed and straightened by vast recent accumulations of sand.

The South Island.—Mountain terrains occupy almost three-quarters of the South Island. The Southern Alps, deeply fretted and glacially eroded, occupy the waist of the island and reach 12,349 ft. in the ice-capped peak of Mt. Cook. Farther north mountain terrains occupy almost the whole width of the island. There the Kaikoura and Seaward Kaikoura ranges parallel the main Spenser mountains and St. Arnaud range, separated by deep valleys cut along the tectonic lines of transcurrent faults. All these lofty folded and faulted mountain masses consist of undifferentiated (lower Mesozoic) greywacke—indurated sandstones and argillites. The belt of block-mountain horst and interspersed grabens across Otago from the outskirts of Dunedin to Mt. Aspiring (9,957 ft.) near the west coast is built of a great thickness of chlorite schists of doubtful late Paleozoic–early Mesozoic Age. The third mountain landscape, the ancient dioritic igneous block of Fiordland, consists of highly metamorphosed gneiss formed early from lower Paleozoic and possibly Pre-Cambrian sedimentaries. Fiordland is thus structurally and lithologically one of the oldest parts of New Zealand. It is essentially an ancient plateau mass with summits of 5,000–7,000 ft., into which Pleistocene glaciers have cut nearly vertically walled, thousand-foot-deep valleys, those

on the west having been since invaded by spectacular deep fiord incursions of the sea (Milford, George, Doubtful, Dusky and other sounds) and those on the east by moraine-dammed finger lakes and their tributary arms (Lakes Te Anau, Manapouri, Monowai, Hauroko and Poteriteri).

To the east the mountains descend to the sea along the coast of Marlborough, at Shag point (east Otago) and again in Southland west of Te Waewae bay. Elsewhere they give place to plains, low hills and downs. The largest lowlands are the Canterbury and Southland plains, the former extending more than 100 mi. from northeast to southwest (except where interrupted by the deeply eroded and sea-invaded twin late-Tertiary basalt domes of Banks peninsula) and as much as 40 mi. inland. The Canterbury plain, the largest land form of sedimentary origin in New Zealand, is an enormous and deep lens of gravel and sand worn from the greywacke Alps and deposited by swollen rivers as a series of gently-inclined piedmont alluvial fans. Other smaller alluvial plains of recent deposition have been built by the Wairau and Awatere rivers in Marlborough, by the Waitaki, by the Clutha in Otago and by the Waiau in Southland. Elsewhere remnants of the covering strata intervene between the highland and the plains or between the mountains and the east coast. In Marlborough, north Canterbury and south Canterbury-east Otago these remnants are principally of upper and lower Tertiary sedimentaries, maturely eroded into undulating hills and smooth low downland, often plowable.

In Southland, the angle between the schist block mountains of Otago and the lake-defined eastern margin of the Fiordland gneiss plateau is occupied by a syncline. On its northern flank Carboniferous, Permian and undifferentiated Paleozoic rocks extend in parallel bands across the country. Triassic and Jurassic rocks also occur more extensively than elsewhere in New Zealand; in the Hokonui hills are 30,000 ft. of steeply dipping Triassic and Jurassic strata in 90 separate beds. Small patches of the cover remain and, although Cretaceous rocks are few and thin, they include the important coal measures at Kaitangata, Ohai and Nightcaps.

The diverse mountainlands are abruptly terminated westward by the Alpine fault, the most prominent structural feature in the South Island. It extends for 300 mi. straight and unbroken, along the western foot of the Southern Alps from the mouth of Milford sound to Lake Rotoroa in Nelson district, whence it continues northeastward for another 90 mi. in the Wairau fault to Cook strait near Blenheim. West of the fault lie the narrow Westland plain and the geologically complex and inaccessible mountain country of Nelson. The narrow coast strip of Westland, where the Fox and Franz Josef glaciers, though retreating, still extend in subtropical forest to within a few miles of the coast, is an irregular dump of glacial and alluvial materials, which almost hides the oldest rocks in New Zealand. These, unfossiliferous and possibly Pre-Cambrian greywackes and argillites, granitic batholiths and gneiss, occur as broken hill country in south Westland and as foothill spurs of the Alps. In north Westland, Cretaceous and Tertiary sediments, including Coal Measures, form part of the cover. There, too, is the distinctive red-coloured, uranium-bearing Hawk crag breccia. In Nelson, geologically the most interesting part of New Zealand, occurs a great syncline with rocks closely matching those of Southland. In the Marlborough sounds block west of the Wairau fault, a sequence of Paleozoic schists, Trias-Jura greywacke, Carboniferous and Permian sediments, deeply dissected, plunges northward into Cook strait to produce an intricate ria coastline.

2. Rivers, Lakes and Hydrology.—New Zealand is rainy and well-watered; it is also mountainous, hilly and corrugated. Half the surface has mountain land forms and another quarter consists of steep and broken hill country. Average elevation is high; slopes are generally steep and broken; thus runoff moves swiftly seaward. The country is effectively drained by numerous rivers and streams, but none is remarkable in length or volume and few are of value for navigation. All flow swiftly and many are obstructed by bars. The Waikato, draining much of the Tongariro National park area into Lake Taupo and much of the North Island to the Tasman sea, is the longest river (270 mi.). Other North Island rivers are the Wanganui (180 mi.), Rangitikei (130 mi.)

PHYSICAL FEATURES OF NEW ZEALAND

and Manawatu (120 mi.), all draining to Cook strait. In the South Island the longer rivers, reaching back to the alpine highland, are fed also by ice and snowmelt and have a more marked and regular seasonal regime. Such snowmelt rivers as the Waimakariri, Rakaia and Rangitata formed the piedmont plains of Canterbury. The Clutha (210 mi.), Taieri (175 mi.), Mataura (140 mi.), Waiau (Southland, 135 mi.), Waitaki (135 mi.), Clarence (130 mi.) and Buller (110 mi.) are the most important in the South Island.

Although of little value for transport, many New Zealand rivers are important sources of hydroelectric power, such as the Waikato, Rangitaiki and Mangahao in the North Island, and the Waitaki, Cobb, Clutha and Waipori in the South Island. The Rangitikei, Motu, Mohaka and Kaituna rivers in the North Island and the lake-fed rivers of Otago and Southland are all potential hydroelectric sources.

New Zealand's wealth and variety of lakes derive from the youth of the structure and land forms, from Pleistocene glaciation, from relatively recent tectonic disturbance and from denudational processes. Lake Taupo (238 sq.mi.) occupies a fault depression; Lake Waikaremoana (21 sq.mi. and 840 ft. deep) was created when a landslide blocked a deep V-shaped valley. The "cold lakes" of Otago and Southland occupy overdeepened glacial trenches, mostly with floors below sea level. Lake Wakatipu, 48 mi. long and averaging less than 2 mi. in width, has its surface at an altitude of 1,017 ft. but its depth reaches 1,239 ft. The largest South Island lakes are Te Anau (136 sq.mi.), Wakatipu (113 sq.mi.) and Manapouri (55 sq.mi.). All are in superb alpine settings.

Most lakes are valuable as regulators of stream and river flow and for their water storage capacity. This is important when they are drained by rivers used for hydroelectric power, as in the case of Lake Taupo feeding the Waikato river. Other lakes (Waikaremoana, Coleridge, Tekapo, Pukaki and Hawea) are tapped di-

rectly to drive turbines. A series of narrow finger lakes has been created by damming rivers, notably the Waikato, Waitaki and Clutha.

3. Climate.—New Zealand has a temperate, mild and equable climate, with abundant precipitation and (paradoxically) a large proportion of sunshine. New Zealand extends through 13° of latitude, but this contributes far less to the strong regional climatic contrasts than do the elevation and mountainous character of the two main islands. Although parts of the northern peninsula and the Auckland isthmus are almost free of frost, and frosts at sea level are commoner with increasing latitude, there are much sharper temperature contrasts between coastal areas and adjacent interior basins, ranges, valleys and plateaus, while extraordinary contrasts in volume, seasonality and character of precipitation occur to windward and seaward of mountain barriers. Thus interior and easterly situations in the South Island experience considerably higher midsummer daily maximum shade temperatures than Auckland or places north of it; and while Milford sound has an average annual precipitation of 253.3 in. on 193 raindays, Alexandra (about 80 mi. E.) has 13.2 in. on 100 raindays and Invercargill 42.8 in. on 199 raindays. Invercargill enjoys 1,670 hr. of bright sunshine annually; but Tauranga with 53 in. of rain enjoys nearly 700 hr. of sunshine more each year than Invercargill.

New Zealand's daily weather is produced by the regular migration eastward of anticyclonic systems with centres usually northward of the country, and of the active meridional frontal zones and enclosed depressions between the anticyclonic systems. Prevailing winds are westerly, with considerable daily variation in speed, direction of movement and origins of the air masses affecting the country. (K. B. C.)

4. Vegetation.—The most characteristic feature of New Zealand vegetation, but one it shares in some degree with other "oceanic" islands, is the very large proportion of endemic species (species peculiar to it). In this it affords a striking contrast to the flora of the "continental" British Isles, with almost no endemics, although the total of wild species is similar in both areas. Of the different kinds of flowering plants and ferns in New Zealand that appear to belong to the primitive vegetation, probably three-quarters at least are endemic. These include many that are prized as garden shrubs, for instance, the evergreen veronicas (*Hebe*), the daisy bushes (*Olearia*), the South Sea myrtle (*Leptospermum*) or, for the alpine and herbaceous gardens, *Celmisias*, the giant forget-me-not (*Myosotidium nobile*) from Chatham Islands, and the white buttercup *Ranunculus lyallii*. But these latter exemplify a marked feature of many native New Zealand species, namely that they are often difficult to maintain in cultivation.

When the Europeans first came to New Zealand the natural plant communities clothed most of both islands and consisted mainly of evergreen forests and tussocky grasslands. The original vegetation still remains in some places. In the higher rainfall areas of the North Island, for example, occur the famous Kauri forests dominated by the giant conifers. Here too, especially in the gullies, are to be seen the magnificent groves of tree ferns sometimes attaining a height of 20 to 30 ft. In the areas of lower rainfall in the South Island evergreen forests are dominated by the southern beeches (*Nothofagus*).

Other characteristic forest trees are the rimu (*Dacrydium cupressoides*), the totara and kahikatea (*Podocarpus* species) and the tawa (*Beilschmiedia*).

In coastal regions notable features were the areas largely occupied by New Zealand flax or flax lily (*Phormium*, *q.v.*). In the South Island especially, vast areas were originally occupied by natural grasslands, the most conspicuous constituent species being the large tussock-forming grasses, the species of *Danthonia*, *Festuca novae-zealandiae* and *Poa caespitosa*.

With the advent of the Europeans and the subsequent extensive development of sheep farming, the areas occupied by the primitive vegetation have been very greatly diminished; moreover, excessive grazing has often led to serious erosion problems. This replacement of the continuous carpet of natural vegetation by increasingly open conditions, depending on the degree of exploitation, has provided habitats for colonization by species introduced through overseas trade. By 1940 about 500 such alien species appeared to have become established and of these nearly half are now either abundant or common.

The relationships of the flora of New Zealand are best indicated by the geographical distribution of the constituent genera, numbering about 390. Of these 10% are endemic, about one-quarter have Malayan affinities and 80% are confined to Australasia. A small number of species (about 4%) are found in the subantarctic area though not in other parts of Australasia. (E. J. S.)

5. Animal Life.—The terrestrial vertebrates of New Zealand are remarkable for their high degree of endemism and for the prevalence of primitive forms. The only indigenous mammals are several species of bats. Birds were originally abundant; there are 251 recent indigenous species, of which 161 breed in New Zealand. The forest-dwelling types include many of ancient Malayan origin while others have more recent Australian affinities. From long isolation many birds such as the kiwi (*q.v.*), huia, fern-bird, saddleback and kakapo now have no near relatives among overseas birds. Through advancing settlement and competition with introduced species, the huia and the native quail and thrush are extinct, while the stitchbird, kaka, kiwi and kokako (crow) are very rare. In 1948 colonies of the large flightless rail *Notornis* (takahe), formerly thought to be extinct, were discovered in Southland. Certain species adapt themselves to changing conditions; the tui, pukeko, morepork owl, pipit and grey warbler are becoming re-established and no doubt other species would rapidly increase if effectively protected. Among water birds the cormorants are especially characteristic, with 16 species and subspecies, mostly endemic. The New Zealand region seems to have been the centre of distribution of the penguins. All but one of the recent genera are represented while the fossilized remains are of the oldest and largest forms known.

Of the native reptiles the lizardlike tuatara (*q.v.*) is most remarkable in being the only survivor of an otherwise extinct order. No longer present on the mainland, it still flourishes on several outlying islands. Turtles and snakes are represented only by a few marine forms straying from tropical waters.

Geckos include about ten species, all endemic, and peculiar as the only known viviparous forms. Species of the widely distributed Pacific genera *Gehyra* and *Lepidodactylus* have been recorded. The remaining lizards are small skinks of two genera, *Leiolopisma* and *Sphenomorphus*. The only indigenous amphibian is a small primitive frog, *Leiopelma*, whose three species are rare and extremely local. The common frog is *Hyla aurea*, which, with the whistling frog (*Hyla ewingii*), was introduced from Australia. The fresh-water fishes are comparatively few. Notable genera are *Galaxias* (native trout), *Neochanna* (mudfish), *Gobiomorphus* (bully), *Prototroctes* (smelt) and *Retropinna*. *Galaxias attenuatus* breeds in tidal waters and is fished locally as white-bait. There are two species of eels and a lamprey (*Geotria australis*) which, like several of the fishes, has affinities with South American forms.

The terrestrial invertebrate fauna is markedly incomplete. The forest-dwelling *Peripatus* (Onychophora, *q.v.*) is widely distributed but distinctly local. The most abundant insects are the beetles, flies and lepidopterans. The moths lack most of the higher groups and have South American rather than Australian affinities. Butterflies are represented by the families Nymphalidae and Lycaenidae; but only four species are common. Anopheline mosquitoes do not occur. Among arachnids the katipo spider (*Latrodectus katipo*) is dangerously venomous, but scorpions are absent. There is a peculiar fresh-water crayfish, *Paranephrops* with several species.

Resolution, Kapiti and Little Barrier islets are sanctuaries for the native fauna. The law requires that, as far as possible, native flora and fauna shall be preserved and introduced flora and fauna exterminated in the national parks. These parks (Egmont, Tongariro and Urewera in the North Island, and Abel Tasman, Arthur's Pass, Fiordland, Westland, Mount Cook and Nelson Lakes in the South Island) have a total area of 7,153 sq.mi. of which Fiordland National park occupies 4,724 sq.mi. (W. R. McG.)

CITIES AND MOUNTAINS OF NEW ZEALAND

Mt. Cook, 12,349 ft., New Zealand's highest peak, seen from a distance of 25 mi., with Ferinto[illegible] tation two miles away in the foreground

Wellington's waterfront with its docks, railway yards and sheds, and the business area immediately beyond them

Queenstown stands at the bend of Lake Wakatipu in a perfect setting of lake and mountain scenery. It is a favourite South Island resort town

Milford sound, one of the most magnificent fjords on the coast of South Island. Mitre peak rises over 5,000 ft. sheer from the water

The waters of Lake Mathieson reflect New Zealand's two tallest peaks, Mt. Cook and Mt. Tasman

Dunedin, the capital of Otago province, is an important industrial centre. It is the site of the University of Otago, the oldest in New Zealand

PHOTOGRAPHS, ROBIN SMITH PHOTOGRAPHY LTD.

NEW ZEALAND

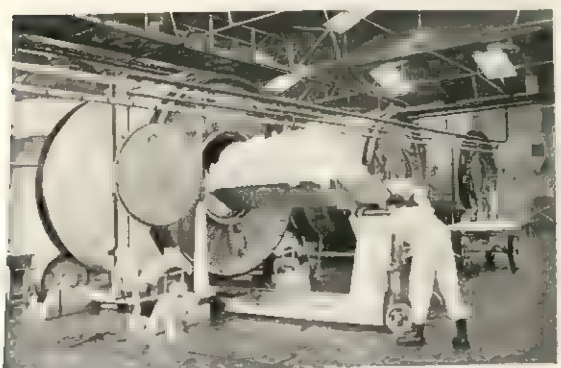
INDUSTRIAL NEW ZEALAND

Railway locomotive being moved by overhead crane in workshops at Hillside, Dunedin

Geothermal steam station at Wairakei taps natural underground steam to generate electricity for power grid

Drilling blast holes in a rock face to mine uranium ore at Buller gorge on South Island

Carcasses being loaded for export at Bluff, one of New Zealand's largest meat exporting centres



Christchurch butter factory churn discharging a load. New Zealand is a major exporter of dairy produce

A shepherd and his dog watch over a flock of sheep near Lake Hayes in central Otago. Sheep raising and the production and export of meat and wool are major industries

PHOTOGRAPHS, ROBIN SMITH PHOTOGRAPHY LTD.

II. HISTORY

European settlement of New Zealand began in the late 18th century; its Polynesian history goes back to the early Christian centuries. In the 19th century the country became predominantly British in the face of determined resistance from the indigenous Maori tribes; subsequently the two races achieved considerable harmony. Upon land bought or wrested from the Maoris the settlers established a society dependent upon agrarian resources and overseas markets. In these circumstances a small population (less than 2,500,000 by the 1961 census) became prosperous and contented.

Discovery.—Little is known about the time or the manner of arrival of the first inhabitants, except that they came over the sea from the north. Chronologies based upon Maori oral traditions cannot be trusted. Recent archaeology indicates a much longer Polynesian occupancy than had earlier been supposed; other studies point to accidental drift voyages as the means of settlement. No more is certain than that the Maoris represent the southernmost point reached by Polynesian expansion in the Pacific. (*See* also OCEANIA.)

The Polynesian period has been divided into an early "Moa-hunter" and a later "Classic Maori" phase, but the transition from early to late is unexplored. In the South Island, if not elsewhere, the first Polynesians found moas (flightless birds) in immense numbers on tussock grasslands. Here was their major food supply. The "Classic Maori" found later by Europeans had only faint memories of the moa, and was an agriculturalist. The 18th-century Maori population was most dense in the warmer northern parts of the country, where the Maori (*q.v.*) variant of Polynesian culture had reached its high point, particularly in the arts of war, in canoe construction, in building, weaving and agriculture. Estimates of the extent of the Maori population vary widely; it was probably not more than a few hundred thousands. Numbers were to drop sharply in the first century of European influence, from the late 18th to the late 19th centuries.

The first European to discover New Zealand was a Dutch sailor, Abel Janszoon Tasman, who sighted the coast of Westland in Dec. 1642. His sole attempt to land brought only a clash with a South Island tribe in which several of his men were killed. After his voyage, the western coast of New Zealand became a line upon European charts and was thought of as the possible western edge of a great southern continent.

In 1769–70 James Cook (*q.v.*) completed Tasman's work by circumnavigating the two major islands and charting them with a remarkable degree of accuracy. His first contact with the Maoris was violent, but harmonious relations were later established. On this and on later voyages, Cook, with the explorer and naturalist Joseph Banks, made the first systematic observations of Maori life and culture. Cook's journal, published as *A Voyage Towards the South Pole and Round the World* (1777), brought the knowledge of a new land to Europeans. He stressed the intelligence of the natives and the suitability of the country for colonization, and soon colonists, as well as other discoverers, followed Cook to the country he had made known.

Early European Settlement.—Apart from convicts escaping from Australia and sailors seeking asylum with Maori tribes, the first European New Zealanders sought profits—from sealskins, timber New Zealand flax and whale oil. Early New Zealand was an offshoot of Australian enterprise in whaling and other activities; Sydney, New South Wales, founded as a convict settlement in 1788 became a base for South Pacific whaling, and Kororareka (now called Russell), in the far north of New Zealand, became a stopping place for American, British and French deep-sea whalers. Around both islands Australian firms set up tiny settlements of land-based bay whalers. Traders supplying whalers drew Maoris into their economic activity, buying provisions, supplying trade goods, implements, muskets and rum. Initially the Maoris welcomed the newcomers; while the tribes were secure, the European was a useful dependent.

Maoris went overseas, some as far as England. A northern chief, Hongi Hika, amassed presents in England, which he exchanged in Australia for muskets; back in New Zealand he waged devastating war on hereditary enemies. The musket traveled south; a series of tribal wars, spreading from north to south, displaced populations and disturbed landholdings, especially in the Waikato, Taranaki and Cook strait areas. Europeans were soon to found colonies in these unsettled regions. Missionaries quickly followed the traders. Between 1814 and 1838 Anglicans, Wesleyans and Catholics set up stations. Samuel Marsden, Henry Williams, Octavius Hadfield and a French Catholic bishop, Jean-Baptiste-François Pompallier, were important leaders. Success was initially slow, but by the mid-19th century most Maoris adhered, for varying reasons, to some form of Christianity.

All these newcomers had a profound effect upon Maori life. Warfare and disease reduced numbers; new values, pursuits and beliefs destroyed tribal structure. Christianity cut across the sanctions and prohibitions which had supplied social cohesion. A capitalist economy, to which Maoris were introduced both by traders offering new inducements (for instance the brief demand for flax) and missionaries bringing new agricultural techniques, altered the whole material basis of life. At first in the north, and later over the whole country, a process of adjustment began which has not yet been completed. By the late 1830s, chiefly through the Australian link, New Zealand had been joined to Europe. Settlers numbered at least some hundreds, and there were certain to be more. Colonization schemes were afoot in Great Britain, and Australian graziers were buying land from the Maoris. These circumstances determined British policy.

ANNEXATION AND FURTHER SETTLEMENT

In 1838 the British government decided upon at least partial annexation. It commissioned William Hobson, a naval officer, as lieutenant governor and consul to the Maori chiefs in July 1839; he became governor in 1841. Hobson, in the event, annexed the whole country, the North Island by the right of cession from the Maori chiefs and the South Island by the right of discovery. From June 1839 to May 1841 New Zealand was legally part of New South Wales. Before declaring the annexation of New Zealand, Hobson went through a process of discussion with the northern chiefs from which emerged the so-called treaty of Waitangi (Feb. 1840). Under this instrument, Maoris ceded sovereignty to the crown in return for protection and guaranteed possession of their lands; they also agreed to sell land only to the crown. Hobson promised an investigation into past "sales" of land to private individuals to ensure fair dealing. This treaty imposed a strong moral obligation upon the British government to act as guardian to the Maoris.

Even before annexation had been proclaimed, the first organized planting of an English colony was under way. The New Zealand Association, founded in 1837 to colonize on the principles laid down by Edward Gibbon Wakefield (*q.v.*), sent a survey ship, the "Tory," in 1839. The agents on board were to buy land in both islands around Cook strait. The company moved hastily because its founders were aware that British annexation was likely, and would entail a crown monopoly of land sales and a consequent increase in price. "Purchases" were effected in great haste before Hobson could bring to an end such private transactions. Little effort was made to seek out the true Maori owners; this would have been difficult as Maori ownership was communal and titles had been disturbed by the musket warfare of the early part of the century. The company, combining skilful propaganda with outright trickery and brutality, enforced its claim to the land upon which New Plymouth, Wanganui, and Wellington in the North Island and Nelson in the South Island were founded in the 1840s. Later, through the crown, it secured other areas in the South Island where Otago (1848) and Canterbury (1850) were planted by separate associations. Meanwhile, Hobson moved the seat of government south from the Bay of Islands, bringing Auckland into existence (1841).

In the early 1840s settlement and government began to alarm the Maoris. In the Cook strait area a formidable chief, Te Rauparaha, obstructed settlement. Near the Bay of Islands there was open warfare and Kororareka was repeatedly raided. Neither Hobson (d. 1842) nor his successor Robert FitzRoy (*q.v.*) pos-

sessed the means or the resolution demanded by the situation. George (afterward Sir George) Grey (*q.v.*), who became governor in 1845, had money and troops, and the will to use them. His victories brought a peace which lasted from 1847 until 1860. Hone Heke, the northern leader, was thoroughly defeated (1846), and in the south a likely uprising was prevented. Racial strife had been accompanied by economic distress. In the mid-1840s the nascent economy was depressed until the Australian gold rushes of the 1850s offered a market for foodstuffs to the New Zealand farmer, settler and Maori alike.

By the end of the 1840s racial and economic trouble gave way to political agitation. The leading settlements, apart from Auckland, began to campaign for representative government in place of Grey's personal rule. He, while refusing to give way, helped to draft the New Zealand Constitution act (1852) which was designed to meet all the settler demands. He sought not to prevent the introduction of self-government, but to delay it until he had determined both native and land policy. He wished to begin the rapid assimilation of the Maoris (with whom his relations were excellent) to the British pattern. He also wished to bring in a land policy which would safeguard the small farmer against the great owner. He believed he had secured these goals by the time of his departure at the end of 1853.

Responsible Government.—When the Constitution act came into operation New Zealand was divided into six provinces, Auckland, New Plymouth (Taranaki), Wellington, Nelson, Canterbury and Otago, each with a superintendent and a provincial council. The central government consisted of a governor, a legislative council nominated by the crown, and a lower house, elected upon a low property franchise for a five-year term. This general assembly did not meet until 1854; it then embarked upon a quarrel with the acting governor, Colonel Robert Henry Wynyard, which was not ended until the achievement of full responsible government, *i.e.*, a system under which the governor could act in domestic matters only upon the advice of ministers enjoying the confidence of the elected chamber. Henry Sewell and James FitzGerald, of Canterbury, led the representatives in this struggle, against the opposition of E. G. Wakefield, who, having first moved the resolution for responsible government, then secretly opposed it, while serving as extra-official adviser to the acting governor. The colonial office conceded responsible government in 1856. The next governor, Thomas Gore Browne, reserved Maori affairs to the competence of the governor alone.

For most purposes, during the 1850s, New Zealand was administered not by central but by provincial institutions. These authorities (nine in number by the time of their abolition in 1876) directly affected the settler through their administration of land and control of immigration and public works. The native department, directly under the governor, bought land from the Maoris; the provincial governments settled it, regulated immigration, built roads and bridges. Until the wars of the 1860s the central legislature was less important, though its ultimate authority remained.

Each province disposed of a revenue arising from land sales, and upon this revenue depended its strength. Canterbury and Otago, with hardly any Maoris, grew wealthy, spending their money upon communications, immigration and education. Other provinces were either less fortunate or less wise, and enjoyed smaller success. In the North Island numerous and anxious Maoris held on to desirable land. Here most land available for settlement had been taken up by the end of the 1850s, a good deal of it by speculators, and some of it given away to attract immigrants. The island remained largely without roads until the 1870s, so impecunious were its governments. But by that time the major obstacles to settlement had been removed—the continuing power of the tribes. This was the result of a decade of war.

Racial Conflict.—In the 1850s race relations deteriorated. The settler population and the demand for land, especially pastoral land, increased. Many Maoris, fearing for their future, became reluctant to sell more land. In the Taranaki province, where the land shortage was acute, both settlers and those Maoris willing to sell were opposed by Wiremu Kingi, chief of Te Atiawa. In the Waikato, where good land was coveted by settlers and speculators, an elderly chief, Te Whero Whero, was elected "king" in 1858 largely by the Waikato and Maniopoto tribes, and "reigned" as King Potatau I. This "king" movement, and also the unrest in the Taranaki headed by Wiremu Kingi (the two movements remained distinct from each other) were opposed to further land sales.

The likelihood of conflict was not reduced by any particular wisdom in government policy. Gore Browne was guided in native policy by the head of the Native Land Purchase department, Donald McLean, who, responsive to settler demands, increased pressure upon potential sellers. Grey's caution, and his recognition that a chief could veto sales proposed by any section of his tribe, were forgotten. McLean sowed a rich harvest of distrust. Christopher Richmond, the member of cabinet in charge of native affairs, was also a Taranaki representative, fully responsive to the needs of his settler neighbours. The central ministry, theoretically unconcerned with native policy, could not, despite the promise of protection made to the Maoris in the treaty of Waitangi, neglect a matter so vital to the colony's future. In 1859 the representative of the crown unwittingly supplied the occasion for the outbreak of civil strife.

Gore Browne accepted an offer to sell from a Taranaki subchief, Te Teira, and ignored the veto imposed by the paramount chief, Wiremu Kingi. Early in 1860 troops were used to dislodge Kingi from the land in question, the Waitara block. A decade of fighting began. In 1861 Grey was sent back for a second term as governor in the hope that he would again prove to be a peacemaker. In fact he accelerated the extension of conflict. Fearing that Auckland was menaced by the followers of the Maori king, he took defensive measures which could easily be interpreted as acts of aggression. Thus fighting spread from Taranaki to the Waikato. Imperial troops, colonial militia, Maori allies (for not all the tribes supported the Maori nationalist movement) had no easy task, but their victory could not be postponed for long. By the mid-1860s Maori resistance in the Taranaki and Waikato was ended. But the King tribes were by no means crushed, and the chance that they would embark upon war again haunted the colony for many years.

In the later 1860s the fighting was of a different character, in which religion acted as a last, desperate stiffener of Maori resistance. *Pai marire*, a bizarre and bloodthirsty amalgam of Christian and primitive beliefs, was the first of many cults in which the Maori, rejecting the religion of settler and missionary, put his own imprint upon Christianity. Toward the end of the decade, Te Kooti organized resistance on the east coast. He was the founder of another religious cult as well as a guerrilla of some note; his adaptation of Christianity, *Ringatu*, still had thousands of followers in the mid-20th century. Te Kooti was never finally defeated, but by the early 1870s he was forced to retreat into the "King country" (the centre of the island) where he devoted the rest of his long life to religious leadership.

An uneasy peace settled upon the colony in 1870. Casualties had not been high, but the loss of life was serious for the tribes concerned. Especially in those areas in which the Maori king retained some authority, defeat led to a sullen withdrawal from European civilization. Resentment was deepened by a punitive policy of land confiscation adopted by the victors, a policy improper in its nature and made worse in some places by undiscriminating application to "guilty" and "innocent" tribes alike. The Maori future looked black. By the 1862 Native Land act private land transactions between settler and Maori had been legalized, and during the next 40 years the Maoris lost most of their best land. Many years were to elapse before Maori numbers, morale and confidence could revive.

Development of the Colony

Economic growth in the North Island had been considerably retarded by the wars. Meanwhile, during the same period, the South Island, especially Canterbury and Otago, had grown increasingly prosperous. Pastoral farming expanded steadily and the discovery of gold, first in Otago and then on the west coast, led to a sudden boom in production and trade. Population rose as diggers poured in; economic life quickened as gold brought prosperity

less to the digger than to bankers, merchants, land sellers and farmers supplying provisions. The South Island share of the European population jumped from about 40% to 60% during the 1860s. The North Island did not recover its previous lead until the 20th century.

Attempts by other provinces to emulate the development of Canterbury and Otago normally ended in embarrassment (in one case in bankruptcy) as money was recklessly borrowed and spent. To preserve the colony's reputation the central government in 1867 banned further provincial borrowing. About the same time depression struck the greater part of the country, especially the South Island, where the first alluvial gold had by then been worked out. The South Island was thus looking for a stimulus, while the ending of the wars now made further development possible in the North Island. It was widely agreed that only the central government could adequately revitalize the economy.

In 1870 a development policy was provided by Julius Vogel (*q.v.*), the colonial treasurer who was convinced (not altogether accurately) that New Zealand was bursting with potential resources needing no more than the stimulus of capital and labour for their exploitation. He borrowed overseas capital for public works on an unprecedented scale and swelled the labour force with assisted immigrants. Not all his schemes were wisely conceived; the prosperity of the mid-1870s was more an investment boom than a solid growth of productivity. But the colony ended the decade with a doubled population (about 500,000) and the beginnings of efficient internal and external communications. Roads, bridges, railways and telegraph systems had been built, and overseas shipping services improved. Private lending agencies contributed to the boom, and in a heady atmosphere land values and interest rates climbed alarmingly. The public debt greatly increased, and many of the men who had acquired land were in desperate financial straits. Falling overseas prices for farm products (chiefly wool and wheat), a declining gold output, a cautious note in government finance, and widespread unemployment marked the 1880s. Emigrant ships discharged their passengers at ports where unemployment was already rife. There had been growth in the 1870s, but it was succeeded by a depression which lasted till 1895.

Vogel abolished the provincial governments in 1876. They had earned his enmity by refusing to allow their lands to be used as security for public works, and by blocking a forest conservation scheme. Essentially, they became outmoded when, in the early 1870s, the initiative in development passed to the central government. Provincial governments had been set up to colonize their districts; when the centre assumed this function they lost their *raison d'être*. Abolition came fairly painlessly; it was an affront more to local pride than to local prosperity. Only in Otago was there a strong attempt to resist change. Thereafter, provincial interests were long pursued by the respective delegates in the general assembly, whose achievements were in no way diminished by the lack of particularist (provincial) institutions.

The governments of the 1880s, though led by men of some ability and imagination, such as Sir Robert Stout and Sir Harry Atkinson (*q.v.*), did not deal effectively with the depression. The time-honoured remedy, spending loan money on development, was not fully given up until 1887. The basic problem was to find productive work for the country's labour force; closer land settlement was the remedy suggested in the 1880s and applied in the 1890s. Great areas, especially in the South Island, had fallen to large owners; these "monopolists" were attacked by the radicals, though probably the pastoral industry could not have been established under any other system. William Rolleston, minister of lands from 1852 to 1884, first proposed that the state should help men to become small farmers as state tenants; John McKenzie and the Liberal government applied this remedy with vigour in the 1890s. But closer settlement and intensive farming did not succeed until small farmers had a product to export and gained a good price for that product. Refrigeration and rising world prices provided the answer. It became possible in the 1880s to send to Great Britain refrigerated cargoes of butter, cheese and meat; this encouraged the spread of small-scale intensive farming.

The Liberal Era 1891–1912.—The energetic Liberal government led by John Ballance (*q.v.*) which took office in 1891 accelerated the process of change. It opened more land (much of it bought from the Maoris), it established farmers on perpetual state leaseholds, it provided generous credit for land purchase and for improvements. So came into existence great dairying and meat producing areas, especially in the North Island. Dairy, meat and also wool prices rose in about 1895 and stayed generally high until about 1920.

This economic stimulus was not limited to farmers. Urban distress had been serious in the 1880s, for many recent immigrants had been townsmen who had stayed in New Zealand towns on arrival. The ultimate cure for their distress was for the towns to share in the farmers' high prices. Urban New Zealand depended upon the prosperity of the country. But other remedies were considered, and some of them were applied. In the 1880s there was serious discussion of insurance against sickness, poverty and old age; the Old Age Pensions act of 1898 was the first measure of social security. Tariff protection to foster industrial employment was halfheartedly applied in the late 1880s. Revelations of oppression in industry led, in the 1890s, to a labour code to protect workers.

But the chief Liberal industrial policy, formulated by William Pember Reeves, minister of labour from 1892 to 1896, was to encourage trade unions and to introduce, in the Industrial Conciliation and Arbitration act of 1894, a conciliation and compulsory arbitration system intended to end industrial unrest and give the unions the means of protecting their members. The growth of unions was stimulated by the fact that only through them could the workers use the system. Reeves's act, amended and occasionally suspended, but still essentially his own handiwork, has never been repealed. It has enabled the worker in good times to resist wage cuts and to press for increases; but it has not managed to prevent cuts and unemployment when falling overseas prices have brought depression to New Zealand. It has not been strikingly radical in effect; employers and governments have used it to break strikes, such as that of miners at Waihi in 1912. It has built up the power of those majority elements in the unions which prefer coming to terms with capitalism to any effort to destroy it. Some occupations, such as transport, cargo handling, meat processing and mining, have fostered unions keen to relinquish arbitration for direct action, but they have been in a minority, and seldom, in the long run, successful. Farmers and governments have usually acted with severity in disputes affecting the movement of exports.

The Liberal era, from 1890 to 1912, transformed political life. Previously politics had not been marked by neat party divisions. Local advantage had determined political behaviour in the development period during and after the 1870s; men had argued over the scope and details of policies, and had advanced the claims of locality and province for a proper share of largesse. Acute depression ended development, and with it the politics of local advantage. In 1890 the Liberals began to act as a more or less unified party. Their 20 years in office, the success of their land and labour policies, and the formidable qualities of leadership discovered in Richard John Seddon (*q.v.*), premier from 1893 to his death in 1906, welded the Liberals into a fairly coherent parliamentary and popular party.

Seddon was a portent of a new age. In 1893 this energetic goldfields trader-turned-politician provided a sharp contrast to the gentlemanly premiers who had preceded him. But his crudeness assisted rather than hindered the attainment of a popularity none of them had known. He was devoted to political success and skilled in the manipulation of the means of success—parliamentary procedure, patronage and party organization. By the time of his death he had established a kind of elective despotism over the country.

The 20th Century

Seddon's successors, in his own and in other parties, were of the same stamp—men of the people devoted to a political career. Politics ceased to be a duty of the well-to-do amateur. The Liberal government, under Sir Joseph Ward (*q.v.*), survived Seddon

for six years. In 1912 it fell before a new party, Reform, led by a dairy farmer, William Ferguson Massey (*q.v.*), prime minister until 1925. Based on prospering farmers and townsmen, especially of the North Island, and closely connected with their professional organizations, it was more narrowly sectional than the Liberals had been. Except for views borrowed from the Liberals, it had little positive policy. Reform made much of a promise to enable the state leaseholder to buy the freehold of his farm at original valuation; this promise was an emotional rallying cry for conservatives fearing land nationalization and complete socialism. Only a minority of farmers were state tenants, and not all of these bought the freehold when the Reform government gave them the chance.

While the Liberals lost support in rural areas, they were further weakened by urban left wing defections which eventually led to a separate Labour Party. Four Labour members were returned in 1911. The initiative, on the right and on the left, was passing to other parties, and the Liberals were gradually eclipsed. The period before World War I was one of discontent and anxiety. Prosperity, though still considerable, had somewhat declined. The farmers were disturbed by what they took to be the threat of socialism, detected in the radicalism of a Liberal minority, but chiefly in the rebirth of direct action in some trade unions. This change in temper arose from labour dissatisfaction with wage levels achieved under arbitration, and from the growth of syndicalist and socialist ideas. After 1906 the Arbitration court refused to grant further increases of real wages. Discontent flared up in the strikes of 1912–13, the biggest occurring on the waterfront when the farmers' government, headed by Massey, vigorously repressed a strike movement which had some of the overtones of social revolution.

World War I and the Inter-War Years.—New Zealand supported Great Britain in World Wars I and II, chiefly by sending men overseas and producing food and wool. In World War II the Japanese brought danger close to New Zealand's shores; in the earlier conflict the peace of the Pacific was seldom disturbed.

New Zealanders served in the Dardanelles campaign at Gallipoli, and subsequently in France. In these battles they began to learn that they were a distinctive branch of the British people. The infantry "digger" of 1914–18 came to symbolize those qualities which the country most respects—courage, endurance and resourcefulness. New Zealand lost many of her young men, a serious loss for succeeding decades.

At home the war brought prosperity, as export markets were assured and prices good. Domestic unity was hardly shaken by the antiwar feeling of a handful of left-wingers. Massey remained prime minister, but in the wartime coalition government (1915–19) Ward and the Liberals carried great weight. Reform stayed in office till 1928, led after Massey's death in 1925 by Joseph Gordon Coates (*q.v.*). The party survived the first postwar depression, but not that of the mid-1920s. Led by Ward the Liberals, under the new name of United Party, were victorious in 1928; they thus had to face the deepening depression of 1929–30. After Ward's death (1930) and at the height of the depression, Reform and United formed a new coalition (1931) under the premiership of George Forbes, which lasted till an electoral landslide in 1935 brought in a Labour government.

Some postwar developments were of great importance. In external affairs, Massey led a delegation to the peace conference, signed the treaty of Versailles, and so committed New Zealand to membership in the League of Nations. New Zealand thus began to acquire the status of a sovereign state, though Massey denied this consequence. The Liberals, especially Seddon, had already taken steps toward autonomy within the empire. At the series of colonial and imperial conferences from 1887 onward, New Zealand had followed Canada and Australia in asserting its right to a voice in certain foreign policy issues. Seddon argued vehemently against British reluctance to acquire more Pacific islands, while permitting German influence to grow in Samoa. New Zealand legislation to restrict Asian emigration was sharply and obstinately at variance with British policy. Western Samoa, which New Zealand had captured from the Germans in 1914, and over which it was granted a mandate in 1920, also provided occasions for British and New Zealand differences.

Reform leaders professed little love for the principle of autonomy which, in the 1920s, came to dominate commonwealth relations. New Zealand took part in the conferences leading to the statute of Westminster in 1931, but did not adopt the statute till 1947. But the substance of autonomy had been enjoyed long before.

The major domestic achievement of the Reform administration was a system of export marketing agencies in which authority was shared by producer and state. These failed in their short-term objective—to sustain farmers' returns while prices fell—but they laid the foundations of a collectivist marketing structure which has continued to expand.

The leading domestic phenomenon was the rise of Labour. The New Zealand Labour Party was established in 1916; in the 1920s it came to dominate working class urban electorates. But complete success eluded it. It had little to offer the rural voter until 1928, when it offered easier credit, and then the revitalized Liberals (United) offered an attractive alternative quite free from the taint of extreme socialism which still clung to Labour. The United Party went back to the old remedy of massive expenditure of borrowed money. In fact the prospect of electoral success had by this time caused the Labour Party to substitute for its socialism a series of welfare and credit proposals. The formation of the coalition between Reform and United in 1931 made Labour the official opposition. Industrial labour, notably sections influenced by semi-syndicalist ideas, was a restive ally for the party. But unemployment, the suspension of the arbitration system in 1932 and a nationwide series of wage cuts drove the two wings of the labour movement together. Trade unionists had now learned that their welfare depended upon political power. Politicians could abolish arbitration, their main defense against poverty, and other politicians would be necessary for its restoration. The new solidarity played a large part in the Labour victory of 1935.

J. G. Coates was the most energetic and least conservative coalition minister. His attempts to counter depression concentrated upon the rehabilitation of the farmer as a step toward the revival of the whole country. In order to increase export receipts he devalued the New Zealand pound from £110 to £125 per £100 sterling; he protected the farmer against foreclosure, and he set up a credit agency, the Mortgage corporation. He also established the Reserve Bank of New Zealand. When overseas prices began to recover in 1934 the country was financially strong.

But he had done little for the multitude of unemployed. Unenviable conditions in towns and relief camps led to outbreaks of rioting and violence, to widespread discontent, and to the Labour victory. Successful in the towns, Labour also won in many rural areas, especially in the dairying districts. Prices for dairy exports were slowest to recover, and the dairy farmer was drawn by Labour promises of a guaranteed price for dairy produce and cheap and plentiful credit. The victory was particularly notable in terms of seats, for a right-wing third party (the Democrat Party) split the conservative vote to Labour's advantage. However, a contest in 1938 without the Democrat Party had the same result, and the opposition (the successors of Reform and United now renamed the National Party) was rendered temporarily ineffective.

The new ministers, among whom the most notable were Peter Fraser (*q.v.*) as minister of health and education, and Walter Nash as minister of finance, showing great energy and genially led by Michael Joseph Savage, had the good fortune to govern a country to which prosperity was fast returning. The farmer was enjoying increased earnings, the worker increased wages and shorter hours. Jobs were multiplied by a massive public works and housing program; attempts were made to stimulate secondary industry, and to diversify the economy to make it less vulnerable to overseas conditions. The education system was revitalized. In 1938 the Social Security act provided a state medical service, extended the pension system and increased benefits. The expansion of industry was accelerated after the outbreak of World War II in 1939.

World War II and After.—The alacrity with which New Zea-

land went to war in 1939 showed that dominion autonomy had not weakened the country's ties of sentiment with Great Britain. At first the war resembled that of 1914; troops were sent to Egypt to train for the European conflict. There they were directly involved by the enemy advance in North Africa and the Balkans, and saw action in Greece, Crete, North Africa and Italy before the final Axis collapse. After 1941 New Zealand was directly threatened by Japan, and New Zealand forces were also engaged in the Pacific. They were not withdrawn from the European fighting and well before the end of the war the double strain upon the country's manpower, together with the demands of home production, enforced a reduction of commitments in the Pacific.

The Pacific theatre was dominated by the U.S. whose forces, after the loss of Singapore (1942), provided New Zealand's sole defense. U.S. troops were stationed in New Zealand, and New Zealand forces fought under U.S. command. The fact that disaster was averted by U.S. and not by British troops imposed a certain strain on New Zealand's loyalties. For generations security had been guaranteed by British power; now it was conferred by a foreign, though friendly, power. External relations in the postwar period reflected this new situation, chiefly through the ANZUS pact (1951), a defensive alliance between Australia, New Zealand and the United States.

At home the total economy was mobilized in the war effort. Controls, already considerable by 1939, were extended to cover every aspect of economic life. Conscription and direction sent manpower either into the armed forces or to essential occupations; heavy taxation, war loans, bulk purchase, and controlled marketing kept the economy in a firm grip. These devices also served to keep inflation in check; together with price control and wage restraint they amounted to a complete policy of economic stabilization. These controls were applied by a Labour government which remained in power until 1949. Savage died early in the war. Fraser, his successor as prime minister, inherited a large share of the tasks of war administration and peacetime reconstruction. In economic affairs, the leading minister was Nash. No full coalition was formed, but for a few months in 1942 a war cabinet, on which some National M.P.s had seats, among them Coates (d. 1943) and Sidney (afterward Sir Sidney) Holland (*q.v.*), existed alongside the normal cabinet.

Holland led the revival of the National Party which was marked in the elections of 1943 and 1946 and culminated in victory in 1949. Discontent with controls and with the rising cost of living were among the factors which caused opinion to swing away from Labour. Subsequently, the two parties remained fairly evenly balanced. The National government benefited from its vigorous handling of a serious waterfront dispute in 1951, but in later elections its majority narrowed until Labour returned to office in 1957. In 1960, however, the National Party, now led by Keith Holyoake, was returned to power, which it maintained for the next two elections. By the time of the 1966 election the ideological differences between the two parties had narrowed. That the economy had to be controlled, secondary industry encouraged, and the welfare state maintained ceased to be matters for debate. But the nation's prosperity was precarious, and this led, especially in rural areas, to the emergence of a Social Credit movement, which in 1966 won its first parliamentary seat.

The most striking postwar development took place in international affairs. Not only did the U.S. come to supplant the U.K. in New Zealand's thinking about military security, but also New Zealand began to play a relatively independent role in world politics. This latter development in fact began before World War II, when the Labour government's attitude to the League of Nations was coloured by an idealism which clashed with prewar British policy, especially over the Ethiopian issue. This independent spirit was carried by Fraser to the formation of the United Nations organization. During the war Fraser had insisted upon an independent voice in the councils of the Allied powers, especially where the fate of New Zealand troops was concerned. At the formation of the United Nations at San Francisco in 1945 he became a notable spokesman for the small powers and made a large impression upon the deliberations of the Trusteeship council. None of these developments weakened New Zealand's close affinity with Great Britain, nor its loyalty to the Commonwealth of Nations. Independence and close identity were found to be compatible.

Geography and insecurity shaped New Zealand's postwar foreign policy. With Australia, New Zealand claimed a voice in the settlement of the South Pacific through the Canberra Agreement of 1944. This regional concern also appeared in its role in the South Pacific Commission, and in the transfer of authority in Western Samoa, successfully completed when that country became independent in 1962. New Zealand also became deeply involved in Southeast Asia. From 1951, through the Colombo Plan, it provided assistance to many Southeast Asian countries. More militantly, New Zealanders fought in Malaya, Korea, and Vietnam; further, New Zealand became a member of the Southeast Asia Treaty Organization (SEATO) and supported U.S. initiatives in that region. This reflected the fear felt at the growth of Communist power in Asia. Thus the independent spirit of the immediate postwar years was modified to a greater dependence on Western powers during the 1950s and 1960s.

Two major social problems confronted New Zealand in the second half of the 20th century: to find a productive occupation for a growing population, and to preserve harmonious relations between the two races. The country was still an exporter of primary products and an importer of manufactured goods and industrial raw materials. But farming absorbed a decreasing share of the labour force, and traditional farm exports and their markets proved less reliable. To maintain full employment and to strengthen exports, the country began to diversify at home, to explore new products, and to seek new markets. The threat of British entry into the European Economic Community (Common Market) was an incentive to economic reconstruction.

The Maori population had been increasing with greater speed than the total population, and a great number of Maoris, especially younger people, had moved into the towns. In the 1950s the government began an effort to raise the economic and social standards of the Maoris. By the 1960s their standard of living was not yet, on the average, comparable with the European standard, and forethought was necessary to secure the harmonious integration of the two races. Full legal equality existed, and social harmony was common. But there were instances of prejudice and discrimination. In the long run the solution to the problem may be found in the merging of the two races. (W. H. OL.)

III. POPULATION

Since the European settlement of New Zealand in 1840, the white population has risen from about 1,000 to 2,676,919 (1966 census, excluding island territories). The two significant population trends have been the increasing proportion resident in the North Island—a reflection of the markedly different range of resources available in the two islands; and the increasing urbanization—a reflection of the changing character of the economy. The existence of land suitable for sheep grazing and the discovery of gold initially favoured the settlement of the South Island, which by 1871 contained 62% of the 256,393 white inhabitants. But the ascendancy of the North Island was assured by the establishment of dairying and fat-lamb farming upon the huge tracts of forest land which had been cleared. The mounting contribution made by manufacturing industry to the economy during the period 1930–60 underlined this superiority. In 1966, 70% of the population resided in the North Island. With 70% of the workers engaged in manufacturing, the North Island was dominant also in the industrial sector, the Auckland employment district alone accounting for 28.5% of the total employed.

Although New Zealand is primarily a pastoral country, earning overseas exchange almost wholly by the sale of pastoral produce, it has a highly urbanized society, and only 17% of the total labour force is engaged in primary industries. In 1911 the population was divided equally between rural and urban districts but at the 1961 census 63.6% were classed as urban dwellers, though 70% would have been a more realistic figure. The principal urban areas are Auckland (*q.v.*; 548,293), Wellington (*q.v.*; 167,859) and Hutt (114,628) in the North Island; and Christchurch (*q.v.*; 247,248)

Area and Population of New Zealand

Statistical Area	Area (sq.mi.)	1956 Census	Density	1961 Census	Density
Northland	4,883	83,330	17.1	86,391	17.7
Central Auckland	2,155	441,069	204.7	514,507	238.8
South Auckland Bay of Plenty	14,187	302,304	21.3	349,624	24.6
East Coast	4,195	45,042	10.7	46,478	11.1
Hawke's Bay	4,260	102,326	24.0	114,470	26.9
Taranaki	3,750	94,109	25.1	99,774	26.6
Wellington	10,870	429,184	39.5	473,541	43.6
Total, North Island	44,300	1,497,364	33.8	1,684,785	38.0
Marlborough	4,220	25,697	6.1	27,748	6.6
Nelson	6,910	59,376	8.6	62,967	9.1
Westland	6,010	25,584	4.3	24,841	4.1
Canterbury	16,770	311,909	18.6	344,597	20.5
Otago	14,070	168,861	12.0	176,325	12.5
Southland	11,460	85,271	7.4	93,721	8.2
Total, South Island	59,440	676,698	11.4	730,199	12.3
Total, New Zealand	103,740	2,174,062	21.0	2,414,984	23.3

and Dunedin (*q.v.*, 105,003) in the South Island. Thirteen other urban areas had populations exceeding 20,000, of which Hamilton (*q.v.*, 50,505) and Palmerston North (*q.v.*, 43,185) were the largest.

The vital statistics of the European population display the trends common to the western countries. The death rate and the infant mortality rates have shown constant decreases, except for a slight increase in death rate since 1946 attributable to the aging population. The death rate per 1,000 of population is 9.0. From a peak of 41 births per 1,000 in 1876 the birth rate gradually decreased until it reached its lowest point in 1935 with 16. Following World War II the rate remained fairly stable at 24–25 births per 1,000. Combined with immigration, which over the period 1956–61 gave an average net increase exceeding 11,500 annually, this rate produced during the 1950s an average annual increase of 2.3%, one of the highest in the world.

The Maoris.—Susceptibility to European diseases and the social disorganization resulting from European contacts caused the Maori population to decline from 56,049 in 1857 to 42,113 in 1896. Thereafter it increased; and did so spectacularly after the 1920s. In 1921 Maoris numbered 56,987; by 1961 there were 167,086, but they represented only 6.9% of the total population. Following World War II the Maori birth rate remained at the high level of 46 per 1,000. The death rate declined considerably in the first half of the 20th century and now compares favourably with that of the Europeans. But the Maori infant mortality rate (44.5 per 1,000 births) is higher than the European (19.7) and the favourable death rate is markedly influenced by the youthful character of the Maori population as a whole. Thus while 47% of the Maoris are under 15 years of age the corresponding figure for the European population is 30%. Similarly, persons of 60 years of age and over account for 13% of the European and only 3½% of the Maori population.

Few Maoris dwell in the South Island. Most live in the more northern parts of the North Island, especially in the Auckland land districts. The Maori population remains largely rural in character (76.23%) and consequently most Maoris are employed in the primary industries. Urban drift is apparent, especially among the younger Maoris, Auckland with 19,847 Maoris in 1961 being the main centre of attraction. In 1926, 3,457 Maoris lived in towns; by 1961 the Maori population of the major urban areas had reached 55,681. The department of Maori affairs estimated that intermarriage was responsible for reducing the proportion of full-blooded Maoris to 20% of the total Maori population. (*See* also MAORI.)

Population Totals.—The total population, Maoris included, at the following census dates, was: 1858, 115,462; 1881, 534,030; 1901, 815,853; 1921, 1,271,664; 1936, 1,573,810; 1951, 1,941,366; 1956, 2,176,224; 1961, 2,414,984. The population of the island territories at the census of 1961 was 25,252 and that of the trust territory of Western Samoa (which became an independent state in 1962) was 114,427.

Immigration.—Persons wholly of British birth and parentage or wholly of European race and colour are given verbal permission to enter New Zealand on arrival, subject to good health and character and possession of a valid passport. Such immigrants do not need written permits, visas, guarantees of work nor any prescribed sum of money. Other categories of immigrants require written permits from the immigration division of the department of labour.

The New Zealand government in 1947 introduced an assisted passage scheme for single persons from the United Kingdom aged 20–35. In 1951 the scheme was amended to include single persons up to age 45, certain categories of married British immigrants and, after the conclusion of agreements with the countries concerned, of a number of non-British single men and women. In the period 1946 to March 1962, 58,783 migrants settled under these schemes and 274,070 unassisted migrants took up permanent residence.

Religion.—According to the 1961 census, the adherents of the main denominations were distributed as follows: Church of England 34.6%, Presbyterian 22.3%, Roman Catholic 15.1%, Methodist 7.2%. Of the overwhelmingly Maori Christian sects Ratana (23,126 adherents) and Latter-day Saints (17,978) were the strongest.

In 1857 the Anglican Church of the Province of New Zealand was inaugurated in full communion with Canterbury. Government is by a general synod, which elects the archbishop-metropolitan or primate from among the diocesan bishops; thus the primate's see is not fixed in any one city. There are nine dioceses (including two with jurisdiction over Melanesia and Polynesia) and a separate bishopric (Aotearoa) for the Maoris. The Roman Catholic Church is organized in three dioceses subject to the archiepiscopal see of Wellington. (S. H. F.)

IV. ADMINISTRATION AND SOCIAL CONDITIONS

1. Constitution.—New Zealand was constituted a dominion in 1907. Although the Statute of Westminster (1931) was not formally adopted until 1947 by the New Zealand parliament, the dominion had freedom to conduct both its internal and external affairs as it saw fit. In accordance with parliamentary legislation Queen Elizabeth II was proclaimed in Wellington on May 29, 1953, "by the Grace of God, of the United Kingdom, New Zealand and her other Realms and Territories Queen, Head of the Commonwealth, Defender of the Faith." This now declared the British monarch's specific and separate sovereignty over New Zealand, as also over other commonwealth realms. The sovereign is represented by the governor general, whom the former appoints after consulting the New Zealand government. Representing a constitutional monarch, the governor general must be guided by the advice of the New Zealand cabinet; while he does not "govern" and his functions are formal, his signature affixed to an act of parliament or order in council expresses legislative or executive decision.

2. Central Government.—There were in the early years six distinct settlements—Auckland, Wellington, Nelson, New Plymouth, Canterbury and Otago—between which communication was for long irregular and infrequent. To meet their political needs the Constitution act of 1852 made them into provinces, with elective councils and superintendents subordinated to one colonial legislature. In 1876 the provincial system was abolished and full control passed to the legislature, usually known simply as parliament, which consisted of the legislative council (the upper house) and the house of representatives (the lower house). The members of the legislative council were appointed for seven years by the governor general on the advice of the cabinet. Women became eligible for appointment in 1941. As in the case of the United Kingdom house of lords, the legislative council could not initiate or amend taxation and revenue bills, and most legislation was first introduced in the lower house. In 1951, however, the legislative council was abolished.

The house of representatives has 80 members, four of whom are Maori. After each population census the 76 European electorates are readjusted according to population distribution, and following the 1961 census there were 52 European seats for the North Island and 24 for the South Island. In 1937 the normal life of parliament was fixed at three years. Women became eligible as members in 1919 and public servants in 1936, the latter with the provision that if elected they immediately ceased to be public servants. An elector must be a British subject resident for one year in

New Zealand and for three months in the electoral district in which he claims to vote.

Registration became compulsory in 1924. The Electoral Amendment act of 1937 introduced a secret ballot for Maori voters, who enjoy the same electoral privileges as non-Maoris in electing the representatives of the four Maori electorates. In 1948 a further amendment was made to provide for the registration of Maori voters.

Executive administration is conducted on the principle of the British parliamentary system, that is, executive power is vested in a cabinet (the members of which, with the governor general, also constitute the executive council) responsible to the elected legislature—the house of representatives. The cabinet, chosen from members of the majority party in the house, consists of the ministers or "political heads" of departments of the government. The Maoris are usually represented by one member in the cabinet. Members of the house of representatives are paid.

3. Local Government.—With the abolition of provincial administration in 1876 (*see* above) the dominion was divided into 63 counties, with provision for elective councils to deal with such primary needs as road and bridge building. For local administration the 63 counties were later subdivided into 121 and, in addition, there were 143 borough councils (for areas not greater than 9 sq.mi. having a population of at least 1,500), 11 dependent town districts (where there were 50 householders in an area of not more than 2 sq.mi.) and 15 independent town districts (having a population of 500). Besides the 121 counties, and the boroughs and independent town districts within them forming separate administrative entities, there were numerous autonomous, overlapping districts formed from parts of counties (concerned with roads, drainage and rivers) and others made up of groups of adjacent districts

ADMINISTRATIVE LAND DISTRICTS OF NEW ZEALAND

of other types united for a common purpose. By 1962 there were 952 local authorities functioning.

The provincial districts of Auckland, Hawke's Bay, Taranaki and Wellington in the North Island, and Canterbury, Marlborough, Nelson, Otago and Westland in the South Island are merely historic divisions which serve as convenient units for a primary geographical breakdown. The 12 land districts into which the country is divided for the administration of crown land correspond to the provincial districts except that Auckland is split into North Auckland and South Auckland, Hawke's Bay into Hawke's Bay and Gisborne, and Otago into Otago and Southland. *See* separate articles on the districts.

4. Political Parties.—After the coalition in 1931 of the Liberals and Reformers, only two parties were represented in parliament: the Labour party; and the National party. Other parties, such as the Social Credit party, contested elections but failed to gain representation. The Labour party, like its counterpart in the U.K., derives its strength chiefly from trade unionism and the urban industrial electorate, while the National party depends mainly on rural interests, merchants and employers. But the policies of both parties make it necessary for them to win the support of a large middle-class element. The parties base their policies and programs largely on annual conferences attended by their members of parliament and by the district representatives of the party organizations. (W. B. Pn.; A. T. Cl.)

5. Labour Legislation.—As a result of the legislation of the Liberal government which came into power in 1891 New Zealand acquired world fame as a land of advanced social legislation while still in the pioneer stage of economic development. The labour code, established principally by the Industrial Conciliation and Arbitration act of 1894, provided for the settlement of industrial disputes by judicial means and not by strike action and enabled working conditions to be modified to meet changes in the economy without constant recourse to acts of parliament. The system of compulsory arbitration was modified to the point of abolition during the depression of the 1930s. It was restored by an amending act of 1936 which also empowered the court to fix basic wage rates for adult workers and, where practicable, to fix the work week at 40 hours (exclusive of overtime). Union membership was made compulsory until 1961, when the legislation was modified. During World War II strikes and lockouts were illegal. The position of the unions is also regulated by the Trade Union act of 1908, largely based on the corresponding British act of 1871. The unions that have exerted the greatest pressure are those of the transport workers, miners, seamen and waterfront workers. As a result of the serious waterfront strike of 1951 legislation was passed to ensure democratic control of unions. It provided for the election of officials by secret postal ballot and gave the state power to require a secret ballot to be taken at any stage during a strike. After 1944 all workers had a minimum paid holiday period of 14 days annually.

6. Social Security.—New Zealand's Old-Age Pensions act (1898) was the first such measure in any British country. Widow's pensions were introduced in 1911; pensions were granted in 1915 to miners incapacitated through miner's phthisis or other occupational disease; in 1926 allowances were granted to families having more than two children and limited incomes; blind persons and chronic invalids also received pensions. The Social Security act of 1938 increased the rates of the various noncontributory civil pensions and placed them on a universal contributory basis. It also introduced a universal superannuation scheme under which benefits were paid irrespective of income received or property owned. In 1945 family benefits were made payable for each child irrespective of income or number of family. In 1948 many New Zealand social security benefits were put on a reciprocal basis with those in Australia and family benefits only were made reciprocal with the United Kingdom. A reciprocal agreement for other benefits took effect from April 1, 1956. New Zealanders pay 1*s.* 6*d.* in each £1 of income to the Social Security fund which is also supplemented from general revenue.

Hospitals and Health.—Before 1938 the expenses of hospital boards were met by payments from local ratepayers, government

subsidies and contributions from those patients who were able to pay. By the Social Security act the responsibility for the patient's share was transferred to the Social Security fund. The contribution of local ratepayers was reduced in the mid-1950s and after 1958 the entire cost was borne by the state.

Under the social security scheme every person is entitled to medical treatment. Medicines prescribed are free. Maternity benefits include antenatal and postnatal advice and treatment, attention at confinements and treatment and maintenance in hospital. In private hospitals part of the fee for treatment and maintenance is covered by the Social Security fund.

Housing.—Through the state advances department, created in 1894, the government lent money for the purchase of homes and the improvement of farms. In 1934–35 the department was reconstituted as the Mortgage corporation, some private share capital being subscribed, but in 1936 the State Advances corporation was founded, with the elimination of private share capital and the liberalizing of advances. The government undertook direct home building in 1937. While actual erection was by private builders the purchase of land and the designing and letting of houses were carried out by the state. From 1950 tenants were given the opportunity of purchasing these state houses. The housing shortage became acute during World War II and continued after the war.

7. Justice.—The chief justice of New Zealand and a number of puisne judges constitute the supreme court and court of appeal. There are also three special courts—arbitration, compensation and land valuation. Magistrates' courts have both civil and criminal jurisdiction, but more serious criminal cases are not tried summarily but are sent to the supreme court for trial or sentence. Maoris may use their own language in court. The police force, which is a national organization, and the national police training school are maintained wholly by the central government. In 1962 New Zealand appointed its first "ombudsman," an official who examines complaints against the state.

8. Education.—The Education act of 1877 made state education in New Zealand free, secular and compulsory between the ages of 7 and 14 (in 1944 raised to 15). It is controlled by a state education department and local education boards.

Kindergartens.—Children between the ages of three and five may be enrolled at free kindergartens maintained by the Free Kindergarten association. The government makes annual grants toward the support of the kindergartens, but the system is far from universal. In the 1960s there were about 15,000 children on the rolls in about 200 free kindergartens.

Primary Schools.—Entry to primary school is permissive from the age of five. All state primary schools are coeducational. The syllabus of instruction includes elementary science, agriculture and cultural subjects. Older boys receive instruction in woodwork and metalwork at manual-training centres, and older girls are taught domestic subjects. In country districts where the numbers do not warrant separate secondary schools, older pupils attend district high schools, which are under the same control as the primary schools. In addition, intermediate schools provide varied and enriched courses for older children to help them decide on their lines of further education.

Postprimary Schools.—In 1936 free postprimary education to the end of the year in which he is 19 was offered to every child completing a primary-school course or attaining the age of 14. About 94% of children leaving public primary schools proceed to full-time postprimary schooling. Postprimary (secondary) schools are termed grammar schools in Auckland, colleges in Wellington and high schools in the North Island and over most of the South Island. A secondary and a technical school amalgamated under a single governing body is known as a combined school. Technical schools fall roughly into two types: those in the small centres distinguishable from secondary schools only by a more strongly developed practical side; and large technical schools in the main centres—where city secondary schools provide an academic curriculum. In 1938 the government assumed responsibility for vocational guidance at postprimary schools.

Rural Education.—Country children, as far as practicable, receive the same educational facilities as town children. Small rural schools have been consolidated and school buses or free railway passes are furnished. Correspondence classes are conducted for those in remote areas, and broadcasting is much used. Country teachers are better paid, and every city teacher, to qualify for promotion, serves three years at a country school. The teaching of agriculture is a special feature in rural schools, and projects are undertaken by boys' and girls' agricultural clubs.

Private Schools.—In 1922 registration of private schools was made compulsory and standards of efficiency and suitability were imposed. The majority of the private primary schools are conducted by the Roman Catholic Church. That denomination and the Anglican and Presbyterian Churches maintain their own secondary schools, generally boarding establishments. Some of the private secondary schools are endowed and run on English public-school lines and the headmasters of some of the boys' schools belong to the Headmasters' Conference of Great Britain. Of such schools Christ's college, Christchurch (1850), is the oldest. Others are King's college, Auckland (1896), and Wanganui Collegiate school (1854).

Maori Education.—In 1879 the department of education took over direct control of Maori education. The system has contributed much to the progress of the Maoris. More than half the Maori children attend public schools with white children. The remainder attend Maori schools which number about 150, with a primary enrollment of about 12,000. Maoris are entitled to free secondary education in postprimary schools and in the 11 Maori secondary schools and to postprimary education of a practical nature in 10 Maori district high schools. The Maori has complete equality in citizenship with Europeans and a time can be foreseen when Maori schools will be absorbed by the general system.

Higher Education.—The University of New Zealand, founded 1870 as an examining body and refounded 1926 as a federal university with constituent universities and university colleges, was dissolved by act of parliament effective Jan. 1, 1962, and its constituent institutions became autonomous universities: University of Auckland (1882), Victoria University of Wellington (1897), University of Canterbury (1873) at Christchurch and University of Otago (1869) at Dunedin. Although each provides the customary degree courses in arts and science, Auckland specializes in architecture, engineering and fine arts; Victoria in political science, public administration and social science; Canterbury in engineering and fine arts; and Otago in medicine, dentistry, home science, mining and physical education. The two agricultural colleges that had been associated with the University of New Zealand became university colleges of agriculture: Lincoln college (1878) became a constituent college of the University of Canterbury; Massey University College of Manawatu, at Palmerston North, founded 1963 by merger of Massey College (1926) and Palmerston North branch of Victoria University of Wellington (1960), became associated with Victoria. An extramural branch of Auckland became independent in 1964 as the University of Waikato.

Adult Education.—The Workers' Educational association was the pioneer of adult education classes, working with the then university colleges through tutorial classes. A National Council of Adult Education supervises grants to the university areas where local directors of adult education organize adult classes in a variety of subjects. Similarly, postprimary schools extend the night classes to cover nonvocational subjects.

Educational Research.—With the financial assistance of the Carnegie Corporation of New York, the New Zealand Council for Educational Research was founded in 1933, given statutory existence in 1944 and since 1945 has received government support. Research is also fostered through the assistance of traveling grants under schemes provided by the Imperial Relations trust of the United Kingdom and the U.S. Fulbright grant scheme.

9. Defense.—In the South African War of 1899–1902 New Zealand sent ten contingents of mounted rifles numbering 6,495 officers and men. In 1909 compulsory training in peacetime was introduced and in 1914 New Zealand joined in World War I. A total of 98,950 men went overseas, serving in many parts of the world, notably at Gallipoli (where the title Australian and New Zealand Army corps was condensed to the famous "Anzac") and

in France; 16,697 lost their lives on active service.

Compulsory military training in peacetime was suspended in 1930 and New Zealand faced the beginning of World War II with a voluntary territorial force together with the New Zealand division of the Royal Navy (established 1920) and the Royal New Zealand Air Force (established as a separate service in 1937).

World War II.—New Zealand immediately joined the United Kingdom when Germany attacked Poland. In June 1940 both home and overseas service were put on a compulsory basis. The New Zealand second division (as the new expeditionary force was called) suffered severe casualties in 1941 in Greece and in Crete where the defense of the island was entrusted to its commander, Maj. Gen. B. C. (later Lord) Freyberg. Later in the year the division took part in the advance into Libya. In June 1942 it played a decisive part, at Minkar Kuaim, in stemming the Axis advance into Egypt. It was an assaulting division at El Alamein and was prominent in the pursuit of the Axis forces until their surrender in Tunisia. In Oct. 1943 the division crossed to Italy where it saw further hard fighting—particularly at Monte Cassino—until the end of the war.

The 3rd division, formed for action in the Pacific, took part in operations in the Solomons. The New Zealand naval forces (designated the Royal New Zealand Navy in 1941) took an active part in hostilities from Dec. 1939 when the New Zealand cruiser "Achilles" joined in the battle of the River Plate against the German pocket battleship "Admiral Graf Spee." Seven squadrons of the Royal New Zealand Air Force served in Europe with the R.A.F. and 26 with the U.S. forces in the Pacific. In all, 135,000 New Zealanders served overseas, 10,130 were killed, 19,345 wounded and 8,086 taken prisoner. Although conscription did not apply to the Maoris, 7,000 of them served voluntarily.

Apart from its fighting men, New Zealand's main contribution was in the maintenance of supplies of meat and dairy produce on which the U.K. depended. To assist the large U.S. forces stationed in New Zealand and elsewhere in the Pacific from 1942, substantial assistance was given by New Zealand under reciprocal aid both in defense construction and the supply of foodstuffs.

Postwar.—In 1949 all male New Zealanders were made liable for a 14-week period (altered to 10½ weeks in 1956) of military training on becoming 18, followed by 60 days' service over the next three years. The introduction of compulsory training made possible the organization and training of a division in peacetime.

In fulfillment of its obligations under the United Nations charter New Zealand sent troops and warships to join the United Nations forces in Korea. New Zealand also supplied some officers for the Fiji military forces. Following the Southeast Asia Defense treaty of Sept. 1954 and the commonwealth prime ministers' conference of Jan. 1955, there was a redirection of New Zealand's defense effort, when the country's commitments in the middle east were transferred to the southeast Asia area.

In 1958 compulsory military training was abolished but in 1961 a form of selective national service for the army was reintroduced. Close co-operation on defense existed between New Zealand, Australia, the U.K. and the U.S. In the mid-1960s a small New Zealand force was serving in Malaysia. (A. T. Cl.)

V. THE ECONOMY

A. Production

The economy of New Zealand is extremely dependent on specialized production, especially of primary products, on their disposal overseas and on the large volume of maritime commerce entailed. The thriving trade is the basis of the high standard of living.

During the 1950s the net value of output of the primary-produce processing and other manufacturing industries exceeded that of the farming industries. By 1960 the former represented more than 20% of net national income at factor cost. Employment statistics suggest that agriculture and manufacturing are of about equal importance in the economy: more than a quarter of all those in active employment (23% of them females) are employed in manufacturing; 16% are employed in the primary industries (about 14% in agriculture and livestock production and the rest in forestry, fishing, hunting, mining and quarrying). Nearly 60% of the population are engaged in building and construction, transport, trade and commerce and services.

1. Agriculture.—New Zealand has essentially a pastoral agriculture, based primarily on introduced pasture grasses, the maintenance of productive swards and the support of large numbers of domestic livestock. No other country has so swiftly and so completely and successfully been converted from a pre-European forested land into a land of productive pasture. No other country has nearly so much livestock in relation to its human population.

Of the total area of 66,390,700 ac. of New Zealand proper (including the minor islands) 43,666,746 ac. are in occupation (excluding land within borough boundaries and in holdings of less than 10 ac.). Of the occupied area, more than 21,000,000 ac. are in cultivation, including nearly 19,000,000 ac. in sown grasses and clovers used for grazing, hay, seed or silage. Of 23,316,416 ac. of unimproved occupied land, more than 13,000,000 ac. are in native tussock and other grasses, much of it used for grazing. Thus almost 70% of the occupied land (45% of the total area) is devoted directly to the support of livestock. In addition much of the arable crops is used to feed livestock. Less than 1% of the occupied land is devoted to cereal crops; less than 2% to green, root and other fodder crops; and only 16,000 ac. to orchards. In addition, nurseries and market gardens and specialized crops (grapes, hops, passion fruit, etc.) take 17,000 ac. and private gardens 80,000 ac.

Although the acreage of farmland occupied and of sown grasses and annual crops changed little after 1900, the number of sheep and cattle (though not of pigs and horses) increased remarkably, indicating the improved carrying capacity of farmland. Dairy cows increased from 634,000 in 1911 to about 2,000,000 in the 1960s, and sheep from 24,000,000 to nearly 50,000,000. The growth of livestock thus kept pace with the growth of human population but the carrying capacity of the land was doubled. No more men are employed on the land to handle twice the number of sheep and three times the number of cattle kept in 1911. Of importance in this increasingly efficient farm production have been a high degree of specialization; the lavish use of artificial fertilizers (especially lime and superphosphates); the breeding of new and improved grasses and clovers; the discovery and elimination of soil deficiencies; careful selection of breeding stock for performance rather than appearance; the emphasis in pasture management on intensive rotational grazing practices; careful conservation of surplus spring and early summer herbage by the mechanized making of hay and silage; and, latterly, the widespread use of aircraft for top dressing with artificial fertilizer, especially of inaccessible hill-country pastures.

Intensive dairy farming on single-family farms of 75–100 ac. closely subdivided, usually in mild, coastal areas and at lower elevations, is characteristic of the North Auckland peninsula, the Waikato, the Bay of Plenty, Taranaki and parts of the Manawatu. Most dairy cows are grade (nonpedigree) Jerseys. Annual exports of dairy produce are about 160,000 tons of butter, 100,000 tons of cheese and 75,000 tons of processed milk products (dried milk, casein, etc.).

Farms with emphasis primarily on breeding and rearing sheep are fewer, much more variable in size and generally much larger than dairy farms. They occur in all occupied portions of the country: in the windswept, peaty Chatham Islands, in the tussock alpine high country of the South Island, on the deforested and fast-eroding hill country inland of Poverty bay and on the subtropical, winterless gumland soil of North Auckland. The fattening of prime "Canterbury lamb" may also be practised on dairy farms. The tussock grazing lands—crown leaseholds—are often held in blocks as large as 50,000–80,000 ac. and carry 10–20 fine-wooled sheep per 100 ac. Typically North Island hill country, on which pastures of rye grass, browntop or the native danthonia and white clover have replaced the indigenous bush, is subdivided into farms of 500–5,000 ac. and carries Romney flocks, reared for both wool and meat, at a density of 1–5 ewes per ac.

The Canterbury plains and downland and parts of east Otago

and Southland—drier leeward South Island situations—have characteristically a mixed crop and livestock farm economy in which some combination is made of cash crops (wheat, oats, barley, peas, flax and grass and clover seed), fodder crops (turnips, lucerne, chou moellier, lupins, rape) and rotational pastures, either for grazing a ewe flock, for fattening store lambs or for the support of a small dairy herd (especially in Southland).

Fruit growing and horticulture, overshadowed by the large-scale export farm activities, have in favoured localities proved successful. Abundant sunshine and economic factors (including transport costs and access to internal markets, processing factories or ports) explain the prominence of Hawke's Bay (Hastings), Nelson, central Otago and the suburban districts. About 2,000,000 bu. of apples and pears are exported annually and following World War II there was a remarkable expansion in the canning, preserving and quick-freezing of both fruit and vegetables.

2. Forestry.—The forest industries are of growing significance to the economy and are based on two distinct types of forest—the remnants of the indigenous forest ("bush") and the planted exotic forests. The scattered acres of indigenous forests contain little tall and millable timber and are suitable only for regulating stream flow and erosion control. The exotic plantations of nearly 1,000,000 ac. are concentrated largely on the volcanic plateau in rapidly maturing stands of Monterey pine (*Pinus radiata*) and other North American conifers planted mostly between 1926 and 1935. Kaingaroa state forest (260,000 ac.) is claimed to be the world's largest artificial forest. It was planted with conifers in the 1920s–1930s on infertile pumice soil in the centre of South Auckland. Exotics account for nearly two-thirds the annual cut and the proportion is increasing. Numerous small and often temporary mills handle the cut of indigenous timbers, while a few large units cutting 20,000,000 board feet annually process the exotic cut.

Timber resources assumed vastly increased importance with the establishment in South Auckland between 1939 and 1959 of modern integrated pulp and paper industries. These have brought new communications and towns to a region long neglected, and contribute significantly to New Zealand's economy. By the 1960s timber products ranked as important in New Zealand's exports as the traditional product, cheese.

3. Fisheries.—New Zealand has a long coastline but a small and narrow coastal shelf. Much of the west coast is exposed and has few sheltered harbours. Fishing is done chiefly from east-coast ports (Auckland, Thames, Timaru, Gisborne, Napier, Wellington, Kaikoura, Lyttelton, Akaroa and Bluff) and off eastern shores. Most fish is caught in shallow water by motor trawlers. The most important of the wet fish caught are Australian snapper (*Chrysophrys auratus*), tarakihi (*Cheilodactylus macropterus*), hapuku (groper, or *Polyprion oxygeneios*), blue cod (*Parapercis colias*), flounder and gurnard. Crayfish, oysters, whitebait and whales assume economic importance. A shore whaling station operates in Tory channel (Queen Charlotte sound) and crayfish tails, exported to the United States, are a significant dollar earner. The east-coast waters of the North Island are renowned for big-game fishing and Lakes Taupo and Rotorua for brown and rainbow trout which were successfully introduced.

4. Mining.—To the Maoris, nephrite (greenstone) and obsidian were the most important minerals. In the period of European settlement first gold and then coal proved of outstanding significance. Gold provided capital and attracted population for the development of the country. Coal, even in the days of large hydroelectric plants, continues to supply a significant but declining proportion of the energy required. Important reserves include manganese, tungsten, uranium, titanium ironsands and bauxite clays. The ilmenite sands on the west coast of the South Island are estimated to contain 43,000,000 tons of ilmenite, and the black iron sands on the Taranaki and Auckland coast as far north as the Manukau river are estimated to contain 800,000,000 tons of titanomagnetite assaying at 50–59% iron and 5–10% titanium. About 3,000,000 tons of coal are produced annually, mainly on the Waikato, in Westland and in Southland. Gold production is declining and annual output is only about £N.Z. 350,000.

5. Power.—Mountainous, well watered and favoured with natural lake reservoirs, New Zealand is generously provided with water power and with suitable sites for generating hydroelectric power. But such sources are badly distributed, with the greatest potential in Fiordland and the Otago-Southland lake district while the main demand comes from the populous northern half of the North Island. Petroleum production is negligible, so that petroleum figures prominently among the imports of a country which in relation to population has more oil-burning motor vehicles than all except two other countries. Coal remains an important source of energy—especially for industrial and domestic use, and for gas and by-product manufacture. The 1950s saw the harnessing of underground sources of geothermal steam for electric power generation at Wairakei in the thermal belt of the North Island.

Hydroelectric generating stations are owned and operated by the government, which supplies power in bulk to regional and urban public supply authorities. In the 1960s the installed capacity of the government hydroelectric stations totaled nearly 1,500,000 kw., more than half of it on the Waikato river, and two-thirds in the North Island. Electricity generated for public supply totaled almost 9,000,000,000 kw.hr. or about 3,500 units per head of population. This is a high figure in view of the limited development of heavy industries, and in fact two-thirds of the consumption is not in factories but in homes and on farms. Domestic demand alone takes almost 50% of the supply, most of it for water and space heating.

In the early 1960s tests at oil wells drilled near Kapuni in Taranaki confirmed the existence of a natural-gas reservoir estimated to be capable of yielding about 100,000,000 cu.ft. of natural gas daily. Distillate from the gas was to be refined at Whangarei. If gas could be piped to Wellington and Auckland it was expected to meet half New Zealand's needs.

6. Industries.—Industrial development in New Zealand has long been hampered by the small size of the market, the lack of basic raw materials, successful competition from overseas, the ease of importing in exchange for primary-product exports and the availability of return shipping space for manufactured goods.

World War II and the shortages it occasioned stimulated industrial output. Encouraged by government policy, monetary exchange controls, import licensing, the development of hydroelectric resources, the immigration of skilled workers, the influx of overseas capital, the growth of the internal market (both in wealth and in size), the growing tendency to process primary products before export, the availability of new raw materials like softwood timber and domestic pulp for newsprint manufacture, factory industries made such strides in the period 1940–60 as to surpass primary industry both in general economic importance and in the numbers employed. Although during the period the population increased by nearly 50%, the volume of industrial production increased nearly threefold and its employees doubled in number. This development relied increasingly on imported raw or partially processed materials. But manufacturing is still organized on a relatively small scale. Nearly two-thirds of the 9,000 manufacturing establishments had individually ten workers or fewer in the 1960s, when manufacturing industries absorbed 190,000 persons (including 48,000 females) out of a total employed population of 900,000. Farming and other primary industries then employed 144,000 persons. Industrial employment is distributed among the urban centres approximately in proportion to total population, with the largest single concentration in Auckland.

The most important are the food industries, including meat freezing and preserving and butter, cheese and other milk-product manufacturing. These employ nearly one-fifth of those engaged in manufacturing and contribute nearly 40% of value of manufacturing output. In numbers employed other industries rank in the order: transport equipment assembly and repair; clothing and footwear; machinery; timber products (excluding furniture); printing and publishing; and mineral products. (K. B. C.)

B. Trade and Finance

New Zealand has always depended on overseas trade for its development; about 30% of the national income is derived from exports. Although secondary industries play an increasing part, ...

main exports continue to be agricultural and pastoral products—a development that began toward the end of the 19th century with the introduction of refrigerated shipping. The value of total trade per head of population is among the highest in the world, amounting to about £N.Z.250 (exports and imports combined) in the 1960s.

New Zealand is thus particularly sensitive to changes in world economic conditions. Prosperity largely depends on export and import prices, which are determined by market conditions outside New Zealand. Moreover, exports are confined to a relatively narrow range of products which are subject to considerable price fluctuations. Export prices have sometimes dropped 15–20% in one year, thus necessitating a corresponding reduction in imports, though the reduction may be tempered by drawing upon external exchange reserves or by temporary overseas borrowing.

1. Imports.—More than 80% of New Zealand's imports normally consist of articles wholly or mainly manufactured, a large proportion of them being goods (such as vehicles and tractors) that could not be produced economically in the country. In addition, many imports of manufactured or semimanufactured goods form the raw material of further factory processes in the country (*e.g.*, cotton piece goods). The principal imports are textile piece goods and drapery, metals and machinery, sugar, tea, alcoholic liquors, tobacco, paper and stationery, oils, motor vehicles and accessories, chemicals and drugs and manufactured fertilizers.

Most of New Zealand's imports come from the more highly industrialized countries, nearly 40% coming from the U.K. The next most important suppliers are Australia, Asian countries, the U.S. and European countries.

Customs Tariffs.—New Zealand is a moderate tariff country and about half its imports enter free of duty. Customs tariffs maintained are a general tariff, a most-favoured-nation tariff at lower rates, and preferential tariffs at still lower rates applying to imports from Commonwealth of Nations countries. The preferential tariff margin, which fostered much of the development of imports from other Commonwealth of Nations countries, is subject to periodic negotiations in the General Agreement on Tariffs and Trade (GATT) to which New Zealand is a party. Tariffs are administered by the customs department, which collects about 15% of total taxation by this method.

Import and Exchange Controls.—These controls may be applied to meet serious declines in overseas funds resulting from falling export receipts. If the prices of principal export commodities fall heavily, the country cannot easily provide all the overseas funds normally required to pay for imports. Control of imports by licensing was introduced in 1938 to give priority to essential imports and to keep payments within the funds available. This system continued throughout World War II and the early postwar years. By 1951 most of the licensing control was removed. A similar system, in the form of exchange allocations operated through the banks, was reintroduced following a balance of payments crisis in 1952. Relaxation was almost complete by 1958 when import licensing was again applied and it was substantially tightened in 1961. The application of import and exchange controls is a matter for consultation by New Zealand with the other parties to GATT.

2. Exports.—About 90% of the total value of exports derives from wool, meat and dairy produce. Wool usually constitutes one-third of total exports by value, dairy produce and meat about one-quarter each.

New Zealand wool is principally of crossbred variety, although fine wools are also grown. Dairy produce consists mainly of butter and cheese, but includes dried milk and casein. In the meat trade, New Zealand is famous for high quality lamb and mutton, together with beef, veal and pork. Most of this is exported in frozen form, but better quality beef is merely chilled so that it reaches its destination more like fresh meat.

Other traditional exports are hides, skins and pelts; fish and fish liver oils; apples; peas; grass and clover seeds. Newer exports are forest products, most of which go to the Australian market as timber and paper products, particularly newsprint, kraft paper and pulp.

Wool has always been competed for at auction by a number of countries. The U.K. has been the main traditional market for wool, meat and dairy produce, but other major markets have been developed in Europe, North America, Australia, Asia and the far east. There is an expanding trade in the products of the exotic timber industry, including pulp and paper.

3. National Finance.—Income tax consists of two parts: a flat rate social security income tax of 1*s.* 6*d.* in the pound on all salaries, wages and other income; and a graduated ordinary income tax. All wage and salary earners have tax deducted at the source on the "pay as you earn" system. Other principal sources of revenue are customs duties, beer duty, sales tax, estate and racing duties, interest, profits from trading, and departmental receipts. The largest single revenue item is the income tax. Government revenue amounts to about 35% of national income.

Government Expenditure.—The most costly item of expenditure is represented by the social services. The growth of this program each year has been considerable and represents over 50% of total government expenditure. The item included expenditure on health and public hospitals, education, war pensions and social security. The government contribution toward the social services reflects the extent to which the conception of the welfare state has expanded.

Other expenditures include interest and repayment of debt; works and other capital expenditure; subsidies to stabilize the cost of living in consumer goods; maintenance of public works and services; and expenditure on roads. The remainder represents the cost of general government administration, including defense.

Investment.—The population is increasing at a rate of more than 2% annually and construction work and capital investment must maintain high levels to meet the demand for more production from farms, forests and factories. New Zealand invests more than 20% of its gross national product each year in the provision of capital assets. House and commercial building is at a high level; electrical generating facilities are being doubled in less than ten years; communications are being extended and improved; provision is being made for increasing numbers of students at schools and universities. About 13% of the gross national product goes to private investment and 9% to public investment.

Government capital projects in 1963–64, for example, costing £N.Z.81,000,000 included: electricity; land settlement; house construction; education buildings; railways; telephones and telegraphs; and forest development. The program is financed partly from revenue, reserves and miscellaneous receipts, but principally by borrowing through long-term internal and overseas loans.

Public Debt.—The outstanding public debt in 1962 for the first time exceeded £N.Z.900,000,000. Of this about 84% was held in New Zealand (53% by government departments and 31% by the public), 14% in the U.K. and the remainder in the United States. Except for £N.Z.240,000,000 raised for war purposes, most of the debt was incurred for productive projects and development and is represented by revenue-producing assets such as railways, hydroelectric plant, telephones and housing.

(G. D. L. W.; A. C. Ss.)

4. Banking.—The banking institutions of New Zealand are the Reserve Bank of New Zealand, five trading banks, the Post Office Savings bank and eight trustee savings banks. The Reserve bank, which began operations on Aug. 1, 1934, is state owned. As the central bank, it is authorized to control credit, currency, the transfer of money to and from New Zealand and the disposal of export receipts held overseas. It also has the duty of maintaining a high and stable level of activity in New Zealand insofar as this can be effected fiscally. Between 1939 and 1950 the minister of finance could issue directives to the bank on any aspects of central banking practice or policy. In 1950 the law was amended to require the bank to implement resolutions of parliament in respect of its functions or business. The right of note issue was transferred from the trading banks to the Reserve bank on its establishment. The bank also issues and regulates the supply of coin and since 1936 has managed the public debt.

Two of the trading banks, the Bank of New Zealand and the National Bank of New Zealand, are incorporated by acts of the

New Zealand parliament. All the share capital in the former, which had been partly state owned, was acquired by the government in 1945. It conducts more than 40% of banking business. The other three banks are predominantly Australian institutions. All five banks maintain branches and agencies throughout the country.

Following the assumption by the Reserve bank in 1934 of the sole right to issue notes, the trading-bank notes were withdrawn from circulation. Until 1950 the Reserve bank was required to maintain a minimum reserve of 25% of the aggregate amount of the notes and other demand liabilities. This obligation was abolished in 1950 and the bank was required to hold such reserves as, in the opinion of the board of directors, would provide a reasonable margin for contingencies. "Reserve" is defined as gold coin and bullion, sterling exchange, net gold exchange and net holdings of currencies freely convertible into sterling. From 1933 to 1948 exchange rates were based on a selling rate of £N.Z.125 = £100 sterling but from Aug. 1948 the New Zealand pound was at parity with sterling.

In 1938, to meet a serious fall in overseas reserves, control over foreign exchange was introduced in conjunction with export and import licensing regulations. The exchange control system was extended in 1940 as a war measure and continued with modifications after the war. Under the system, administered by the Reserve bank with the trading banks acting as its agents, foreign currency receipts for export must be paid to a bank; payments for imports are not subject to exchange restrictions (though, as mentioned above, the imports themselves may be subject to licensing); other payments within the sterling area are not restricted except capital exports by New Zealand residents and travel allowances; remittances to countries outside the sterling area are treated on their merits; interest, dividends and profits may be remitted to any country but capital movements are strictly controlled; the export of money is subject to permission but the importation of money is not limited; dealings in nonsterling securities held by residents are subject to Reserve bank approval and the bank is empowered to acquire such securities if necessary.

In pursuance of its function of controlling credit in New Zealand, the Reserve bank introduced in 1942, with the co-operation of the trading banks and as an official measure, a selective control over bank advances aimed at combating speculation and other activities inconsistent with the war effort. This control was continued after the war to avoid expenditure for nonessential purposes or for financing capital expenditure for which other funds were available. The policy was subsequently modified to meet changing conditions and in 1952 was supplemented by increasing the cash balances which the trading banks were required to hold at the Reserve bank. Up to 1952 each bank had to maintain a balance of not less than 7% of its demand liabilities and 3% of its time liabilities. In subsequent years these ratios varied with the trend upward and in the early 1960s stood at about 30% and 10% respectively. The Reserve bank's discount rate is 7%.

In the 1960s the number of open accounts in the Post Office Savings bank reached more than 2,000,000 or about 80% of the population, and the deposits totaled more than £N.Z.350,000,000. Interest at 3% is paid on all deposits. The first of New Zealand's eight trustee savings banks was established at Wellington in 1846. The other seven of these nonprofit savings institutions are at Auckland, Christchurch, Dunedin, Hamilton, Hokitika, Napier and in the Waikato. In the 1960s they had more than 500,000 depositors with savings amounting to more than £N.Z.100,000,000.

In addition, all the savings banks carry national savings accounts which cannot normally be withdrawn for two or three years. They pay 3½% interest and were originally opened in 1940 to help meet war expenditure. In the 1960s these accounts totaled about £N.Z.50,000,000.

5. Coins and Currency.—Gold, silver and bronze coins of Great Britain and Australian gold coins were legal tender in New Zealand until 1935 with Australian silver and bronze in free, though not legal, circulation. New Zealand silver coins were introduced in 1933 and bronze coins in 1939, with denominations and standards of fineness as in the U.K. After 1947 cupronickel coins replaced silver. The Reserve bank issues notes in denominations of 10*s*., £N.Z.1, £N.Z.5, £N.Z.10 and a few £N.Z.50.

(D. L. Ws.; G. D. L. W.; A. C. Sb.)

C. Transport and Communications

The irregular dispersion of population through two broken and mountainous islands has made the provision and operation of modern systems of transport difficult and expensive. Most external trade is by sea. Coastal shipping between a large number of small ports, each serving small and often isolated coastal communities, persisted until the advent of modern roads and motor vehicles in the 1930s.

1. Roads.—Motor vehicles in New Zealand increased from 180,000 in 1930 to 950,000 by 1960, equivalent to one motor vehicle to every 2.5 persons, or one private automobile to every 4.4 persons—higher ratios than in any country outside North America. This growth occurred despite the necessity of importing petroleum products and vehicles and despite high import duties and gasoline tax. Of the 57,000 mi. of formed roads in the country more than 13,000 mi. are part of the national highway system and are the direct financial responsibility of the National Roads board. About 15,000 mi. are tar-sealed or concreted. Dual carriageway highways to motorway or expressway standards have been constructed on the approaches to the main metropolitan centres. With the continued increase in the number of motor vehicles and the high level of taxation on gasoline, the National Roads board, which administers about £N.Z.25,000,000 collected annually in motor taxation, has undertaken increased responsibility for the cost and design of highways and relieved the burdens of the local authorities and ratepayers.

Urban traffic volumes increased so rapidly after 1950 as to cause formidable problems. Express motorways were penetrating the heart of the cities. Multistoried parking buildings were constructed in Auckland. Commercial road services for passengers and freight cover the North and South islands.

2. Railways.—New Zealand railways date from 1863, though the decade 1870–80 saw the most energetic railroad building program. The 3,400 mi. of railways built to a gauge of 3 ft. 6 in. are owned and controlled, with a few minor exceptions, by the state. The route mileage is about equally divided between the two islands. Traffic volumes are much heavier in the North Island, and 40% of freight ton-mileage is carried on the Main Trunk line between Auckland and Wellington. In ton-miles, coal, timber, artificial fertilizers, livestock, cement, petroleum products and agricultural lime are the principal items of freight. The densest traffic, passenger and freight, is carried on the relatively short sections of line between Auckland and Frankton (Hamilton), Wellington–Paekakariki, Wellington–Upper Hutt, and Christchurch–Lyttelton. These last three sections, and the steeply graded 8½-mi. section between Arthur's Pass and Otira in the South Island, are electrified; the remainder of the system is about equally divided between steam and diesel traction.

3. Shipping.—New Zealand is linked by regular shipping services to most parts of the world. By direct routes Great Britain can be reached via the Panama canal in 33 days or via South Africa in 35 days; the voyage can also be made via Australia, the Suez canal and the Mediterranean. Regular Pacific services connect with Vancouver, Can., and San Francisco, Calif., via Honolulu, Hawaii and Suva, Fiji. Trans-Tasman services take 3½ days between Sydney, Austr., and Auckland or Wellington. An overnight ferry service between Wellington and Lyttelton (Christchurch) was in 1962 supplemented by a service carrying railway wagons (freight cars), motor vehicles and passengers between Wellington and Picton. New Zealand's mercantile fleet consists of about 500 vessels. The chief ports are Auckland, Wellington, Lyttelton and Port Chalmers (Dunedin).

4. Air Transport.—The terrain of New Zealand renders surface transport relatively slow and costly. Cook strait imposes further difficulties. Hence internal air transport, especially of passengers and mails, has proved most rewarding. The government-owned National Airways corporation operates a close network of

domestic services on which its aircraft fly more than 8,000,000 mi. annually carrying mail and about 600,000 passengers; figures which in relation to its size and population make New Zealand one of the most air-minded of nations. There are 22 airfields in regular commercial use, half of them with all-weather runways and night-flying facilities.

In addition, aerial work operators use aircraft for spreading fertilizer (about 500,000 tons annually), in distributing seed, poisoned rabbit bait, insecticides and weed killers and in dropping supplies, wire, fence posts and other equipment. Since operations started in 1949, more than 20,000,000 ac. (nearly one acre in every three) have been top-dressed with fertilizer from the air.

Tasman Empire Airways Ltd. (TEAL) and three other airlines provide New Zealand with international services. Besides operating trans-Tasman schedules it provides a feeder service from Auckland to Nandi, Fiji, connecting with trans-Pacific services and with Papeete, Tahiti. Other airlines (Canadian and U.S.) link Auckland with San Francisco, Los Angeles, Calif., and Vancouver. TEAL shares the trans-Tasman route with Qantas and BOAC. By 1959 for the first time the number of passengers entering or leaving New Zealand by air exceeded those arriving and departing by sea. International air services to New Zealand also carry freight and mail.

5. Newspapers and Broadcasting.—Improvements in transport have broken down New Zealand's isolation but New Zealanders are still avid readers of cabled news in the press. The four main metropolitan centres have both morning and evening newspapers with a daily circulation of 750,000. In addition about 35 other dailies are published in smaller towns. Transport difficulties have prevented the establishment of a national daily press but there are three national illustrated weeklies with a total circulation of about 500,000 and numerous weekly or monthly trade and technical papers.

Broadcasting is a government monopoly and was administered as a department of state under a minister of broadcasting until 1962 when a nominally independent broadcasting commission was established. About half of the 34 medium-wave and 2 short-wave radio transmitters broadcast commercial programs. In metropolitan centres there is always a choice of two radio programs and sometimes four. Regular television broadcasting began in Auckland in 1960 and was followed by programs broadcast from transmitters in Christchurch, Wellington and Dunedin. Both radio and television rely largely on "canned" programs from records, tape recordings, videotapes and films.

See also references under "New Zealand" in the Index.

(K. B. C.)

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NEXØ, MARTIN ANDERSEN (1869–1954), Danish novelist who describes working-class life with warmth and unshakable faith in the virtues of the proletariat, was born June 26, 1869, into a working-class family in Copenhagen. As a boy he worked on a farm and as a cobbler's apprentice. He attended high school from 1891 to 1893 and during 1894–96 traveled in southern Europe following an attack of tuberculosis. He taught for several years, but after 1901 he was able to earn his living as a writer. During 1923–30 Nexø lived on Lake Constance and from 1951 to 1954 in eastern Germany. He died at Dresden, June 1, 1954.

Nexø's early works are stamped with the decadence of the 1890s, especially the novel *Dryss* ("Drizzle"; 1902), though his collection of short stories, *Skygger* (1898), contained realistic descriptions of working-class life. A trip to Spain, described in *Soldage* (1903; Eng. trans., *Days in the Sun*, 1929), substituted for his pessimism a belief in the people, the labour movement and the international solidarity of the proletariat—concepts which became dominant in his life. His epic novel, *Pelle Erobreren* (4 vol.,

1906–10; Eng. trans., *Pelle the Conqueror*, 1913–16), describes the progress of a worker—"the unendowed man"—from poverty on the land to an artisan's life in a little provincial town and to trade unionism in the city. Nexø's other great novel, *Ditte Menneskebarn* (5 vol., 1917–21; Eng. trans., 1920–23), is the chronicle of a woman's destiny, fraught with suffering and sacrifice. During this period Nexø also wrote short stories collected in *Muldskud*, i–iii (1922–24).

After the Russian Revolution, Nexø sided with the Soviet Union, which he visited often and praised in his travel book *Mod Dagningen* (1923). His communism antagonized Danish public opinion. His later works include four volumes of reminiscences (1932–39) which are among the most human and best-written memoirs in Danish literature. *Morten hin Röde* (1945) and *Den fortabte Generation* (1948) continue the story of Pelle with a Communist interpretation of political events between the wars.

His motives and ideals, the universal appeal of his subjects and the warmth of his style made Nexø the best-known Danish author after Hans Christian Andersen, and his books have been widely translated.

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NEY, MICHEL, Duc d'Elchingen and Prince de la Moskowa (1769–1815), French army officer, one of the emperor Napoleon I's marshals, a military hero whose death sentence made him a martyr against the forces of reaction and political expediency, was born at Saarlouis on Jan. 10, 1769, the son of a cooper. Speaking German (his mother's language) as well as French, he worked for a time as a lawyer's clerk before enlisting in a French hussar regiment in 1788.

Ney rose to high rank in the French Revolutionary Wars before reaching the summit of his greatness in the Napoleonic Wars (*qq.v.*). His former colonel took him as aide-de-camp in 1792. A captain in 1794, he was picked out by J. B. Kléber as a hussar "partisan," and he led light cavalry and infantry in all the actions of the army of Sambre-et-Meuse to 1797, becoming general of brigade in 1796. Under Jean Bernadotte's command, he boldly took Mannheim by surprise in March 1799. He was then promoted general of division to command André Masséna's "vanguard" in Switzerland, but was wounded on May 27, near Winterthur. In August he was transferred by Bernadotte, now minister of war, to Mannheim. In temporary command in chief, he formed the small army of the Rhine in mobile brigades, with which he acted offensively as a typical hussar leader.

A division under J. V. Moreau in 1800 was Ney's first command of infantry of the line in battle; he was conspicuous at Hohenlinden. Napoleon Bonaparte, as first consul, received him cordially in May 1801; and Josephine arranged his marriage to Aglaé Auguié next year. Ney was put in charge of the political and military organization of Switzerland from Oct. 1802 to Dec. 1803; thence he was sent to command the camp at Montreuil.

On May 19, 1804, Ney was made a marshal of the empire. An admirable trainer of troops, he formed the fine VI corps which served under his orders till 1811. In 1805 his brilliant attack across the Danube at Elchingen (for which in 1808 he was created duc d'Elchingen) made the surrender of Ulm inevitable, after which he was sent to clear the Tirol flank. His premature attack at Jena in 1806 and his rash advance almost to Königsberg in Jan. 1807 were criticized by Napoleon, and his action at Eylau was ineffective; but he led the decisive attack at Friedland and was described by the emperor as the "bravest of the brave."

Ney was sent to Spain at his own request in Aug. 1808, hoping for the command in chief, and rallied King Joseph's troops on the Ebro (*see* Peninsular War). He resumed his corps in Napoleon's operations and occupied Galicia and the Asturias temporarily. He resented Masséna's supreme command (1810) and was pained by the losses of his corps; at last, after a most skilful retreat from Portugal, he refused to obey Masséna and was removed by him from his command.

In Aug. 1811 Ney was at Boulogne camp, forming the new III corps for the invasion of Russia. In 1812 he commanded the centre at Borodino and was created prince de la Moskowa (the Moskva river) on the evening of the victory. In the retreat he was a tower of strength, animating the rear guard with his sublime courage. Near Smolensk he was cut off, and his escape across the frozen Dnieper to rejoin Napoleon made him the hero of the army. At Kovno on Dec. 13 he stood in the ranks musket in hand; and he brought the last remnant to Königsberg. The strongest corps of the army of 1813 was given to him; and he commanded two corps in the battle of Bautzen—with less success than was expected. But on Aug. 23 he was called to command three corps detached before Berlin. His defeat at Dennewitz on Sept. 6 showed that he could not command an army, and in 1814 he had only 2,000 of the young guard under Napoleon's direct command. He was the most prominent of the army leaders who confronted Napoleon at Fontainebleau to demand his abdication in April 1814, though the marquis de Caulaincourt, his colleague, thought that Ney exaggerated his account of their interviews and did not want the return of the Bourbons.

Ney's conduct made him a peer and governor of Besançon for Louis XVIII under the first Restoration, but he felt the loss of his grants and was insulted by the attitude of the returned *émigrés* toward his wife at court. Hearing that Napoleon had landed again in France on March 1, 1815, he concentrated the Besançon troops with the famous declaration that the usurper should be brought to Paris in an iron cage; but on March 13, on the impulse of the moment and certainly not by premeditation, he received Napoleon's envoy, and the next day he publicly declared himself for Napoleon. He was received kindly but had no command. The army was already marching when Napoleon called him to the front. He arrived on June 13 without horses or staff and, on June 15, was sent to take charge of the two corps on the left wing. Much controversy has raged over Ney's strategy and tactics in this improvised command at the battle of Quatre Bras (*see* Waterloo Campaign).

At Waterloo, Ney was a battle leader again, not a general. He did not co-ordinate the French attacks; and when he took the initiative of engaging the whole heavy cavalry Napoleon observed that this was premature, as Ney's action at Jena had been. With the cavalry he rode in four charges up to the British squares; and he was dismounted for the fifth time in the last desperate attack of the guards. When all was lost his courage was extinguished; he made no attempt to rally the troops and left the army at once. On June 22 he shocked opinion by a despairing speech in the chamber of peers and on July 6 he left Paris with a passport to Switzerland. He decided, however, to take refuge in the Cantal, where he was arrested on Aug. 5. On hearing this news, Louis XVIII exclaimed "By letting himself be caught he has done us more harm than he did on March 13!"

Neither the king nor his ministers could resist the clamour of the ultraroyalists for blood. The duke of Wellington would not intervene. Though the court-martial declared itself not competent to try a peer, the result of trial by the peers, which began on Nov. 21, was a foregone conclusion (the young duc de Broglie—the future statesman of the July monarchy—alone voted for acquittal); but neither the members of the court-martial nor the peers were forgiven by public opinion. On Dec. 7, 1815, Ney was shot in the Luxembourg gardens, in Paris. He met his death with a soldierly dignity which effaced the memory of his political vagaries and made him, next to Napoleon, the most heroic figure of the time.

See also references under "Ney, Michel" in the Index.

See J. de La Bédoyère, *Le Maréchal Ney* (1902); H. Kurtz, *The Trial of Marshal Ney* (1957). (I. D. E.)

NEZ PERCÉ, a tribe of Sahaptin (*q.v.*) lineage on Snake river in Idaho and Oregon. The population was estimated at 6,000 in 1805. There were 1,534 on Lapwai reservation, Idaho, and 83 on Colville reservation, Wash., in 1906; the total Nez Percé population in the 1960s was estimated at 1,500, including about 1,150 reported from the reservation in Idaho. In 1877, under Chief Joseph, they fought the United States, winning some engagements and engaging in a notable but finally unsuccessful re-

treat almost to Canada. They were the largest and easternmost Sahaptin tribe and most affected by influences from the Plains Indians. *See* also CAYUSE; IDAHO: *History*.

See F. Haines, *The Nez Percés: Tribesmen of the Columbia Plateau* (1955); H. Chalmers, *The Last Stand of the Nez Percé* (1962).

NGADJU, Dayak people of southern Borneo (Kalimantan); in older ethnographies they are also called Biadju. In the 1960s they numbered about 80,000 of whom 20,000 were Christians. They inhabit the middle and lower reaches of the Kahajan, Kapuas, Barito and Katingan rivers and also the Sampit region and the upper Serujan. Settlement in the latter areas was made first by those employed as minor government officials; relatives followed, as traders, and thus the Ngadju achieved social and economic, and sometimes numerical, superiority over the original population. Their language has become the *lingua franca* of all southern Borneo, apart from the predominantly Malay coastal region.

Formerly, the villages consisted of one single longhouse, partitioned into a number of rooms for each family. The longhouse was governed by elected elders; a man came to dwell in his wife's house. Present-day villages consist mainly of separate family dwellings. These villages are impermanent, as the Ngadju practise shifting agriculture. Rice is the main crop, yams being a subsidiary, in case of failure of the rice crop. Where rattan is cultivated as a trade crop, permanent settlements arise. Trade consists mainly of bartering forest produce, supplied by inhabitants of the interior, for manufactured goods obtained from Malay or Chinese shopkeepers. The forms of wealth traditionally prized most highly are bronze gongs and large glazed earthenware jars; both objects also have a cosmological significance.

The native religion has an elaborate priestly theology; it recognizes a supreme "total" divinity, which appears in an upperworld and an underworld aspect, with the hornbill and the water serpent as its principal manifestations. In the most important ritual, the *tiwah* (feast of the dead), priestesses convey the souls of the dead to their final abode by long incantations in the spirit language. Long cycles of sacred tales are also important in the rich oral literature. *See* also BORNEO: *The People: The Dayak Peoples*; DAYAK.

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(P. E. DE J. DE J.)

NGAMI, LAKE, a shallow depression at the southeastern (southwest) corner of the 4,000-sq.mi. inland delta of the Okovango (*q.v.*) river in Ngamiland in the northwest of Bechuanaland protectorate, southern Africa. It lies 43 mi. by road from Maun, the chief town of Ngamiland, and 320 mi. from the railway through the eastern part of the protectorate. The lake was discovered by David Livingstone in 1849. Lying 3,000 ft. above sea level, it is 40 mi. long and 6–10 mi. wide.

Ngamiland is part of the great sandy Kalahari desert (*q.v.*). Around Lake Ngami the country is well timbered with scrub and long thorn trees and supports a large cattle population. The local village is Sehitwa, midway along the northern margin of the lake.

The flow of water within the swamps of the inland delta is complex, and outflow normally follows annual floods which begin in March at the head of the delta and reach the base, near Maun, about four or five months later. The Taokhe, the largest southflowing channel of the delta, is said to have been the main source of supply to the lake, but, because of blockages caused by extensive papyrus growth in the channels among the swamps, water has not reached the lake from the Taokhe since 1887. The lake is fed with floodwater from the combined Kunyere and Nghabe rivers which drain toward Lake Ngami and follow a northeast-southwest course along lines of parallel faults that form the base of the delta. These channels join at Toteng at the northeastern end of the lake. Inflow varies greatly from year to year, and is generally insufficient to maintain perennial water in the lake.

Lake Ngami has no natural outlet. If it became filled, the Kunyere and Nghabe valleys would be submerged, and any excess water would be deflected into the Botletle river, 12 mi. south of Maun.

(W. G. BD.)

NGONI (ANGONI). About 500,000 people (as of the 1960s), belonging to about a dozen groups scattered throughout eastern Africa, call themselves Ngoni. They, like the Zulus, belong to the Nguni branch of the Bantu people. Each group of Ngoni has a history of migration from the vicinity of Zululand (*q.v.*), south Africa, in about 1820–35, and their common name is derived from a praise title current in the Zululand area. The growth of the Zulu empire under Chief Shaka (Chaka) caused many refugee parties and bands led by his rivals to move outward from Zululand in search of more favourable conditions. Some, like the Fingo who entered Cape Colony (Cape of Good Hope), and the Tlokwa under Chief Mantatise, remained in the south; others, like many Ngoni, went north. Chief Zwangendaba led his Ngoni party to Lake Tanganyika, where it split into three, and the descendants of his group (the Ngoni cluster proper; pop. 350,000) are located in northern Nyasaland, in Northern Rhodesia, and in Songea and Kahama districts of Tanganyika. Chief Soshangana's Ngoni went to Gazaland, Portuguese East Africa. Mzilikazi, one of Shaka's generals, took his party of Ndebele (*q.v.*) to Southern Rhodesia, and it is probably from him that the Maseko Ngoni, now in southern Nyasaland, broke away.

Each Ngoni group formed a small independent state with a central administration based on hereditary patrilineal succession. It raided its weaker neighbours for some of its food supply, and when the fertility of its own cultivated area was exhausted, the group as a whole moved elsewhere, seeking fresh fields and pastures at the expense of new enemies.

The superior Ngoni military organization, based like that of the Zulu on universal conscription into age-set regiments, enabled them to capture many of the people whose lands they seized or pillaged. Some captives, particularly in Tanganyika, were sold to Arabs as slaves, but many were assimilated into the tribe, some achieving high rank in the army and administration. Despite losses through continual warfare, the population increased greatly, leading eventually to splits in the state and dispersal of rival segments.

Internally each state, at least among Zwangendaba's people, was divided into numerous segments, many of which were under the nominal leadership of queens. Smaller segments controlled by lords were likewise each subdivided among the several wives of the lord. Selected captives were appointed lieutenants of their lord, were placed in command of his dependents and might succeed him if he had no son. The large compact villages, with their central cattle barns, were built fairly close to one another, each village containing about 2,000 or 3,000 inhabitants. A belt of empty no man's land surrounded the settled area, isolating it from the territories of the tribes raided by the Ngoni.

At the end of the 19th century Portuguese, British and German forces invaded the hinterland where the Ngoni had been virtually unchallenged for 50 years. By 1910 all Ngoni groups had come under white control. The high density of population consonant with their former life of migratory brigandage has, under settled conditions, caused serious shortage of land, accentuated in some instances by alienation of land to whites. *See* also NGUNI.

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(J. A. Bs.; X.)

NGUNI, the largest cultural and linguistic division of the Bantu of southern Africa numbering 6,500,000 in the 1960s. They are cattle-herding, subsistence farmers who live in patrilineal homesteads or kraals (*umuzi*) which combine into localized exogamous clans. Nguni traditions say that they came from farther north and divided into four main stocks: Xhosa (*q.v.*), Ntungwa, Lala and Mbo. By 1900 tribes derived from these stocks were distributed in the three cultural and territorial areas of: (1) the southern Nguni, known to Europeans as Kaffirs; *e.g.*, the Xhosa, Tembu and Mpondo of the Transkei region of Cape of Good Hope

(pop. 2,380,000); (2) the Transvaal Nguni, called by their Sotho neighbours Ndebele (pop. 144,000); (3) the Natal Nguni (pop. 2,048,000). Warfare among the latter resulted in the ascendancy of the Zulu nation and produced migrations from Natal of Nguni under various military leaders (*see* ZULULAND). Those who moved north combined with the various non-Nguni people they conquered to become: (4) the Swazi (*q.v.*) nation formed by Sobhuza and his successor Mswazi (pop. 410,000); (5) the Ndebele (*q.v.*) nation of Southern Rhodesia (pop. 300,000); (6) the Shangana nation of Gazaland, Portuguese East Africa (Mozambique), formed by Chief Soshangana (pop. 400,000 in South Africa, figures not available for Portuguese East Africa); (7) the Ngoni (*q.v.*) cluster of chiefdoms which derive from Chief Zwangendaba and which are distributed in Nyasaland, Northern Rhodesia and Tanganyika territory (pop. 350,000). Less successful Ngoni migrants to the west became dispersed in the southern Nguni area as the Fingo (Mfengu), Bhaca, Xesibe and other tribes.

See also SOUTH AFRICA, REPUBLIC OF: *The People*.

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NIAGARA, FORT, a historic fortification in Niagara county, N.Y., U.S., on the east bank of the Niagara river where that river flows into Lake Ontario. As the strategic key to the Great Lakes it was a major military objective in the Anglo-French contest for the interior of the North American continent in the 18th century. As early as 1678–79, La Salle established a trading post there, and in 1687 the French erected Ft. Denonville, only to abandon it the following year. Ft. Niagara was built by the French in 1725–27 and rebuilt in 1756, as tension mounted over control of the Ohio valley. A British force captured the fort on July 24, 1759, in one of the most decisive battles of the French and Indian War (*q.v.*). Gen. John Prideaux, the British commander, was killed on the field and Sir William Johnson took his place. The British enlarged the fort after the war and during the American Revolution used it as a base for raids into the Mohawk valley. Along with other British posts on soil nominally American by the peace of 1783, it was not evacuated until 1796. During the War of 1812 the British under John Murray captured the fort in 1813. From its return to the United States on March 27, 1815, until Dec. 31, 1945, it was garrisoned by the regular army, except for the years 1826–36. Later the vicinity was designated Fort Niagara State park.

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NIAGARA FALLS, a city and port of entry of Welland county, Ontario, Can., on the left bank of the Niagara river opposite the falls, 43 mi. S.E. of Hamilton. It is connected with the U.S. town of Niagara Falls on the opposite bank by the renowned Rainbow and Whirlpool Rapids bridges. First named Elgin in 1853, then Clifton in 1856, the town became known as Niagara Falls in 1881. The first suspension bridge across the gorge at Niagara Falls was completed in 1855 by John Augustus Roebling (*q.v.*). In 1904 Niagara Falls was incorporated. Pop. (1961) 22,351. Its importance is largely due to the cataract, a tourist attraction and major source of electrical power for Ontario. Manufactures include chemicals, fertilizers, abrasives and refractories, silverware, cereals, machinery and sporting goods. Queen Victoria park, of the provincial Niagara Parks commission, extends along the bank of the river and includes the unique Oakes Garden theatre and carillon tower. (F. G. R.)

NIAGARA FALLS, a city and port of entry of Niagara county in western New York, U.S., is located about 20 mi. N.N.W. of Buffalo at the great falls of the Niagara river, opposite Niagara Falls, Ont.

Each year the city accommodates more than 2,000,000 visitors to the falls, which have proved to be one of the most durable and popular tourist attractions in the world. At night the falls are illuminated by multicoloured floodlights from Victoria park on the Canadian side. Behind the façade of a busy tourist mecca, however, is a thriving industrial community which converts the power of the great river into useful products enjoying both local and national importance. Electrochemical and electrometallurgical industries predominate, with chromium silicon, silicon carbide, carbon and graphite, caustic soda, chlorine, fluorine and hydrazine accounting for a major part of their output. Paper products, rocket components, storage batteries, foods and business forms are also produced. Most of the industries are located in an L-shaped section which lies along the upper Niagara river east of the city and then northward along its eastern margin.

The falls, which Jacques Cartier (*q.v.*) heard about but did not visit on his voyage of 1535, were first described by Father Louis Hennepin (*q.v.*), a Franciscan missionary who saw them in 1678. As the only break in the all-water route between the St. Lawrence river and the upper Great Lakes, the area around the falls had great strategic value in colonial times. A French fort was built in 1745 and another (Little Niagara) in 1751 to supplement Ft. Niagara (*see* NIAGARA, FORT) at the mouth of the river. In 1759 both forts were burned by Chabert Joncaire, French master of the portage, to prevent their falling into British hands. Under Joseph Schlosser, a German captain in the British army, Ft. Schlosser, part of which has been restored, was erected in 1761. Augustus Porter who purchased the area around the falls and established a gristmill in 1805, saw in the mighty cataract power that would some day build a thriving city, and so he named his settlement Manchester after the great English industrial centre. Manchester, with Ft. Schlosser, was burned by the British on Dec. 19, 1813 during the fighting on the Niagara frontier in the War of 1812, and thereafter remained a small rural community which seemed to be caught in the backwash of its larger neighbour, Buffalo. The opening of the Erie canal in 1825 seemingly doomed the region to the life of a rural tourist centre, for traffic which had once moved over the portage from Lewiston below the falls to Ft. Schlosser dwindled and disappeared, apparently taking with it any hope of an industrial future. In 1847, Porter tried to interest speculators in an attempt to build a canal for hydraulic power from the river above the falls to a point roughly one mile downriver from the brink. He failed and others went bankrupt digging that canal, completed in 18[illegible] through the tough Onondaga limestone that underlies the region. Jacob Schoelkopf bought the "ditch" in 1877 and began to sell the water to mills along the bank downstream from the falls. In 18[illegible] he installed a small generator at the base of the cliff and the true future of Niagara Falls, hydroelectric power, was found. Another great step was taken when Edward Dean Adams (1846–1931) formed the Niagara Falls Power company in 1886 to develop the potential of the falls. During World War I the Schoelkopf holdings were merged with Adams' company and the modern era of industrial growth really began. To protect their aesthetic value, the amount of water which may be diverted from either the U.S. or Canadian (Horseshoe) falls is limited by international treaty. In addition, Goat Island, which separates the U.S. and Canadian falls, several smaller islands and Prospect park, 10 ac. on the brink of the gorge, were set aside as a state park in 1885.

In 1892 Manchester, by that time renamed Niagara Falls, and the downstream village of Suspension Bridge, formerly Niagara City, were merged and incorporated as the city of Niagara Falls which in 1916 adopted a council-manager form of government. Niagara university (Roman Catholic, 1856) is located in the suburbs.

A wagon and foot bridge was constructed across the gorge in 1848 and the first railway bridge, a suspension type by John Augustus Roebling (*q.v.*), was completed in 1855. The falls have been the scene of many daring exploits since Sam Patch leaped 100 ft. into the gorge from a specially built platform in 1829. Several persons have safely plunged over the Canadian falls or ridden through the whirlpool (about 1½ mi. below the falls) in barrels. In 1859 and again in 1860 (on the occasion of the visit of Edward VII, then Prince of Wales) Charles Blondin, a French acrobat, performed on a tightrope stretched across the gorge. Probably the most amazing occurrence at the falls, however, happened in 1960 when seven-year-old Rodger Woodward was accidentally swept over the falls and survived with little injury.

Horseshoe Fall, adjoining the left (Canadian) bank, and the American Fall (centre right), alongside the right bank. The river, spanned by Rainbow Bridge (centre), flows north through the gorge toward Lake Ontario

NIAGARA RIVER AND FALLS

BY COURTESY OF THE POWER AUTHORITY OF THE STATE OF NEW YORK

The falls, separated by Goat Island, with tourist observation towers in the foreground

BY COURTESY OF THE NIAGARA FALLS AREA CHAMBER OF COMMERCE

The falls in winter, when ice plunging over the cataracts forms a bridge in the Niagara River below the American (at left) and the Horseshoe falls

Niagara Falls, with a population (1960) of 102,394, is part of the Buffalo standard metropolitan statistical area. For comparative population figures *see* table in NEW YORK: *Population*.

See also NIAGARA RIVER AND FALLS. (R. T. R.)

NIAGARA RIVER AND FALLS, flowing in a northerly direction from Lake Erie to Lake Ontario, a distance of about 28 mi., constitute part of the boundary between the United States and Canada, separating the state of New York from the province of Ontario. It is the drainage outlet of the four upper Great Lakes, whose aggregate basin area is about 260,000 sq.mi. The mean discharge of the river at its head is about 196,200 cu.ft. per second, with a range from a low monthly mean in winter of about 119,000 cu.ft. to a high monthly mean in summer of about 245,000 cu.ft. per second.

For a distance of about 5 mi. from its head the river flows through a single channel; then it is divided into two channels by Strawberry and Grand islands, the eastern or U.S. channel being about 15 mi. long and the western or Canadian channel being about 12 mi. long. At the foot of Grand Island these two channels merge into one about 3 mi. long, extending to Niagara falls (*see* below). Downstream from the falls the gorge section of the river is 7 mi. long; the river then flows across a lake plain for a distance of 7 mi., to Lake Ontario.

The river is navigable from its source in Lake Erie to the upper rapids, a distance of 20 mi. in which the river descends about 10 ft. From the head of the rapids to the brink of the falls the river descends 50 ft.; then it drops 167 ft. in the falls and descends 98 ft. farther in the lower rapids of the Niagara gorge. In the last 7 mi. the river descends less than a foot, and this section (from Lewiston, N.Y., to the mouth) is navigable. The total descent of the river, from Lake Erie to Lake Ontario, is 326 ft.

Niagara Falls.—The falls of Niagara are justly celebrated for their grandeur and beauty, and are viewed every year by over 2,000,000 visitors. The falls are in two principal parts, separated by Goat Island. The greater division, adjoining the left (Canadian) bank, is called the Horseshoe fall; its height is 158 ft., and the length of its curving crest line is about 2,600 ft. The American fall, adjoining the right bank, is 167 ft. high and 1,000 ft. broad.

The water is free from sediment, and its clearness contributes to the beauty of the cataract. In recognition of the importance of the waterfall as a great natural spectacle, the province of Ontario and the state of New York retained or acquired title to the adjacent lands and converted them into public parks.

Excellent views of the falls are obtained from Queen Victoria park on the Canadian side; from Prospect point on the U.S. side at the edge of American fall; and from Rainbow bridge, which spans the gorge about 1,000 ft. downstream from Prospect point. Visitors may cross from the U.S. shore to Goat Island by footbridge, and may take an elevator to the foot of the falls and visit the Cave of the Winds behind the curtain of falling water. The Horseshoe fall has been receding, or migrating upstream, at the average rate of nearly five feet per year in historic time.

Geologic History.—The shaping of the gorge and the maintenance of the falls as a cataract depend upon peculiar geologic conditions. The rock strata in the Niagara gorge are nearly horizontal, dipping southward only about 20 ft. to the mile. The uppermost layer of hard Niagaran dolomite is underlain by soft layers which are easily worn away, and this provides the conditions for keeping the water constantly falling vertically from an overhanging ledge during a long period of recession.

The river came into existence late in the Glacial or Pleistocene epoch (*q.v.*) when the margin of a great continental ice sheet melted back and exposed the escarpment of Niagaran dolomite rock, allowing the discharge from the Lake Erie basin to pour over it. Recession of the falls created the Niagara gorge, which extends about 7 mi. upstream from Lewiston to the present falls. The age of the gorge, when calculated by dividing its length by the average rate of recession of the falls in recent time, is about 7,000 years. Other considerations led some geologists to estimate an age as great as 25,000 years. Determinations of the age of the last glacial ice advance in the area suggest, however, that the Niagara river is about 10,000 years old. Continued recession of the falls toward Lake Erie will ultimately cause the drainage of that lake but such an event is not expected to occur within the next 25,000 years.

The Niagara gorge runs 2½ mi. N.N.E. from the Horseshoe fall to the railway bridges, and this stretch is known as the Maid-of-the-Mist pool. It has a descent of only five feet, and is navigable by excursion boats. Downstream, the river flows one mile northwest through the narrow, Whirlpool Rapids section to the Whirlpool; this section differs from the rest of the gorge because there the river intersects an old channel which was formed before the last glacial ice advance and was later filled with glacial drift. At the Whirlpool the gorge makes a 90° bend to the northeast and extends two miles, then runs one-and-one-half miles north to the foot of the Niagara escarpment at Lewiston, N.Y.

Navigation.—Water-borne traffic from Lake Erie passes through the upper single channel and the U.S. channel to Tonawanda, N.Y., to enter the New York State Barge canal. That canal, with a 12-ft. minimum depth, connects with the Hudson river and has branches which connect with Lake Champlain and with Lake Ontario.

The principal shipping between Lakes Erie and Ontario, however, passes through the Welland Ship canal which lies a few miles west of the Niagara river. It extends from Port Colborne, Ont., on Lake Erie, about 27 mi. north to Port Weller, Ont., on Lake Ontario. The minimum depth in the canal is 27 ft., and the ships which pass through it include vessels engaged in trade between the upper Great Lakes and Europe. (*See* WELLAND SHIP CANAL; SAINT LAWRENCE SEAWAY.)

Hydroelectric Power.—Canada and the U.S. agreed, in a treaty signed in 1950, to reserve sufficient amounts of water for flow over Niagara falls to preserve their scenic value. The agreement provided for a minimum daytime flow during the tourist season of 100,000 cu.ft. per second, and a minimum flow of 50,000 cu.ft. per second at all other times. All water in excess of these amounts, estimated to average about 130,000 cu.ft. per second, was made available for diversion for power generation, to be divided equally between the U.S. and Canada. The total hydroelectric capacity of the river was fixed at about 3,600,000 kw. This was developed by power plant installations, completed or under construction by 1960. The power plants receive water diverted from the river above the falls and carried to them by open channels or tunnels, and they discharge the water into the gorge at various places below the falls. Much of the energy was used in nearby electrochemical industries for the manufacture of aluminum, ferrosilicon, carborundum, artificial graphite, liquid chlorine, calcium carbide, cyanamide and other products. The remainder was transmitted to various cities for miscellaneous uses. The maximum distance to which this power was transmitted was somewhat in excess of 200 mi.

The principal cities located along the river are Buffalo, N.Y., at the eastern end of Lake Erie; Tonawanda, N.Y., the western terminus of the New York State Barge canal; Niagara Falls, N.Y., and Niagara Falls, Ont., situated beside the falls and gorge; Lewiston, N.Y., at the mouth of the gorge; and Niagara-on-the-Lake, Ont., at the mouth of the river.

Fort Niagara, a 288-ac. U.S. military reservation on the east bank at the mouth of the river, is on the site of a blockhouse built by the French in 1678–79. It includes Old Fort Niagara, which was built by the French in 1725–27 and is still standing. (J. L. Hr.)

NIAMEY, the capital of the Republic of the Niger, west Africa, is situated on hills above the left bank of the Niger river, in the southwest corner of the republic. Pop. (1959) 30,030. Before it became a capital in 1926 it was merely a collection of villages inhabited by Djerma (Zarma) cultivators; latecomers were Yoruba from Nigeria, Hausa, and people from the republics of Dahomey and Togo, including traders, weavers, smiths, leatherworkers and cloth merchants. There are few industries (oil works, brick factories, repair shops), but Niamey is commercially important because of its position at the intersection of east–west–south

land routes and the Niger. It also has an important airport.
(J. D.)

NIAS, largest of the chain of islands west of Sumatra, Indonesia, lying immediately north of the Mentawai (*q.v.*) group. Administratively it is a *kabupaten* (regency) of the province of Sumatera-Utara (North Sumatra). The island is 80 mi. long and nearly 30 mi. wide, with an area of 1,569 sq.mi. The topography is hilly, with rocky or sandy coasts, often dangerous for landings. Geological structure is much like that of western Sumatra, but there are no volcanoes; earthquakes do occur. Highest elevation is 2,300 ft. The island is densely populated, especially in the valleys of the south and around the chief town and port, Gunungsitoli on the east coast. Population in 1961 was 314,829.

The indigenous population belongs to the early (Proto-) Malay stock and speaks dialects of a distinct branch of the Malayo-Polynesian language family. Most of the people are animists, but some, especially in the north, are converts to Islam and Christianity. Marriage is exogamic and wives are bought. At death, a man's wife and property pass to his brother. Land belongs to the settler and is inherited in the direct line. A council of notables assists hereditary chiefs in administration. The Dutch, who began trading there in 1669, suppressed slave trade.

In North Nias villages are small, situated on hilltops, each enclosing a stone-paved rectangle. In South Nias the villages are larger and include a bathing pool. Those on high sites have broad paved stairways with remarkable sculptures. Megalithic monuments and wooden sculptures, common all over the island, are more elaborate in the south; they honour the dead or represent fertility symbols. The houses, built on piles, contain several families, the private quarters adjoining the large communal room. The chief's house is very large with high roof and massive pillars and beams, often skilfully carved. The main crops are yams, sweet potatoes, rice and maize, grown on temporary fields. Pigs and chickens provide most of the meat. Copra is the export commodity. The Niasese are good craftsmen in gold and silver. A road, mainly a trail, runs around the island and connects with another road through the centre. There is no good port, and ships calling at Gunungsitoli must anchor offshore. (J. O. M. B.)

NIBELUNGENLIED, the generally accepted name of a German epic poem written about A.D. 1200, although *Der Nibelunge Nôt* would appear to have been an earlier title. Neither is entirely satisfactory as an indication of the content of the poem; that this was felt at an early date is shown by the superscription of one of the manuscripts, from the early 14th century: "the book of Kriemhild."

The story as we have it has a long history behind it, and as a result contains a number of disparate elements which have not always been completely reconciled; the following summary of the contents, while aiming at presenting the story as a consecutive and coherent whole, does not seek to suppress inconsistencies where they are prominent. The word *Nibelung* itself presents difficulties. In the first part of the poem it appears as the name of Siegfried's lands and people and his treasure, but throughout the second it is used as an alternate name for the Burgundians. A possible explanation is that the Nibelung treasure is, after Siegfried's death, acquired by the Burgundians.

The Story of the Poem: Siegfried and Kriemhild.—The poem begins with two cantos (*Aventiuren*) which introduce respectively Kriemhild, a Burgundian princess of Worms, and Siegfried (*q.v.*), a prince from the Lower Rhine. The action begins in Canto 3, which describes Siegfried's determination to woo Kriemhild, in spite of his parents' warning of the dangerous nature of the suit; his departure; and his arrival at Worms. There Hagen, the henchman of King Gunther (Kriemhild's brother), identifies Siegfried, even though he has never seen him, and gives a brief account of his former deeds—the killing of a dragon, from which resulted Siegfried's horny skin, and the acquisition from two quarreling brothers of their treasure. Siegfried does not mention his suit, but challenges Gunther to fight to defend his lands; a reconciliation is achieved (but not before some hard words pass, with Siegfried twice addressing Hagen in challenging tones), and Siegfried stays at the court. Messengers arrive from the Danes and Saxons, declaring war, but Siegfried offers to lead the Burgundians and distinguishes himself in the battle. Kriemhild is delighted, and during the festivities on the warriors' return the two meet for the first time. Their mutual affection has the opportunity to develop during Siegfried's subsequent residence at the court, where he occupies a privileged position.

At this point an entirely new element is introduced, which is to dominate the action for a long time: the story of the wooing of Brunhild (*q.v.*). News from overseas reaches the court of Worms which tells of a queen of outstanding strength and beauty who may only be won by a man capable of matching her in athletic prowess. Gunther expresses his intention of wooing her but he is warned by Siegfried of the danger to which he would expose himself. Hagen suggests that Gunther allow Siegfried to help him; Gunther accepts the suggestion and Siegfried agrees, on condition that Gunther promise him the hand of his sister Kriemhild if he succeeds. Throughout the expedition Siegfried takes charge, even more decisively than he did in the Danish-Saxon war, and gives instructions on the conduct of the expedition down to the smallest details; his ability to pilot the expedition to Brunhild's abode on Isenstein is a variant of the well-known motif in medieval German literature of the much-traveled warrior who is able to give advice and help to the master with whom he has taken service. It is in the same tradition when one of Brunhild's followers singles out among the newcomers one who "looks like Siegfried." This is no surprise to Brunhild because of the very nature of her vow, which was to marry only the best and bravest. Siegfried, however, presents himself not as the wooer, but as Gunther's vassal; and in the ensuing contests Gunther goes through the motions of deeds in fact performed by Siegfried in his cloak of invisibility. When Brunhild is defeated she accepts Gunther as her husband. After an interlude in which Siegfried goes to his own "Nibelung" lands—where his treasure lies—to fetch some followers, he is sent on ahead to Worms to announce Gunther's victory and his impending arrival with his bride. Siegfried and Kriemhild also are married, as promised, but Brunhild remains ill at ease, ostensibly because she is hurt at seeing her sister-in-law married to one who is, as she has been told, a vassal of Gunther's. After a period during which Siegfried returns with Kriemhild to his own domains, they are invited, at Brunhild's request, to Worms. During this visit the two queens quarrel over precedence. In the course of the quarrel Kriemhild reveals to Brunhild the treachery which had been practised on her when Siegfried entered the bridal chamber invisibly to overcome her resistance to Gunther.

It is at this point that the figure of Hagen becomes prominent. He seizes the opportunity of coming to the defense of the injured Brunhild and takes the initiative in plotting vengeance. The plan is to entice Siegfried away from the court so that he can be killed, but it is first necessary to ascertain where and how he is vulnerable. Hagen succeeds in ingratiating himself into Kriemhild's confidence, and learns the secret of Siegfried's one vulnerable spot; he also strikes the fatal blow.

It is noteworthy that during and after these events Brunhild slips almost unnoticed out of the story, and the death of Siegfried is seen not so much as vengeance by her, but rather as a blow struck by Hagen, who was becoming suspicious of Siegfried's growing power; all emphasis is on Kriemhild's grief and her hatred of Hagen. Siegfried's funeral is conducted with great ceremony. Kriemhild decides to remain at Worms with her mother and younger brothers, but for long remains estranged from Gunther and Hagen. Hagen persuades Gunther to attempt a reconciliation, so that they may have the benefit of Siegfried's treasure, and Kriemhild agrees to make peace with Gunther. The treasure is then brought to Worms but Hagen, seeing that Kriemhild is distributing it, and fearing the influence she may gain, seizes it and sinks it in the Rhine.

The Fall of the Burgundians.—The preceding events close what is generally known as the first half of the poem; the second is simpler in structure. Etzel, king of the Huns, who is widowed, sends messengers to Worms to ask the hand of Kriemhild. Gunther is willing, in spite of Hagen's warnings, and Kriemhild agrees

when she sees the possibilities for vengeance this match could offer her. After many years she persuades Etzel to invite her brothers to his court, and is particularly insistent that Hagen shall come. Hagen suspects Kriemhild's motives and warns his masters against accepting, but he only succeeds in persuading them to go armed; and it is not until they have crossed the Danube that they are convinced. On their arrival Kriemhild's plan is quickly revealed and. although there is much large-scale fighting, the poet makes clear the essentially personal nature of the conflict; the climax is reached when Hagen—as the last survivor of the Burgundians and, though bound, still defiant—faces Kriemhild, who kills him when he still refuses to reveal where Siegfried's treasure is hidden. She in turn is executed by Hildebrand, who is at Etzel's court with his master Dietrich von Bern (*q.v.*). "Daz ist der Nibelunge nôt" ("that is the story of the destruction of the Nibelungs [or Burgundians]") are the final words; and they are an apt description of the second half of the poem.

The Elements in the Story.—In this story some elements of great antiquity are discernible. In the first part one recognizes the story of Brunhild, which retains its separate existence in Old Norse literature; there are also the brief allusions in Canto 3 to the two ancient stories of the heroic deeds of Siegfried; and finally the whole of the second part is the story, albeit with a different motivation, of the Fall of the Burgundians which exists in an older form in the *Eddaic* poem *Atlakvida* ("Lay of Atli"). It was the great merit of the scholar Andreas Heusler to isolate the stories of Brunhild and the Fall of the Burgundians as the two mainstays of the action. It is, however, no mere formal joining together of two separate stories, which is what they originally were; the poet sought by various devices to combine the different elements into a meaningful whole in which the component elements would be integrated. One of the major alterations is in making Kriemhild, and not Etzel, as was originally the case, send the treacherous invitation; but this must have been done much earlier, for Saxo Grammaticus refers to the recital, in 1131, of the poem of the "well-known treachery of Kriemhild against her brothers." Once this step had been taken it would not be difficult to envisage a combination of the Burgundian and the Brunhild stories into one; for, although the emphasis in the latter was on Brunhild, Kriemhild suffers a blow through the death of her husband which she may well be expected to wish to avenge. Other inconsistencies and contradictions, which could not be revealed in the summary above, emphasize the long history of the subject matter. Karl Lachmann's view that it is a collection of 20 originally separate short poems was held, and debated, for many years; it was, however, superseded after the appearance of Heusler's principal work, in which he demonstrated the central position of two themes, and explained the difference in length between the old short lays and the long epic in terms of a different style of narration.

Heusler's views on the role of these two stories in the history and structure of the poem found such general acceptance that the importance of the other elements, with which he also dealt, tended to be overlooked. After about 1940, however, attention was concentrated on them, perhaps excessively. An example of these elements is the scene in which Siegfried meets his death. In the Norse versions, particularly in the older ones, the death of Siegfried is dismissed in a few words as a fact which has to be recorded, and this is perfectly consonant with the theme of the original story, in which Brunhild was the principal character and Siegfried the means by which her problem arose. The role Siegfried plays in the corresponding part of the *Nibelungenlied* is still comparable. Much is made, it is true, of his conduct of the expedition and of the part he plays in the actual contests, but from the time of Brunhild's arrival at Worms he becomes a passive participant, until the plot for his death is hatched. From this moment all attention is concentrated on him and Kriemhild. After Hagen has elicited his vital secret from Kriemhild there follows a carefully constructed scene in which she confesses her premonitions and tries to dissuade Siegfried from participating in the hunt which has been arranged: she claims to have had dreams which point to her husband's sudden death. He, however, with unquestioning confidence in his own powers and—note the dramatic irony—equally confident of the friendship of all, brushes aside her objections and goes out, utterly happy, to what is to be his last hunt. This picture of a young hero, in the fullness of his powers and at the height of his happiness, is further developed in the hunt itself, culminating in a boisterous practical joke which he plays on his fellows. In the final act, the race to the spring, he again demonstrates his physical superiority and, in his refusal to drink until Gunther has drunk, his meticulous regard for courtly precedence. By this very delay he gives Hagen the opportunity to strike the fatal blow while he is bending over the water. There is no source in Germanic antiquity for the details which make this scene so effective, and the poet would appear to have had his inspiration from a contemporary Romance epic *Daurel e Beton*.

Similarly there is a scene in the second half which also serves to heighten the tragedy by relieving the tension. The purpose of the journey of Gunther and his followers is known to the audience from the beginning; and although the participants, apart from Hagen, at first suspect nothing, the tension rises as they proceed. It is, however, relieved by a few days' rest at Bechelaren, where the party is entertained by the margrave Rudeger and his wife and daughter. The idyllic nature of the interlude is stressed by the betrothal of the youngest of the Burgundian princes Giselher and the margrave's daughter; it is agreed that the marriage shall take place on their return. The effectiveness of the scene has long been universally recognized, and in 1945 Friedrich Panzer suggested a source, not a literary one, but an event in 12th-century history. In 1189, when passing through Hungary on his crusade, the emperor Frederick I was festively entertained by King Bela of that country and his wife, and the marriage of Frederick's second son with King Bela's daughter was arranged; the marriage was to take place on the return of the emperor and his son from the crusade in which, in fact, both met death. Panzer has drawn attention to possible contemporary literary and topical historical sources for other incidents.

Both approaches have proved fruitful in determining the author's theme, or whether in fact he had a single theme, and in estimating his poetic achievement. It cannot be disputed that the second part of the poem deals with the disaster that overcame the Burgundians, or Nibelungs (and to that extent the title *Der Nibelunge Nôt* is apt), nor that this disaster was the deliberate purpose of Kriemhild. It is preceded by a story in which Siegfried plays a prominent part, and to the extent that Siegfried is Kriemhild's husband and attention is concentrated on his death, the events of this first part may be considered integrally connected with those of the second. There are other indications that it was the poet's intention to present the story in this way: Kriemhild is the first person to be introduced and the poem ends when she is killed. She is introduced, too, in a way which leads one to believe that she is to play an important role. The poet's treatment of Brunhild is consonant with such a purpose; her story once existed in its own right and ended when her honour was satisfied, but in the *Nibelungenlied* the death of Siegfried is presented in the very different light discussed above. Further, there is the attention paid to Hagen. Early in the story his words to and about Siegfried indicate anger and resentment; he takes the initiative in the plot against him and strikes the blow, earning Kriemhild's uncomprising hatred by having tricked her into revealing his one vulnerable spot. Particularly striking is the scene in the second part where, on their arrival at the court of the Huns, Hagen remains defiantly seated before Kriemhild, with Siegfried's sword ostentatiously laid across his knees. To what extent this concentration on Kriemhild and on the enmity between her and Hagen was already present in the sources must remain a matter of conjecture, but the consistency with which it is carried through would seem to suggest that it was the poet's intention to stress the theme.

Dating and Manuscripts.—The poem was written in the classical period of medieval German literature, but it holds a special position in it. A characteristic feature of the literature of that period is the emphasis on the current "courtly" virtues of

moderation and refinement of taste and behaviour. The *Nibelungenlied*, with the violence of its emotions and its uncompromising emphasis on vengeance, bears unmistakably the mark of a different origin: the heroic literature of the Teutonic peoples at the time of the migrations. The basic subject matter also goes back to that period, for there can be no doubt that the story of the destruction of the Burgundians was originally inspired by the overthrow of the Burgundian kingdom at Worms by the Huns in A.D. 437, and the story of Brunhild and Siegfried may have been inspired by events in the history of the Merovingian house of the Franks about A.D. 600. Much of the heroic quality of the original stories has remained in the poem, particularly in the poet's conception of Hagen in the second half. Nevertheless, to judge by the manuscript transmission, which can be traced through three whole centuries, the poem became and remained popular in spite of its "out-of-period" characteristics. The most important of these manuscripts are the Hohenems-Munich (*A*), the St. Gallen (*B*) and the Hohenems-Lassberg (*C*). Lachmann regarded *A* as the best and based his edition on it; Holtzmann and Zarncke later made the same claim for *C* and used that; but the consensus now favours *B*, on which the standard edition of Karl Bartsch is based. *C* is the earliest and was written in the early 13th century. Some of the later manuscripts make quite substantial alterations to the subject matter, but even *A*, *B* and *C* show differences which go beyond mere verbal variation, including a difference of over 100 in the number of strophes.

See also references under "Nibelungenlied" in the Index.

BIBLIOGRAPHY.—The literature on the poem is enormous, and forms the subject of special bibliographies: *see* T. Abeling, *Das Nibelungenlied und seine Literatur* (1907; with a supplement, 1909); and M. Thorp, *The Study of the Nibelungenlied* (1940). The standard edition is *Der Nibelunge Nôt, mit den Abweichungen von der Nibelunge Liet, den Lesarten sämmtlicher Handschriften und einem Wörterbuch*, edited by K. Bartsch (1870 *et seq.*); on this is based the smaller edition, with commentary, *Das Nibelungenlied*, re-edited by H. de Boor (1956). Two excellent monographs covering the whole problem are: A. Heusler, *Nibelungensage und Nibelungenlied*, 3rd ed. (1929; reprinted as 5th ed., 1955); and F. Panzer, *Das Nibelungenlied* (1956). Very helpful for detailed study of the elements of the story (*e.g.*, the figures of Siegfried and Brunhild) is the section, "Nibelungensagen," in H. Schneider, *Germanische Heldensage*, vol. i (1928). An English trans. of the poem by M. Armour is in Everyman's Library (1908). (K. C. K.)

NICAEA (modern IZNIK, in the *il* of Bursa, Turkey), an ancient city of Bithynia in Asia Minor, on the Ascanian lake (Iznik Golu). It was built on an old deserted site by Antigonus Monophthalmus (316 B.C.?) but soon afterward Lysimachus changed its name from Antigonia to Nicaea, calling it after his wife. Probably soon after Lysimachus' death (281) it was incorporated in the kingdom of Bithynia, whence it passed to the Romans (74). It flourished under the Roman empire, being on one of the main roads through Asia Minor, and continually disputed the title of metropolis of Bithynia with the provincial capital, Nicomedia.

After Constantinople became the capital of the empire, Nicaea grew in importance. It gave its name to the two ecumenical Councils of Nicaea (A.D. 325 and 787) and the Nicene Creed (*see* COUNCIL). The Seljuk Turks gained possession of it *c.* 1080 and it was the capital of the sultanate of Rum until its recapture in 1097 during the first crusade. After the capture of Constantinople by the Latins (1204) Nicaea became the seat of the Byzantine emperor Theodore I Lascaris and his successors until the recovery of Constantinople (1261). It was finally taken by the Ottoman Turks under Orkhan (1331) and continued to be of some importance, particularly for the production of polychrome pottery (*see* POTTERY AND PORCELAIN: *Islamic Pottery of the Near and Middle East*). Ruins of the Byzantine walls survive at the modern village of Iznik.

Nicaea was also the name of the Greek settlement founded at an unknown date from Massilia (Marseilles) on the site of modern Nice (*q.v.*).

NICAEA, COUNCILS OF. Two ecumenical councils of the Christian church were held at Nicaea (modern Iznik, Turkey). The first (also the first ecumenical council) was convoked by the emperor Constantine I in 325 and was concerned primarily with Arianism. The second Council of Nicaea (787) dealt chiefly with iconoclasm. *See* COUNCIL.

NICARAGUA (REPÚBLICA DE NICARAGUA), the largest country of Central America, lying between Honduras and Costa Rica which form its northern and southern boundaries respectively, and reaching from the Caribbean sea on the east to the Pacific ocean on the west. Its area, which is still undetermined because of incomplete surveys, is generally put at 53,398 sq.mi. The coast line extends about 300 mi. on the Caribbean, and 200 mi. on the Pacific. The Honduran boundary starts at Cabo Gracias a Dios, follows the Coco river inland and then at about 86° W. takes an imaginary line to the upper waters of the Negro river, which it follows to the Gulf of Fonseca. The Costa Rican boundary is, under treaties of 1858, confirmed in 1888 and settled in 1896, a line 2 mi. S. of the San Juan river and Lake Nicaragua.

PHYSICAL GEOGRAPHY

Geology.—Between Lake Nicaragua and the Pacific are Miocene lavas, calcareous shales and sandstones. In the Nicaraguan lowland, from the Gulf of Fonseca southeast to the mouth of the San Juan river, basic rocks are Miocene marine sediments, covered at both ends with Pleistocene and recent alluvium, and on the western margin by lavas and ashes of 30 Pleistocene volcanoes extending northwest to southeast from Cosigüina to Madera in Lake Nicaragua; highest volcano is Viejo (5,545 ft.). The central highlands are made up of Tertiary and of igneous and metamorphic rocks, overlain with volcanic ash in the northwest, Precambrian and Cretaceous intrusive granites in the north and northeast. The eastern lowlands consist of Pleistocene sediments, recent alluvium and areas of igneous rocks, sandstones and shales.

Relief and Drainage.—Level plains in western Nicaragua are fairly well drained by many short rivers flowing into the Pacific and into Lakes Managua and Nicaragua. The central highlands, 7,000 ft. high in the west, are rugged; eastward are lower undulating, plateaulike areas. From the divide, long rivers flow eastward: Coco (*q.v.*), navigable for 200 mi.; Grande, navigable in its lower course; Escondido, navigable 60 mi. to Rama City; and San Juan, navigable 100 mi. to Lake Nicaragua. The flat eastern plains have large swamps and coastal lagoons.

Climate.—The mean annual temperature in the eastern lowlands is 80° F., with little variation. The western lowlands have mean monthly temperatures of 80° to 86° F. Above 3,000 ft. they average 10° F. lower. East of the central highlands divide where there is no distinct dry season, annual precipitation decreases from 255 in. near San Juan del Norte (Greytown) to 100 in. on the Coco river. On the western flanks of the central highlands annual rainfall decreases sharply, from 80 in. to 53 in. in the lowlands; slopes of volcanic mountains receive 15 to 25 in. more; the period December through April is very dry.

Vegetation.—In the eastern lowlands and eastern parts of the central highlands, which are rainy all year, natural vegetation consists of slash pine, covering an expanse 40 to 100 mi. wide from Grande river to the northern boundary, and elsewhere, broadleaved evergreen forests of many species. These forests contain 80% of Nicaragua's timber. The western central highlands and middle slopes of volcanic mountains have deciduous hardwoods (oak and others) and subtropical grasses. The western lowlands comprise savannas and, along streams, deciduous forests.

Animal Life.—Inhabiting rainy, hot areas are many species of reptiles: crocodiles, lizards (iguanas and others), snakes and turtles. In forested areas deer are common. Wild life also includes the puma, jaguar, monkey and peccary. Many species of water and land birds, fresh-water and salt-water fishes (including mollusks), rodents and insects are abundant.

GEOGRAPHICAL REGIONS

Nicaragua may be divided into four clearly defined regions: (1) volcanic mountains and hills near the Pacific; (2) around and east of these mountains, the low plains and lakes of the great depressions, stretching from the Gulf of Fonseca to the mouth of the San Juan river; (3) the broad area of rugged central highlands extending from Honduras to near the San Juan; and (4) east of these, rolling plateaus and Caribbean lowlands.

The first two regions are characterized by much level and gently

sloping land, rich volcanic and alluvial soils, annual precipitation of 53 to 80 in., a very dry season of from four to six months and high temperatures. Together they comprise 62% of the country's population, most of its large cities, modern transportation facilities and industrial establishments. They produce about 75% of the nation's agricultural products and minerals, including clays and cement-making materials. Fertile valleys in the western part of the central highlands, inhabited by about 30% of the country's population, produce about 25% of the nation's coffee, tobacco, corn, beans, cotton and animal products; and highland mines supply nearly 25% of the mineral production. The rolling plateaus and Caribbean lowlands, poorly drained near the coast, comprise nearly half the area of Nicaragua. Hot and rainy all the year, they are largely uninhabited except along the coast and rivers, but their tropical forests supply most of the forest products exported and consumed domestically. In these lowlands three commercial banana districts, important until 1936, were largely abandoned as a result of Panama disease. (C. F. J.)

HISTORY

By the 15th century there were several Indian tribes living along the Pacific coast, whose cultural and linguistic ties were with the northwest, and other groups at a lower cultural level in the central and eastern regions, whose associations were with the southeast. The country's name is said to have been derived from that of Nicarao, an Indian chief whose people lived on the shores of Lake Nicaragua. Christopher Columbus, on his fourth and last voyage to the New World, landed on the east coast near modern Bluefields Sept. 16, 1502. Twenty years later Gil González de Ávila, with about 100 Spaniards and four horses, marched overland from Panama along the Pacific coast—reaching beyond Lake Nicaragua—but retired when he encountered hostility. Two more years passed before the conquistadores returned.

Colonial Period.—Nicaragua was the first of the Central American provinces to become firmly Spanish. Granada and León were founded in 1524 by Francisco Hernández de Córdoba, acting for Pedro Arias de Ávila (Pedrarias Dávila), governor of Panama. When Pedrarias came to León in 1526 he executed Hernández on suspicion of intrigue with Hernán Cortés, then in Honduras. Pedrarias as governor of Nicaragua (1527–31) developed an export trade in Indian slaves (who were used in Panama), had Río San Juan explored and tried unsuccessfully to establish his rule in Honduras and El Salvador. León was designated the seat of Central America's first bishopric in 1531, and the port of El Realejo developed in 1533. Rodrigo de Contreras, son-in-law of Pedrarias, was the second governor (1535–44); during his rule the province was placed first under the jurisdiction of a new *audiencia* at Panama (1538), then transferred to another at Gracias a Dios, Honduras (1544). Dissatisfaction with the Spanish code of New Laws of 1542 (which ended the Indian slave trade) and the loss of the governorship in 1544 led to a rebellion by the two sons of Contreras in 1550. Nicaraguan Bishop Antonio de Valdivieso was murdered and León, Granada and Panama city seized before the uprising was halted.

The province of León along the Pacific developed quietly as an agricultural colony for the next 250 years, with a variety of products from farm and forest. Trade was carried on at El Realejo, and from Granada via Lake Nicaragua and Río San Juan. Ships were also built at El Realejo. Except for two periods of buccaneer activity (in the 1660s and 1680s), life for Spaniards in the province was relatively easy, there being a plentiful supply of Indian labour. The province was a part of the *audiencia* of Guatemala, whose president, until 1786, directly controlled many Nicaraguan Indian communities through appointment of *corregidores* to manage their affairs. León had its own governorship which, in 1786, was raised to the status of an intendancy. By that time Spaniards, Negroes and persons of mixed blood were common residents of the "Indian" villages: Chinandega, Matagalpa, Managua and Masaya.

The country to the east and north, called the district of Tologalpa by the Spaniards, had a separate history because of the lack of Spanish settlement. Negroes moving in from the West Indies gave parts of the coast a new racial complexion. Buccaneer visits were frequent but friendly, and by mid-17th century a few permanent settlements were formed, including that at Bluefields. Later in the same century Great Britain formed an "alliance" with the chief of the Miskito tribe (of mixed Indians and Negroes), and from 1740 to 1786 the Mosquito coast (*q.v.*), containing many English residents, was counted as a British dependency. The Spanish prevented in 1780 a British attempt to ascend the San Juan and establish a transisthmian route.

Independence.—The relative calm of Spanish Nicaragua was succeeded by more than four decades of confusion and turbulence. Violence began in Dec. 1811 when the governing intendant was deposed in a revolution inspired by earlier struggles in Mexico and El Salvador. Ill feeling developed between León and Granada when León returned early to the royalist cause and Granada bore the brunt of the punishment for disobedience. León declared independence from Guatemala on Sept. 28, 1821 (following Guatemala's act of independence from Spain, Sept. 15), but Granada chose to stay with Guatemala. Both accepted union with Mexico (1822–1823), but then fought until 1826, when Nicaragua was organized as a state in the Central American federation. Dissension remained the order of the day until 1838, when Nicaragua left the federation, and then was resumed as part of the general isthmian struggle between Liberals and Conservatives, León being the stronghold of the former, Granada of the latter. Meantime in the east relations between the "king" of the Miskito peoples and the British government were strengthened to the point where English officials were again living in Bluefields. San Juan del Norte was seized by the British in 1848.

The discovery of gold in California brought attention to Nicaragua's strategic position between the oceans. The Accessory Transit company of Cornelius Vanderbilt, which carried passengers by steamship and carriage from San Juan del Norte to the Pacific, began operations in 1852. Adventurer William Walker (*q.v.*) from Tennessee, invited to assist the Liberals in warfare in 1855, brought new excitement to Nicaragua. By 1856 Walker had made himself president of the country. In 1857 he was routed through the joint efforts of the five Central American republics and the Accessory Transit company.

Tomás Martínez, who assumed the Nicaraguan presidency in 1857 and held it for ten years, was the first of a line of Conservative chiefs of state who ruled until 1893. Under them Nicaragua enjoyed relative peace, though with little democracy. The capital was placed in Managua as a compromise between Granada and León. The first railroads were built, agriculture was revived to some extent and a treaty with Great Britain (1860) provided for the nominal reincorporation of the eastern coast with the nation, under the form of an autonomous reservation. José Santos Zelaya, Liberal president from 1893 to 1909, established real Nicaraguan jurisdiction over the Miskito peoples for the first time, and increased his power to the point where he could interfere in the affairs of Honduras and El Salvador. Two great writers sprang from Nicaragua during this quieter half century. Rubén Darío (*q.v.*) became recognized as one of Latin America's greatest poets. Salvador Mendieta (1879–1958) was a distinguished diagnostician of his own region's ills, who dedicated his life to the rebuilding of the Central American union. Both men were critical of the new interest taken in isthmian affairs by the United States once the decision was made to build the Panama canal.

United States Intervention.—A new era in Nicaraguan history involved intervention by forces of the United States government. It may be said to have begun when Philander C. Knox, secretary of state for President Taft, became angered at the execution of two U.S. citizens who had participated in a revolution against Zelaya. When Zelaya resigned late in 1909 the United States refused to recognize his successor, José Madriz. In 1910 its naval forces prevented government occupation of Bluefields, the revolutionary headquarters, an act leading directly to the success of the revolution. When new civil war broke out in 1912 U.S. forces took a direct hand in support of Adolfo Díaz, president from 1911 to 1917. A hundred marines stationed at the United States embassy also helped to maintain the peace under Emiliano

Chamorro Vargas (1917–20) and his nephew successor. United States bankers meanwhile managed the Nicaraguan customs collections, the national bank and railway. The Bryan-Chamorro treaty of 1916 gave Nicaragua $3,000,000 in exchange for the U.S. right to build an interoceanic canal and to establish naval bases on the Gulf of Fonseca and Corn Islands.

Withdrawal of the marine guard (1925) led to new complications. Rebellion by Chamorro Vargas against a new administration brought Díaz back as a "compromise" president (1926–28), reinforced by 2,000 United States marines. Díaz was opposed in warfare (1927) by Juan Bautista Sacasa, Gen. José María Moncada, Gen. César Augusto Sandino and others. Though elections in 1928 under U.S. auspices brought Moncada to the presidency, followed in 1933 by Sacasa, Sandino fought on against both his old friends and the marines and came to typify for many Latin Americans the cause of resistance against *yanqui* imperialism.

Later Developments.—Sacasa's inauguration (Jan. 1, 1933) terminated the stay of the U.S. marines. Within the year Sandino made peace with his government. Prominent on the scene by then were the Nicaraguan national guard, carefully trained by the marines before their withdrawal, and its commander, Gen. Anastasio Somoza, nephew of the president. In Feb. 1934, just after he had dined with Sacasa, Sandino was assassinated by members of the national guard with Somoza's approval. Against Sacasa's wishes Somoza decided he would next have the presidency, though both his position and his family relationship made him ineligible. Constitutional problems were "solved" by the deposition of Sacasa (June 1936) and a temporary relinquishment of the guard command. Somoza became president Jan. 1, 1937, backed by a coalition of segments of the old parties. Leonardo Argüello, his defeated opponent, had support from both of the traditional parties.

One man then controlled Nicaragua for 20 years. A new eight-year term commenced March 30, 1939, under a revised constitution which increased the power of both president and national guard. In 1945, after *caudillos* had been removed from office in El Salvador and Guatemala, Somoza announced that the guard would remain loyal to the winner of the next elections. When Argüello won those elections and took office May 1, 1947, Somoza (still at the head of the guard) had him ousted within a month. Somoza's uncle Víctor Manuel Román y Reyes, chosen by the party organization to succeed, was president until he died May 6, 1950. Somoza then reassumed the position, and was elected to another six-year term beginning May 1, 1951. A pre-election agreement with Emiliano Chamorro Vargas guaranteed the opposition a minority voice in the new congress.

The development of a small gold mining industry by foreign capital in the 1930s gave the nation its first sizable export commodity. Strict economic dictatorship was coupled after 1941 with wartime co-operation with the United States, which brought material benefits in its wake. After the war an aura of prosperity developed with new large plantings of coffee and cotton for export (subsistence crops suffered badly for a time), establishment of textile and food processing industries and the organization in 1953 of a private shipping line, Marina Mercante Nicaragüense (Mamenic). But observers noted the extent to which Somoza family holdings bound the economy together, while the people at large benefited little from the rise in national income.

The constitution of 1950, written by agreement between Somoza and Chamorro Vargas, provided that no president of Nicaragua might be re-elected and that no person might be elected to the office who had exercised the presidency temporarily during the last six months of the term or who was a relative of the president. Despite these provisions, it became clear as Somoza's term progressed that he intended to succeed himself. A serious attempt to assassinate Somoza failed in 1954. On Sept. 21, 1956, a few hours after he was nominated by his Nationalist Liberal party for six more years in office, he was shot by Rigoberto López Pérez, who gave his own life for the deed. Somoza died eight days later. The death of Somoza did not end the rule of his family. All the constitutional prohibitions having been repealed by the Nationalist Liberal majority in congress, 34-year-old Luis Somoza Debayle was given his father's position at once, and then was nominated in his father's stead and chosen president for the term 1957–63. A younger brother, Anastasio Somoza Debayle, remained head of the national guard. An unsuccessful attempt to unseat this second generation was made in 1959 by a group led by Enrique Lacayo Farfán, consisting of opposition Conservatives and Independent Liberals. During this time the country found itself united on one matter, the revival of an old boundary dispute with Honduras, but withdrew its forces from the disputed territory after a 1960 decision of the International Court of Justice favouring Honduras.

The constitutional provisions concerning the presidential succession were reinstituted in 1959, and Luis Somoza Debayle promised free elections at the end of his term. He did not, however agree to the demand of the Traditionalist Conservatives and Independent Liberals for supervision of the elections by foreign and neutral observers. René Schick Gutiérrez, a constitutionally eligible close friend of the Somozas, then won a four-year term in the 1963 election in which these other parties refused to participate. Though Schick showed some spark of independence in his term which began May 1, 1963, there was little doubt that Anastasio Somoza Debayle, still the head of the national guard, expected to campaign for the presidency in 1967. Schick died in office in Aug. 1966, and congress elected Lorenzo Guerrero, one of the three vice-presidents and also a Nationalist Liberal, to fill out the term.

(F. D. P.)

POPULATION

Number and Distribution.—A census taken in 1963 showed Nicaragua to have a total of 1,535,588 inhabitants, or the equivalent of 30.6 persons for each of the 50,193 sq.mi. of national territory (*see* Table). By 1965 the total population was estimated to have risen to 1,620,000, and after that time it was expected to continue to increase rapidly by about 50,000 per year. A very high birth rate (probably at least 45 per 1,000 population), coupled with a death rate of less than 20, was responsible for this increase.

Nicaragua's population, which is largely agricultural, is heavily concentrated in the western one-third of the country, especially in the small section near the Pacific coast that extends from the city of Chinandega on the north to the city of Granada and Lake Nicaragua on the south. According to the 1963 census 41.1% of the population resided in urban centres, of which Managua (*q.v.*), the capital with a population of about 240,000, was the largest. León and Granada (*qq.v.*), with populations (1963) of 45,048 and 28,507, respectively, are the next largest cities in the republic.

Number of Inhabitants and Density of Population in Nicaragua by Departments, 1963

Departments	Area (sq.mi.)	Population	Persons per sq.mi.
Total	50,193*	1,535,588	30.6
Boaco	1,924	71,615	37.2
Carazo	398	65,888	165.5
Chinandega	1,800	128,624	71.5
Chontales	1,910	75,575	39.6
Estelí	849	69,257	81.6
Granada	372	65,643	176.5
Jinotega	3,697	76,935	20.8
León	2,021	150,051	74.2
Madriz	679	50,229	74.0
Managua	1,403	318,826	227.2
Masaya	210	76,580	364.7
Matagalpa	2,623	171,465	65.4
Nueva Segovia	1,290	45,900	35.6
Río San Juan	2,876	15,676	5.5
Rivas	830	64,361	77.5
Zelaya	22,816	88,963	3.9

*Includes lakes, lagoons, rivers, etc., not included in the area of the departments.

Composition.—Approximately 20% of Nicaragua's population is white and 10% Negro, with mestizos, *zambos* (Indian-Negroes) and mulattoes making up the remainder. Practically no full-blooded Indians remain and mestizos greatly predominate.

Because of the high birth rate and the comparatively high death rate that has prevailed throughout the 20th century, Nicaragua's population is highly concentrated in the younger ages, as is evidenced by the fact that in 1950, 44.3% were under 15 years of

age, 53.9% in the age group 15–64 and only 2.8% were 65 and over.

Spanish is the mother tongue of the Nicaraguan people, although many members of the upper and middle classes have a familiarity with English as well. Although the various tongues once spoken by the aboriginal inhabitants have almost disappeared as languages, they have left their impress upon Nicaragua's place names, and many designations of things have been incorporated into the Spanish used in this part of the hemisphere.

The vast majority of the people of Nicaragua are of the Roman Catholic faith, although a sprinkling of Protestants of various denominations and small groups of those professing Judaism are found in the principal cities. In the religion of the common people few aboriginal beliefs and practices survive. (T. L. Sh.)

ADMINISTRATION AND SOCIAL CONDITIONS

Government.—Nicaragua has had nine constitutions: 1838, 1854, 1858, 1893 (amended 1896), 1905, 1911, 1939, 1948 and 1950 (as amended). The last, in force since Nov. 1, 1950, provides for separation of powers (legislative, executive and judicial branches) with strong, centralized, executive government. Nicaragua is one of the few Latin-American countries which has not attempted to control centralized, executive power through a semi-parliamentary system. Although the president is theoretically elected for a four-year term (six years until May 1, 1963) and is ineligible for immediate re-election, Gen. Anastasio Somoza, the most distinguished *caudillo* or leader of the 20th century, dominated government from the 1930s until his assassination in Sept. 1956. Congress is empowered to appoint a *designado* to take the president's place when it is necessary to fill out an unexpired term

Nicaragua is the only country in Central America with a bicameral legislature. It is also the smallest bicameral legislature in all of Latin America. The senate of 16 members (plus former presidents, who hold senatorship for life, and the defeated runner-up in the presidential contest, who receives a term of six years) and the chamber of deputies of 54 (one to every 30,000 of population, with each department guaranteed at least one representative) are elected directly for 4 years. The legislature meets only two months each year.

With opposition practically eliminated during several decades of mid-20th century, the legislature was almost completely subservient to the executive. The legislature can and does delegate broad authority to the president to legislate by decree, even in economic fields. Local government is controlled by the central government. The country is divided into 16 departments and one *comarca* (national district) each with a political head, appointed by the president, nominally in control. The president governs Managua, the capital, through a minister. The supreme court of seven members, elected by congress, has authority to introduce bills in the legislature. Although Nicaragua, like Costa Rica, does not have an army, it does have a national guard of about 7,500 men, originally trained by the United States marines.

Education and Social Welfare.—Although about 18% of the national budget is usually devoted to education, probably more than 65% of the people are illiterate. Schools are unavailable in many of the rural areas. Furthermore the average length of primary school enrollment is two to three years, a period which is considered inadequate preparation for the duties of citizenship. The National University of Nicaragua is in León, with branches in Managua and Granada. Legislation limiting the total number of hours to be worked per year and establishing maximum daily and weekly working hours was introduced in 1945. The 1950 constitution contains many welfare guarantees, only some of which have been made effective. (W. S. Ss.)

THE ECONOMY

Production.—Nicaraguan economy is predominantly agricultural; the chief crops are cotton, coffee, sesame, sugar, rice, corn and beans. Sorghum, cacao, yucca, tobacco, plantains and a variety of other fruits and vegetables are also produced on a relatively smaller scale for the local market. Exports of cotton and coffee account for roughly 75% of total export value. The importance of bananas has fallen markedly because of sigatoka disease. There are possibilities for greater agricultural development since only about one-fifth of the arable land is used for crop production. Cattle raising is significant for dairy produce in the west and beef in the eastern plains. Gold mining has been an important activity since precolonial days and the principal mines are owned by U.S. and Canadian concessionaires.

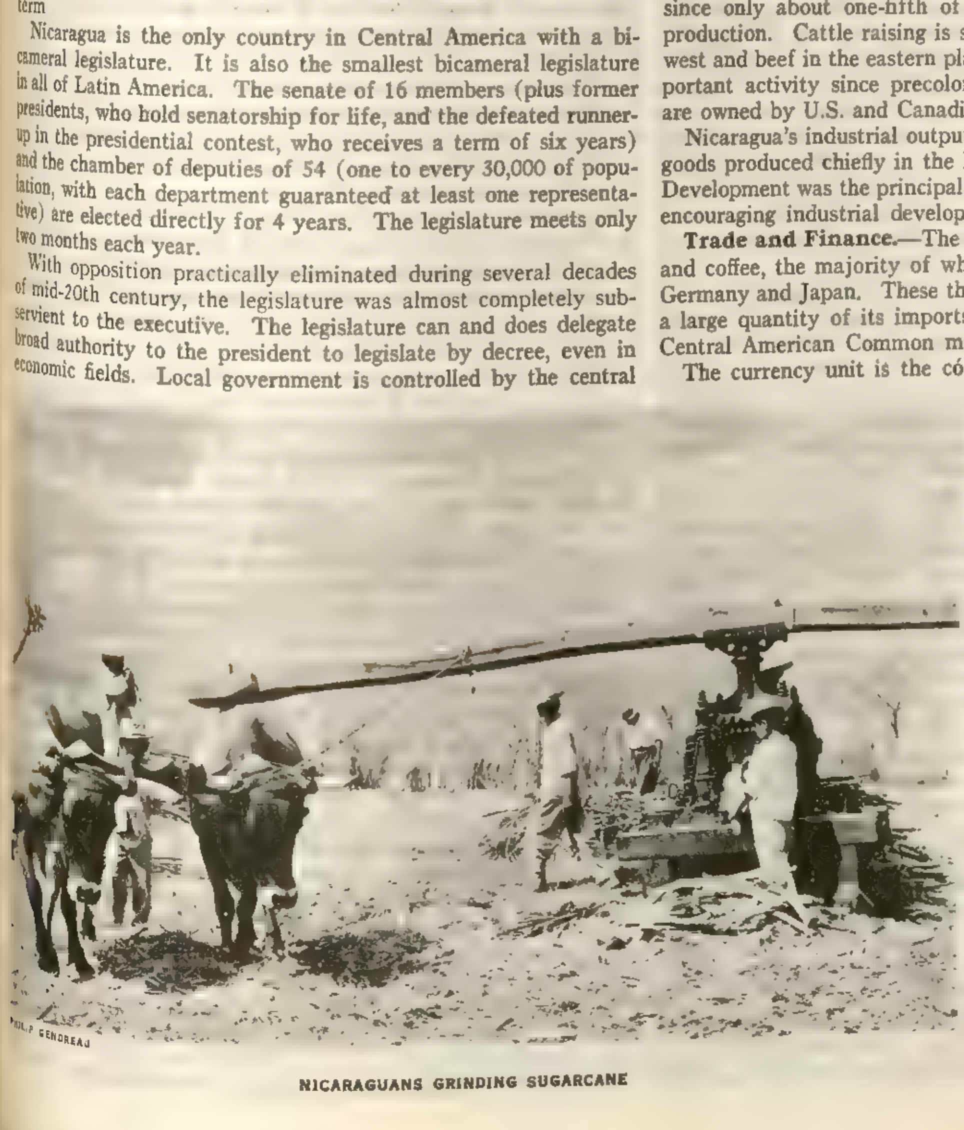
Nicaragua's industrial output consists of a variety of consumer goods produced chiefly in the homes. The Institute of National Development was the principal government agency responsible for encouraging industrial development.

Trade and Finance.—The nation's leading exports are cotton and coffee, the majority of which are shipped to the U.S., West Germany and Japan. These three nations furnish Nicaragua with a large quantity of its imports. Nicaragua is a member of the Central American Common market.

The currency unit is the córdoba. A single exchange rate of seven córdobas to the U.S. dollar was established in 1955 and applied to all imports. The Nicaraguan banking system has been dominated by the state-owned National Bank of Nicaragua. A new Central bank, however, was established in 1961.

The main source of government revenue is through indirect taxation—import duties and surcharges, export taxes on coffee and sales taxes on liquor, cigarettes and other consumer items.

Transport and Communications.—The Pan-American highway is passable in all weather from the Honduran border to the Costa Rican border. However, it is unpaved for nearly half this distance. A railroad runs from Corinto on the Pacific coast to Granada and Diriamba. The chief ports are Corinto, San Juan del Sur and Puerto Somoza, all on the Pacific coast. Managua is on the north-south air route from



NICARAGUANS GRINDING SUGARCANE

the U.S. to Panama and is linked by air to the capitals of other Central American republics. *See* also references under "Nicaragua" in the Index.

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NICARAGUA, LAKE, the largest of several fresh-water lakes in southwestern Nicaragua and the largest lake in Central America, is nearly 110 mi. long and 45 mi. wide at its widest place, with an area of 3,089 sq.mi. In the lake are many picturesque islands, the largest of which is Ometepe, bordered by two high volcanic peaks. The lake has long been important for fishing, sailing, swimming and in local transportation, steamships having operated on it since 1882. The lake and San Juan river have long been discussed as a possible canal route between the Caribbean sea and the Pacific ocean. (C. F. J.)

NICCOLITE, a mineral consisting of nickel arsenide, containing 43.9% nickel. It usually occurs as compact masses of a pale copper-red colour, with metallic lustre on the uneven, fractured surfaces. It is opaque and brittle, and the streak is brownish black. It occurs with ores of cobalt, silver and copper at Annaberg and Schneeberg in Saxony, Ger., at Cobalt, Ont., and other localities. (*See* Nickel.) The formula is NiAs. Crystals are hexagonal, but are rare and indistinct. The specific gravity is 7.5 and the hardness 5.5.

NICE (Italian Nizza), a port and resort city of France, capital of the *département* of Alpes-Maritimes, situated at the mouth of the Paillon river at the northern end of the Baie des Anges, 420 mi. (676 km.) S.E. of Paris. Pop. (1962) 278,714. Beautifully situated and with an agreeable climate, Nice is the leading resort city of the Côte d'Azur, or French Riviera. It has excellent communications by rail, road and sea, and its airport is the second busiest in France. The entrance to the outer port is 300 ft. wide, that to the inner 220 ft. The area of the harbour is about eight acres, and it can be used by vessels drawing up to 23 ft. Nice is an episcopal see (first mentioned at the end of the 4th century) under the archbishop of Aix. It is the seat of a prefect, of tribunals and of a board of trade arbitrators.

The historical nucleus of the town is an isolated limestone hill, running back for some distance from the shore and formerly crowned by a castle (destroyed 1706). The old town stretches along the western base of the hill; the 18th-century town, farther west, slopes gently toward the Paillon; to the northeast and north and west beyond the river lies the modern city. East of the hill the commercial quarter surrounds the port. The whole frontage of Nice is composed of fine embankments, notably the 4-mi.-long Promenade des Anglais, begun in 1822–24 at the expense of the English colony and having two 33-ft.-wide carriageways separated by banks of flowers. The course of the Paillon also is embanked on both sides. Nice has a Roman Catholic cathedral, Ste. Réparate, of the 17th century, restored in 1901; a Russian cathedral (with a richly decorated interior) and church; two synagogues; two Anglican and American chapels; and a Greek church. An astronomical and meteorological observatory is located on Mont Gros. At the Centre Universitaire Méditerranéen (founded in 1933, first director Paul Valéry) French lessons are given for foreign students. The city has several libraries, museums and *lycées*, as well as many theatres, an opera house, three casinos and an open-air theatre. During its famous carnival, beginning on the second Saturday before Shrove Tuesday, Nice becomes the capital of a short-lived kingdom of pleasure; battles of flowers and a *veglione* (party) at the municipal casino add to its gaiety. Carnival is only one of several festivals. Other attractions include automobile, bicycle and yacht races, as well as canoeing, pedalboating, motorboating and skin diving. The beaches are shingle. Summer visitors outnumber those in winter by about three to one.

A mile northeast of the city centre is the ancient episcopal town of Cimiez, with majestic ruins of a Roman amphitheatre of the 1st century A.D., built to seat 6,000 and surrounded by splendid villas and the Regina palace, where Queen Victoria wintered during 1895–99. From east to west Nice is ringed by beautiful districts: Carabacel, St. Étienne, St. Philippe and Les Baumettes. East of the port lie Mont Boron, Riquier and St. Roch.

Though catering for tourists is the leading commercial activity of Nice, it also has some industrial establishments. These include distilleries and oilworks and factories producing perfume, furniture and woodwork, confectioneries, soap, silk goods, straw hats, rubber goods, metal goods and tobacco. Besides the vine, the trees cultivated principally in the neighbourhood are olive, orange, mulberry and carob. Staple exports are olive oil, agricultural produce, fruits and flowers. Trade of the port is mainly coastal.

History.—Nice (Nicaea) was founded about 2,000 years ago by the Phocaeans of Marseilles and was named in honour of a victory (*nikē*) over the neighbouring Ligurians. It soon became a busy trading station, but had a rival in the town of Cemenelum, in existence till the time of the Lombard invasions, the ruins of which are at Cimiez. In the 7th century Nice joined the Genoese league formed by the towns of Liguria. In 729 it repulsed the Saracens; but in 859 and 880 they pillaged and burned it, and for most of the 10th century remained masters of the surrounding country. As an ally of Pisa, Nice was the enemy of Genoa, and both the king of France and the emperor endeavoured to subjugate it; but it maintained its liberties. In the course of the 13th and 14th centuries it fell more than once into the hands of the counts of Provence; and at length in 1388 it placed itself under the protection of the counts of Savoy. The maritime strength of Nice rapidly increased till it was able to cope with the Barbary pirates; the fortifications were largely extended and the roads to the city improved.

During the struggle between Francis I and Charles V great damage was caused by the passage of the armies invading Provence; pestilence and famine raged in the city for several years. In 1543 Nice was attacked by the united forces of Francis I and Barbarossa; the inhabitants were ultimately compelled to surrender, and Barbarossa pillaged the city and carried off 2,500 captives. Pestilence appeared again in 1550 and 1580. In 1600 Nice was taken by the duc de Guise.

By opening the ports of the countship to all nations, and proclaiming full freedom of trade, Charles Emmanuel in 1626 gave a great stimulus to the city. Captured by Catinat in 1691, Nice was restored to Savoy in 1696, but it was again besieged by the French in 1705, and in 1706 its castle and ramparts were demolished. The treaty of Utrecht in 1713 gave the city back to Savoy, and in the peaceful years which followed the "new town" was built. From 1744 till the peace of Aix-la-Chapelle (1748) the French and Spaniards were again in possession. In 1775 the king of Sardinia destroyed all that remained of the ancient liberties of the commune. Conquered in 1792 by the armies of the French Republic, the county of Nice continued to be part of France till 1814; but after that date it reverted to Sardinia. By a treaty concluded in 1860 between the Sardinian king and Napoleon III it was again transferred to France. (A. G. Gr.)

NICEPHORUS, SAINT (Nicephorus Patriarcha) (c. 758–c. 829), Byzantine theologian, historian and patriarch of Constantinople (806–815), whose historical works consist of a useful short history (***Breviarium***) from 602 to 769 and a chronological list from the Creation to his death. Like his father Theodorus he opposed the policy of the iconoclasts. He held office in the imperial secretariat at the time of the Council of Nicaea when the use of icons was restored. For some unknown reason he retired to a monastery on the Bosporus, although he was not a monk. He was then appointed director of the largest poorhouse in Constantinople and in 806 succeeded Tarasius as patriarch of Constantinople. In 815 he was deposed by the iconoclast Leo V and he died in exile in 828 or 829 and was later canonized by the Orthodox Church. His theological works (some unedited) demonstrate the use of new scholastic methods in defense of the icons.

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Alexander, *The Patriarch Nicephorus of Constantinople* (1958). *See* also G. Moravcsik, *Byzantinoturcica*, vol. i, pp. 456–459, 2nd ed. (1958). (J. M. Hy.)

NICEPHORUS, the name of three Byzantine emperors.

NICEPHORUS I (d. 811), Byzantine emperor from 802 to 811, a native of Seleucia in Pisidia, became a high financial official (logothete) under the empress Irene. When officials and army officers rose against Irene's inefficient rule, Nicephorus was acclaimed emperor and the empress was sent to a nunnery. Nicephorus' religious policy was orthodox and he allowed the cult of icons, but he was not favoured by ecclesiastical extremists such as Theodore Studites because he tended to assert his authority over the church, and in particular he appointed a learned layman, Nicephorus, as patriarch of Constantinople. He practised strict economy and strengthened military and naval defenses, both by improved methods of recruitment and by enforced colonization of vital areas, but his rigorous methods involved him in considerable unpopularity. In 803 and 810 he made a treaty with Charlemagne, by which Venice, Istria, the Dalmatian coast and south Italy were assigned to the east, while Rome, Ravenna and the Pentapolis were included in the western realm. By withholding the tribute which Irene had agreed to pay to Harun al-Rashid, Nicephorus committed himself to a war with the Muslims. Compelled by the disloyalty of his general Bardanes, he had to take the field himself; he sustained a severe defeat at Crasus in Phrygia (805) and obtained peace only on condition of paying a yearly contribution of 30,000 gold pieces. By the death of Harun in 809 Nicephorus was left free to deal with the Bulgarian king Krum, who was harassing his northern frontiers. In 811 Nicephorus invaded Bulgaria and drove Krum to ask for terms. But he rejected these overtures and in his attempt to crush the Bulgars he was caught in the mountains and killed together with most of his army on July 26.

NICEPHORUS II PHOCAS (*c.* 912–969), Byzantine emperor from 963 to 969, belonged to a Cappadocian family which had produced several distinguished generals. Under Constantine VII he became commander on the eastern frontier. In 960 he led an expedition to Crete and by 961 had gained the island from the Arabs. In the campaigns of 962–963 he forced his way through Cilicia to Syria and captured Aleppo, but made no permanent conquests. On the death of Romanus II he was proclaimed emperor at Caesarea by the eastern troops, and was soon after acknowledged at Constantinople as co-emperor and guardian of Basil II and Constantine VIII, the young sons of Romanus. He married the empress, the notorious Theophano. In 964–966 he conquered Cilicia and again overran Mesopotamia and northern Syria, while the patrician Nicetas recovered Cyprus. In 968 he reduced most of the fortresses in Syria, and after the fall of Antioch and Aleppo (969), which were recaptured by his lieutenants, secured his conquests by a peace. On the northern frontier he refused to pay tribute to the Bulgars, and instigated the Russians under Svyatoslav to attack them, though only to find that he had introduced a dangerously powerful ally into the Balkans. In the west Nicephorus renounced his tribute to the Fatimid caliphs, and sent an expedition to Sicily under Nicetas (964–965), but was forced by defeats on land and sea to evacuate the island. In 967 he made peace with the Muslims of Kairouan in Tunisia and turned to defend himself against Otto I of Germany, who was establishing his authority in Italy, and indeed wished for a marriage alliance with the imperial family which Nicephorus refused. Owing to the care which he lavished on the army, Nicephorus was compelled to exercise rigid economy in other departments. He was a member of the Asian landed aristocracy and favoured this class at the expense of the small farmers. Very ascetic in outlook, he tried to prevent monasteries from acquiring further wealth. By his heavy taxation he forfeited his popularity; he was assassinated in his palace bedroom on the night of Dec. 10–11, 969, by another successful general, the magnate John Tzimisces.

NICEPHORUS III BOTANEIATES, Byzantine emperor from 1078 to 1081, belonged to the military aristocracy of Asia Minor and was related to the powerful Phocas family. As the commander (*strategos*) of the Anatolikon theme he led his army against the feeble Michael VII Ducas. With some support from the Seljuk ruler Suleiman in Asia Minor, he was proclaimed emperor by his troops and entered Constantinople in March 1078. His imperial claim was ratified by the aristocracy and clergy of the capital who had already deposed Michael VII. Nicephorus thus forestalled the *dux* of Dyrrachium, Nicephorus Bryennius, the rival claimant for the throne, though he subsequently had to face another rival in Asia Minor, Nicephorus Melissenus, as well as Turks. But he failed to maintain his position in face of the brilliant young Alexius Comnenus, and on April 4, 1081, he abdicated and entered a monastery.

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NICHIREN (ZENSHŌBŌ RENCHŌ) (1222–1282), saint and prophet, founder of the Nichiren sects, the most fanatical in Japanese Buddhism, which, with its offshoots, had about 10,000,000 followers in the 1960s. Of humble birth, Nichiren renounced the world in his 12th year and entered a monastery. After years of ardent study on Mt. Hiei and at Nara he reached the conviction that the Lotus Sutra (Saddharma Pundarika; *see* BUDDHISM: *Literature of the Mahayana*) forms the kernel, the quintessence, of Buddha's teaching, a conviction he announced publicly in 1253.

Nichiren was at the same time passionate and tender-hearted, and these two sides of his character presented themselves in turn during the chequered course of his prophetic life. His first warning was given in 1260 in a treatise, the *Risshō-ankoku-ron* ("Ways of Upholding Justice and Stabilizing the Nation"), addressed to the Kamakura shogunate (*see* JAPAN: *History*). It set forth the idea that good government should adhere to the ideal of righteous teaching and blamed the current social unrest on the false faith of the nation's leaders. The result was banishment to the Izu Peninsula, where he stayed for four years. Throughout his life Nichiren continued to attack the erroneous teachings of Buddhist sects (especially Jōdo, or Pure Land, Zen, Shingon, and Ritsu) and the government that supported them. He and his followers saw in the Mongol invasion (beginning in 1274) a fulfillment of his prophecies. His denunciation of the shogunate led to another four-year exile on Sado Island. Pardoned in 1274, he spent the rest of his life on Mt. Minobu with his disciples. He died on Oct. 13, 1282.

Nichiren was not the first Buddhist in Japan or China to proclaim the quintessential importance of the Lotus Sutra: this had been propounded also by the Tendai sect, in a monastery of which Nichiren had first been apprenticed. What was most original in his teaching was his emphasis: it was not understanding of but rather belief in the *sutra* that would lead the devout to enlightenment. This emphasis found expression in the form of *shōdai*, constant repetition of the name of the *sutra* (*Namu Myōhō Rengekyō*, or "Adoration to the Lotus Sutra of Perfect Truth"), and in the worship of the great Mandala (*see* MANDALA), representing the supreme truth revealed in the *sutra*.

Most conspicuous among 20th-century groups claiming to be followers of Nichiren are the Risshō Kōsei Kai and the Sōka Gakkai, the latter a politically active religious organization of growing power in the 1960s. *See* also BUDDHISM; JAPAN: *The People: Religion*.

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NICHOLAS, SAINT (? 4th–5th century A.D.), the patron of schoolchildren and sailors, is the most popular of the saints who are not martyrs in both Eastern and Western churches (feast day Dec. 6). But his existence is not attested by any historical document, so nothing certain is known of his life. It is, however, highly probable that he was bishop of Myra in Lycia (Asia Minor) about the end of the 4th century, or not later than the beginning

of the 5th, for his shrine was well known at Myra from the 6th century, according to the biography of another Nicholas, the abbot of the monastery of Sion near Myra under Justinian I. The earliest account of St. Nicholas is the famous miracle of the three officers unjustly condemned to death but saved by his appearance in a dream to the emperor Constantine I; the Greek text of this *praxis de stratelatis* may go back to the 6th century and the Latin translation of it to the 8th. Legends about St. Nicholas multiplied rapidly; all the incidents of the life of Nicholas of Sion were attributed to him, as well as numerous miracles directed toward the poor, the sick and the unhappy. The best known are those of the three girls whom he dowered to save from the prostitution that poverty was forcing on them and of the three children whom he brought to life again after they had been chopped up by a butcher and put in a salting vat.

Devotion to St. Nicholas extended to all parts of the world: there were 25 churches or chapels dedicated to him in Constantinople, 45 in Rome, 40 in Iceland and so on. In 1087 Italian sailors brought his body from Myra to Bari in Apulia; this translation, commemorated on May 9, greatly increased the saint's popularity, and Bari became one of the most crowded pilgrimage centres. The name Nicholas was frequently given to persons and places in many countries; numerous surnames in European languages are derived from Nicholas (*e.g.*, in English, Nichols, Nicholson, Colson, Collins). St. Nicholas was chosen patron saint of Russia and Lorraine, as well as of various charitable fraternities and merchant guilds, particularly in France, the Netherlands, Germany and England. His miracles were a favourite subject for medieval artists and liturgical plays, and his feast day was the occasion for the ceremonies of the boy bishop (*q.v.*).

The Netherlands Protestant settlers in New Amsterdam (New York) replaced St. Nicholas ("Sinter Claes" in Dutch) by a kind of benevolent magician, Santa Claus. The transformation of St. Nicholas into Father Christmas or Father January took place first in Germany, then in countries where the Reformed churches were in the majority and finally in France, the feast day being put off to Dec. 25 or to the New Year. But there are still Catholic areas where children hang up their stockings by the chimney on the night of Dec. 5 so that St. Nicholas may fill them with toys and delicacies.

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NICHOLAS, the name of five popes and one antipope.

SAINT NICHOLAS I, called THE GREAT (d. 867), pope from 858 to 867, was the most forceful of the early medieval popes. Before his election, in April 858, he had almost 15 years of service in the papal curia, and in all the acts of his pontificate he urged the supremacy of the Roman see. His reign was marked by three memorable contests, which left their mark in history. The first was that in which he supported the claims of the unjustly degraded patriarch of Constantinople, Ignatius; but two of its incidents, the excommunication of Photius (*q.v.*), the rival of Ignatius, by the pope (863) and the counterdeposition of Nicholas by Photius (867) were steps toward the permanent separation between the Eastern and the Western Churches. The second great struggle was that with Lothair of Lorraine about the divorce of his wife, Theutberga (*see* LOTHAIR). The pope not only quashed the whole proceedings against Theutberga but even created a precedent by deposing the archbishops of Cologne and of Trier, who had brought to Rome the *libellus* of the synod of Metz that declared the marriage null (863). The third great ecclesiastical affair of this pontificate was that in which the right of bishops to appeal to Rome against their metropolitans was maintained in the case of Rothad of Soissons, deposed by Hincmar (*q.v.*) of Reims. Nicholas, a strict upholder of the Roman church's primacy of jurisdiction, reinstated Rothad in 865.

Nicholas was indeed one of the master theorists of the papal plenitude of power. Deeply dependent on the writings of his great predecessors Leo the Great, Gelasius I and Gregory the Great, he was probably the first pope to draw on the False Decretals (*see* DECRETALS, FALSE). For Nicholas, the Roman church is both the head and the epitome of the universal church. It alone has all power by divine commission. As both the sacerdotal and royal functions were conferred by Christ on St. Peter, so they are exercised by St. Peter's successors, the popes. The sword of temporal power is delegated to the emperor for the protection of the church. Thus the teaching of Nicholas contained in embryonic form the complete doctrine of papal theocracy. Nicholas died on Nov. 13, 867, and his feast is celebrated on the anniversary.

NICHOLAS II (GERHARD) (d. 1061), pope from 1058 to 1061, was a Burgundian and bishop of Florence when, about Dec. 1058, he was elected at Siena to succeed Stephen X (IX) in opposition to the antipope Benedict X. He was enthroned in Jan. 1059. Nicholas II is a major figure in the reform associated with the name of Hildebrand (*see* GREGORY). In the Lateran synod of April 1059, a milestone in the Gregorian reform and in the history of the papacy, Nicholas enacted the famous decree on papal elections. In this he was expressly reacting against the disorders that had preceded his own elevation. The leading part in elections was assigned to the seven cardinal bishops, who were to deliberate together on a suitable candidate and then to call in the other cardinals. The rest of the clergy and the people were to acclaim the choice. The emperor's part in the matter was dismissed with a vague covering phrase. A legate, sent to notify the German court of this, was refused an audience, and an imperialist version of the decree was put into circulation. At a synod held in 1061 the German bishops declared the election decree void and quashed all the pope's acts. These proceedings signified the rupture of the alliance between Germany and the Holy See and heralded the contest between empire and papacy.

Nicholas had entered into friendly relations with the Normans of southern Italy in the early months of his pontificate, and this new alliance was cemented by the treaty of Melfi (Aug. 23, 1059), when he invested Robert Guiscard with the duchies of Apulia and of Calabria and the lordship of Sicily, and Richard of Aversa with the principality of Capua in return for fealty and the promise of assistance. This arrangement was destined to make the papacy more independent of both the western and eastern emperors. The immediate result was the reduction, in the following autumn, of Galeria, where the antipope Benedict X had taken refuge. Nicholas died on Aug. 27, 1061. (R. E. McN.)

NICHOLAS III (Giovanni Gaetano Orsini) (*c.* 1225–1280), pope from 1277 to 1280, was a son of the Roman senator Matteo Rosso Orsini, who had been a friend of St. Francis of Assisi and had played a great role during the pontificates of Gregory IX and Innocent IV and in the conclave which led to the election of Celestine IV. Giovanni was made cardinal deacon of St. Nicholas in Carcere Tulliano by Innocent IV as early as 1244 and thus was well versed in the business of the Roman curia when he became pope on Nov. 25, 1277. The contemporary sources stress his impressive personality, his virtue and personal integrity, but also his nepotism, because of which Dante (*Inferno* 19, 31 ff.) placed him in hell. He had been cardinal protector of the Franciscans and as pope in 1279 issued the important bull *Exiit qui seminat* which temporarily settled the struggle concerning the interpretation of perfect poverty within the order; it revoked the concessions concerning the use of money made by Innocent (*q.v.*) IV and clarified the latter's ruling that all movable and immovable possessions of the order, except those reserved by the donors, be in the ownership of the Holy See, while the friars were to have only the usufruct.

Nicholas III successfully continued Gregory X's policy of curbing the expansionist ambitions of the Sicilian king Charles I (*q.v.*) of Anjou. He did not renew Charles's positions as imperial vicar of Tuscany and senator of Rome; as far as the latter office was concerned, he legislated against its ever being filled again by a foreign ruler. At the same time he induced the German king and prospective emperor Rudolf of Habsburg to acknowledge that the Romagna with Ravenna and Bologna belonged to the papal states; though this province was not effectively incorporated until

much later, the pope thus consummated the policy of recuperations begun by Innocent III. He also succeeded temporarily in making papal arbitership and influence felt in Florence, Siena and other Tuscan cities.

It would seem that Nicholas also had adopted a constructive plan of reorganization of the Holy Roman empire. It is known for certain that the kingdom of Burgundy (Arelat) was to be given to Charles of Anjou's grandson Charles Martel (later titular king of Hungary), who was betrothed to a daughter of Rudolf of Habsburg. The kingdom of Germany, it seems, was meant to become a hereditary Habsburg monarchy, whereas imperial Italy apparently was to be divided into two kingdoms, Lombardy and Tuscany, to be ruled perhaps by papal nephews. The German king would have had no direct control of the other three kingdoms but as emperor would have remained their feudal overlord. This so-called four states project, which almost certainly would have proved beneficial, is mentioned only by Tolomeo of Lucca, but its existence is not improbable.

The early death of Nicholas III, on Aug. 22, 1280, from a stroke ruined such plans and opened the door to renewed Angevin-French influence upon the papacy under his successor, Martin IV (see MARTIN).

NICHOLAS IV (Girolamo Masci) (1227–1292), pope from 1288 to 1292, was the first Franciscan to occupy the throne of St. Peter. He was elected to succeed Honorius IV after a vacancy protracted by antagonism between the French and Italian cardinals for almost 11 months, during which six cardinals died, no doubt from malaria. He had been elected a first time on Feb. 15, 1288, but did not accept until after he had been elected a second time a week later.

Girolamo Masci was born of humble parents at Lisciano near Ascoli in the Marches. He joined the Franciscans at an early age and became the order's minister for Dalmatia. In 1272 Gregory X sent him to Constantinople, where he had a share in bringing about the short-lived union with the Greeks. From 1274 to 1279 he was minister-general of the Franciscan order; then and later during his pontificate he showed much more severity against the Franciscan Spirituals than had his predecessor as minister-general, St. Bonaventura, let alone the earlier general John of Parma. He was made cardinal priest of St. Pudenziana by Nicholas III in 1278 and in 1281 cardinal bishop of Palestrina by Martin IV.

As pope he relied very much on the Colonna, increasing the number of cardinals belonging to that family. In the bull *Coelestis altitudo* of 1289 he granted to the cardinals half of the revenues of the Roman church and a share in its administration.

Like his predecessor Martin IV, Nicholas IV, as feudal overlord of the south Italian Sicilian kingdom, tried vainly to force the royal house of Aragon to restore the island of Sicily to the south Italian Anjous. Yet he abandoned the political concept of Martin IV insofar as he terminated in 1291 the conflict between France and the kingdom of Aragon. Charles of Valois gave up his claim upon Aragon in return for the counties of Anjou and Maine which the son and successor of Charles of Anjou, Charles II (*q.v.*) of Naples, agreed to renounce in favour of his Valois cousin and namesake in the interest of concerted action against the Aragonese of Sicily.

Nicholas IV no more than any other pope after Gregory X was able to revive the idea of the crusade. During his pontificate the last remnant of the Christian crusader states, the fortress of Acre, fell to the Mameluke sultan of Egypt (1291). Even at that late date the outcome could have been different had the west availed itself of an opportunity for alliance with the Mongols against the Muslims, for which Innocent IV and St. Louis IX of France had looked in vain. This now seemed to materialize through the initiative of the Il-khan Arghun of Persia, who sent urgent requests for joint action to Nicholas IV, to Philip IV of France and to Edward I of England; but he received only promises in return. Nicholas, however, did send the Franciscan Giovanni di Monte Corvino (q.v.) to the court of Kublai Khan; this mission led to the first establishment of the Catholic Church in China, where Nestorian Christians had previously been influential. The pope also sent missionaries, mostly Franciscans, to the Balkans and the near east.

Nicholas did much for Roman architecture and art, especially in restoring the basilicas of S. Giovanni in Laterano and S. Maria Maggiore and their mosaics. He died on April 14, 1292.

(G. B. L.)

NICHOLAS V (Pietro Rainallucci) (d. 1333) was antipope in Italy from 1328 to 1330. An assembly of priests and laymen in Rome under the influence of the excommunicated emperor Louis IV of Bavaria elected this Franciscan to the papacy during the pontificate of John XXII. After John excommunicated him in April 1329, Nicholas, having obtained assurances of pardon, presented an abjuration to the pope at Avignon (Aug. 25, 1330). He remained in honourable imprisonment in the papal palace until his death on Oct. 16, 1333.

NICHOLAS V (Tommaso Parentucelli) (1397–1455), pope from 1447 to 1455, was born on Nov. 15, 1397, at Sarzana, where his father was a physician. Eugenius IV made him bishop of Bologna (1444) and a papal negotiator with the Holy Roman empire regarding the reforming decrees of the Council of Basel. He was elected to succeed Eugenius on March 6, 1447. Faced with the problem of an antipope, Felix V (*q.v.*), Nicholas, by conciliation and patience, won the abdication of Felix on April 7, 1449. The next year, in thanksgiving for the restoration of unity in the church, he held a Jubilee in Rome. He crowned Frederick III Holy Roman emperor in St. Peter's in March 1452—the last occasion in which a German emperor was crowned in Rome. In 1450 he sent Nicholas of Cusa as legate to Germany and Bohemia with the task of reforming abuses, a mission that was outstandingly successful. Nicholas was also responsible for the mission of St. John of Capistrano to Germany and that of Guillaume d'Estouteville (*q.v.*) to France.

Nicholas was perhaps the best of the Renaissance popes. He was a generous patron of humanists, eager to reconcile religion and the new learning. He employed hundreds of copyists and scholars and, by his collection of manuscripts, began the formation of the great library in the Vatican. His last years were darkened by Stefano Porcaro's conspiracy against papal government in Rome and by the fall of Constantinople, both in 1453. Nicholas died on March 24, 1455. (J. A. Ct.)

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NICHOLAS I (NIKOLAI PAVLOVICH) (1796–1855), emperor of Russia from 1825, was born at Tsarskoe Selo on July 6 (new style; June 25, old style), 1796, the eighth child of the future

emperor Paul I and his consort Maria Fedorovna. He was not five years old when the murder of his father brought his eldest brother to the imperial throne as Alexander I. His education was supervised by Gen. Count M. I. von Lambsdorff, director of the 1st cadet corps and former governor of Courland, a strict disciplinarian but a miserable pedagogue who awakened little enthusiasm for learning either in Nicholas or in his elder brother Constantine (*q.v.*); and though Nicholas had various tutors, his interest remained generally limited to military matters, in spite of his mother's efforts to change this. His approach to many problems was to be that of a simple, honest and devoted officer.

In 1814, in the concluding phase of the Napoleonic Wars, the grand duke Nicholas joined the Russian headquarters in France, but not to take part in any fighting. He was with the Allies in Paris in 1815. In the following year he set out on a tour, visiting not only Moscow and the western provinces of Russia but also Prussia and England. In Berlin he was betrothed to Princess Charlotte (in Russia called Aleksandra Fedorovna), daughter of King Frederick William III of Prussia. His marriage on July 13 (N.S.; 1, O.S.), 1817, marked the beginning of a close relationship between the courts of Berlin and St. Petersburg. Nicholas gave himself over to a happy family life—his first child, the future emperor Alexander II, was born on April 29 (N.S.), 1818—and did not participate in governmental affairs. His only public role prior to his accession to the throne was as commander of a brigade of the guard and as inspector general of the engineering branch. In this capacity he showed his interest in military education and promoted the establishment of several military schools.

Accession.—Alexander I was childless, and his brother Constantine, bearing the title of tsarevich or crown prince, was expected to succeed him on the throne. But in 1823 Constantine, who lived in Poland with a Polish wife, had secretly renounced any claim to the imperial succession. When Alexander I died at Taganrog on Dec. 1 (N.S.), 1825, Nicholas, unaware of the renunciation, proclaimed Constantine emperor. Informed of the renunciation, he still hesitated to accept the crown without a public statement by Constantine, for he was too conscious of the unpopularity that his drastic discipline had earned for him in the army. A three-week interregnum ensued, and the discontented army officers took advantage of it to bring to a head a plot that had long been hatching in favour of constitutional reform. When on Dec. 26 the troops who had taken the oath to Constantine were ordered to take another to Nicholas, it was easy to persuade them that this was a treasonable plot against the true emperor. The Moscow regiment in St. Petersburg refused to take the oath, and part of it marched, shouting for "Constantine and Constitution," to the square before the senate house, where they were joined by a company of the guard and by sailors from the warships.

In this crisis Nicholas showed high personal courage. For hours he stood, or sat on horseback, amid the surging crowd, facing the mutinous soldiers while hazardous efforts were made to bring them to reason (Gen. Count M. A. Miloradovich, military governor of St. Petersburg, was mortally wounded by a pistol shot in an argument with the mutineers). When at last Nicholas consented to use force, a few rounds of grapeshot quelled the mutiny. The chief conspirators were arrested the same night and interrogated by the emperor in person. A special commission, consisting entirely of officers, was then set up; and before this, for five months, the prisoners were subjected to a rigorous inquisition. It was soon clear that the December rising was but one manifestation of a vast conspiracy permeating the whole army and embracing such aims as the abolition of serfdom and the attainment of some degree of representative government. (*See* DEKABRISTS.) Nicholas was crowned emperor in Moscow on Sept. 3 (N.S.), 1826. His coronation in Warsaw, as king of Poland, did not take place till May 24, 1829.

Internal Policy.—Nicholas saw the need for reforms and appointed a committee to examine the unfulfilled projects of Alexander I as well as other measures for the overhauling of the administration. But the revolutionary movement in western Europe, breaking out in 1830, prompted the shelving of most of the committee's proposals, as Nicholas turned increasingly to military discipline as the means of rejuvenating the tired and corrupt administration. He put civil servants, professors and students into uniform and, for little offenses, had them marched to the guardhouse. Though a certain autonomy was extended to the universities—they elected their own deans and professors—the expression of thought was censored. The army was disciplined by an unceasing round of parades and inspections which left it woefully unprepared for actual combat. In general, everything was done to protect Russia from foreign revolutionary influence. Students were no longer sent to study in western Europe, and travel abroad was restricted. Meanwhile a secret police network, the dreaded "third section" of the emperor's private chancery, had been established in July 1826; and a policy of russification was pursued throughout the empire to make the idea of nationality (*narodnost*), together with Orthodox Christianity and autocracy, one of the pillars of Russian absolutism. Nicholas was not blind to the evils of Russian society (he regarded serfdom as an evil), but he feared that changes would be worse yet.

The reign saw much emphasis on bureaucracy and officialdom, yet Nicholas was reluctant to delegate authority. In this he resembled his contemporary, the emperor Francis I of Austria. But whereas Francis would "sleep upon" a difficult problem, Nicholas never did. His constitution was of iron, his capacity for work prodigious: reviews and parades, receptions of deputations, visits to public institutions, then eight or nine hours in his cabinet to deal with reports and dispatches—such was his ordinary day's work. Under the "Iron Tsar" the outward semblance of authority was perfectly maintained; but behind this façade the whole structure of the administrative system continued to rot.

Foreign Affairs.—Throughout his reign Nicholas I sought to discipline Russia and, by means of a disciplined Russia, to discipline the world. Russia's mission in the west was, in accordance with the principles of the Holy alliance (*q.v.*) as Nicholas interpreted them, to uphold the cause of legitimacy and autocracy against revolution; and in the east it was, with or without the co-operation of "Europe," to advance the cause of Orthodox Christianity, of which Russia was the natural protector, at the expense of the decaying Ottoman Turkish empire (*see* EASTERN QUESTION). The sympathy of Europe with the insurgent Greeks gave Nicholas an early opportunity (*see* GREEK INDEPENDENCE, WAR OF). Great Britain sent the duke of Wellington to St. Petersburg in 1826 not only to congratulate the new emperor on his accession but also to concert a policy on the Eastern question. The upshot proved the diplomatic value of Nicholas' apparent sincerity of purpose and charm of manner: the "Iron Duke" was to the "Iron Tsar" as soft iron to steel; and the British found themselves committed, without efficient guarantees for the future, to a policy that turned out very much to Russia's advantage. The execution of this policy, however, incidentally exposed the rottenness of Russia's administrative system.

The newly organized Russian naval squadron on its way to join the British and the French in the Ionian sea reached the English channel only with difficulty and had to be completely refitted at Plymouth before it could proceed; yet it arrived in time to participate in the destruction of Ottoman seapower in the unforeseen battle of Navarino (Oct. 20, 1827). When overt war broke out between Russia and Turkey in 1828 (*see* RUSSO-TURKISH WARS) the emperor went to join his troops on their march through the Balkans toward Istanbul, hampering by his presence the initiative of the nominal commander in chief (Prince L. A. P. von Wittgenstein) and obliging the soldiers, weary and starving in the marshes of Dobruja, to parade before him as smartly as if they were at St. Petersburg. When hundreds died of scurvy or dysentery, Nicholas could do nothing to repair the scandalous inefficiency of the commissariat or of the hospital service. Even so, the peace treaty of Adrianople (Edirne; Sept. 14, 1829) seemed to reduce Turkey to a position little better than that of vassalage to Russia; and the Russo-Turkish treaty of Unkiar Skelessi (July 8, 1833) after the first revolt of Mohammed Ali of Egypt against Turkey strengthened Russia's hand still further.

In the west Nicholas himself proposed an armed intervention of the Holy alliance "to restore order" after the July revolution in France and the Belgian revolution (1830). When Austria and

Prussia held back, he even proposed to intervene alone; but this project was rendered impracticable by the outbreak of the great insurrection in Poland (Nov. 29, 1830), which tied the hands of all three powers.

After the Poles had been crushed (1831), Nicholas went in person to reach an understanding with Austria on the Eastern question at Münchengrätz (Mnichovo Hradiste) in Sept. 1833. This enabled his minister K. R. von Nesselrode to draw Austria and Prussia into a reproduction of the Holy alliance with Russia by the secret convention of Berlin (Oct. 15, 1833), whereby they reaffirmed the right and duty of intervention at the request of a legitimate sovereign. When the emperor Ferdinand I had succeeded his father Francis I on the Austrian throne (1835), Nicholas went to renew the Austro-Russian understanding in Sept.–Oct. 1835 through meetings at Teplitz (Teplice) and in Prague. At these meetings he recommended the eventual suppression of the republic of Cracow by Austria, since Cracow was a centre of revolutionary agitation (though Austrian, Russian and Prussian troops occupied the territory from 1836 to 1841, formal annexation was deferred till 1846); and he was also persuaded by Metternich, the Austrian chancellor and minister of foreign affairs, to support the cause of Don Carlos in Spain. As early as May 1837, in view of the agitation in Hungary, he announced that "in every case" Austria might count on Russia.

These cordial ties were loosened when war broke out in Syria between Turkey and Egypt in 1839. Metternich was anxious to summon a European conference to Vienna, with a view to placing Turkey under a collective guarantee, but Nicholas refused to be a party to it. Moreover, as Austria showed an inclination to consult both Great Britain and France, Nicholas decided to come to an agreement with Great Britain in order to settle the Eastern question according to his own views and without reference to the France of the July monarchy. He therefore departed so far from the position given to him by the treaty of Unkiar Skelessi and made such concessions that the convention of London (July 15, 1840) could be concluded between Russia, Great Britain, Austria and Prussia for the settlement of the question regardless of France's views. The new Anglo-Russian entente led in June 1844 to a visit of the emperor to England.

The imperial regime in Russia was unshaken by the European revolutionary movement of 1848; and in 1849 Nicholas sent his army into Hungary, at the request of the young Austrian emperor Francis Joseph, to crush the insurgent Hungarians. He also did a valuable service to Austria during the German crisis of 1850. Prussia was then trying to organize a new union of German states that would have put an end to the predominance enjoyed by Austria in the German confederation as set up in 1815; and the troubles that broke out in Electoral Hesse might have led to war between Austria and Prussia if both powers had persisted in intervening at cross purposes there (*see* GERMANY: *History*). At a meeting in Warsaw, however, in Oct. 1850, Nicholas told the Prussian prime minister, Friedrich Wilhelm, graf von Brandenburg, that in order not to forfeit Russia's friendship Prussia must adhere to the settlement of 1815 and to the entente with Austria. Thus deterred by Nicholas, Prussia submitted to Austria's will in the punctation of Olmütz (Olomouc) in November.

Nicholas was soon to be disappointed in his faith in Austria's friendship. In 1853, when the dispute arose with the French emperor Napoleon III over the guardianship of the Holy Places in Palestine (*see* CRIMEAN WAR), Nicholas could not believe that Christian powers would resent his claim to protect the Christian subjects of Turkey. On the contrary, he thought that Austria was in gratitude bound to be at least neutral, if not favourable to him; that Prussia would adopt a similar position; and that he could hope to come to a frank understanding with Great Britain. Having in June 1853 ordered his armies to occupy Turkish Moldavia and Walachia, he conferred with Francis Joseph at Olmütz in September and met him again, with the Prussian king Frederick William IV, in Warsaw in October. Finally, however, when France and Great Britain had already declared war on Russia, both Austria and Prussia subscribed to an agreement with the allies guaranteeing the integrity of the Turkish empire (April 9, 1853) and then proceeded to sign a defensive alliance of their own (April 20, 1854) which would come into operation if the Russians annexed the banks of the Danube or marched on Istanbul. Thus Nicholas, the professed champion of the European alliance, found himself obliged to withdraw his troops from the Balkans at Austria's behest in the summer of 1854. The Franco-British invasion of the Crimea followed, and with it a fresh exposure of the corruption of the Russian system. At the outset Nicholas had grimly remarked that "Generals January and February" would prove his best allies, but they acted impartially: if thousands of British and French soldiers perished of cold and disease in the trenches before Sevastopol, the tracks leading from the centre of Russia into the Crimea were marked by the bones of Russian dead. Disillusion broke the emperor's spirit; he neglected ordinary precautions for his health; and, on March 2 (N.S.; Feb. 18, O.S.), 1855, he died of pleurisy.

See also RUSSIAN HISTORY.

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NICHOLAS II (NIKOLAI ALEKSANDROVICH) (1868–1918), the last Russian emperor, was born at Tsarskoe Selo on May 18 (new style; 6, old style), 1868, the eldest son of the tsarevich Aleksandr Aleksandrovich (emperor as Alexander III from 1881) and his consort Maria Fedorovna (Dagmar of Denmark). Succeeding his father on Nov. 1 (N.S.), 1894, he was crowned in Moscow on May 26 (N.S.), 1895.

Character and Views.—Neither by upbringing nor by temperament was Nicholas fitted for the complex tasks that awaited him as autocratic ruler of a vast empire. He had received a military education from his tutor, Gen. G. G. Danilovich, and his tastes and interests were those of the average young Russian guards officer of his day. He had few intellectual pretensions, but delighted in physical exercise and the minutiae of army life: uniforms, insignia, parades. Yet on formal occasions he felt ill at ease. Though he possessed great personal charm he was by nature timid; he shunned close contact with his subjects, preferring the privacy of his family circle. His domestic life was serene. To his wife Alexandra (*q.v.*), whom he had married on Nov. 26 (N.S.), 1894, Nicholas was passionately devoted. She had the strength of character that he lacked, and he fell completely under her sway. She communicated to him her morbid mystical outlook. Under her influence he sought the advice of spiritualists and faith healers, most notably G. E. Rasputin (*q.v.*), who eventually acquired great power over the imperial couple. Nicholas also had other irresponsible favourites, often men of dubious probity who provided him with a distorted picture of Russian life, but one that he found more comforting than that contained in official reports. He distrusted his ministers, mainly because he felt them to be intellectually superior to himself and feared that they sought to usurp his sovereign prerogatives. His view of his role as autocrat was childishly simple: he derived his authority from God, to whom alone he was responsible, and it was his sacred duty to preserve his absolute power intact. However, he lacked the strength of will necessary in one who had such an exalted conception of his task. In pursuing the path of duty Nicholas had to wage a continual struggle against himself, suppressing his natural indecisiveness and assuming a mask of self-confident resolution. His dedication to the dogma of autocracy was an inadequate substitute for the constructive policy which alone could have prolonged the imperial regime.

Soon after his accession Nicholas proclaimed his uncompromising views in an address to liberal deputies from the *zemstva* in which he dismissed as "senseless dreams" their aspirations to share in the work of government. To the rising groundswell of popular unrest he replied with intensified police repression. In foreign policy, his naïveté and lighthearted attitude toward international obligations sometimes embarrassed his professional diplomats; *e.g.*, when he concluded an alliance with the German emperor William II during their meeting at Björkö in July 1905. He was the first Russian sovereign to evince personal interest in Asia. In 1891, while still tsarevich, he visited India, China and Japan; and later he nominally supervised the construction of the Trans-Siberian

railway. The forward policy he pursued in regard to Korea, where he had private financial interests, was partly responsible for the Russo-Japanese War (1904–05). The outcome of this struggle not only frustrated Nicholas' grandiose dreams of making Russia a great Eurasian power with China, Tibet and Persia within its sphere of influence but also faced him with serious problems at home, where discontent grew up into the revolutionary movement of 1905.

Domestic Affairs.—Nicholas considered all who opposed him, regardless of their views, as malicious conspirators. Disregarding the advice of S. Y. Witte, his prime minister, he refused to make concessions until events forced him to yield more than might have been necessary had he been more flexible. On March 3 (N.S.), 1905, he reluctantly agreed to the creation of a national representative assembly or duma (*q.v.*) with consultative powers; and by the manifesto of Oct. 30 he promised what was virtually a constitutional regime: no law was to take effect without the duma's consent. Nicholas, however, cared little for an undertaking extracted from him under duress. He strove to regain his former powers and ensured that in the new "fundamental laws" (May 1906) he was still designated an autocrat. He furthermore patronized an extremist right-wing organization, the Union of Russian Men, which sanctioned terrorist methods and disseminated anti-Semitic propaganda. Witte, whom Nicholas blamed for the October manifesto, was soon dismissed, and the first two dumas were prematurely dissolved as "insubordinate." P. A. Stolypin, who carried out the coup of June 16, 1907, whereby the second duma was dissolved, was loyal to the dynasty and a capable statesman. But the emperor distrusted him and allowed his position to be undermined by intrigue. Stolypin was one of those who dared to make representations about Rasputin's influence and thereby incurred the displeasure of the empress. In such cases Nicholas generally hesitated but ultimately yielded to Alexandra's pressure. To prevent exposure of the scandal he interfered arbitrarily in matters properly within the competence of the Holy synod.

Foreign Affairs.—In foreign affairs attention now centred on the Balkans. Nicholas sympathized with the national aspirations of the Slavs and was anxious to win control of the Turkish straits, but tempered his expansionist inclinations with a sincere desire to preserve peace among the great powers. After the assassination of the Austrian archduke Francis Ferdinand at Sarajevo he tried hard to avert the impending catastrophe by diplomatic action and resisted, until July 30 (N.S.), 1914, the pressure of the military for general, as distinct from partial, mobilization. The outbreak of World War I temporarily strengthened the monarchy, but Nicholas did little to maintain his people's confidence. The duma was slighted, and voluntary patriotic organizations were hampered in their efforts; the gulf between the ruling group and public opinion grew steadily wider. Alexandra turned Nicholas' mind against the popular commander in chief, his father's cousin the grand duke Nicholas (Nikolai Nikolaevich); and on Sept. 5, 1915, he dismissed him, assuming supreme command himself. Almost all his ministers protested against this step as likely to impair the army's morale, since the emperor had no experience of war. They were overruled and soon found themselves dismissed.

Nicholas II did not in fact interfere unduly in operational decisions, but his departure for headquarters had serious political consequences. In his absence supreme power in effect passed, with his approval and encouragement, to the empress. A grotesque situation resulted: in the midst of a desperate struggle for national survival competent ministers and officials were dismissed and replaced by worthless nominees of Rasputin. The court was widely suspected of treachery, and antidynastic feeling grew apace. Conservatives plotted Nicholas' deposition in the hope of saving the monarchy. Even the murder of Rasputin failed to dispel Nicholas' illusions: he blindly disregarded this ominous warning, as he did those by other highly placed personages, including members of his own family. His isolation was virtually complete.

Abdication and Death.—When riots broke out in Petrograd on March 8 (N.S.), 1917, Nicholas instructed the city commandant to take firm measures and sent troops to help restore order. It was too late. The government resigned, and the duma, supported by the army, called on the emperor to abdicate. At Pskov, on March 15, with fatalistic composure, Nicholas renounced the throne—not, as he had originally intended, in favour of his son Alexis, but in favour of his brother Michael. Michael, however, refused the crown.

Nicholas was detained at Tsarskoe Selo. It was planned to send him and his family to England; but instead, mainly because of the opposition of the Petrograd soviet, they were removed to Tobolsk, in western Siberia. This step sealed their doom. In Apr. 1918 they were taken to Ekaterinburg (now Sverdlovsk) in the Urals. When "White" Russian forces approached the area the local authorities were ordered to prevent a rescue; and in the night of July 29–30 (N.S.; 16–17 O.S.) the prisoners were all slaughtered in the cellar of the house where they had been confined. The bodies were burned and cast into an abandoned mineshaft, but the facts were established by investigation after Ekaterinburg had been taken by the "White" forces. The *Journal intime de Nicolas II* was published in 1925 and *The Letters of the Tsar to Tsaritsa, 1914–1917* in 1929. For portrait *see* article RUSSIAN HISTORY.

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NICHOLAS I (1841–1921), prince of Montenegro from 1860 and king from 1910 to 1918, was born at Njegosh on Oct. 7 (new style; Sept. 25, old style), 1841, the son of Mirko Petrovich-Njegosh. Heir presumptive to his uncle Danilo II, he was educated at Trieste and at the *lycée* Louis-le-Grand in Paris. Returning to Montenegro as prince after Danilo's assassination (Aug 13, 1860), he took part in the campaign of 1862 against the Turks, which after Austrian intervention was followed by a long period of peace. On a visit to St. Petersburg in 1868 he was well received by the Russian emperor Alexander II, who thereafter supplied him regularly with arms and money and on one occasion referred to him as his "only friend." During the international crisis that arose from the revolt of Hercegovina against Turkish rule, Nicholas declared war on Turkey in July 1876 and won brilliant successes in the ensuing campaigns (*see* EASTERN QUESTION). He took Bar and Ulcinj; and the congress of Berlin (1878) recognized Montenegro as a sovereign state, with its previous area doubled and access to the Adriatic at Bar. Nicholas, who in 1860 had married Milena (1847–1923), daughter of Petar Vukotich, now proceeded to seek useful dynastic connections. Of his daughters, Zorka was married in 1883 to Peter Karageorgevich (she died, however, in 1890, before Peter became king of Serbia); two were married to Russian grand dukes; and Elena was married in 1896 to the future Victor Emmanuel III of Italy. He himself assumed the style of "Royal Highness" in Dec. 1900. Meanwhile he had begun to intrigue, sometimes with and sometimes against Peter Karageorgevich, for the formation of a Yugoslav state to comprise both Montenegro and Serbia.

Discontent at his despotic rule in Montenegro forced Nicholas to grant a constitution in 1905. Quarrels with political opponents culminated in the "Cetinje bomb plot" against him (1907), which led to severance of relations with Serbia till 1908.

On Aug. 28, 1910, Nicholas proclaimed himself king of Montenegro. The Balkan War of 1912–13 began with his declaration of war against Turkey (*see* BALKAN WARS), but the resultant acquisition of territory by Montenegro was less than had been hoped, so that the dynasty lost prestige. Nicholas at first made common cause with Serbia in World War I, but asked Austria-Hungary for a separate peace on Jan. 13, 1916, before taking refuge in Italy. When the Serbians had occupied Montenegro, a "national assembly" proclaimed his deposition and that of his dynasty (Nov. 1918); and on March 2, 1921, Nicholas died in exile, at Antibes in France. The small monarchist party of Montenegro then proclaimed his eldest son Danilo (1871–1939), as king, but Danilo on March 7 abdicated his rights in favour of his nephew Michael (1908–).

Nicholas I was a talented writer of plays, poems and songs.

(R. G. D. L.)

NICHOLAS (NIKOLAI NIKOLAEVICH) (1856–1929), Russian grand duke and army officer, commander in chief against the Ger-

mans and Austro-Hungarians in the first year of World War I. He was born in St. Petersburg on Nov. 18 (new style; 6, old style), 1856, the son of the emperor Alexander II's brother, the grand duke Nikolai Nikolaevich "the Elder." Educated at the general staff college, he received his commission in 1872. In the Russo-Turkish War of 1877–78 he served on the staff of his father, then commander in chief of the Russian forces. He next joined the Guard Hussar regiment, becoming its commander in 1884. He was appointed inspector general of cavalry in 1895 and held this post for ten years, during which he introduced fundamental reforms in training and equipment. When he was appointed in 1905 to be commander of the St. Petersburg military district he again demonstrated his enthusiasm for the effective training of his troops, especially in the application of modern methods and of the lessons learned from the Russo-Japanese War.

In 1905 Nicholas was also appointed first president of the newly created imperial committee of national defense, a position that he held until its abolition in 1908, when Gen. V. A. Sukhomlinov became chief of the general staff. Sukhomlinov also became minister of war in 1909 and was entrusted by the emperor Nicholas II with the strategic planning for the war expected to break out in Europe: the grand duke Nicholas had no part in this planning. On the outbreak of war against Germany and Austria-Hungary in 1914, however, the emperor, though he had intended to take over the active command of the armies himself, yielded to the advice of his ministers and to popular opinion and appointed the grand duke Nicholas to be commander in chief. During the war the grand duke adapted the plans already made by the general staff and proved himself an extremely able commander. On Sept. 5 (N.S.; Aug. 23, O.S.), 1915, however, the emperor assumed the supreme command and sent the grand duke to the Caucasus as viceroy and commander in chief. This appointment gave new heart to the Russian forces ranged against Turkey, and they took the offensive with some success.

The grand duke was still in the Caucasus at the time of the Russian revolution of March 1917. The emperor's last official act was to appoint him once more commander in chief; but within 24 hours of the grand duke's arrival at his new headquarters in Mogilev his appointment was canceled by Prince G. E. Lvov, head of the provisional government. For two years Nicholas remained in the Crimea, but in March 1919 he left Russia in a British cruiser. He lived quietly in France until his death at Antibes on Jan. 6, 1929.

See V. A. Sukhomlinov, *Veliki knyaz Nikolai Nikolaevich* (1925); Yu. N. Danilov, *Le Premier Généralissime des armées russes, le grand duc Nicolas* (1932); Bernard Pares, *The Fall of the Russian Monarchy* (1939). (I. Gy.)

NICHOLAS OF CUSA (NIKOLAUS VON CUSA, NICOLAUS CUSANUS) (1401–1464), scholar and churchman, was the son of a Moselle boatman named Krypffs or Krebs. He studied the arts, philosophy, law, mathematics, the sciences and theology at Deventer, Heidelberg, Padua, Rome and Cologne (1413–25) and was ordained priest *c.* 1430. To his colleagues at the council of Basel he dedicated his book *De concordantia catholica* (*On Catholic Concordance;* 1433), in which he stressed the harmony of the church as the supreme society on earth. The pattern for priestly concord he found in the heavenly orders. He maintained the supremacy of general councils over divinely commissioned but strictly limited papal power. Later, however, he became a critic of conciliar politics and an ally of the papacy (1437). He negotiated with the Hussites and served on a commission to Constantinople, seeking the reunion of Eastern and Western Christendom (1437). Philosophy and mathematics were conjoined in his work *De docta ignorantia* (*Of Learned Ignorance;* 1440), in which he described the learned man as one aware of his own ignorance. Such wise unknowing led to a faith transcending reason. The way was thus opened for the mystical life described in his *De visione Dei* (*Vision of God;* 1453).

Nicholas became a cardinal in 1448 and bishop of Brixen, in the Tirol, in 1450. He was papal legate for reform in Germany and the Netherlands (1450–52). Attempted reform of his own diocese (1453–58) ended with his eviction by secular powers (1459). He died at Todi in 1464.

Nicholas emphasized mathematics and experimental knowledge, including diagnostic medicine and applied science. Before Copernicus he discerned a universal movement involving but not centred in the earth; he denied that celestial bodies are strictly circular in form and motion. (*See* also SCIENCE, HISTORY OF: *The Renaissance and Early Modern Science.*) He conceived God as irreducible unity, the coincidence of all contradictions, that which enfolds all things in its infinite simplicity, even as it unfolds all. Cusa flatly disavowed pantheism. All things are in God as things caused are in the cause; this, he held, in no way identified creatures with their creator.

Christ was envisaged as the perfect mediator between God and man, the union between the divine nature that created and the human nature that was created. Humanity experienced its true nobility and personalized freedom in cosmic community with Christ. He was celebrated as the incarnate Word of the sermon and the heart of the saving eucharistic mystery. In Christ's mystical body and sacramental unity, Cusa found the cure of Bohemian separatism, the hope for Greek-Latin reunion and the reconciliation in worshiping diversity that would ultimately unify all faiths. Cusa reflected sources as divergent as the Neoplatonists, Eckhart, the Christian Fathers and the Averroists. His role in the history of thought deserves perennial re-evaluation.

Nicholas' *Opera Omnia* were edited by E. Hoffmann and P. Wilpert (1932 *et seq.*); and also may be found in *Schriften in deutscher Übersetzung* (1936 *et seq.*). English translations are E. Gurney-Salter, *The Vision of God* (1928), and G. Heron, *Of Learned Ignorance* (1954).

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NICHOLAS OF DAMASCUS (NICOLAUS DAMASCENUS) (fl. 1st century B.C.), Greek historian and philosopher of Damascus, whose works included a universal history from the time of the Assyrian empire to his own days. He instructed Herod the Great in rhetoric and philosophy, and attracted the notice of Augustus when he accompanied his patron on a visit to Rome. Later, when Herod's conduct aroused the suspicions of Augustus, Nicholas was sent on a mission to bring about a reconciliation. He survived Herod and it was through his influence that the succession was secured for Herod Archelaus; but the date of his death, like that of his birth, is unknown. Fragments of his universal history, his autobiography and his life of Augustus have been preserved, chiefly in the extracts of Constantine Porphyrogenitus. *See* CONSTANTINE: *Constantine VII.*

For fragments *see* L. Dindorf (ed.), *Historici Graeci minores,* vol. i (1870). The text of his life of Augustus, with Eng. trans. and commentary, was edited by C. M. Hall (1923). F. Navet, *Nikolaus von Damaskus* (1853), contains an account of his life and translation of the fragments.

NICHOLAS OF LYRA (NICOLAUS LYRANUS) (*c.* 1265–1349), called by Martin Grabmann "the foremost exegete of the Franciscan-Scotistic school," was born at Lire (now Vieille-Lyre) in Normandy. He entered the Franciscan order at Verneuil about 1300, studied at Paris, became a professor before 1309 and taught for many years in the Sorbonne. From 1319 he was provincial of his order in France and in 1325, as provincial of Burgundy, he founded the College of Burgundy at Paris, where he died in the autumn of 1349.

Nicholas' most important writing is the monumental 50-volume *Postillae perpetuae in universam S. Scripturam,* a commentary on the whole Bible, first according to the literal sense, then according to a mystical or spiritual exposition. This book, the first commentary printed, soon became a favourite manual of exegesis, and some scholars claim that it exerted an important influence on Luther. The prime significance of the work is the author's insistence, against the allegorical interpretations common in his time, on the literal sense as the foundation for all mystical applications. Nicholas also wrote on the Eucharist, the Beatific Vision and other matters, including a book of devotions. (WM. J. B.)

NICHOLAS, SIR EDWARD (1593–1669), English statesman and secretary of state under Charles I, was born at Winter-

bourne Earls, Wiltshire, on April 4, 1593. He was educated at Salisbury grammar school, Winchester and Queen's college, Oxford. After studying law at the Middle Temple, Nicholas became in 1618 secretary to Lord Zouche, warden and admiral of the Cinque ports, and continued in a similar employment under the duke of Buckingham. He was member of parliament for Winchelsea in 1621 and 1624 and for Dover in 1628. He became secretary to the admiralty, then extra clerk of the privy council with duties relating to admiralty business in 1626; and he was one of the clerks in ordinary to the council (1635–41). In this situation Nicholas was concerned with the levy of ship money. He had Charles's confidence, became a privy councilor and a secretary of state in Nov. 1641, attended the king at Oxford and was one of the royal commissioners at the treaty of Uxbridge (Feb. 1645). Nicholas helped to arrange the details of the king's surrender to the Scots, though he does not appear to have approved of the step, and he signed the capitulation of Oxford. He went to France, and after the king's death remained on the continent.

Despite his friendship with Sir Edward Hyde, he had little influence with Charles II and two years after the Restoration he was persuaded to resign his secretaryship. He died at West Horsley, Surrey, on Sept. 1, 1669.

Much of Nicholas' correspondence is printed in *The Nicholas Papers*, 4 vol. (1886–97), and in *The Diary and Correspondence of John Evelyn*, ed. by W. Bray (1906). *See* also D. Nicholas, *Mr. Secretary Nicholas* (1955). (R. B. Wm.)

NICHOLS, JOHN (1745–1826), English writer, printer and antiquary, who in the *Gentleman's Magazine*, with which he was connected from 1778 until his death, and in numerous volumes of literary anecdotes, made an invaluable contribution to knowledge of the lives and works of 18th-century men of letters. Born at Islington, Feb. 2, 1745, he was apprenticed in 1757 to William Bowyer the younger, "the learned printer," who took him into partnership in 1766. His first literary work was as editor of Swift (1775–1779) but his career as biographer to his age was begun by his memoir of Bowyer, expanded into *Anecdotes of William Bowyer and His Literary Friends* (1782), which formed the basis of *The Literary Anecdotes of the 18th Century* (1812–15). The supplementary *Illustrations of the Literary History of the 18th Century*, begun in 1817, was completed by his son, John Bowyer Nichols (1779–1863).

Nichols became part manager of the *Gentleman's Magazine* in 1778 and sole manager and editor in 1792. His antiquarian studies, based on his own accurate observation and research, included a *Bibliotheca Topographica Britannica* (1780–90) and the *History and Antiquities of Leicester* (1795–1815), perhaps his most important original work. Of many friendships and literary collaborations—with Joseph Warton, Richard Gough, Bishop Percy—that with Samuel Johnson was one of the most valuable, and as publisher of the *Lives of the English Poets* he exercised considerable editorial influence and supplied its author with much information. All his work showed the care which caused Walpole to say of his *Life of Mr. Bowyer*, "I scarce ever saw a book so correct."

Nichols died in London, Nov. 26, 1826.

See articles by E. Hart, *PMLA* (Publications of the Modern Language Association of America), vol. lxv (1950), vol. lxvii (1952).

NICHOLSON, JOHN (1822–1857), Irish soldier and administrator who rendered outstanding service during the Indian mutiny, was born in Lisburn on Dec. 11, 1822, and educated at Dungannon college. His uncle Sir James Hogg secured him a Bengal army cadetship in 1839 and during the first Afghan War he distinguished himself in the defense of Ghazni (1841–42) before enduring several months' souring captivity in Afghan hands. In Afghanistan he met Henry (later Sir Henry) Lawrence who, after the First Sikh War secured him a political post first in Kashmir and then in the Punjab. In 1848, during the Second Sikh War, Nicholson seized the important Attock crossing and delayed Sikh concentration. During Lord Gough's campaigns he secured intelligence, marshaled supplies and headed the drive to the Afghan borders.

After the Punjab was annexed he took charge of Bannu, reducing that wild district to quiet and creating a legend by his personal activity, fearlessness, and prompt, if severe, justice. He embodied the Punjab myth of justice administered in shirt sleeves, of ubiquitous activity, of the strong paternal administrator, though his disregard for regulations and office work called down the reproofs of both Henry and John Lawrence.

With the outbreak of the Indian mutiny in 1857 his vigour, decision and delight in action found full employment. He supported Herbert Edwardes at Peshawar in disarming the sepoy regiments there, led the pursuit and destruction of the 55th regiment when they fled from Nowshera and helped dissuade John Lawrence from abandoning Peshawar. In June, promoted to the rank of brigadier general, he led a movable column (*i.e.*, troops equipped for quick movement) toward Delhi. On the way he disarmed or destroyed other mutinous regiments and defeated a force of mutineers near Gurdaspur. His arrival at Delhi early in August and his brilliant victory at Najafgarh inspirited the British forces while he nerved Brig. Gen. Archdale Wilson to risk an assault. On Sept. 14 he led the attacking column against the Kashmir gate. He took his objective, but while working westward along the defenses to link with the fourth column was shot leading a frontal assault upon enemy guns. He died in Delhi on Sept. 23.

See L. J. Trotter, *The Life of John Nicholson*, 9th ed. (1904); Hesketh Pearson, *The Hero of Delhi* (1948). (J. B. Ha.)

NICHOLSON, REYNOLD ALLEYNE (1868–1945) English orientalist, lecturer in Persian (1902–26) and Sir Thomas Adams professor of Arabic (1926–33) at Cambridge university was a foremost scholar in the fields of Islamic literature and mysticism. He was born at Keighley, Yorkshire, on Aug. 18, 1868. His *Literary History of the Arabs* (1907) remains the standard work on that subject in English; while his many text editions and translations of Sufi writings, culminating in his eight-volume *Mathnawi of Jalalu'ddin Rumi* (1925–40), advanced the study of Muslim mystics to an eminent degree. He combined exact scholarship with notable literary gifts; some of his versions of Arabic and Persian poetry entitle him to be considered a poet in his own right. His deep understanding of Islam and of the Muslim peoples was the more remarkable in that he never traveled outside Europe. A shy and retiring man, he proved himself an inspiring teacher and an original thinker; he exercised a lasting influence on Islamic studies. He died at Chester on Aug. 27, 1945.

See "Reynold Alleyne Nicholson," *Proceedings of the British Academy*, vol. xxxi (1945); A. J. Arberry, introduction to *Pages From the Kitāb al-Luma'* (1947). (A. J. Ar.)

NICHOLSON, SIR WILLIAM NEWZAM PRIOR (1872–1949), English painter, engraver, theatre designer and illustrator, was born at Newark-on-Trent on Feb. 5, 1872. At Herkomer's school, London, he met James Pryde, with whom he collaborated under the pseudonym "J. and W. Beggarstaff" to produce strikingly bold posters (1893–98). He studied at the Académie Julian, Paris, 1889–90. His illustrations to *An Alphabet* *An Almanack of Twelve Sports* and *London Types* in 1898 and the woodcut "Portrait of Queen Victoria" earned him wider recognition. He made sets for *Peter Pan* in 1904. Nicholson's paintings, whether landscapes, portraits or still life, are characterized by solid construction and heavy colour, as in "Girl With the Tattered Glove" (1909, Fitzwilliam museum, Cambridge) "Mushrooms" (1940, Tate gallery, London) and "The Stack Hoar's Fields" (1925). He was knighted in 1936, and died on May 16, 1949, at Blewbury, Berkshire.

His eldest son, Ben Nicholson (1894–), leading English abstract painter, was born on April 10, 1894, at Denham, Buckinghamshire. After studying briefly at the Slade School of Art he traveled extensively in Europe during 1911–18 and held his first one-man show in London in 1922. From 1920, under the influence of Cubism and the De Stijl movement, he began his severe, geometrical designs, notable for an icy brilliance of colour, which culminated in the series of constructions "White Reliefs" of 1935–39 (one of 1935 in the Tate gallery). He was a member of Abstraction-Création, Paris (1933–35), and coedited *Circle* (1937).

See Lillian Browse, *William Nicholson*, with bibliography (1956); Sir Herbert Read, *Ben Nicholson*, 2 vol. (1948, 1956). (D. L. Fr.)

NICIAS (d. 413 B.C.), Athenian general and statesman, noted for his wealth and piety. In 427 he captured the small island of

Minoa, blocking the Megarian harbour of Nisaea, and next year he sailed to Melos and Oropus. In 425, when the Athenian force at Pylos failed to capture the Spartans on Sphacteria and Cleon complained of the generals' slackness, he resigned this command to Cleon, who spectacularly fulfilled his promise to bring the Spartans alive within 20 days, or destroy them. Nicias recovered his reputation in an expedition against Corinth later in the year, and by taking the Spartan island of Cythera in 424. He had no part in the Athenian defeat at Delium that year, and now concentrated on making peace, though he helped to recover Mende in the north during the truce of 423.

The deaths of Cleon and Brasidas in 422 made it easier to negotiate the "Peace of Nicias" (spring 421) and an alliance with Sparta, but the hostility of Sparta's allies and the opposition of Alcibiades (*q.v.*) foiled Nicias' efforts to uphold the peace. In 417 an ostracism (*q.v.*) was held, in the hope of exiling Nicias or Alcibiades, but instead they joined to procure the ostracism of the demagogue Hyperbolus.

In 415 he was appointed, most unwillingly, as one leader of the expedition to Sicily. The recall of Alcibiades and the death of Lamachus left him, while ill with kidney trouble, in sole charge of the siege of Syracuse. The circumvallation was not completed and the Spartan Gylippus succeeded in building a counter-wall. Nicias asked to be relieved of his command, but instead reinforcements came early in 413 with Demosthenes. When these failed to reverse the situation, Demosthenes favoured departure, but an eclipse of the moon and Nicias' superstition delayed it till too late. The disastrous retreat by land ended in the surrender of the force. The Syracusans executed Nicias.

See, for bibliography, PELOPONNESIAN WAR. (A. As.)

NICKEL (symbol Ni), a grayish-white metallic element, hard, tough and markedly resistant to oxidation and corrosion. It is widely familiar because of its use in coinage, but has become more important for its many domestic, industrial and military applications. The metal itself is well suited for direct use in many kinds of mechanical equipment, but it is more commonly employed in the form of alloys. Use in this form dates from prehistoric times, for early man fashioned some of his implements from meteoric iron, which normally contains 5% to 15% nickel. It was also used in alloy form by the Chinese in ancient days, but nickel itself was not isolated until 1751, when A. F. Cronstedt prepared an impure sample from an ore containing niccolite (NiAs). An ore of this same type had earlier caused copper and silver miners in Saxony considerable trouble because although it resembled copper in colour it yielded a brittle unfamiliar product. They came to refer to it as "kupfernickel," after "Old Nick" and his mischievous gnomes, and Cronstedt applied their name to his new element. His results were confirmed in 1775 by T. O. Bergman, and the name nickel soon became generally accepted. About a century elapsed before nickel was mined in quantity for a growing world market.

Occurrence and Production.—Nickel is the 24th element in order of abundance, and constitutes about 0.016% of the earth's crust. It is a fairly common minor constituent of igneous rocks but there are singularly few deposits which qualify with respect to concentration, size and accessibility for commercial interest. The most important sources of the metal are the mixed sulfide ores containing pentlandite, $(Fe,Ni)S$; nickel-bearing pyrrhotite, Fe_5S_6 to $Fe_{16}S_{17}$; and nickel-bearing chalcopyrite, $CuFeS_2$. Ores of this type are mined on a large scale in Canada (Sudbury, Ont., and Lynn Lake, Man.), and to a lesser extent in the Petsamo district of Finland, ceded to the U.S.S.R. during World War II. Minor deposits of nickel-bearing sulfide ores occur in Norway, China, India, Alaska and the United States (Missouri), some production being achieved from the last source. Oxide ores ranging from hydrous magnesium silicates, garnierite, $(Ni,Mg)SiO_3 \cdot nH_2O$ (varieties), to nickel-bearing iron oxide (laterite) have become an increasingly important source of the metal since World War II. The former comprise the important ores of New Caledonia and also are found in the United States (Oregon). The latter occur in Cuba, the Philippines, Indonesia, Brazil and Venezuela.

Metallurgy.—The extractive metallurgy is fairly complex and costly; it underwent rapid changes during and immediately following World War II. The nickel-bearing sulfide ores of Canada, which are embedded in a matrix of basic rock, are first ground and carried through a series of flotation and magnetic separation processes. In the operations of the International Nickel company, three distinct concentrates are isolated for separate processing: nickel-bearing iron sulfide, copper-bearing nickel sulfide and copper sulfide. The nickel-bearing iron sulfide is desulfurized in a fluid-bed roaster, reduced with carbon monoxide and hydrogen in a rotary kiln and then leached with ammonia-carbon dioxide solution to remove the nickel. The residue from the extraction is sintered (formed into solid mass without completely melting) and sold as iron ore pellets to the steel industry. The nickel is recovered as a basic carbonate when the final solution is treated with steam. The copper-bearing nickel sulfide is partially desulfurized in multiple-hearth roasters (*see* COPPER: *Commercial Production Processes: Roasting*), melted and cooled under specially controlled conditions which allow subsequent magnetic and flotation separations into three concentrates: nickel sulfide, copper sulfide and precious metals. The nickel sulfide is sintered for direct sale to the alloy markets, and for further refining, both electrolytically and by the carbonyl process. (*See* CARBONYLS, METAL.)

Nickel-bearing sulfide ores are also treated to a lesser extent by the Hybinette process which involves selective leaching of the copper with sulfuric acid from a nickel-copper matte derived from a flotation concentrate. The crude products are refined by a combination of electrolytic and cementation techniques (*see* CEMENTATION). Flotation concentrates from nickel-bearing sulfide ores are also leached directly in water or ammonia under aeration at elevated pressures and temperatures. The nickel in the resulting salt solutions is recovered directly as a salable powder by treatment with hydrogen gas at elevated temperatures and pressures.

The silicate ores of New Caledonia are largely treated by a matte smelting process. The ore is fused with calcium carbonate, calcium sulfate and coke to yield a nickel-iron sulfide concentrate which is further refined by smelting to eliminate the iron in a siliceous slag, and yield ultimately fairly pure nickel metal. Some of the New Caledonia ores, as well as those from Oregon in the United States, are treated by electric smelting to yield ferronickel which can be sold directly to the steel industry.

Oxide, or lateritic, ores can be reduced in multiple-hearth furnaces and then selectively leached with ammonia-carbon dioxide solutions. The ammonia is recovered efficiently for reuse by steaming the solution which results from leaching, while the nickel is simultaneously precipitated as the basic carbonate. The latter is calcined to nickel oxide for direct sale, or for further processing to nickel-oxide sinter or ingot nickel. Nickel can also be extracted from lateritic ores by direct leaching with sulfuric acid solution at elevated pressure and temperature. A sulfide precipitate produced from the leach solution then can be chemically refined for the production of metallic nickel.

Physical Properties.—Nickel has an atomic number of 28 and occurs in Group VIII of the periodic arrangement of the elements, after iron and cobalt and above palladium and platinum. It resembles iron in strength and toughness but is more like copper,

Physical Constants of Nickel

Density, g./c.c.	8.9 (20° C.)
Melting point, ° C.	1,455
Boiling point, ° C.	2,900
Specific heat, cal./g./° C.	0.1095 (18° C.) 0.1340 (1,360° C.)
Latent heat of fusion, cal./g.	73.8
Coefficient of expansion, cm./cm./° C.	0.0000129 (25°–100° C.) 0.0000135 (375°–1,000° C.)
Thermal conductivity, cal./cm./cm.²/sec./° C.	0.142 (18° C.)
Hardness, Brinell number	85 (99.99% Ni, annealed) 210 (99.4% Ni, cold-rolled)
Atomic radius, Å (angstrom unit = 10^{-8} cm.)	1.24
Ionization potential, volts	7.61 (I), 18.2 (II)
Electrode potential, molal, volts	+0.231 (25° C.)
Electrical conductivity, basis copper = 100%	16%
Resistivity, microhm-cm.	7.8 (20° C.)
Magnetic permeability, μ	110 (initial) 600 (maximum)
Curie temperature, ° C.	360
Tensile strength, lb./in.²	46,000 (99.99% Ni, annealed) 105,000 (99.4% Ni, cold-rolled hard temper)

which follows it with atomic number 29, in resistance to oxidation and corrosion. This combination of useful properties accounts for many of its applications. Nickel has an atomic weight of 58.71 and consists of the following stable isotopes:

Mass number	58	60	61	62	64
Per cent abundance	67.76	26.16	1.25	3.66	1.16

Uses of Nickel in Alloys and as the Metal.—More than 50% of the nickel produced is normally incorporated in alloys with iron. Nickel steels (0.5%–10% nickel) possess special properties of strength and toughness and are used in great quantities in the manufacture of automobiles, trucks, buses, ships, airplanes, railway locomotives and cars and special parts for most types of transportation equipment. They are also used in agricultural equipment, machine tools, mining and excavating machinery, oil well and refinery equipment, steel mill machinery, power-generating equipment and many types of steel construction. Stainless steels (2%–26% nickel) are resistant to corrosion, tarnish and stain and are used extensively wherever these properties in association with strength and toughness are required, as, for example, in transportation equipment such as streamlined trains, airplanes and truck tanks; kitchen equipment, tableware and cooking utensils; and in equipment for the chemical and food-processing industries, textile and paper mills and oil refineries. Heat-resistant steels (2%–26% nickel) are used to meet the high-temperature requirements of furnace and other equipment parts for the glass, ceramic, metal and chemical manufacturing industries. Many other alloys with iron such as the nickel cast irons (1%–5% nickel) meet special needs in the manufacture of metal equipment. About 25% of the nickel produced is used in high nickel alloys. Those with copper (65%–70%) have desirable physical properties and are highly resistant to corrosion. They are used in building, chemical and food-processing equipment and in marine and power-generating equipment. Considerable quantities are also incorporated in cupronickel alloys (2.5%–45% nickel), which are used for condenser tubes and saltwater lines, and in heat-resisting alloys (commonly 78% nickel, 14% chromium, the balance iron and minor elements). They retain their strength, toughness and resistance to oxidation and corrosion at high temperatures, and are therefore particularly useful for jet engine parts and other advanced propulsion systems. Electrical resistance alloys (80%–85% nickel) are used in heating elements, pyrometers, rheostats and other electrical controls. Magnetic alloys (29%–90% nickel), nonmagnetic alloys (8%–27% nickel), permanent magnet alloys (14%–32% nickel), high permeability alloys (45%–80% nickel) and controlled expansion alloys (30%–60% nickel) have been developed for many diverse applications. Nickel coinage (25%–100% nickel) has been adopted in many countries and the so-called nickel silvers (10%–30% nickel, the balance primarily copper and zinc) are used in many familiar articles such as plated silverware stock, slide fasteners, decorative hardware and jewelry. Many other alloys are in use and new nickel alloys are constantly being developed for changing industrial needs.

The fabrication of many modern nickel-based alloys has presented severe technological problems. Techniques developed to solve these problems include: the precision casting of small complex parts by a modification of the cire perdue (investment or precision casting) process, long known to sculptors, using wax or frozen mercury; extrusion with the help of molten glass as a lubricant; and various applications of powder metallurgy. Thoria dispersion (or TD) nickel, composed of 98% nickel and 2% thorium oxide, is produced by a process combining colloidal chemistry and powder metallurgy to form sintered billets that can be extruded and drawn into bars for fabrication into tubing, turbine vanes and blades and other parts for high-temperature service (1,800°–2,400° F.; about 982°–1,316° C.). (*See* ALLOYS; NICKEL-CHROMIUM STEELS; NICKEL STEEL; STEELS, ALLOY.)

About 20% of the nickel produced is normally used directly as the virtually pure metal. It is employed in equipment for the food-processing, chemical, and radio, television and electronic industries. Nickel, as well as stainless steel and other nickel alloys, is used to clad steel and provides, in an economical way, a protective coating which is markedly effective against the corrosive action of chemicals. It is similarly used in electroplating, where it is particularly useful to secure protection from atmospheric corrosion and is kept free from tarnish by a thin layer of chromium. Thin nickel deposits claimed to possess good corrosion resistance may also be produced nonelectrolytically by immersing the article in a hot aqueous solution containing, inter alia, Ni^{2+} and hypophosphite ions.

Chemical Properties and Compounds.—The 28 orbital electrons of nickel are distributed as follows: $1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^6$ $3d^8$ and $4s^2$. The two electrons in the highest energy level (4s) are readily yielded to form a stable, doubly charged cation. The electrode potential for this reaction is +0.231 v., placing nickel above hydrogen in the electromotive series in the following position: Co, *Ni*, Sn, Pb, H. The metal reacts slowly with strong acids under ordinary conditions to liberate hydrogen and form Ni^{2+}. The salts formed are slightly acid and yield a precipitate of hydrous nickel oxide when the pH of dilute solutions is raised above about 6.7. The metal is uniquely resistant to the action of alkalies and is frequently used for containers to handle concentrated solutions of sodium hydroxide. The element exhibits only a minor tendency to assume the univalent or tervalent states and such ions are not stable in aqueous solution. The third shell contains only 16 electrons, lacking 2 of the stable inert gas arrangement, and many of the compounds involving special valence forces can be attributed to this electronic structure.

Nickelous oxide, NiO, occurs in nature in small quantities as the mineral bunsenite and can be prepared by heating a variety of nickel compounds in air. It can be reduced to nickel by heating with carbon, hydrogen and other reducing gases. It is soluble in strong acids unless it contains impurities or has been sintered, in which case fusion with $KHSO_4$ may be necessary. Nickel oxide is used in the preparation of nickel alloys, in ground-coat enamels for its beneficial effects on adherence and in colouring ceramics and glass. Nickelous hydroxide, $Ni(OH)_2$, is obtained as a light-green precipitate when nickel salts are treated with alkalies. It is readily soluble in acids and ammonium hydroxide, yielding in the latter case complex ammine ions. It may be reduced with hydrogen at sufficiently low temperatures to yield active nickel catalysts and is incorporated in the Edison nickel-iron alkaline storage battery where it yields higher valent hydrous oxides when the battery is charged. Basic nickel carbonates result from the reaction between nickel salts and alkali carbonates. If a mixture of alkali and hypohalite is used, higher hydrous oxides of variable composition are yielded as black precipitates. These products are all converted to nickelous oxide, NiO, on complete dehydration and yield exclusively the double-charged nickel cation on solution in acids. Nickel forms a related series of compounds with sulfur. In addition to the commercially important mixed sulfide ores already mentioned, such minerals as millerite (NiS) and polydymite (Ni_3S_4) belong to this group of compounds. Nickelous sulfide, NiS, is highly insoluble and is readily precipitated when nickel salts are mixed with alkaline sulfide in aqueous solution. Other sulfides, such as Ni_3S_2, can be obtained by direct reaction of sulfur and sulfur compounds with the metal and its derivatives.

Nickel sulfate is the most familiar salt. It can readily be prepared by dissolving nickel metal or nickelous hydroxide in sulfuric acid. It is quite soluble in water (140 g. Ni per 1,000 ml. water at 0° C., 761 g. at 100° C.) and can be purified by recrystallization, to yield the hexahydrate $NiSO_4 \cdot 6H_2O$. This salt is widely employed in plating baths and in dips for steel vessels which are to be coated with vitreous enamel and commonly serves as a reagent for the preparation of nickel catalysts. The nickel halides and nickel nitrate can be similarly prepared and purified. Nickel chloride crystallizes as the hexahydrate, $NiCl_2 \cdot 6H_2O$, and becomes anhydrous when heated above 140° C. Nickel nitrate hexahydrate $Ni(NO_3)_2 \cdot 6H_2O$, dissolves in its own water of crystallization at about 57° C., readily dehydrates at higher temperatures and decomposes at about 300° C. to yield NiO in air, or pyrophoric nickel when heated in a reducing atmosphere. It is used in the preparation of special nickel catalysts and powders and, along with the chloride, is also used to some extent in nickel plating. Most nickel salts form double compounds with other salts, and co-ordination

complexes with ammonia. Nickel also forms co-ordination complexes with alkali cyanides and in this behaviour exhibits properties similar to those of palladium and platinum.

Nickel readily forms salts with organic acids, either by direct reaction between nickelous hydroxide and the acid or by double decomposition between suitable salts. Nickel formate, $Ni(HCOO)_2$, which is one of the most familiar of these, is unique in that it decomposes at about 240° C. to give off hydrogen and carbon dioxide, leaving a residue of finely divided nickel which is particularly useful as a hydrogenation catalyst. The higher fatty acid salts, such as the stearate and oleate, are water insoluble and exhibit colloidal properties typical of the metal soaps when dispersed in organic liquids.

Nickel forms a series of compounds in which co-ordination or secondary valence forces are involved in addition to those of the usual salt structure. The highly insoluble, striking red derivative with dimethylglyoxime, commonly precipitated in nickel analyses, is a characteristic inner-complex compound involving a chelate ring. This derivative is nonpolar in character, highly insoluble in water, but somewhat soluble in chloroform and other organic solvents. It sublimes without decomposition when heated in vacuo, but is readily converted quantitatively to NiO on strong heating in air.

Nickel carbonyl, $Ni(CO)_4$, is an unusual compound in that it contains a neutral nickel atom surrounded by four co-ordinately bound carbonyl groups. It can be prepared by treating finely divided metallic nickel with carbon monoxide; sulfur acts as a catalyst for this reaction. The product is a colourless mobile liquid with a high vapour pressure and is poisonous if inhaled. It boils at 43° C. and begins to decompose at 60° C. or less, depending on the conditions, to metallic nickel and carbon monoxide. A fine nickel powder may be prepared in this manner, or pellets may be built up on nuclei of nickel as in the Mond process. A bright nickel mirror or nickel plate may also be obtained and nickel carbonyl can serve as a source of reactive carbon monoxide in certain organic syntheses. (*See* CARBONYLS, METAL.)

Analytical.—Nickel is precipitated in the ammonium sulfide group along with cobalt, manganese, zinc and iron in systematic analyses. The nickel and cobalt sulfides remain as undissolved residue after the precipitate is extracted with dilute hydrochloric acid. Nickel may be identified by its red precipitate with dimethylglyoxime, or its brown borax bead. In quantitative analysis nickel is usually isolated and weighed as the dimethylglyoxime complex. It may also be determined by titration with potassium cyanide solution, electrolysis of a strongly ammoniacal solution, or polarographically.

Uses of Nickel Compounds.—Nickel compounds have been used mainly in electroplating, in the production of nickel catalysts, in ground-coat enamels, in storage batteries of the Edison type and in the production of special nickel powders. Many nickel compounds exhibit insecticidal, fungicidal and bactericidal action, but have not received wide practical use because of the availability of effective cheaper materials. Ingested nickel is relatively nontoxic and any quantities that might be picked up incidentally through the use of nickel or nickel-alloy cooking utensils or in fats hydrogenated over nickel catalysts are considered to be without physiological action.

Nickel Catalysts.—Substantially more than 2,000,000 lb. of the metal are used in catalytic applications each year. Catalytic nickel can be prepared by many different methods. Nickelous hydroxide and basic carbonates, nickel nitrate, formate and various other organic compounds yield, on thermal decomposition at moderate temperatures in a reducing atmosphere, finely divided nickel in a highly active form. Nickel sulfate and other soluble salts are frequently the starting reagent. The precipitates obtained when they are mixed with alkalies in aqueous solution, frequently in admixture with carrier materials such as diatomaceous earth, are washed, dried and reduced. Nickel formate yields active nickel directly when it is decomposed without access to air, such as under oils which are to be treated. Nickel alloys containing a metal which can be selectively dissolved away, such as the nickel-aluminum preparations of M. Raney which yield on treatment with sodium hydroxide soluble sodium aluminate and an active nickel residue, are commonly employed. Nickel catalysts are most frequently utilized in hydrogenating unsaturated organic compounds. The most familiar application is the hydrogenation of fats and oils, in the process known as fat hardening. A fraction of 1% of active, finely divided nickel suffices to catalyze the addition of hydrogen to unsaturated compounds in vegetable, animal and fish oils, converting them from liquids to solids with more desirable physical properties and greatly improved chemical stability. The nickel is recovered by filtration and may be reused or may be employed in continuous processes. Many millions of pounds of natural oils are treated annually in this manner for use in edible products such as shortenings and oleomargarine, in soaps and numerous industrial preparations. Nickel catalysts are also extensively used in the synthesis of organic chemicals and pharmaceuticals, in petroleum chemistry and gaseous fuel production. Although the quantity of nickel used in chemical operations is dwarfed by the tonnages which go into structural applications, it has become a reagent of great importance in chemical industries.

See also references under "Nickel" in the Index.

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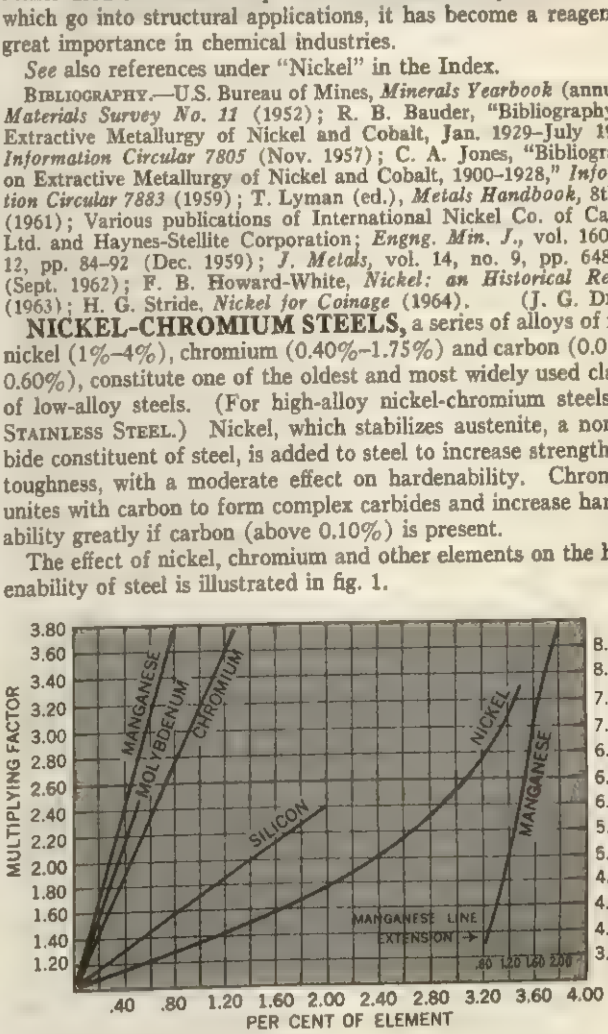
NICKEL-CHROMIUM STEELS, a series of alloys of iron, nickel (1%–4%), chromium (0.40%–1.75%) and carbon (0.05%–0.60%), constitute one of the oldest and most widely used classes of low-alloy steels. (For high-alloy nickel-chromium steels *see* STAINLESS STEEL.) Nickel, which stabilizes austenite, a noncarbide constituent of steel, is added to steel to increase strength and toughness, with a moderate effect on hardenability. Chromium unites with carbon to form complex carbides and increase hardenability greatly if carbon (above 0.10%) is present.

The effect of nickel, chromium and other elements on the hardenability of steel is illustrated in fig. 1.



BY COURTESY OF AMERICAN IRON & STEEL INSTITUTE

FIG. 1.—HARDENABILITY MULTIPLYING FACTORS FOR A VARIETY OF ALLOYING ELEMENTS

The low-alloy grades of nickel-chromium steels (1.0% to 2.0% nickel and 0.5% to 1.0% chromium) have hardening characteristics similar to those of other low-alloy steels. They are hardened by water quenching up to 0.40% carbon and oil-quenched with higher carbon contents. The higher-alloy grades (3.00% to 4.00% nickel and 0.50% to 2.00% chromium) may be air- or oil-quenched, depending on the composition and size of cross section.

The effect of nickel and chromium on the physical properties of air-cooled, hot-rolled 0.20% carbon steel for a 0.05 to 0.75 in. section is illustrated in fig. 2.

Nickel-chromium steel may be produced in an electric or open-hearth furnace. Nickel is not oxidized in the molten bath and

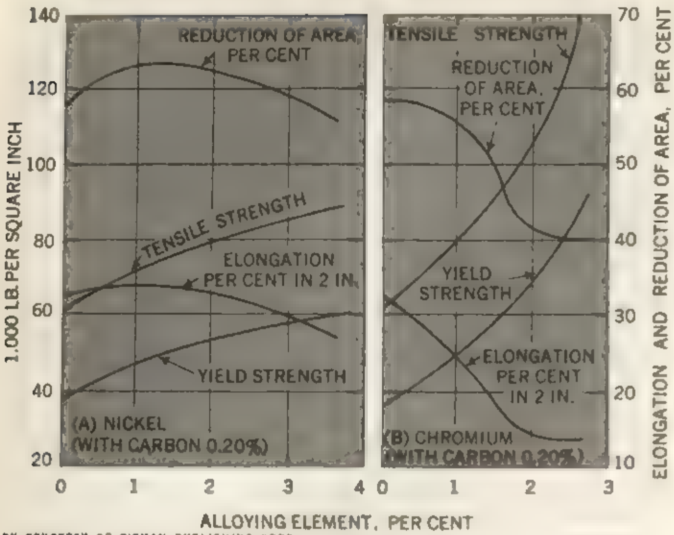


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FIG. 2.—EFFECT OF (A) NICKEL AND (B) CHROMIUM ON THE TENSILE PROPERTIES OF ROLLED CARBON STEELS

therefore yields 100% recovery (*see* NICKEL STEEL). Chromium presents a different problem because it is oxidized and enters the slag under normal basic open-hearth operations.

It is, therefore, not recovered from scrap in this operation, and additions must be made in the bath after it is thoroughly deoxidized or to the ladle during the tap. Recovery of chromium is possible, however, in the electric furnace with proper slag manipulation; that is, using a reducing slag or adding silicon or chrome silicide (reducing agents) to the furnace bath following an oxidizing condition to reduce the Cr_2O_3 in the slag to chromium and return it to the metal portion. Nickel-chromium steel may also be made in an acid open-hearth or acid electric furnace, using raw materials free from undesirable elements that cannot be removed by these processes. Nickel-chromium steels may be poured into ingots or castings; and the usual deoxidizer, as in nickel steel, is silicon, which is added in the ladle to about 0.25% of the final chemical analysis of the heat.

Ingots are stripped and placed in soaking pits as soon as they are solidified to prevent cooling cracks, and semifinished products, such as blooms, slabs and shapes, are stacked close together to prevent cooling cracks. Nickel-chromium steels are subject to flakes or hair cracks, as are many other air-hardening steels. Thorough deoxidation, slow pouring at correct temperatures and slow heating and cooling assist in avoiding flakes.

Nickel-chromium steels are used for important parts that are to be case-hardened or for highly stressed forgings. They are also widely used for heavy castings, such as those for bridges, locomotives and rolling-mill machinery, and for abrasion-resisting castings, such as power-shovel teeth and impact hammers.

The accompanying table shows a range of about 60 A.I.S.I. and S.A.E. nickel-chromium steels used in the United States.

Range of A.I.S.I. and S.A.E.† Standard Nickel-Chromium Open-Hearth and Electric Furnace Steels*

No. (Series)	C	Ni	Cr	Mo
A.I.S.I. 3100	0.13/0.53	1.10/1.40	0.55/0.90	—
S.A.E. 3200	.10/ .55	1.50/2.00	.90/1.25	—
A.I.S.I. 3300	.08/ .19	3.25/3.75	1.40/1.75	—
S A.E. 3400	.10/ .55	2.75/3.25	.60/ .95	—
A.I.S.I. 4300	.15/ .43	1.65/2.00	.40/ .90	0.20/0.30
A.I S.I. 8600	.13/ .65	.40/ .70	.40/ .60	.15/ .25
A.I.S.I. 8700	.18/ .53	.40/ .70	.40/ 60	.20/ .30
A.I.S.I. 9300	.08/ .20	3.00/3.50	1.00/1.40	.08/ .15
A.I.S.I. 9400	.35/ .48	.30/ .60	.30/ .50	.08/ .15
A.I S.I. 9700	.45/ .67	.40/ .70	.10/ .25	.15/ .25
A.I.S.I. 9800	.38/ .43	.85/1.15	.70/ .90	.20/ .30

*American Iron and Steel Institute.
†Society of Automotive Engineers.

Steels of the 3100 series, such as 3115 and 3120, are low-cost carburizing grades used for piston rings, automotive power train gears, oil-well-bit reamer cutters and many other small, case-hardened parts. The S.A.E. 3200 steels containing 2% nickel and 1% chromium are most often used in the high-carbon ranges. These steels are superior to the 3100 series in tensile properties and are used for automobile drive and axle shafts, master connecting rods of radial aircraft engines and many highly stressed keys and pins.

Steels of the A.I.S.I. 3300 series, containing around 0.30% or 0.40% carbon, develop mechanical properties superior to those of the lower alloy content nickel-chromium steels, particularly in sections over $3\frac{1}{2}$ in. They are therefore used extensively for forgings and bars that require rigid mechanical properties, such as large rocker arms and connecting rods. The S.A.E. 3400 series steels exhibit excellent resistance to fatigue, combined with good strength and ductility, which is especially valuable in parts likely to be subject to occasional overstressing from vibration or other causes. A.I.S.I. 3450 is used for heavy-duty gears of medium section in machine-tool construction.

Many nickel-chromium steels have been developed containing small additions of molybdenum, which are more complex steels (*see* table) with outstanding properties. The addition of molybdenum increases depth-hardening properties which makes it possible to develop strength and hardness in large sections equal to those secured in small sizes of other steels. Another characteristic of the nickel-chromium-molybdenum steels that contributes to their usefulness is high-hardness-machinability properties. Some compositions may be machined with Brinell hardnesses exceeding 400. These steels also show high resistance to creep up to about 1,000° F., and find application in valves and fittings in steam power plants.

Steels with about 0.55% carbon, 0.65% manganese, 2.00% nickel, 0.90% chromium and 0.20% molybdenum are used for roller bearings where ductility is required along with high hardness and fatigue resistance.

See also NICKEL; ALLOYS; IRON AND STEEL INDUSTRY.

BIBLIOGRAPHY.—Frank T. Sisco, *Modern Metallurgy for Engineers*, 2nd ed. (1948); J. M. Camp and C. B. Francis, *Making, Shaping and Heating of Steel*, chap. xxxii, pp. 1258–1274, 509, 1208 and 1209, U.S. Steel Corp. (1951); American Iron and Steel Institute, *Steel Product Manual*, sec. 7 (1952), sec. 10, 28 and 29 (1949); American Society for Metals, *Metals Handbook*, 8th ed. (1961); H. F. Keating, *Chromium-Nickel Austenitic Steels* (1956). (N. B. Ma.)

NICKEL SILVER comprises a range of alloys of copper nickel and zinc which are silvery in appearance but contain no silver. Its composition varies from 7% to 30% nickel, the alloy most widely used being "18% nickel silver" (18% nickel, 62% copper, 20% zinc). In general the zinc content is lowered as the nickel is increased, the copper content varying between 53% and 63%.

The importance of these alloys lies in their colour, ductility good mechanical properties and suitability for working in a wide variety of cast, rolled and extruded or drawn shapes. The addition of 1%–2% lead improves machining properties. Such alloys resist corrosion better than does brass but tarnish slowly through the action of sulfur in the air. Their colour ranges from nearly white in the 30% alloy to pale brassy yellow in the alloys with low nickel content.

A natural alloy known as paktong (white copper), smelted by the Chinese from copper-nickel ores, was one of the first alloys used by man. It was later improved by the addition of zinc ores and was imported into Europe by the East India company. Not until the 1840s was the alloy made in Europe by mixing the three metals and it was known as German silver until 1914. After an electroplating plant was set up in Birmingham in 1844 German silver was found very suitable as a basis for silver plating.

Nickel silver is used extensively for electroplated table and ornamental silverware, for jewelry, for architectural and ornamental metalwork, for some food and chemical equipment and for marine and plumbers' fittings. In hard-rolled strip form it is used for spring elements, especially in electrical and telephone relays. (P. E. G.)

NICKEL STEEL. Nickel steel was first produced by J. F. Hall of England and M. Marbeau of France about 1885, each working independently. The grades commercially used are an alloy of nickel (0.20%–5.00%), carbon (0.10%–0.60%) and the remainder

iron. The primary reason for adding nickel to steel is to increase its strength, toughness, depth hardness, and resistance to fatigue. These properties may be gained with small percentages of nickel (often referred to as an austenite former), which lower the eutectoid ratio (1% of nickel = 0.042% carbon) and tend to suppress transformation of austenite during cooling. In effect this results in a full-hardened steel with great strength and toughness, even after slow cooling, which is not possible with ordinary carbon steel.

Higher percentages of nickel than those specified above are not used commercially in nickel steel (*see* STAINLESS STEEL) because a martensitic structure, such as 0.40% carbon and 7% nickel, will result which has low elongation and shock-resistant values and is difficult to work and machine. (*See* also STEELS, ALLOY.)

Nickel steel may be produced in the electric or open-hearth furnace in the same manner as carbon steel, except that cleaner scrap is generally used and greater control exercised because of the economic risks. Nickel is not oxidized in the molten bath. It is, therefore, completely recovered from nickel-bearing scrap, and nickel may be added to meet specification early or late during the making of the heat.

Nickel steel may be teemed into ingots or castings; and the usual deoxidizer is silicon, which is added in the ladle to about 0.25% of the final chemical analysis of the heat. Ingots are stripped as soon as solidified and placed immediately in soaking pits to prevent cooling cracks.

The hot-working temperatures vary slightly from 2,200° F., depending on the chemical composition. Blooms, slabs, plates and shapes are stacked close together and protected from drafts while cooling. Surface imperfections are removed from nickel steel in the semifinished state and in the finished state if permitted by the user.

Industrial Uses.—By using high-strength steel, structures can generally be lightened in weight; for this reason, nickel steels and other alloy steels are widely used in the automotive and railroad industries. It is estimated that the U.S. automotive industry alone consumes 60% of all alloy-steel bar stock used in the country for the production of gears, shafts, roller bearings, nuts, bolts and various forgings. The weight saving over carbon steel by the use of nickel-alloy steel may be as much as 50%. For example, the weight of the entire rear-end assembly of an automobile may be reduced one-half by using smaller axles, housings and bearings of nickel steel and at the same time be as strong as twice its weight of carbon steel.

In steam locomotives, nickel steel was used for axles, boilers and firebox plates and frame castings. In diesel locomotives it is used for gears, generator roofs and side sheets and frames. In marine propulsion, such steels are used for shafts and in reduction-gear assemblies. In aircraft it is used for landing-gear parts and power-transmitting parts of reciprocating engines. Nickel steel was chosen for the forging of the world's largest supersonic wind tunnel at the air force research centre at Tullahoma, Tenn., with the following composition 0.28% carbon, 0.65% manganese, 2.85% nickel, 0.35% molybdenum and 0.07% vanadium. Nickel steel has also been used in long-span bridges to reduce dead weight and increase the pay load (for example, the George Washington bridge across the Hudson river at New York city and the San Francisco-Oakland bridge).

TABLE I.—*Effects of Nickel on Hardness and Low Temperature Strength Using a 0.20% Carbon Normalized Steel*

Nickel (%)	Brinell hardness	Charpy impact resistance in ft.-lb. at	
		Room temperature	-50° F.
0.0	127	80	7
1.0	146	94	30
2.0	155	88	35
3.0	168	88	40
4.0	187	75	50

Although the greater portion of nickel steel is employed for rolled or forged products, a generous quantity is used for castings. Cast-nickel alloys respond to heat treatment and give high values for strength and hardness.

A few uses are railroad passenger-car truck frames, rolling-mill rolls, heavy-cast machinery gears, crusher-jaw castings, impact hammers and power shovels.

One of the outstanding characteristics of nickel steels is resistance to embrittlement at low temperatures, for which reason it is utilized in chemical equipment for subzero operations. This fact, plus the effect of nickel on hardness, is shown in Table I.

Table II illustrates the wide range of these steels used in the United States.

Steel A is an inexpensive water or oil hardening steel for parts of moderate importance, steel B can be oil-quenched direct from the carburizing heat for a tough core and file-hard case; it has good machining properties and is widely used for roller bearings, gears, piston pins and drive shafts. Steel C usually is given a more elaborate heat treatment for a strong, tough core; it is used for gears, shafts, and machine parts requiring extra toughness as well as surface hardness and constancy of dimension. Steel D is hard to work but after proper case hardening gives parts having extreme hardness and resistance to shock; examples are aircraft engines, crankshafts, truck, bus and tractor transmission, and differential gears.

TABLE II.—*Range of Analyses of Nickel-Bearing Steels*

	Low-nickel		Medium-nickel	High-nickel
	A (%)	B (%)	C (%)	D (%)
Carbon	0.10–0.40	0.06–0.43	0.10–0.50	0.09–0.20
Manganese	.30–1.20	.25– .90	.40– .90	.40– .60
Nickel	.20–1.00	1.40–2.00	3.25–3.75	4.50–5.25
Molybdenum	—	.15– .30	None or .20– .30	—

Great strides had been made by the 1960s in finding substitutes for nickel in steel. Manganese, boron and nitrogen had been proved possible substitutes. Many high-nickel alloys had been developed containing up to 95% nickel. Some uses of these are lead-in wire for light bulbs and electron tubes, thermocouples, low-coefficient-of-expansion material, alloys that resist chemicals and other corrosive mediums and magnets.

See also NICKEL.

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NICOBAR ISLANDS, a group of 12 inhabited and 7 uninhabited islands in the Bay of Bengal, between Sumatra, Indon., and the Andaman Islands (*q.v.*). The Andaman and Nicobar Islands together constitute a Union territory of the Republic of India under a chief commissioner, with its capital at Port Blair (*q.v.*) in the Andamans. The aggregate area of the Nicobars is 627 sq.mi., and Great Nicobar (Loöng), the largest and southernmost of any size, has an area of 333 sq.mi. Principal of the central group of islands are Camorta and Nancowry (Nankauri), between them being a landlocked shelter called Nancowry harbour. Chief island of the northern group is Car Nicobar (Pu), area 49 sq.mi. Some of the islands have mere flat coral-covered surfaces; others, again, are hilly, Great Nicobar rising to 2,105 ft. On that island there are considerable and beautiful streams, but the others generally are badly off for fresh surface water. In 1961 the inhabitants of the Nicobar Islands numbered approximately 14,500, Car Nicobar being by far the most densely populated island.

Geology and Climate.—The Nicobars form part of a great submarine mountain chain linking the Arakan Yoma range of Burma, through the Andamans and Nicobars, with the main mountain chain of Sumatra. There are early geological reports issued by a Danish scientific expedition of 1846 and an Austrian expedition of 1858. Later work by the Indian geological survey revealed

a structure of a complex anticlinorium like that of the Arakan Yoma range with intrusive masses of serpentine and gabbro probably of Cretaceous age, but the folded sedimentaries are mainly Tertiary. Earthquakes of great violence were recorded in 1847 and 1881 (with tidal wave), and mild shocks were experienced in Dec. 1899.

Being situated between latitude 6° and 10° N. of the equator, the islands have a nearly equatorial climate. They are exposed to both monsoons, and smooth weather is experienced only from February to April and in October. Rain falls throughout the year, generally in sharp, heavy showers. The rainfall varies from 90 to 135 in., and the shade temperature from 18° to 33° C. (64° to 92° F.).

Vegetation and Animal Life.—The vegetation of the Nicobars has not been subjected to a systematic examination by the Indian forest department like that of the Andamans, and indeed the forests are inferior in economic value to those of the more northerly group. There are fruit trees, such as the coconut (*Cocos nucifera*), the betel nut (*Areca catechu*), and the Nicobar breadfruit (*Pandanus leram*), a thatching palm (*Nipa fruticans*) and various timber trees of some commercial value, but only one timber tree, the black chuglam (*Myristica irya*), would be considered first class in the Andamans. The palms of the Nicobars are exceedingly graceful.

The mammals are not numerous: in the southernmost islands are a small monkey, the crab-eating macaque (*Macaca irus*), a tree shrew (*Tupaia nicobarica*), rats and mice, bats and the Nicobar flying fox. It is doubtful if the wild boar is indigenous; cattle when introduced and left, have speedily become "wild." The birds, of which there are many kinds, show strong Indian affinities. Notable among those found in the islands are the megapode (*Megapodius nicobaricus*), characteristic of the Australian region, the edible-nest-building swift, the hackled and pied pigeons, a parakeet (*Palaeornis caniceps*) and an oriole. Snakes, lizards and chameleons, crocodiles, turtles and an enormous variant of the edible Indian crab are numerous; butterflies and other insects have not yet been systematically collected. The freshwater fish are reported to be of the types found in Sumatra.

History.—The situation of the Nicobars along a line of an ancient trade route caused them to be reported by traders and seafarers through historical times. In the 17th century the islands began to attract the attention of missionaries. At various periods, France, Denmark, Austria and Great Britain all had more or less obscure rights to the islands, the Danes being the most persistent in their efforts to occupy the group, until in 1869 they relinquished their claims in favour of the British, who at once began to put down the piracies of the islanders, and established a penal settlement, which was withdrawn in 1888. Car Nicobar in the north and Camorta in the centre became the principal ports of the group.

In 1942, during World War II, the Nicobar Islands were occupied by Japanese forces, who developed Car Nicobar as a big supply base. In 1945 the islands were reoccupied by the Allies. With the Andamans they passed to India on the establishment of Indian independence. (L. D. S.)

The People.—The Nicobarese are probably a mixture of Malay and Burmese (Talaing) strains. They are of relatively short stature (average height of adult male, 5 ft. $3\frac{3}{4}$ in.) and sturdy build; hair may be slightly wavy or curly, scanty on face and body; brachycephaly is usual. The language, which has several dialects, belongs to the Mon-Khmer group.

The political unit is the village. There are hereditary headmen who govern with a council of elders; the power of the headman depends on his personality, and public opinion is the final arbiter. Land is held by the community, but there is private ownership of fruit and coconut trees. The status of women is high; they inherit and own property, and girls have considerable freedom in the choice of a husband. The marriage tie is loose, and separation (which ends the marriage) is frequent. Polygamy is rare and is confined to the rich. A man who feels himself offended or ill-used will express his sense of grievance and put his enemy to shame by destroying his own property or even by self-mutilation.

Clothing is scanty. Men wear a belt and a cloth perineal band with a tail behind, perhaps connected with one of their stories of origin—that they are descended from a man who mated with a bitch. Articles of European clothing are now often worn. Houses vary in shape; they are built on piles, with thatched roofs, and are reached by a notched pole. Much cooking is done in them on clay hearths, but there are also separate cookhouses. Special houses are built by communal labour for feasts and meetings. The coconut is the main crop and yams and other vegetables are grown; fish, turtles, pigs and fowl are also important in the diet. Crossbows are used for shooting birds, spears for hunting pigs, spears, nets, traps and poison for fish, harpoons for turtles. The dao (half sword, half chopper) is the universal tool. Canoes are single outriggers with dugout hulls.

The concept of a beneficent creator is known, probably as a result of missionary influence. The indigenous religion consists in belief in a multiplicity of spirits, many of them those of ancestors, who may be friendly (locally) or more frequently malevolent. The latter bring disease and misfortune. There is a class of mediums who can communicate with, and control, the spirits; those causing sickness may be caught and towed out to sea on model rafts. Grotesque carvings of aggressive mien, which are probably regarded as residences for friendly ancestral spirits, are kept in houses to scare away evil spirits. Men can acquire reputations as sorcerers by eccentric behaviour, such as sitting in pig wallows and collecting bristles; they are much feared, and were sometimes killed.

The natives of Chowra, a small island of the central group, act as middlemen for the group. They alone make pottery, with clay obtained from Teressa, and exchange it for canoes made in the southern and central islands, which they trade to the north. Chowra men go to Nancowry to burn shells for lime (used in betel chewing), paying in pots for the privilege.

The Shom Pen of the interior of Great Nicobar may represent an earlier element in the population. They practised a simple type of cultivation, the digging stick being their only implement, and relied heavily on hunting; wild pigs, which they hunted with dogs, were the main quarry. Their only weapon seems to have been a wooden spear. They are now few in numbers and have been considerably influenced by the coastal people.

(B. A. L. C.)

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NICOLAI, CHRISTOPH FRIEDRICH

NICOLAI, CHRISTOPH FRIEDRICH (1733–1811), German author and bookseller who, with Lessing and Moses Mendelssohn, was a leader of the German *Aufklärung* (Enlightenment), was born on March 18, 1733, at Berlin, son of the well-known bookseller, Christoph Gottlieb Nicolai (d. 1752). In 1749 he went to Frankfurt an der Oder to learn his father's business, finding time also to become acquainted with English literature.

In 1752 he returned to Berlin, where he began to take part in literary controversy by defending Milton against the attacks of J. C. Gottsched. Nicolai's *Briefe über den jetzigen Zustand der schönen Wissenschaften in Deutschland*, published anonymously in 1755, were directed against both Gottsched and Gottsched's Swiss opponents, J. J. Bodmer and J. J. Breitinger; his enthusiasm for English literature won him the friendship of Lessing and Mendelssohn. With Mendelssohn he established the periodical *Bibliothek der schönen Wissenschaften* (1757–60); and with Lessing and Mendelssohn *Briefe, die neueste Literatur betreffend* (1759–65); from 1765 to 1792 he edited the *Allgemeine deutsche Bibliothek*. The *Bibliothek* was the organ of the so-called "popular philosophers," who warred against authority in religion, and against what they conceived to be extravagance in literature, and Nicolai showed a complete incomprehension of the new movement of ideas represented by Herder, Goethe, Schiller, Kant and Fichte.

Of Nicolai's independent works, perhaps the only one with some historical value was his *Charakteristischen Anekdoten von Friedrich II* (1788–92). His romances are forgotten, although *Das Leben und die Meinungen des Magisters Sebaldus Nothanker* (1773–76) and his satire on Goethe's Werther, *Die Freuden des jungen Werthers* (1775), had a certain reputation in their day.

Between 1788 and 1796 Nicolai published in 12 volumes a *Beschreibung einer Reise durch Deutschland und die Schweiz,* which bore witness to the narrow conservatism of his views in later life. He died in Berlin on Jan. 8, 1811.

Nicolai's *Bildniss und Selbstbiographie,* edited by M. S. Löwe, was published in the *Bildnisse jetzt lebender Berliner Gelehrter* (1806).

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NICOLAI, (CARL) OTTO EHRENFRIED (1810–1849), German composer known for his comic opera *Die lustigen Weiber von Windsor* (*The Merry Wives of Windsor*) based on the comedy by Shakespeare. Born at Königsberg on June 9, 1810, he was exploited by his father in his youth as a prodigy. In 1827 he studied in Berlin and later under G. Baini in Rome, producing from 1838 onward several successful operas in Italy and Vienna. In 1841 he became court conductor in Vienna and founded the Philharmonic society there the following year. In 1848 he was appointed conductor of the opera at Berlin and on March 9, 1849, he produced there *Die lustigen Weiber von Windsor*, which remained one of the most popular comic operas throughout the 19th century. He died in Berlin on May 11, 1849.

See Otto Nicolai, *Tagebücher,* ed. by W. Altmann (1937).

NICOLE, PIERRE (1625–1695), French Jansenist theologian and moralist, was born at Chartres. He studied at Paris, and taught at Port Royal, for which, with Antoine Arnauld and others, he wrote schoolbooks, especially *Logique de Port-Royal.* From 1655 to 1668 he played a decisive part in writing or editing most of the Jansenist pamphlets (*see* JANSENISM). His special contribution to this controversy was the distinction drawn between the *question de droit* (are the doctrines called Jansenist heretical?) and the *question de fait* (did Jansen teach these doctrines?). By answering the first affirmatively and the second negatively, he enabled the Jansenists to pursue their program without openly breaking with the church. From 1669 Nicole devoted his theological talents mainly to the defense of Roman Catholic dogma against the historical criticism of Protestant writers. But his best, and best-known, work is the *Essais de Morale* (4 vol., 1671–78, 10 more posthumously), in which he discoursed, with some humanity of outlook and great penetration of mind, upon the practice and problems of a rigorously Christian ethic in the world of his day. He had no sympathy with advanced mystical speculations. He died in Paris on Nov. 16, 1695.

See C. A. Sainte-Beuve, *Port-Royal,* 5th ed., vol. iv (1888); M. J. F. R.; H. Bremond, *Histoire littéraire du sentiment religieux en France,* vol. iv (1920). (N. J. A.)

NICOLLE, CHARLES JULES HENRI (1866–1936), French bacteriologist, winner of the 1928 Nobel prize in medicine for his discovery that typhus fever (*q.v.*) is transmitted by the body louse, was born on Sept. 21, 1866, at Rouen, where his father, Eugène Nicolle, was professor of medicine. After graduating M.D. at Paris in 1893 he became a member of the Rouen medical faculty, and in 1896 was appointed director of its bacteriological laboratory, where he carried out important work on the preparation of diphtheria antiserum. In 1903 he was appointed director of the Pasteur institute in Tunis, and during his 33 years' tenure of that post the institute became a world-famous centre for bacteriological research and for the production of serums and vaccines to combat many of the most prevalent infectious diseases. His researches on the transmission of typhus culminated in 1909 when he made the discoveries for which he received the Nobel prize. Later he helped to make a clear distinction between classical louse-borne epidemic typhus and murine typhus, which is conveyed to man by the rat flea. He also made valuable contributions to the knowledge of rinderpest, brucellosis, measles, scarlet fever, diphtheria and tuberculosis, and was responsible for many innovations in bacteriological technique. Apart from his scientific activities, Nicolle enjoyed a considerable reputation as a philosopher and as a writer of fanciful stories. In 1928 the silver jubilee of his directorship of the Tunis institute was commemorated by a gold medal, and in 1932 he was elected to a chair in the Collège de France. He died in Tunis on Feb. 28, 1936. (W. J. BP.)

NICOLLS, RICHARD (1624–1672), the first English governor of the province of New York, was born at Ampthill, Bedfordshire, Eng., the son of a barrister, in 1624. A stanch royalist, he served in the army during the English Civil War and followed the Stuarts into exile. In 1664, soon after the Restoration, he was appointed by the duke of York to be governor of the territory in America that was about to be acquired from the Dutch. With a squadron of four vessels he blockaded New Amsterdam and the Dutch capitulated in September without bloodshed. Although Nicolls' commission gave him practically absolute power, the transition from Dutch to English rule was made tactfully and gradually. His rule brought increased freedom to the Dutch but it did not meet the expectations of the English inhabitants for representative government. A legal code known as the "Duke's laws" was issued in 1665 and continued in force until 1683. Nicolls ruled so fairly and well that he was held in high esteem by all. He resigned in 1668, returned to England, and was killed on May 28, 1672, in a naval battle during the Third Dutch War. *See* also NEW YORK: *History.*

See M. Schuyler, *Richard Nicolls* (1933). (RA. MU.)

NICOMACHUS (fl. 4th century B.C.), of Thebes, Greek painter, was a contemporary of the greatest painters of Greece; Vitruvius observes that if his fame was less than theirs, it was the fault of fortune rather than of demerit. Pliny the Elder gives a list of his works, among them a "Rape of Persephone," "Victory in a Quadriga," a group of Apollo and Artemis and the "Mother of the Gods Seated on a Lion." Pliny also says that he was a very rapid worker and used only four colours.

NICOMACHUS, a Neopythagorean philosopher and mathematician whose works had a great vogue, was born at Gerasa in ancient Palestine (modern Jordan) and flourished about A.D. 100. One of his two extant treatises, called *Introductio arithmetica,* sets out the elementary theory and properties of numbers. Numbers are no longer denoted by lines as in Euclid, but are written in the ordinary notation; hence general principles can be stated only with reference to particular numbers taken as illustrations. Nicomachus states a rule about cubes that makes it possible to sum any number of forms of the series of natural cubes beginning from one. His popularity is revealed by Lucian's having a character say, "You count like Nicomachus." A Latin translation by Apuleius of Madauros (born about A.D. 125) is lost; but Boëthius' version survives. The commentators include Iamblichus, Heronas, Asclepius of Tralles, John Philoponus and Proclus. The Greek text was edited by R. Hoche (1866) and the commentaries of Iamblichus and Philoponus by E. Pistelli (1894) and Hoche (1864 and 1864–67), respectively. There is an English translation by M. L. D'Ooge with essays by F. E. Robbins and L. C. Karpinski (1926). Nicomachus' *Enchiridion Harmonices* (ed. by C. Jan in *Musici Scriptores Graeci,* 1895) is on the Pythagorean theory of music. Nicomachus is said to have written *Theologumena arithmetices* (in two books) on the properties of numbers, of which the *Theologumena arithmeticae* edited by F. Ast (1817) contains no more than fragments, at most. (T. L. H.; X.)

NICOMEDES (*c.* 240 B.C.), Greek mathematician, is known only through references to his work by the commentators Pappus (*c.* A.D. 320), Iamblichus (*c.* A.D. 310) and Proclus (*c.* A.D. 450). His date is estimated from the fact that he is said to have compared his work with that of Eratosthenes and that he is referred to by Apollonius, these two men being contemporaries.

Nicomedes seems to have been the inventor of the conchoid, a curve that he used in trisecting an angle and in doubling a cube. The use of this curve to solve the problems of trisecting an angle and duplicating a cube should not be interpreted to mean that these problems can also be handled by the Euclidean instruments of the compass and the straightedge, for this is impossible.

See Ivor Thomas (trans. and ed.), *Selections Illustrating the History of Greek Mathematics,* vol. i (1939–42). (V. SD.; X.)

NICOMEDIA: *see* IZMIT.

NICOPOLIS (VICTORY CITY) **ACTIA** (modern NIKOPOLIS, formerly known as PALAIOPREVEZA, about 4 mi. N. of Preveza,

northwestern Greece), an ancient city of Epirus founded 31 B.C. by Octavian (Augustus) in memory of his victory over Antony and Cleopatra at Actium. The colony, composed of settlers from many neighbouring towns, succeeded and became the capital of southern Epirus and Acarnania, with the right of sending five representatives to the amphictyonic council. On the spot where his tent had stood Octavian built a sanctuary to Neptune adorned with *rostra* (the beaks of captured galleys), and instituted the Actian games in honour of Apollo. The city was restored by the emperor Julian and again (after the Gothic invasion) by Justinian, but in the middle ages it was supplanted by Preveza.

NICOSIA, the capital of the Republic of Cyprus and seat of the archbishop of the autocephalous Church of Cyprus, lies on the Pedieos river about 500 ft. above sea level in the centre of the plain between the Kyrenia mountains and the Troodos massif. Pop. (1960) 45,490, with suburbs 95,343. It contains the presidential palace, the chamber of representatives, the Greek and Turkish communal chambers, the British high commission building and the foreign embassies. It is also the professional and educational centre of Cyprus. There are two chief thoroughfares: Kyrenia street continuing into Ledra street (north and south) and Hermes street continuing into Paphos street (east and west). Ledra street is the Greek business and shopping centre while the northern half of the walled town is largely Turkish. The fine Gothic cathedral of St. Sophia, dedicated in 1325, was converted by the Turks into the Selimiye mosque. The town has several public gardens, in one of which stands the municipal theatre. Near it is the Cyprus museum, erected in 1907 with later extensions.

Nicosia is connected by good roads with the port of Famagusta (38 mi.) and the other chief towns of the island. From Nicosia airport, 5 mi. from the city, there are daily flights direct to London and connecting services with New York and the principal airports in Europe and the middle east. There are many light industries, mainly serving the local market. Manufactures include cotton yarn and textiles, cigarettes, flour, soft drinks, confectionery, footwear and underwear.

The town was known in antiquity as Ledra, and under the Byzantines by the Greek name Lefkosia, corrupted by the Latins to Nicosia. A kingdom in the 7th century B.C. and a bishopric from the 4th century A.D., it has been the seat of government from the 10th century. The Lusignan kings walled the town, which covered a much larger area than that enclosed by the existing Venetian fortifications (3 mi. round). In 1373 it was sacked by the Genoese and in 1426 by the Mamelukes, when the royal palace (a fragment of which survives near the Paphos gate) was destroyed. Many of the Latin religious foundations were abandoned and the medieval city never fully recovered. Under the Venetians, who occupied Cyprus in 1489, the Greeks again had their cathedral (the ruined Bedestan beside St. Sophia). Work started on the new walls in 1567, but was incomplete when a large Turkish invasion force landed in 1570, and the town was again plundered. The Turkish governors established themselves in the former palace of the Lusignans, where the law courts now stand. When Cyprus came under British administration in 1878, Nicosia had greatly declined, but during the 20th century building was extended far beyond the Venetian walls and dry moat. Within these walls the old town has been largely rebuilt, with only a slight widening of its medieval streets. (A. H. S. M.)

NICOTIANA, a genus of plants of the nightshade family (Solanaceae), comprising about 60 species of usually sticky herbs and shrubs, native chiefly to tropical America. Besides *N. tabacum*, important as the source of commercial tobacco (*q.v.*), several other species are cultivated as ornamental plants. They are strongly scented annuals or perennials, possessing narcotic-poisonous properties. They have alternate, simple, usually entire but sometimes wavy-margined large leaves, and white, yellow, greenish or purple, very fragrant flowers, with a long, tubular, five-lobed corolla, usually opening at night.

About ten species are found in the southern and western parts of the U.S., and *N. glauca* (tree tobacco), a slender evergreen shrub native to Brazil, has become widely naturalized on the Pacific coast. *N. rustica,* one of the plants known as wild tobacco, formerly cultivated by the Indians of the eastern states, is of uncertain origin, but is almost certainly the source of the first tobacco taken from Florida to Lisbon and popularized by Jean Nicot, for whom the genus and nicotine were named. Beautiful night-fragrant species for the garden are *N. alata* var. *grandiflora* (jasmine tobacco), three to four feet high, and the somewhat shorter *N. sylvestris,* both tender perennials from South America.

Nicotianas, easily grown from seed and root cuttings, are sensitive to frost. They do well in light rich soil in a warm sheltered location and frequently self-sow in the garden; some make good potted plants.

See T. H. Goodspeed, "The Genus Nicotiana," in *Chronica Botanica*, vol. xvi (1954). (N. Ta.)

NICOTINE, a volatile liquid, is the principal alkaloid of tobacco (*q.v.*), in which it occurs to the extent of about 5% along with minute amounts of closely related alkaloids. Nicotine is used chiefly as a contact insecticide for plants and animals. It is prepared by adding lime or caustic soda to a filtered, concentrated, aqueous extract of tobacco (stalk and other tobacco refuse is generally used) and recovering the alkaloid by extraction with a suitable solvent or by steam distillation. This crude alkaloid is freed from water by a chemical drying agent, such as solid potash, and then fractionally distilled. Pure nicotine, $C_{10}H_{14}N_2$, is a highly poisonous, colourless liquid with an unpleasant odour; it boils at 246°–247° C. and is soluble in most solvents, including water. The dipicrate crystallizes in short, yellow prisms that melt at 224° C. and can be used in the identification of nicotine.

NICTHEROY: *see* NITERÓI.

NICUESA, DIEGO DE (*c.* 1465–1511), Spanish conqueror, was born at Baeza, Jaén. He accompanied Gov. Nicolás de Ovando to the West Indies in 1502 and was active in the early settlement and organization of Santo Domingo. In 1508 Nicuesa received a grant to conquer and govern a colony on the South American mainland called Veragua west of the Gulf of Darién and extending north to Cape Gracias a Dios in Panama (Honduras). At the same time, Alonso de Ojeda was awarded an adjoining grant to the east. In Nov. 1509 Nicuesa's expedition of 745 men left Santo Domingo in five ships. However, they soon encountered bad luck. The larger ships were lost on the inhospitable coast, and no settlement could be made because of attacks by the Indians until Nicuesa decided to "stop here in the name of God" at Cape "Gracias a Dios." There his forces were further reduced by hunger, Indian attacks and disease. Ojeda's men, by then left leaderless, found themselves within the limits of Nicuesa's grant and invited him to be their governor. But they heard of his overbearing conduct and bad reputation among his own men, and when he arrived in March 1511, they refused to let him land. He was forced out to sea in a leaking craft and perished with a number of faithful friends. (U. S. L.)

NIDWALDEN, a demi-canton of central Switzerland, which, with the demi-canton of Obwalden, forms the founder canton of Unterwalden (*q.v.*). Pop. (1960) 22,188. Stans, the capital (4,337), has a baroque church (1641–47) with a Roman tower, and a monument to Arnold von Winkelried, the hero of Sempach. Johann Heinrich Pestalozzi, the humanist educator, founded his first orphanage there in 1798. Nidwalden offers winter sports and its tourist resorts include the Bürgenstock mountain mass that projects into the Lake of Lucerne.

NIEBUHR, BARTHOLD GEORG (1776–1831), German historian who started a new era in historical studies by his method of source criticism; all subsequent historians are in some sense indebted to him. Niebuhr, the only son of the Danish explorer Carsten Niebuhr (*q.v.*), was born in Copenhagen on Aug. 27, 1776. Up to his matriculation at Kiel university he had a solitary education which perhaps intensified his leaning toward a life of scholarship. But on his father's advice he spent over a year in England and Scotland and then embarked on a career in state service, becoming private secretary to Count Schimmelmann, the Danish minister of finance, and in 1804 director of the national bank. In 1806, at the request of Baron von Stein, the Prussian chief minister, he took up a similar post in Prussia. Two years after Stein's fall (1808), however, disapproving of Prince von Hardenberg's

policy, he resigned and became state historiographer. At the same time he became a member of the Berlin Akademie der Wissenschaften and was thereby empowered to lecture at the newly founded university of Berlin. In 1810 he began the series of lectures on Roman history which were the basis of his great book and which made a sensation in Berlin. In 1816 he went as Prussian ambassador to the Vatican, retiring to Bonn in 1823 where he died on Jan. 2, 1831. Niebuhr's chief work was done while he was employed in public service. His interests were academic (to the fine arts he was wholly indifferent; it has been said that to him Rome was only a collection of unsolved problems) and he never wholly reconciled himself to his official career; yet he held that no one could understand the history of Rome without knowing the state as it is seen by the statesman; and his work, above all his gift for analogy, benefited greatly from his practical life.

Niebuhr's *Römische Geschichte* (3 vol., 1811–32; Eng. trans. 1828–42) marked an era in the study of its special subject and had a momentous influence on the general conception of history. Niebuhr made particular contributions of value to learning, *e.g.*, his study of social and agrarian problems; on the other hand some of his theories were extravagant and his conclusions mistaken. But his permanent contribution to scholarship was his method. The failings of classical sources were already recognized but it was Niebuhr who evolved what Goethe called *"tätige Skepsis"*—the constructive skepticism which is the root of a scientific method of criticism. It was Niebuhr who showed how to analyze the strata in a source, particularly poetical and mythical tradition; how to discard the worthless and thereby lay bare the material from which the historical facts could be reconstructed. He thus laid the foundation for the great period of German historical scholarship.

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NIEBUHR, CARSTEN (1733–1815), German traveler who was the sole survivor of the first scientific expedition to Arabia and the compiler of its results, was born at Ludingworth, Hanover, on March 17, 1733. He worked as a peasant in his early years, but managed to learn surveying. In 1760 he was invited to join the expedition being sent out by Frederick V of Denmark for the scientific exploration of Egypt, Arabia and Syria. The expedition visited the Nile, Mount Sinai, Suez and Jidda, whence it journeyed overland to Mokha. In May 1763 the philologist of the expedition, F. C. von Haven, died, followed in July by the naturalist, Pehr Forskål. Sana, the capital of Yemen, was visited, but the remaining members of the expedition were obliged to return to Mokha. Niebuhr saved his life and restored his health by adopting native dress and food. From Mokha they sailed to Bombay, where the artist and the surgeon of the expedition died, leaving Niebuhr alone. He stayed 14 months in India and then turned homeward by way of Muscat, Persia, Mesopotamia, Cyprus and Asia Minor, reaching Istanbul via Brusa in Feb. 1767 and Copenhagen in the following November. He later held posts in the Danish military service and in the civil service of Holstein. He died at Meldorf in Holstein on April 26, 1815.

Niebuhr's major works are *Beschreibung von arabien* (Fr. trans., *Description de l'Arabie*) and *Reisebeschreibung nach arabien und andern umliegenden landern* (Eng. trans., *Travels Through Arabia*). He also edited P. Forskål's *Descriptiones animalium, Flora aegyptiaco-arabica* and *Icones rerum naturalium*.

See the anonymous *Life of Carsten Niebuhr* in the "Lives of Eminent Persons" series (1838); and D. G. Hogarth, *The Penetration of Arabia* (1904).

(Wm. C. B.)

NIEBUHR, REINHOLD (1892–), U.S. Protestant theologian and social critic, a pioneer in the "new theology" or Neo-orthodoxy (*q.v.*) that has striven to restate the biblical-Christian teaching in a form relevant to the great issues of contemporary life and history. Niebuhr's influence has been widespread, cutting across the lines of the diverse religious communities as well as of the various academic disciplines dealing with human affairs. The influence of his thinking has been felt alike in theology and in the fields of history, political science and international affairs.

Niebuhr was born on June 21, 1892, at Wright City, Mo., the son of a clergyman. He attended Elmhurst college (1910), Eden Theological seminary (1913) and Yale Divinity school (B.D., 1914; M.A., 1915). He received a D.D. from Eden Theological seminary in 1930 and numerous honorary degrees from institutions in the United States and abroad. He was ordained to the ministry of the Evangelical Synod of North America in 1915 and served as a pastor in Detroit from 1915 to 1928. In the latter year he joined the faculty of Union Theological seminary in New York city, serving as associate professor of the philosophy of religion until 1930 and as professor of applied Christianity until 1960, the year of his retirement. He married Ursula Keppel-Compton in 1931.

In his earliest writings, Niebuhr exhibited the quasi-humanistic religious "liberalism" and social idealism that pervaded the theological atmosphere of the time. Increasing experience with the actualities of social life which he encountered in the course of his ministry in a great industrial city, together with his reflections on world affairs, sharply reoriented his thinking in a direction more orthodox theologically and more realistic socially. *Moral Man and Immoral Society*, published in 1932, embodying this new orientation, came as a tract for the times, combining a somber Augustinian emphasis on the involutions of sinful self-love in the individual and corporate structures of life with a social radicalism bordering on Marxism. His Marxist inclinations vanished in the years after World War II, and he in fact became a vigorous critic not only of totalitarian communism but of doctrinaire socialism as well; the original combination of a hardheaded Augustinian doctrine of man with a lively social concern, however, remained characteristic of his thought.

The most impressive statement of his fundamental theological position Niebuhr developed in his Gifford lectures, published as *The Nature and Destiny of Man* (2 vol., 1941–43). This work is a sustained and systematic attempt to restate, assess and vindicate the essential Augustinian-Reformation teachings on man in the context of an "existentialist" understanding of the human situation, emphasizing at once man's dynamic of self-transcendence, the ambiguities of his creaturely existence and the corruptions of his sinful egocentricity. It was this work that brought Niebuhr closest to continental neo-orthodoxy, although he was throughout very critical of both Karl Barth and Emil Brunner.

In later years Niebuhr's thinking shifted more and more to a concern with the problem of history and an emphasis on man's essential historicity ("Man's being and human society are by nature historical. . ."). *Faith and History* (1949), *The Irony of American History* (1952) and *The Self and the Dramas of History* (1955) mark this new direction. The last-named work is particularly significant for what it owes to the "relational" (or "dialogical") philosophy of Martin Buber, an influence that came late but remained powerful in Niebuhr's thought. His *The Structure of Nations and Empires* (1959) combines this concern with history with his lifelong preoccupation with the problems of political power.

Bibliography.—Niebuhr's writings and his commentaries on religious, social and political affairs are voluminous. A full bibliography to 1956 may be found in Charles W. Kegley and Robert W. Bretall (eds.), *Reinhold Niebuhr: His Religious, Social, and Political Thought* (1956), and a collection of his outstanding occasional articles in D. B. Robertson (ed.), *Love and Justice: Selections From the Writings of Reinhold Niebuhr* (1957). Important studies of Niebuhr's thought include Edward J. Carnell, *The Theology of Reinhold Niebuhr* (1950); Georgette Paul Vignaux, *La Théologie de l'histoire chez Reinhold Niebuhr* (1957); Gordon Harland, *The Thought of Reinhold Niebuhr* (1960).

(W. He.)

NIEDERSACHSEN: *see* Lower Saxony.

NIEL, ADOLPHE (1802–1869), French army officer, one of the emperor Napoleon III's marshals, was born at Brioudes, Haute-Garonne, on Oct. 4, 1802. Trained as an engineer, he was commissioned in the army in 1825; took part in three campaigns in Algeria (1837–39); superintended the fortification of the St. Denis region; and was promoted lieutenant colonel in 1842 and colonel in 1846. In 1849, as chief of staff to Gen. J. B. P. Vaillant in the papal states, he distinguished himself in the capture of Rome from the republicans. General of division in 1853, he

was twice on active service in command of the engineers during the Crimean War: during the expedition to the Aaland Islands and at the siege of Sevastopol. Aide-de-camp to Napoleon III from 1854 and a senator from 1857, he went to Turin to conclude the alliance of Jan. 1859 between France and Sardinia-Piedmont; in the ensuing war against Austria he played a decisive role in the battle of Solferino, for which he was made marshal next day (June 25, 1859). Appointed minister of war on Jan. 18, 1867, he planned a radical reorganization of the army, but met with obstruction and did not live long enough to put his valuable law of Feb. 1, 1868, into effect. Niel died in Paris on Aug. 13, 1869.

See J. de La Tour, *Le Maréchal Niel* (1912). (L. G.)

NIELLO: *see* Metalwork, Decorative: *Techniques of Metalworking.*

NIELSEN, CARL AUGUST (1865–1931), the outstanding Danish composer of his time. Born on June 9, 1865, at Norre Lyndelse, near Odense, he entered the conservatory of music at Copenhagen in 1884 where he studied with O. Rosenhoff and N. Gade. He was violinist in the court orchestra at Copenhagen intermittently from 1886 to 1905, conductor at the court theatre (1908–14) and director of the *Musikforeningen* (Music society) from 1915 to 1927. In 1915 he was appointed professor at the Copenhagen conservatory. Nielsen's early music was influenced by the romantic composers, but his later works were more enterprising and made use of polytonality. He became known for his six symphonies, particularly the second, *Die fire temperamente* (1902), the third, *Sinfonia espansiva* (1911), and the fourth, *Det uudslukkelige* ("The Inextinguishable," 1916), all of which are richly scored. He also wrote three concertos—for violin, for flute and for clarinet; the operas *Saul og David* (Copenhagen, 1902) and *Maskerade* (Copenhagen, 1906); four string quartets, two quintets, organ and piano music. His early *Hymnus amori* for soloists, chorus and orchestra reveals an influence of Palestrina. He died at Copenhagen on Oct. 3, 1931.

See R. Simpson, *Carl Nielsen* (1952); T. Meyer and F. S. Petersen, *Carl Nielsen*, 2 vol. (1947–48). (J. S. Wn.)

NIEMCEWICZ, JULIAN URSYN (1757?–1841), Polish man of letters who greatly enriched the intellectual life of his day, was born at Skoki, near Brzesc (Brest), on Feb. 6, 1757 or 1758, and educated in the Warsaw Cadet corps (1770–77). He spent the greater part of the period 1783–88 in western Europe. In 1788 he was elected deputy to the *sejm* (parliament). Having been Tadeusz Kosciuszko's aide-de-camp during the insurrection of 1794, he was captured at Maciejowice and imprisoned at St. Petersburg. After his release, late in 1796, he went to the United States, returning to Poland in 1807. In 1831 he went to England as emissary of the insurrectionary government. In 1833 he moved to Paris, where he died on May 21, 1841.

Niemcewicz's works include the most outstanding 18th-century Polish comedy (*Powrót posła*, 1790); a collection of songs on themes from Polish history (*Śpiewy historyczne*, 1816); and *Lejbe i Siora* (1821; Eng. trans., 1830), the first Polish novel to discuss the Jewish problem. His *Memoirs* (*Pamiętniki czasów moich*, 1848) were reprinted in 1957.

See J. Chrzanowski, "Pochwała Niemcewicza," *Roczniki Towarzystwa Naukowego Warszawskiego* (1927); J. Dihm, *Niemcewicz jako polityk i publicysta* (1928). (L. R. Lr.)

NIEMÖLLER, (FRIEDRICH GUSTAV EMIL) MARTIN (1892–), founder of the German Confessing Church (*q.v.*), was born on Jan. 1, 1892, in Lippstadt (Westphalia), the son of a pastor. After serving as a naval officer in World War I he studied theology at Münster and in 1931 became pastor in the fashionable Berlin suburb, Dahlem. In 1933, in protest against National Socialist interference in the church, he founded the *Pfarrernotbund* (Pastor's Emergency league), which, among other things, rejected discrimination against Jewish Christians. Niemöller became a leading member of the Confessing synod of the Evangelical Church. He preached throughout Germany and on March 1, 1938, the Gestapo arrested him, sent him to Sachsenhausen concentration camp and later to Dachau. In 1945, together with Léon Blum and others, he was removed to the Tirol and there was freed by the Allies.

In 1945 Niemöller became head of the German Evangelical Church's foreign relations office and in 1947 president of the church in Hesse-Nassau. The ecclesiastical restoration and the absence of any real change in the German mentality seriously disillusioned him. He opposed the remilitarization of Germany and in 1954 became a pacifist. Niemöller's strength lies in the simplicity of his Bible witness: it demands not just personal piety but active support for international reconciliation and social justice. As a leading German churchman he went to Moscow in 1952, and later lecture tours took him to every continent. In 1961 he was elected one of the six presidents of the World Council of Churches.

Bibliography.—M. Niemöller, *Vom U-Boot zur Kanzel* (1934); *Bekennende Kirche*, essays presented to Niemöller on his 60th birthday (1952); D. Schmidt, *Pastor Niemöller*, Eng. trans. (1959); C. Start-Davidson, *God's Man* (1959). (H. Ko.)

NIEN REBELLION, a major revolt in northern China during the 1850s and 1860s. When the T'ai P'ing armies in 1853 were pushing down the Yangtze river to capture Nanking (*see* T'ai P'ing Rebellion), an uprising broke out in the north China plain led by the Nien secret society, an offshoot of the White Lotus society. Scattered Nien bands, which had fomented sporadic revolts since the first decade of the 19th century, met at Chih-ho in the winter of 1852–53 to form a coalition under the leadership of Chang Lo-hsing and to establish a base of operation in the area north of the Huai Ho in Anhwei.

The northern expedition of the T'ai P'ings in the summer of 1853 gave the Nien the opportunity to consolidate their power. Two years later, the Nien forces, led by family elders, had grown so strong that they were reorganized into five banner armies. Numbering 30,000 to 50,000 they were a motley horde of peasants and army deserters, brigands and salt smugglers, accompanied by their wives and children. They won the support of the local force that had been organized to resist the T'ai P'ings and gained control over the network of mud walls and ditches built by the local troops. With their home base strongly bulwarked and with their cavalry force well organized, Nien columns raided Shantung and Kiangsu, Honan and Hupeh, while they fought alongside the T'ai P'ings in the south.

The loss of their citadel, Chih-ho, to the imperialists led by Seng-ko-lin-ch'in and the death of their leader, Chang Lo-hsing in the spring of 1863, were severe setbacks for the Nien. But their armies remained intact and they rallied to the leadership of Chang's nephew, Chang Tsung-yü. After Nanking fell to imperial forces in July 1864, the Nien were reinforced by a T'ai P'ing army under Lai Wen-kuang that had been operating in Shensi. Organized in military order, they became highly effective in mobile warfare specializing in hit-and-run tactics to elude or to harry the better armed imperialists. They struck at weak points to gain recruits and to obtain supplies but evaded frontal battles.

After the Nien defeated and killed Seng-ko-lin-ch'in in 1865, Tseng Kuo-fan, who took over command of the government forces adopted the strategy of blockade. But the Nien rebels slipped through his cordon and, in the winter of 1866, they split into two armies, the eastern under Lai Wen-kuang and the western under Chang Tsung-yü. After an incursion into Hupeh, the eastern Nien forces were trapped in Shantung by the Huai army under Li Hung-chang and destroyed in the beginning of 1868. The western Nien army, which had invaded Shensi with the aim of joining forces with the Muslims, hastened back. It threatened Peking but, in Aug. 1868, after 15 years of war in eight provinces, it was surrounded and annihilated.

See Siang-tseh Chiang, *The Nien Rebellion* (1954); Ssu-yü Teng *The Nien Army and Their Guerilla Warfare, 1851–1868* (1961). (Jc. L.)

NIETZSCHE, FRIEDRICH (1844–1900), German philosopher, one of the most influential thinkers of modern times, was born Oct. 15, 1844, at Röcken, in the Prussian province of Saxony, the son of a Lutheran minister and the grandson of two [illegible]. The religion of his home had a patriotic complexion, and he was named Friedrich Wilhelm after the reigning king of Prussia. Nietzsche later dropped the "Wilhelm," and no major writer has been a more

stringent critic of his countrymen or of the religion and morality of his fathers. In the English-speaking world his ideas have sometimes been discounted as a mere reaction against his childhood training, but in Germany and in France the most serious philosophers and psychologists, theologians, novelists and poets have unstintingly acknowledged their debt to him.

Basel and Bayreuth.—Nietzsche attended the universities of Bonn and Leipzig and in 1869 was appointed professor of classical philology at the University of Basel. He became a Swiss subject, but when the Franco-German War broke out in 1870, he requested a leave from his university to serve with the Prussian army as a medical orderly. Soon he returned to Basel, his health badly shattered. He offered courses in Greek literature and philosophy and found further inspiration in his friendship with the composer Richard Wagner, who was then living at Tribschen, near Lucerne.

Wagner was born in the same year as Nietzsche's father and appreciated Nietzsche as a brilliant apostle and errand boy. Nietzsche's first book, *The Birth of Tragedy From the Spirit of Music* (*Die Geburt der Tragödie aus dem Geiste der Musik*, 1872) won the composer's enthusiastic approval: the last ten sections were devoted to a rhapsody on Wagner. Of Nietzsche's four essays published as *Untimely Meditations* (*Unzeitgemässe Betrachtungen*, 1873–76), Wagner especially liked the last: "Richard Wagner in Bayreuth." Wherever Nietzsche showed an independent mind, Wagner showed little sympathy. A break was thus inevitable, and Wagner's removal to Bayreuth merely hastened it. The composer made his peace with the young German empire, which Nietzsche considered a cultural menace, and his ideas became influential. Wagner's chauvinism and anti-Semitism, which had mattered less when he was the lonely genius of Tribschen, were now institutionalized as part of the meaning of Bayreuth. Wagner's *Parsifal*, finally, seemed to Nietzsche a thoroughly insincere obeisance to Christianity, and the philosopher had no sympathy for Wagner's deliberate idealization of "pure foolishness." Wagner's inscribed copy of *Parsifal* reached Nietzsche even as Nietzsche's enlightened *Human, All-Too-Human* (*Menschliches, Allzumenschliches*, 1878), with a motto from Voltaire, reached Wagner; and this book was at least as distasteful to the composer, who did not bother to finish reading it, as the opera was to Nietzsche. Their break was sealed.

Later Life and Works.—In 1879 Nietzsche resigned from the university, pleading his ill-health. He devoted the next ten years solely to his writing, living very modestly and driving himself relentlessly. Every book represented a triumph over his half-blind eyes migraine headaches and manifold physical agonies. His major works belong to this period. They were written in utter solitude in various places in Switzerland and Italy (particularly the Engadine and the Riviera) and were ignored by the public until Georg Brandes (Georg Morris Cohen) began to lecture on Nietzsche at the University of Copenhagen in 1888. Ten years later, Nietzsche was world famous.

In Jan. 1889, however, Nietzsche suffered a mental and physical breakdown; and he remained insane until he died, at Weimar, on Aug. 25, 1900. His illness never was diagnosed conclusively, but was probably an atypical general paralysis. In that case there must have been a syphilitic infection, which is usually supposed to have taken place during his student days, although he may have infected himself while ministering to sick soldiers during the war. That he generally lived the life of an ascetic is agreed.

Although he proposed marriage to several women, Lou Salomé was the only one who, for a time, deeply moved his heart. His other proposals represented frantic attempts to escape from his desperate solitude. He scarcely knew the women in question and was profoundly relieved when they refused. Lou Salomé, who later wrote several books and became the beloved of Rainer Maria Rilke and, still later, a friend and disciple of Sigmund Freud, meant a great deal to Nietzsche in 1882—much more than he meant to her. To her, and only to her, he spoke of his inmost ideas; and when the intrigues of his envious sister, Elisabeth, disrupted their relationship, he felt lonelier than ever.

It was then that his most popular, most enigmatic and least understood work was born: *Thus Spoke Zarathustra* (*Also sprach Zarathustra*). After the aphoristic works of the preceding years, culminating in *The Dawn* (*Morgenröte*, 1881) and *The Gay Science* (*Die fröhliche Wissenschaft*, 1882), this was his first attempt to present the whole of his thought. The first three parts appeared in 1883 and 1884 but found no response, and Nietzsche abandoned the project after the fourth part, although it was at first intended as an intermezzo. After *Zarathustra*, Nietzsche composed *Beyond Good and Evil* (*Jenseits von Gut und Böse*, 1886) and *The Genealogy of Morals* (*Zur Genealogie der Moral*, 1887) in a less poetic vein, to clarify his ideas.

Nietzsche's Sister and Last Works.—The *femme fatale* both in Nietzsche's life and for his posthumous reputation was his sister. After his break with Wagner she showed no understanding and little sympathy for his development. She married an anti-Semitic agitator, Bernhard Förster, of whose activities Nietzsche unequivocally disapproved, and moved to Paraguay with her husband to found a colony, "Nueva Germania." After her husband's suicide in the midst of a major financial scandal, she tried to make a national hero of him while salvaging the colony as an island of Teutonic Christianity. Having failed in both attempts, she secured the rights to her brother's literary remains and edited them without scruple or understanding. In an early manuscript, for example, in which Nietzsche mentioned that their father had suddenly become mentally ill and died soon after (in 1849), she erased a few words and published the text as saying that he had become ill after a fall down the cellar stairs. She secured letters which her brother had written to others and suppressed some of them, while publishing his drafts for many of them as drafts for letters to herself, occasionally even erasing address and signature in the notebook manuscripts.

While she gained a wide audience for her misinterpretations, she withheld her brother's self-interpretation, *Ecce Homo*, until 1908. Meanwhile she collected some of his notes under the title *The Will to Power* (*Der Wille zur Macht*) and presented this work, first as part of her three-volume biography (Leipzig, 1895–1904), then in a one-volume edition (1901) and finally in a completely remodeled two-volume edition (1906). Ever since, the two-volume edition has been widely considered Nietzsche's crowning systematic labour. In fact, he had long used many of these notes in writing his later works, where they are occasionally given unexpected twists, while other notes had not been used by him because they were mere jottings and not acceptable formulations of his views. His later books, moreover, became less and less aphoristic and more and more continuous. Clearly, his projected main work, which he planned for a time to call *The Will to Power*, would have looked completely different even in form from the book that his sister put forward.

In 1888, after he had dashed off *The Wagner Case* (*Der Fall Wagner*), a brief polemic, he abandoned the former title and decided to call his main work *Revaluation of All Values* (*Umwertung aller Werte*). He finished the first part, an essay of about 100 pages, and called it *The Antichrist* (*Der Antichrist*, 1888). It is here and in *Twilight of the Idols* (*Götzen-Dämmerung, oder Wie man mit dem Hammer philosophirt*), written earlier in 1888, and in *Ecce Homo*, written in the autumn of that year, that we encounter Nietzsche's final views, not in the sister's book which, however, contains many highly interesting notes. His last literary labour was to assemble under the title *Nietzsche contra Wagner* some passages from his earlier books, slightly revised here and there. This is his shortest and perhaps most beautiful book.

Those who have looked to *The Will to Power* as Nietzsche's magnum opus have found him all but incoherent. In any case, his memorable formulations have invited quotation out of context and prompted a great variety of untenable and mutually contradictory interpretations, beginning with those of his sister. It was at her repeated request, furthermore, that Adolf Hitler eventually consented to visit her Nietzsche-Archiv in Weimar, on his way to Bayreuth. Nietzsche had once written to her that it was typical of her to try to reconcile opposites, and this is epitomized in the name that she adopted after her husband's suicide: Förster-Nietzsche. Although the Nazis followed her lead and published some misleading anthologies of Nietzsche's thought, they could

draw little comfort from his unexpurgated works. All serious students of the matter are agreed that the Nazi version of Nietzsche represents an utterly unscrupulous perversion of his thought.

Will to Power and Overman.—In the course of his psychological observations, Nietzsche gradually came to the conclusion that all human behaviour could be reduced to a single basic drive, the will to power. This notion is inseparable from his idea of sublimation, and the will to power is first discussed at any length in the chapter "On Self-Overcoming" in *Zarathustra*.

What man and every living being wants more than anything else is, according to Nietzsche, a higher, more powerful state of being in which the thousandfold impotence of his present state is overcome. Man wants to perfect himself, to re-create himself, to become a creator rather than a mere creature. It is only when he fails in this endeavour and resigns himself more or less to this failure that he seeks crude power over others as a substitute. Power is wanted in any case, but "power" in the vulgar sense is wanted only for lack of something better.

The higher state for which man strives, Nietzsche calls the overman (*Übermensch*). The overman is the man who has overcome himself; the passionate man who is the master of his passions; the creator who excels in both passion and reason and is able to employ his powers creatively. Although Nietzsche once remarks in *Zarathustra* that there has never yet been an overman, he says in *The Antichrist* (sec. 4): "Success in individual cases is constantly encountered in the most widely different places and cultures: here we really do find a *higher type*, which is, in relation to mankind as a whole, a kind of overman."[1] The disagreement between the two passages is not profound: it is only a question of either stressing the success of a Leonardo or of a Goethe, or emphasizing that even they were in some respects all too human.

The Last Man.—The overman serves Nietzsche as a contrast to man as he is, to "the last man" and to God. The last man appears in "Zarathustra's Prologue" where it is suggested—and this is confirmed elsewhere, most incisively and vitriolically in *Ecce Homo*—that evolution, biological or social, will lead not to the attainment of the overman but in the direction of the last man, who is an uncreative conformist and a complacent hedonist. "One still loves one's neighbor and rubs against him, for one needs warmth . . . A little poison now and then: that makes for agreeable dreams. And much poison in the end for an agreeable death. One still works, for work is a form of entertainment. But one is careful lest the entertainment be too harrowing. One no longer becomes poor or rich: both require too much exertion. Who still wants to rule? Who obey? Both require too much exertion. No shepherd and one herd! Everybody wants the same, everybody is the same: whoever feels different goes voluntarily into a madhouse."

The contrast between the overman and the last man epitomizes Nietzsche's critique of modern civilization. This critique is worked out in great detail and includes not only a critique of the pleasure principle, both as a norm and as the basis of any psychological monism, but also, and above all, a critique of the Christian religion and of morality.

God and the Eternal Recurrence.—The contrast of overman and God is also formulated in "Zarathustra's Prologue": "Remain faithful to the earth, and do not believe those who speak to you of otherworldly hopes!" Perfection can be hypostatized as existing even now in another world, in God, or it can be presented as a challenge and ideal for every one of us. Instead of resigning ourselves to being all too human and worshipping perfection, we can try to perfect ourselves in this life, on this earth.

The image of eternity is, for Nietzsche, the circle. He believed in the eternal recurrence of the same events at gigantic intervals. This he considered the most scientific of all hypotheses. Granted a finite number of power quanta as the basic constituents of the world, only a finite number of configurations would be possible. Now if we do not cling to the Christian belief in creation, there is no beginning of the past, nor has a stable end state been attained by now. The only alternative, Nietzsche supposes, is that the configurations must repeat themselves after enormous periods of time. "And this slow spider, which crawls in the moonlight, and this moonlight itself, and I and you in the gateway . . . must not all of us have been there before? And return . . . must we not eternally return?"

This idea reverts to Stoic speculations. The world is not governed by a purpose; it is an eternally repeated senseless play, and we are condemned to play the same role over and over again. The overman, however, unlike Goethe's Faust, can say to every single moment: abide, thou art so fair—and if this is impossible, at least return eternally!

This conception of the overman does not entail faith in progress, which Nietzsche derided as "merely a modern idea, that is, a false idea" (in a discussion of the overman, *Antichrist*, sec. 4). For Nietzsche, overman and eternal recurrence belonged together. The idea of the overman is a challenge, not a prediction: it is an antithesis to God, even as the eternal recurrence of the same events is an antithesis to the Christian conception of time and history.

Critique of Christianity.—Nietzsche's opposition to Christianity is not confined to its otherworldliness which he considered a mere symptom. Otherworldliness is motivated by the will to power of the weak who have despaired of fulfillment in this life. They slander this world in favour of another world in which they hope for such power that "we shall judge angels" (I Cor. vi, 2, cited in *Antichrist*, sec. 45).

Christianity, according to Nietzsche, is born of weakness and breeds weakness, while making war on those who are better favoured. It is the revolt of failures of every kind: of slaves against masters, of unfree minds against freethinkers, of the mediocre against the exception. Christianity, he says, "has waged deadly war against this higher type of man"; "Christianity has sided with all that is weak and base, with all failures"; "it has corrupted the reason even of those strongest in spirit by teaching men to consider the supreme values of the spirit as something sinful, as something that leads into error—as temptations. The most pitiful example: the corruption of Pascal, who believed in the corruption of his reason through original sin when it had in fact been corrupted only by his Christianity." (*Antichrist*, sec. 5.)

Dionysus.—Although Nietzsche diagnoses any celebration of the "pure spirit" at the expense of the body as a slander against life, prompted by what he calls *ressentiment* (resentment), he does not extol the body at the expense of the spirit. Against licentiousness, which is lack of self-control, and against renunciation, whether prompted by a lack of passion or by fear of any kind, he pits his image of Goethe "who might dare to afford the whole range and wealth of being natural, being strong enough for such freedom; the man of tolerance, not from weakness but from strength, because he knows how to use to his advantage even that from which the average nature would perish; the man for whom there is no longer anything that is forbidden—unless it be *weakness*, whether it be called vice or virtue."

All of Nietzsche's heroes were, like Goethe, men of surpassing intelligence, not irrationalists and least of all "pure fools." With the exception of Arthur Schopenhauer, whom Nietzsche greatly admired in his youth but later criticized, they affirmed this world. To cite the continuation of his portrait of Goethe from *Twilight of the Idols:* "Such a spirit who has become free stands amid the cosmos with a joyous and trusting fatalism . . . *he does not negate any more*. Such a faith, however, is the highest of all possible faiths: I have baptized it with the name of *Dionysus*."

The "Dionysian" in Nietzsche's early works was contrasted with the "Apollinian": it represented the flood of passion as opposed to the serenity which found expression in Greek sculpture. In his later work, as in the quotation above, it represents passion controlled and creatively employed as opposed to the negation of the passions, of the body and of this world.

"Dionysus versus 'the Crucified One': there you have the contrast. It is not martyrdom that constitutes the difference—only here it has two different senses . . . The tragic man affirms even the harshest suffering: he is sufficiently strong, rich, deifying for this; the Christian negates even the happiest life on earth: he is sufficiently weak, poor, and disinherited to suffer from life in any

[1]All quotations are from *The Portable Nietzsche*, The Viking Press, 1954.

form. The God on the cross is a curse on life, a pointer to seek redemption from it; Dionysus cut to pieces is a *promise* of life: it is eternally reborn and comes back from destruction" (*The Will to Power*, note 1,052; written in 1888).

All of Nietzsche's many other criticisms of Christianity are corollaries of the major points here stated; *e.g.*, that most unevangelical sentiments of resentment have been central in Christianity from the beginning, even in the New Testament (though Nietzsche excepts Jesus from this charge); that the religion of Paul and of Catholicism, of Luther and of Calvin is a religion of vengefulness, judgment and negation; that Christianity is deeply antirational and antiscientific; that "the philology of Christianity" as exemplified in its treatment of the Old Testament is profoundly dishonest; that faith in the Christian sense involves self-deception. At bottom the charge is always the same: Christianity is born of weakness, failure and resentment and is the enemy of reason and honesty, of the body and of sex in particular, and of power, joy and freedom.

Slogans.—When Nietzsche took *How One Philosophizes With a Hammer* as the subtitle of *Twilight of the Idols*, he explained in his preface that his intention was "the sounding out of idols . . . which are here touched with a hammer as with a tuning-fork." He wanted "to pose questions here with a *hammer*, and, perhaps, to hear as a reply that famous hollow sound." Yet it has been widely assumed that his "hammer" was a sledgehammer. The slogan is recalled, the text forgotten.

When Nietzsche contrasted "master morality" and "slave morality" it was assumed that he identified himself with the former. In fact, he tried to show the need for "a *typology* of morals" to replace the prejudice that one's own morality is simply "morality." His cutting analysis of "slave morality" with its central *Ressentiment* is particularly pointed and original; but in the chapter on "The 'Improvers' of Mankind" in *Twilight of the Idols* he leaves no doubt of his distaste for master morality. He did not believe in the possibility of any universal moral code. Every morality was to him a prescription for living with one's passions, and different people require different prescriptions. A Luther cannot live like a St. Francis, and a St. Francis cannot live like Goethe. "One thing is needful" is the title of a long aphorism in *The Gay Science* which begins, "'Giving style' to one's character"; and it ends: "For one thing is needful: that a human being attain his satisfaction with himself . . . Whoever is dissatisfied with himself is always ready to revenge himself therefor; we others will be his victims."

That Nietzsche called himself a good European is often forgotten; that he called himself an immoralist is recalled. What he meant was not that he favoured a lack of discipline and letting oneself go. On the contrary, he insisted that without long and hard discipline we should lack all those achievements "for whose sake life on earth is worthwhile; for example, virtue, art, music, dance, reason, spirituality." His "immoralism" was in the main an impassioned nonconformism, and his choice of word was suggested by the fact that "morality" generally designates a social code that equates being moral with conforming.

Influence.—Of those hundreds who have written about Nietzsche, some authors quite deliberately perverted his meaning; others read their own ideas into their subject more or less unconsciously; and the vast majority had never read most of his books from beginning to end. The number of irresponsible interpretations is appalling. On the other hand he also exerted a commanding influence, in various ways, on some of the foremost writers of the 20th century: on Thomas Mann and Hermann Hesse, on Stefan George and Christian Morgenstern, on Rainer Maria Rilke and André Gide, on Karl Jaspers and Martin Heidegger, on Sigmund Freud and Bernard Shaw, on Oswald Spengler and Max Scheler, on André Malraux and Jean Paul Sartre. Freud often expressed his admiration for the profundity of Nietzsche's penetrating self-knowledge and for his insight into psychology. Spengler acknowledged in the preface to *The Decline of the West* that he owed "everything" to Goethe and to Nietzsche. According to Jaspers, Nietzsche belongs with Sören Kierkegaard. Together they determine the situation in which contemporary philosophy must begin. Heidegger sees Nietzsche as the last great metaphysician and the end point of a development begun with Plato. Thomas Mann fashioned the hero of his *Doktor Faustus* after Nietzsche; Malraux included an incident from his biography in *La lutte avec l'ange;* Albert Camus, like Thomas Mann and Stefan Zweig, wrote an essay on Nietzsche; and Stefan George, two poems. More than half a century after his death, his life and work had lost none of their fascination, and modern philosophy had not yet digested all he had to offer. For a portrait of Nietzsche *see* article GERMAN LITERATURE.

BIBLIOGRAPHY.—For a comprehensive bibliography, which lists the various editions of Nietzsche's works and letters as well as items not included in any collected edition and the most important works about him, *see* Walter Kaufmann, *Nietzsche: Philosopher, Psychologist, Antichrist* (1950), the revised ed. (1956) omits the long bibliography.

Of the many editions of Nietzsche's works in German the *Musarion-Ausgabe*, 23 vol. (1920–29), is the most complete. For an English text see *The Portable Nietzsche*, ed. and trans. by Walter Kaufmann (1954), containing *Thus Spoke Zarathustra, Twilight of the Idols, The Antichrist* and *Nietzsche contra Wagner*, as well as selections from his other books, from his notes and from his letters in chronological sequence. For studies *see* Charles Andler, *Nietzsche: sa vie et sa pensée*, 6 vol. (1920–31); Erich Podach, *Nietzsches Zusammenbruch* (1930), *Gestalten um Nietzsche* (1932); Karl Jaspers, *Nietzsche: Einführung in das Verständnis seines Philosophierens* (1936); George A. Morgan, Jr., *What Nietzsche Means* (1941); Martin Heidegger, "Nietzsches Wort 'Gott ist tot'" in *Holzwege* (1950). (W. KN.)

NIEUWPOORT (Fr. NIEUPORT), a town of the province of West Flanders, Belgium, lies near the mouth of the Yser river, 15 km. (10 mi.) S.S.W. of Ostend. Pop. (1961) 6,899. Parts of an ancient cloth market built in 1480 remained after World War I when the town was practically leveled; it was later rebuilt on a grid plan with replicas of many old buildings. Nieuwpoort has one of the main artificial drainage outlets of the low country. The six combined lock bridges of Palingbrug played an important part in World War I; they were the instruments of the famous flooding of the Yser front on Oct. 29, 1914, when the normal process was reversed and the sea water allowed to flow and remain inland, checking the German advance. Buses connect Nieuwpoort with the railway at Diksmuide. Sea fishing, canneries and chemical plants are now important occupations, but the main industry is tourism, especially at the suburb of Nieuwpoort-Bad, a fashionable North sea resort dating from 1869.

The mouth of the Yser was once east of Lombartzyde (Lombardsijde). When it silted up in 1116 ships went farther south to Sandeshove on another estuary, and the place became the *novus portus* ("new port"), whence Nieuwpoort. In the 13th century the town was rich like many Flanders towns. It was the port of Ypres and had shipyards and fish-curing installations. Strongly fortified, it withstood a siege by 20,000 French in 1489. Under its walls, in 1600, Maurice of Nassau defeated the archduke Albert and the Spaniards. (R. M. AN.)

NIÈVRE, a *département* of central France, was formed in 1790 from the ancient province of Nivernais (*q.v.*) together with a small part of Orléanais. It is surrounded by the *départements* of Yonne to the north, Côte d'Or and Saône-et-Loire to the east, Allier to the south, Cher to the west and Loiret to the northwest. Area, 2,640 sq.mi. Pop. (1962) 245,921. In the east are the granite highlands of the Morvan rising to rounded summits above 2,500 ft. (Mt. Prénelay, 2,805 ft.). They are flanked to north and west by clay vales (Bazois) and limestone hills (Côtes de Nivernais). In the west the land falls to the valley of the Loire river, but only a small area lies below 1,000 ft. The Loire crosses the southwest corner of Nièvre, and below Nevers forms its western boundary. Much of the centre and east lies within the upper basin of the Yonne tributary of the Seine.

The Morvan is a thinly peopled area of pastoral farming and woodcutting. The cattle reared there are fattened on the lush pastures of Bazois. The Lias clays of this district provide material for an old-established pottery industry. Farther west in Bas Nivernais wheat, potatoes and fodder crops are extensively grown. The vine is cultivated on favourable exposures of the limestone hills and in the Loire valley, where the white wine of Pouilly is of high repute. The Nivernais is a well-known heavy breed of horse. Iron ore contained in the Jurassic rocks was formerly widely worked and smelted with charcoal. Near Nevers at Imphy

and Fourchambault there are metallurgical industries. A small coalfield is worked near Décize, served by the Nivernais canal (1852), which connects the Yonne with the lateral canal that follows the Loire. Décize has glass and faïence works.

Nevers (*q.v.*), former capital of the duchy of Nivernais, situated at the confluence of the Nièvre with the Loire, is the largest town and *préfecture* of the *département*, as well as the seat of the bishopric. Besides the Gothic cathedral of St. Cyr, the Romanesque church of St. Etienne is noteworthy. In the museum that occupies the old episcopal palace is a fine collection of Nevers and other pottery. The law courts occupy the ducal palace of the 15th and 16th centuries. Farther down the Loire valley, the Benedictine abbey church of Ste. Croix at La Charité is a fine example of Burgundian Romanesque architecture. Pougues-les-Eaux is a small spa 7 mi. N. of Nevers, and there are other mineral springs at St. Aré near Décize and St. Honoré near Château-Chinon.

The *département* consists of four *arrondissements* centred upon the market towns of Nevers, Cosne, Château-Chinon and Clamecy. Its court of appeal is at Bourges and it comes under the *académie* of Dijon. (AR. E. S.)

NIFO, AGOSTINO (Lat. AUGUSTINUS NIPHUS or NYPHUS) (*c.* 1473–1538 [1545 or 1546?]), Italian philosopher who combined a mitigated Averroism with more worldly interests that won him the favour of the humanist princes of his time, was born either at Sessa in Campania or perhaps at Jopoli in Calabria. As professor of philosophy at Padua, he published a corrected version of his treatise *De intellectu et daemonibus* (1492; on the Averroist theme of the unity of all human intellects), which in its original manuscript form would have incurred a charge of heresy. He also edited the works of Averroës (1495–97). Subsequently he taught at Salerno (under the patronage of the prince Roberto Sanseverino), at Pisa, at Bologna and in Rome. Commissioned by Pope Leo X to refute the Alexandrism of Pietro Pomponazzi (*q.v.*), he defended the Catholic interpretation of Aristotle's doctrine on the soul in a treatise *De immortalitate animae contra Pomponatium* (1518). His other works include treatises on the infinity of the prime mover (*De infinitate primi motoris*, 1504), on government (*De regnandi peritia*, 1523; influenced by Machiavelli) and on beauty and love (*De pulchro et amore*, 1531). He is thought to have died at Salerno, in 1538 or in 1545 or 1546. There are collected editions of his minor works on moral and political subjects, 2 volumes (1645), and of his commentaries on Aristotle, 14 volumes (1654).

NIGDE (Arab. NAKIDAH), chief town of an *il* (province) of the same name in southern Turkey, is situated on the Kayseri-Cilician Gates (Kulek Bogazi) road, 75 mi. N.N.W. of Adana. Pop. (1960) 18,042. The town is remarkable for its buildings, many of which date from the Seljuk era. These include several fine mosques—Hanum, Rahmaniye, Ala et Tin, Songur Bey, Dis—and the mausoleum Hudavent Turbesi. After the fall of the Rum sultanate, of which it had been one of the principal cities, Nigde became independent and (according to Ibn Batutah, the Muslim traveler) ruinous and did not pass into Ottoman hands till the time of Mohammed II. It represents no classical town but, with Bor, has inherited the importance of Tyana, whose site lies about 10 mi. S.W. A Hittite-inscribed monument, brought perhaps from Tyana, has been found at Nigde. The town is linked by rail and road with the principal centres of Turkey.

NIGDE IL (pop. [1960] 322,917) forms a part of the central Anatolian plateau. It is semiarid steppe country, bounded in the south by the lofty Taurus mountains (Toros Daglari) and northwest by the massive volcanic Melendiz mountains. In winter the temperature is usually below freezing, whereas the summer is hot. Soils are fertile when irrigated, the chief crops being potatoes, onions, rye, apples and raisins. (N. TU.; E. TU.; S. ER.)

NIGEL (d. 1169), bishop of Ely, treasurer and effective chief of the exchequer under Henry I and Henry II, was nephew of Roger, bishop of Salisbury, Henry I's justiciar, who largely created the 12th-century exchequer. Educated by Anselm of Laon, in royal service by 1126 and treasurer by 1127, Nigel became bishop of Ely in 1133. In 1139 he was involved in the fall of Bishop Roger, when he and his kinsmen were accused by the Beaumont faction of treason. Nigel joined Matilda at Gloucester, but in 1142 was reconciled to Stephen and restored to his see. In 1154 Henry II brought him back to the treasury to restore the proper working of the exchequer, and the highly efficient Angevin financial machine was his monument. His son Richard FitzNeale succeeded him as treasurer and described the exchequer system in *Dialogus de Scaccario* ("Dialogue of the Exchequer," *c.* 1179). Incapacitated by paralysis, Nigel retired in 1164 or 1165 and died on May 30, 1169.

See F. Liebermann, *Einleitung in den Dialogus de Scaccario* (1875); R. L. Poole, *The Exchequer in the Twelfth Century* (1912). (G. W. S. B.)

NIGER, PESCENNIUS (GAIUS PESCENNIUS NIGER JUSTUS), rival Roman emperor A.D. 193–194, was an Italian, an equestrian army officer, promoted to the senate about 180. His earlier service had largely been in the eastern provinces, but in 185–186 he commanded an expeditionary force against deserters who had seized control of a number of cities in southern Gaul. Consul about 189, he was appointed legate of Syria, as a commander most popular in the east and among the urban populace of Rome, in the troubles at the end of Commodus' reign. When Commodus' successor Pertinax was murdered in the spring of 193, Niger was proclaimed emperor and accepted in all the Asiatic provinces. Septimius Severus, however, proclaimed by the legions of the Danube, marched east and speedily defeated him in the decisive battle of Issus in the autumn of 194. Niger fled, but was overtaken and killed. (JN. R. M.)

NIGER, REPUBLIC OF THE (RÉPUBLIQUE DU NIGER), a country of west Africa, bounded on the north by Libya, on the east by Chad, on the south by Nigeria and Dahomey, on the west by Upper Volta and Mali and on the northwest by Algeria. A former territory of French West Africa, the Niger gained its independence in 1960. Area 489,206 sq.mi. Pop. (1959) 2,556,211. Capital Niamey (*q.v.*).

Physical Features.—The Niger is a transitional region between savanna and desert, between the countries of the sedentary Negro peoples and that of the non-Negro nomads. Only 8% of the country receives more than 21 in. of rainfall annually, and 48% receives less than 4 in.

The countryside is monotonous, the main variations deriving from vegetation and climate. To the south, where rainfall is more than 20 in. annually, near the Nigerian frontier, the reclaimed savanna yields coarse millet and peanuts. But this is only a narrow strip, and the savanna gives way toward the north to a fairly varied Sahelian zone (the Sahel). The broad valley of the Niger river which runs through the southwestern part of the country lies in a crystalline base. But the base disappears on the east bank in a sill between the basins of the Niger and the Chad, under sandstone of various ages, sometimes very broken, sometimes, to the east, forming a plateau or plains which slope toward Lake Chad.

A MAP OF THE REPUBLIC OF THE NIGER SHOWING THE MAIN PHYSICAL FEATURES, PRINCIPAL TOWNS AND COMMUNICATIONS

where the rainfall is more than 12 in., the vegetation of thorn trees (acacias) is still quite dense and cultivation of small millet is possible.

Fairly rapidly, toward the north, the Sahara area is reached, and this is more complex. A heavy crystalline mountain mass, the Aïr massif, which is dominated by Pre-Cambrian gneisses and granites, with some Quaternary black volcanic lavas, tuffs and ashes, is pierced by deep valleys, the "Koris," where there is a dense vegetation of acacias and doum palms. The Aïr isolates a few basins: to the southwest, the Azaouack, with pasturage, from which valleys, now dry, run down to the Niger; farther east, the Ténéré, a sandy and particularly arid desert, broken by some relief. Some oases may be found, aligned from Bilma, in the Kaouar, to Djado. (J. D.)

People.—Alongside the sedentary Negro peoples—Djerma-Songhai on the Niger in the southwest, Hausa in the centre and south, Beriberi-Manga in the east—there exist the nomadic herdsmen—Fulani in the south, Berber Tuareg in the north, Teda and Daza, branches of the Tebu (*q.v.*) or Tubu, in the east. The Tuareg and Tebu live only in the desert. The Hausa constitute more than a third of the population. All these peoples are Muslim, though there are some pagan survivals.

History.—Acheulean carved stones have been found in the Bilma region, and Neolithic deposits are numerous in the Sahara area, which the Tuareg have doubtless occupied since a remote age. They established themselves in the Aïr massif in about the 11th century, and the Tuareg sultanate of Agadès dates at least from the 15th. The Djerma (or Zerma), who speaks Songhai (Sonrhai), seem to have arrived in the 17th century. The Hausa, who probably came from the northeast, formed from the 14th century onward a number of kingdoms, of which one, Gobir (Gober), expanded greatly in the 18th century and repulsed the Tuareg. Hausa cities also replaced Bornu as important entrepôts in the trade between north Africa and the central Sudan.

The Fulani had for long been infiltrating into Hausa land. One of them, Usman dan Fodio, in 1804 proclaimed himself commander of the faithful and preached the *jihad* ("holy war") against the Hausa, who tended to be lax in their religious observances. He defeated them and established in the former Hausa states the empire of Sokoto but failed in his attack on Bornu. (*See* also BORNU; FULANI; HAUSA; KANEM; SOKOTO.) These native movements then began to come into conflict with the French and English.

Frederick Hornemann, Mungo Park (*qq.v.*) and other European travelers explored the region in the late 18th–19th centuries. By an agreement of 1890 the English and French divided the country among themselves, following a line from Say on the Niger to Barroua on Lake Chad, a frontier precisely defined in 1899 and 1904. The French "military territory of the Niger" was created, the Tuareg were conquered and in 1904 Agadès was occupied.

The territory was at first dependent upon the Sudan. In 1922 it became a colony of the federation of French West Africa (*q.v.*). The capital, at first at Zinder, was transferred in 1926 to Niamey. The Niger became an overseas territory in 1946 and was granted a territorial assembly and then, in 1957, an elected government. In 1958, despite the local government, 72% of the electorate voted for membership in the French community. On Aug. 3, 1960, independence was proclaimed, and on Nov. 11 Hamani Diori was elected president. On Sept. 20 the Niger became a member of the United Nations. It is also a member of the Sahel-Bénin entente, with Ivory Coast, Upper Volta and Dahomey.

In 1964 an armed revolt by political exiles was crushed and several of its leaders executed. At national elections in Sept. 1965 President Diori, the only candidate, was reelected; the president had survived an assassination attempt in April by, it was said, the clandestine Sawaba movement. Relations with Dahomey were strained in the early 1960s, mainly because of boundary disagreements; the argument was settled, however, in 1966. (HU. DE.)

Population, Administration and Social Conditions.—The constitution of the Niger, adopted on Feb. 25, 1959, declares the country to be a democratic and secular state. Legislative power is vested in the national assembly, composed of 60 members elected for five-year terms by universal suffrage. The president, who is the head of state, is the chief executive officer, invested by the national assembly after each general election. The country is administered by a council of ministers nominated by the president.

For administrative purposes, the Niger is divided into 16 *cercles* or administrative divisions (Niamey, Agadès, Birni N'Konni, Dogondoutchi, Dosso, Filingué, Gouré, Madaoua, Magaria, Maradi, N'Guigmi, Tahoua, Téra, Tessaoua, Tillaberi, Zinder) and a number of subdivisons. The capital, Niamey, and Zinder are independent municipalities. The population is sparse (seven persons per square mile) and largely rural. Niamey is the largest town (pop. [1959] 30,030), and only three other towns have more than 10,000 inhabitants: Zinder (14,891), Maradi (11,762) and Tahoua (11,629). These towns and all the others of any size are in the south. Agadès (4,531) is the only sizable community in the north.

In 1945 the rate of school enrollment was only 1% of children of school age. This had risen to about 6% in 1960 and by the second half of that decade more than 50,000 pupils were attending primary schools; more than 2,500 were attending secondary schools; and more than 100 were in technical schools.

The Economy.—The resources of the Niger are crops and livestock, from which 94% of the population derives its livelihood. The Tuareg and the Fulani are stockbreeders. The Tuareg raise camels; the others raise smaller livestock and cattle. Livestock raising has been helped by the sinking of wells. Stock supplies an important trade on the hoof to Nigeria, meat to the Ivory Coast and Dahomey, refrigerated meat to Niamey and skins (chiefly goatskins). Quality of the stock, however, is impaired by the necessity for constant movement in search of water and by endemic disease. Further, the Fulani are reluctant to sell their cattle.

The Sahel, while it attracts stockbreeders, also attracts cultivators in increasing numbers, less in the west, where the country is less thickly populated, than in the centre. The Hausa have developed the cultivation of peanuts which, with cotton growing, has extended to such a degree that production of foodstuffs is no longer adequate. This is the reason for the agricultural colonization of the Sahel, where a growing number of villages are cultivating small millet. Rice is grown in the valley of the Niger. There is some tin and tungsten mining in the Aïr.

Peanuts are by far the country's most important export product, and a number of oil mills have been established. But the Niger suffers from its isolation and distance from the coast. It has no railway, and the Niger river is barely usable. The road system has been improved, however, and the road from Maradi to Dosso extended to Parakou in Dahomey, terminus of the railroad from Cotonou on the coast. A ferry at Niamey links with the road to Upper Volta. A bridge was constructed across the Niger at Gaya in 1958. There are airports at Niamey, Zinder and Agadès.

Radio Niger broadcasts from Niamey in French, Hausa and Djerma and is government controlled.

On May 12, 1959, the Niger signed a convention of co-operation with the Common Organization for the Saharan Regions (O.C.R.S.), providing for financial and technical assistance. It joined the West African Monetary union (established May 1962) and thus remained in the franc area. (J. D.)

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NIGERIA (FEDERAL REPUBLIC OF NIGERIA), a country of west Africa, occupying the basins of the Niger and Benue rivers and extensive adjacent territories. Pop. (1963) 55,670,052. Area 356,669 sq.mi. Nigeria consists of four regions (known officially as Northern Nigeria, Eastern Nigeria, Western Nigeria and Mid-West Nigeria) and the federal territory of Lagos. The republic is a member of the Commonwealth of Nations. It extends northward from the elbow of the Gulf of Guinea between latitude 4° and 14° N. and is bounded west by the Republic of Dahomey, north by the Republic of the Niger and east by the republics of Chad and Cameroon.

This article contains the following sections and subsections:

I. PHYSICAL GEOGRAPHY

1. Geology and Structure.—Crystalline rocks of Pre-Cambrian age (Basement complex) comprise the larger part of surface exposures. These rocks make up the Jos plateau, the central areas of the northern plateau and the part of the southern hill belt lying west of the Niger. The characteristic hill forms are inselbergs and *kopjes* of bare rock, found most often immediately below each step in the landscape. Basement rocks also form much of the eastern highlands (especially in the northern districts) and of the plains immediately to the west.

The oldest sedimentaries are of Lower Cretaceous age, exposed chiefly in the Benue valley and the Cross river basin, with less extensive outcrops on the northwestern side of the High plains of Hausaland and also along the southern margin of the hilly zone adjoining the coastal lowlands. Upper Cretaceous sediments lie immediately over Basement rocks along much of the Niger valley and overlap the Lower Cretaceous elsewhere; their most important exposure is east of the lower Niger, where they form the rolling country culminating in the Udi escarpment. Mainly sandstones, they give rise there to poor, sandy soils, badly leached and eroded, which in some densely populated districts have been cropped almost to exhaustion. Some of these sandstones are suitable for glassmaking and include clays that could be used for pottery, but the most important mineral of the Upper Cretaceous series is the coal mined principally around Enugu. Limestones, mainly of Lower Cretaceous age, are developed for cement manufacture. Younger sediments are found along the coastal margin (including large unexploited lignite reserves west of the lower Niger), in the northwest and in the Chad basin. Nigeria's commercial oil wells are mostly east of the Niger delta, near Port Harcourt.

Volcanic activity started in the Cretaceous and appears to have been most vigorous in the Tertiary. Extinct cones, sometimes severely eroded, are found in the middle and upper parts of the Benue valley, but the main areas are the Jos and Biu plateaus.

The Basement rocks contain some gold and other minerals, but the mineralized area of the Jos plateau produces abundant tin ore (cassiterite) as well as smaller quantities of associated ores such as wolfram, tantalite and columbite. Small quantities of these ores are also found in the Basement areas away from the Jos plateau.

2. Physiography.—Nigeria can be divided into six relief regions: (1) a low coastal belt which includes the Niger delta; (2) an adjacent hilly belt, rising in places above 2,000 ft.; (3) the valleys of the Niger and the Benue, above their confluence at Lokoja, altitude 250–600 ft.; (4) the broad northern plateau, consisting of stepped plains at altitudes of 600–2,500 ft., with steep-sided inselbergs rising above 4,000 ft.; (5) the Jos plateau, at 3,800–4,600 ft. with peaks rising to over 6,000 ft.; and (6) the eastern highlands rising toward the Cameroons. The main rivers are the Niger (*q.v.*), entering the country in the northwest and flowing first southeast and then south to the Gulf of Guinea; its major tributary, the Benue (*q.v.*), rises in the mountains of the Cameroon republic. Outside the Niger system, the most important river is the Cross (*q.v.*), which flows into an estuary east of the Niger delta. The Jos plateau is an important hydrological centre; from it rivers flow to the Niger, to the Benue and northeastward to the inland drainage basin of Lake Chad.

In the region of the Niger delta the coastal belt reaches its greatest width (about 50 mi.). This is an area of swamp covered with mangrove and freshwater swamp forest, with patches of heavier forest on the islands above flood level. The distributary channels of the Niger form a complicated pattern, which varies from year to year. The coastal belt narrows eastward from the delta; westward it consists of an outer sand beach backed by mangrove, with mangrove and freshwater forest on the northern shores of the coastal lagoons. The tidal range is only three feet at Lagos and increases eastward to nine feet at Calabar. The creeks and lagoons form important waterways.

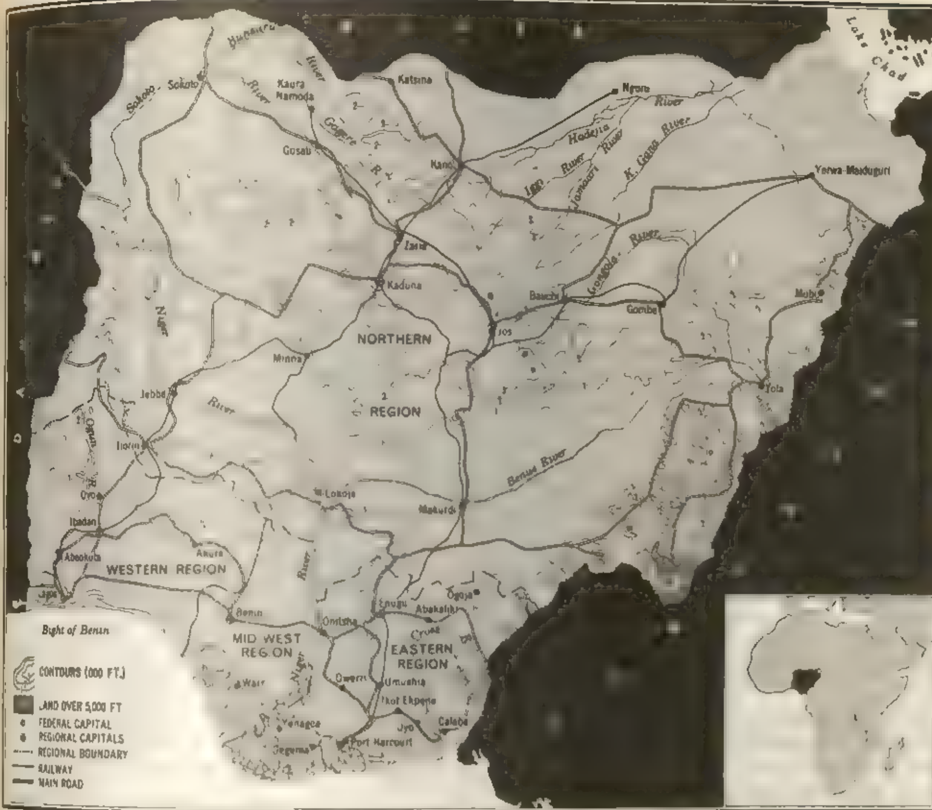
The hilly belt behind the coastal lowlands is widest in the west, where its northern margin is about 200 mi. from the sea. Eastward it contracts and is crossed by the lower Niger in a narrow valley. The broad western part of this belt resembles the wide stepped plains of the northern plateau, but east of the Niger the landscape is characteristically one of gentle slopes rising to eastward-facing scarps; the Udi scarp, with coals exposed near its base, overlooks the broad plains of the Cross river. Parts of this eastern section have the appearance of open downland, in places badly scarred by huge erosion gullies hundreds of feet deep. The southern margin is wooded, but the forest has been impoverished by periodic clearing to allow cultivation. The drier northern and western margins of the belt are covered with a derived savanna of grassland and fire-resistant trees which have replaced the forest as a result of grass fires after clearing.

The Niger and Benue valleys form a great lowland arc across the country. The rivers and their tributaries are mostly sluggish and in broad open valleys, but whereas the Benue is (in the flood season) navigable to beyond the Cameroon frontier, rapids prevent navigation of the Niger above Jebba. The valleys tend to be oppressive from the high humidity accompanying evaporation from the rivers. The vegetation is mainly savanna woodland.

The northern plateau in its central part consists of broad, stepped plains known as the High plains of Hausaland. Covered with savanna parkland, which thins into scrub along the northern frontier, and with gallery forest following the watercourses, these plains were ideal for cavalry, and there the Hausa and Fulani kingdoms developed and flourished. The soils are superior to those farther south, where the combination of heavy rainfall with a long dry season forms a hard, lateritic surface crust. In the northeast the plains fall to about 600 ft. in the sandy basin of Bornu (*q.v.*), the northern part of which is marked by lines of old dunes. East of the Gongola river and south of the Chad basin the extinct volcanic plateau of Biu rises locally to over 3,000 ft.

The Jos plateau forms the uppermost step of the High plains but may be distinguished by its high bounding scarp (more than 2,000 ft. in places) and by its bare grassland surface. It is also notable for its tin fields, for its many extinct volcanic cones and for the small pagan groups who took refuge there and who executed the impressive terrace farming of the surrounding scarp, particularly in the southeast. The abrupt descent of the rivers from the plateau to the surrounding plains has been utilized for hydroelectric power.

The eastern highlands lie almost entirely in the Cameroons, but outlying hill masses in Eastern Nigeria include the Sonkwala hills, which exceed 6,000 ft. They are forested on the lower slopes, but



L. P. PROTHERO

POLITICAL REGIONS, PRINCIPAL TOWNS, COMMUNICATIONS AND PHYSICAL FEATURES OF NIGERIA

the upper slopes are grassed. (J. C. PH.)

3. Climate.—Although Nigeria has a tropical climate throughout, there are marked differences between north and south. The south has more rain, less defined seasons and generally lower daily temperature ranges.

Most of southern Nigeria has a mean annual rainfall exceeding 60 in., occurring chiefly in a rainy season between early April and late October. The rain is brought by storms traveling from east to west and varying in frequency; heralded by towering cumulonimbus clouds which bring a brief burst of wind and rain, easing into an hour or two's drizzle from an overcast sky. Daily temperatures during this season range between 20° and 28° C. (69° and 83° F.) and relative humidities between 75% and 98%. In the southwest there is a brief season in late July and August when practically no rain falls, although high humidities and heavy cloud persist. From November to March is a dry season dominated by daily temperatures between 21° and 32° C. (70° and 90° F.), relative humidities often exceeding 70% and plentiful afternoon cumulus cloud. Thunderstorms occur irregularly, especially in November and March, while on a few occasions between mid-December and mid-February the harmattan (*q.v.*) wind may reduce night temperatures below 18° C. (65° F.) and daytime relative humidity below 40%.

Northern Nigeria's climate is dominated by a dry season from early October to early June. For much of this, daily temperatures range from 15° to 35° C. (60° to 95° F.) and the sky is cloudless. Under the influence of the dust-laden harmattan the air is hazy and relative humidity often falls below 10%. From March onward it grows steadily hotter, especially at night, when humidity increases as the rains approach. These arrive suddenly in heavy thunderstorms which lower temperatures to levels similar to those of southern Nigeria. The rains cease abruptly in late September or early October, and soon the dry season is again established.

The climate of both southern and northern Nigeria is modified locally by highlands. The Jos plateau, for example, is cooler and wetter than its surroundings, and the eastern highlands cooler and wetter than the remainder of Eastern Nigeria. (B. J. GA.)

4. Vegetation.—Broad belts arranged roughly parallel to the equator vary from lush rain forest in the south to arid thorn scrub in the far north. The coastal vegetation consists largely of species that also occur on the Atlantic shores of tropical America. Three species of red mangrove (*Rhizophora*) form extensive thickets and forests in brackish swamps; behind these, in fresh water, the swamp forest is characterized by various trees with breathing roots, such as the raffia palms (*Raphia*), screw pines (*Pandanus*) and the valuable abura timber (*Mitragyna ciliata*).

The rain-forest region is honeycombed with villages and farms. In the best forests the largest trees are 120–200 ft. tall and 10–20 ft. in girth. They include valuable timbers such as African mahogany (*Khaya ivorensis*), African walnut (*Lovoa trichilioides*), guarea (*Guarea cedrata*), sapele (*Entandrophragma cylindricum*), iroko (*Chlorophora excelsa*), obeche (*Triplochiton scleroxylon*) and opepe (*Sarcocephalus diderrichii*). Smaller trees include ebonies (*Diospyros*), kola nut (*Cola acuminata*), camwood (*Pterocarpus* and *Baphia*) and silk rubber (*Funtumia*). Silk-cotton trees (*Ceiba*) and kapok trees (*Bombax*) grow in farmlands and secondary forest, where oil palms (*Elaeis guineensis*) are abundant, especially in the east. Small plantations of edible kola nuts, cocoa and Para rubber are common in the west.

Fallow farmland is soon covered by quick-growing trees and by dense tangles of climbing shrubs which become large lianas when left to grow up with the developing forest. Where tall grass invades the fallows, fierce fires occur almost every dry season, gradually killing the forest species. This happens especially near the northern, drier limit of the forest regions, where wide tracts have become degraded to a savanna type.

The rain-forest region reaches only 50–150 mi. inland. The rest of the country is covered with a more open vegetation of tall grass and of deciduous, fire-resisting trees. At its best the vegetation consists of closed woodland 20–60 ft. tall, but fires and shifting cultivation have caused the trees to be usually rather widely spaced amid the grass. Belts of such savanna run right across northern Africa between the Sahara and the rain forest. In the moister savanna regions tussocky grass 5–12 ft. tall and broad-leaved hardwood trees predominate. In the more arid regions shorter, feathery grass and fine-leaved thorny acacia trees, including gum arabic (*A. senegal*), are widespread. Narrow strips of more or less evergreen forest vegetation fringe the rivers and streams in the savanna regions.

Savanna trees are used mainly as fuel, for rough building poles and for their fruits. Fruit trees common in and around towns and villages are: locust bean (*Parkia*), shea tree (*Butyrospermum parkii*), baobab (*Adansonia digitata*) and tamarind (*Tamarindus*). The fan palm (*Borassus*), the doum palm (*Hyphaene*) and species of *Raphia* occur in the savanna; the date palm (*Phoenix dactylifera*) is found only in towns, but a wild relative, *P. reclinata*, is common along the streams.

With the rainy season the savanna trees come into new leaf, often with vivid tints, fresh grass grows up from the burned ground and numerous bulbous monocotyledons blossom. During the rainy season the grass grows apace and the tree canopy thickens. Toward the end of this season the grasses flower and with them many of the Compositae and other dicotyledonous herbs. During the

dry season the grass is burned and the vegetation remains charred and bare for a few weeks.

Most of the extreme north is covered by a drift of sand formed during arid periods in Quaternary times. The climate has since become moister and the sand has been stabilized by vegetation. But where such ground has been cleared of its natural vegetation the loose sand is easily blown about; whence a belief that the Sahara is encroaching into Nigeria. In fact, the northern boundary of Nigeria is separated from the desert by a wide belt of thorn woodland.

There is little montane vegetation; the best example (in Sonkwala, Ogoja province) has close affinities with that of the mountains of eastern and southern tropical Africa and includes some typically European genera and species. The flora of the Jos plateau also has many affinities with that of east and south tropical Africa. (R. W. J. K.)

5. Animal Life.—The high forest zone is poor in large terrestrial species; the typical hoofed animals are the duikers (dwarf antelopes) and the red river hog. About 12 species of arboreal monkeys live in the forest, sometimes in great numbers; chimpanzees are found locally in this zone. The two most notable primates, the gorilla and the drill, inhabit the dense forest and are largely terrestrial; their range extends into the Cross river area. The manatee and hippopotamus occur in the Niger and Benue rivers, as well as in some of the creek country. The pygmy hippopotamus once occurred in the Owerri area but its present status is unknown.

The bush cow is found close to rivers throughout most of Nigeria and the sitatunga in the swamps of the coastal areas and around Lake Chad. The most important ungulates of the open country are kob, waterbuck, reedbuck, roan and western hartebeest. Three species of gazelle and the scimitar-horned oryx inhabit the driest zones, but the Nigerian giraffe is becoming increasingly scarce and the black rhinoceros has almost certainly disappeared. Elephants, too, have greatly decreased, though still found in some places; the status of other animals is threatened continuously by the steady expansion of farming everywhere. The lion and serval range through savanna woodlands north of the high forest, the cheetah and caracal in the Sudan savanna zone while the leopard is found in small numbers almost everywhere. The commonest carnivores are the mongooses, civets and genets.

Hundreds of species of birds are common, including such tropical families as parrots, hornbills, touracos, barbets, weaverbirds and sunbirds. There are ostriches in the extreme north, together with several species of storks and bustards. The most plentiful game birds are guinea fowl, francolins (bush fowl), green pigeons, ducks and geese. Tsetse flies exclude domestic stock, except some poor sheep and goats, from the forest zone, but horses, donkeys, camels, cows and pigs, as well as numerous sheep and goats, are kept in the north. Reptiles are plentiful both in variety and number, with three species of crocodiles, several turtles and tortoises and many lizards and snakes. The most important snakes are black cobras, green mambas, giant vipers and pythons. Nigeria's rivers and creeks abound in amphibians and fish. Invertebrate life is rich and varied; many species have not yet been described. Butterflies and moths are numerous in forest areas and the massive migration of butterflies is seen in open country. Many species are of outstanding size. There are large scorpions, and the Goliath beetles are among the world's largest insects. (G. S. Ce.)

II. THE PEOPLE

The population of Nigeria is Negro, though with an admixture of other stocks. Limited anthropological surveys show no clear-cut racial divisions. Blood group analyses show that while local differences occur on all systems, the pattern of gene-frequency distribution on any one system does not match that on any other. The most to be said is that the pastoral Fulani (*q.v.*) diverge from the other peoples on more than one (but not every) system, and that the divergency is toward the Mediterranean pattern. The Fulani, who have drifted into Nigeria from the west with their herds for more than 300 years, may indeed have a Mediterranean strain; they regard themselves as white and look less Negroid than other Nigerians. Much variation in physique and pigmentation occurs in the more certainly Negro population; the darkest skins are in the Sudan savanna, where insolation is high, and in the humid and largely forested south are some conspicuously light-skinned populations, notably among the Edo and Ibo (*qq.v.*).

More than 100 languages and dialect clusters (probably all using tone lexically) have been distinguished in Nigeria, but a mere four of them are the mother tongues of 60% of Nigerians: Hausa and Fulani in the north, Yoruba in the west and Ibo in the east. Most of the languages in Northern Nigeria, including Hausa (*q.v.*) the official language, are in the Chad group of the Afro-Asiatic (Hamito-Semitic) family; Arabic, spoken by the 100,000 or so pastoral Shuwa (who are nevertheless reported to be Negro) near Lake Chad, is in the Semitic branch. Kanuri belongs to the central Saharan family. Some of the fishing tribes along the Niger speak a dialect of Songhai, a middle Niger language given the status of a separate family. All southern and some northern languages, including Fulani, belong to the Niger-Congo family (Greenberg's classification). English, the language of commerce and higher education, is widely spoken and understood.

The main cultural and religious contrasts follow the division of the various social systems into Islamic states, typically African states and tribal societies with no centralized political authority. The contrasts are softening under modern conditions and Christian and Muslim proselytizing. Islam, introduced in the 14th century, is professed by 44% of the people and is supreme in Northern Nigeria, where Christian missions in Muslim areas are prohibited. About 34% acknowledge Christianity and only 22% the old tribal religions, which are rapidly losing their hold although traditional beliefs are not always abandoned by converts to Christianity or Islam.

Most of Northern Nigeria is organized into Islamic states: the ancient realm of Bornu (*q.v.*) in the northeast and the old Hausa, Nupe (*q.v.*) and northern Yoruba (*q.v.*) states, which were conquered by the Fulani early in the 19th century and regrouped into emirates under the sultan of Sokoto. All these administer Maliki (Islamic) law. Most of the other states, of which the various Yoruba kingdoms, Benin and the Jukun (*qq.v.*) of the upper Benue are best known, are hieratic city-states headed by a quasi-divine king and usually including cult associations and secret societies in the institutions of government. The few states that emerged in the Niger delta and Cross river estuary during the slave-trade era grafted on to the village organization a political system based on rivalry between powerful trading "houses." Formerly, titled slaves were important officials in all types of state. The tribes without a state system can be small—a few dozen households in the rocky hills of the Jos plateau and other highlands, where they shelter from the raids of nearby states; but the Tiv (*q.v.*) and Ibibio are large tribes and the Ibo form the largest group in Eastern Nigeria. The social organization rests on lineage groups (commonly with ancestor cults) owning tracts of land often centred on Earth-spirit shrines. Closed associations are prominent, as they are in the states, and in both have been models for new political pressure groups.

Western culture has been most readily assimilated by the peoples of Western and Eastern Nigeria where English is the official language; native institutions have not been protected as carefully as those in the emirates of Northern Nigeria. Education of the English sort, provided by government and missions, flourishes in the south and among the non-Muslim peoples of the north. (P. M.-W.)

III. HISTORY

Very little is known of the history of Nigeria, least of all the history of the coastal tribes, before the country was first visited by Portuguese navigators in the second half of the 15th century. A number of Negro tribes occupied the swampy coastal areas and the thickly forested lands which lay immediately behind, while the interior, which became the Northern region of Nigeria, was the home of peoples of mixed Arab, Hamitic and Negro blood. The Muslim religion probably was introduced into this northern area as early as the 13th century and profoundly influenced the social

A Fulani chieftain riding up to salute the Emir of Katsina at the end of the Muslim festival of Ramadan in Northern Nigeria

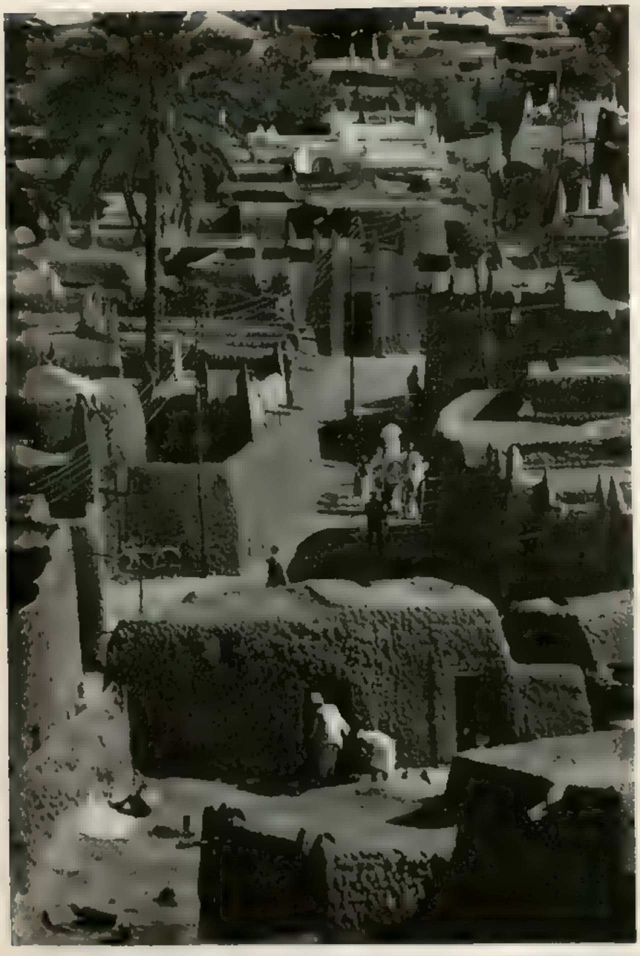
A tribesman of Northern Nigeria, the main area for livestock rearing, with his Red Long-horned steers

NIGERIAN SCENES

A village artisan carefully shapes water pots with local red clay

PHOTOGRAPHS, KEN HEYMAN—RAPHO GUILLUMETTE

NIGERIA



A view of Kano, showing mud houses and narrow streets, crisscrossed by telephone and power lines

A Yoruba woman in Western Nigeria carryi g her water pots

NIGERIAN SCENES

The Central Bank of Nigeria in Independence Square, Lagos

BY COURTESY OF (BOTTOM) MINISTRY OF INFORMATION, LAGOS; PHOTOGRAPHS, (TOP LEFT, TOP RIGHT) KEN HEYMAN—RAPHO GUILLUMETTE

as the religious life of the inhabitants, although much pagan- ... survived. There was little intercourse between these ...hern peoples and the pagan tribes inhabiting the forest coun- ...to the south, and until Europeans visited the coast the only ...tacts of Nigeria with the outer world were with the eastern ... and, across the Sahara, with the Muslim states of north ...

1. **Bornu and the Hausa Lands.**—The principal peoples in the ... were the Kanuri, who occupied Bornu (*q.v.*), the Hausa- ...ing tribes and the Fulani. The empire of Kanem, of which ... was a province, by the end of the 11th century A.D. extended ... east and west of Lake Chad and included the greater part of ...e Hausa lands. Toward the end of the 14th century the power of ...em waned and the empire shrank until little was left of it except ... Meanwhile, to the west of Bornu, the fortunes of the ... states rose and fell. These states, the most important of ...h were Kano, Zaria, Daura, Gobir and Katsina, had existed ... an early date, each independent of the others, and often fight- ... supremacy but joining from time to time in a loose con- ... for mutual defense. Conquered in turn by Kanem and ...ia the Great, king of Songhai (Sonrhaï)—early in the 16th ...tury—they retained their identities under native rulers who ...wledged the suzerainty of the conquerors. When the influ- ...e of Songhai declined and the Hausa states recovered their ...ependence, they engaged again in internecine wars and were ...rrun at different times by the armies of Bornu or of Kebbi, a ... to the west of the Hausa lands, which was of importance in ... 16th century.

Meanwhile, for several centuries, there had been a steady move- ... into the Hausa lands of a pastoral tribe, the Fulani (*q.v.*), ... whose origin little is known. While most of the Fulani remained ...h their herds, moving from place to place in search of water and ...rage, a number drifted to the towns and mingled with the ... population. Their intelligence and ability quickly estab- ...d these "town Fulani" in positions of influence.

...h a position had been gained by Usman (Othman) dan Fodio, ...tical Fulani sheikh of great reputed sanctity who had made ...pilgrimage to Mecca. When, about 1802, Usman intervened ...lf of a number of Muslims who had been enslaved, the ... king of Gobir ordered his arrest and Usman roused his ... to revolt. Recognized as *sarkin musulmi* (commander ... faithful), Usman was supported by the Fulani and some ... Muslim Hausa and easily defeated the forces of the king of ... after conquering all the Hausa lands in a triumphant jihad, ... was directed against lax or lukewarm Muslims and pagans. ... Muslim state, was overrun in 1808 but quickly recovered ...ependence. Fulani amirs were appointed as rulers of ...ous states and the Fulani empire was established from ... (Gandu) in the west to Adamawa in the east. Usman ...ceeded by his son Bello who, as sultan of Sokoto (*q.v.*), ...ognized as *sarkin musulmi* and suzerain of all the Fulani ...

... courts and the systems of government and taxation, which ...sed on Koranic law in the Hausa states, were adapted with ...ange by the new Fulani rulers, and for a time a high stand- ...stice and administration was maintained. However, grad- ... courts became corrupt and the administration extortionate ...rannical (amirs raiding neighbouring pagan tribes and some- ... their own subjects to get slaves). This state of affairs ...ed until the British occupation of the country.

... the Bornu armies were defeated by the Fulani in 1808 and ... king) was forced to flee before the invaders, the coun- ...saved by the military skill of Lamino (Mohammed al-Amin ... a Muslim sheikh born in Fezzan of Arab and Kanem ... With a small force of fanatical followers he defeated the ... in a number of battles and drove them from Bornu. He ...red the *mai* to his throne and allowed him to continue as the ... ruler but retained all power to himself, governing the coun- ... and well, with the title of *shehu* ("sheikh"), until his ... in 1835. The puppet *mai* then attempted to recover his lost ... was defeated and killed by Omar, Lamino's son, who ...ed to rule Bornu with the title of *shehu*.

In 1893 Bornu was invaded by Rabah Zubayr (*q.v.*), with an army better armed and disciplined than that of Bornu, which he completely defeated, making himself the ruler of Bornu. In 1900, however, Rabah was defeated and killed by the French, who were extending their control over the western Sudan.

2. **The Coastal Tribes.**—To the south of Bornu and the Hausa lands were a large number of tribes having various origins and customs and speaking distinct languages. Of these the largest and most important were the Yoruba and the Beni or Bini (*see* BENIN), who occupied what later became the Western region of Nigeria, and the Ibo, in what later became the Eastern region. The Ibo tribe was divided into several clans speaking different dialects and lacking any central organization. For this reason it has practically no known history until after the British occupation. The same could be said of the numerous small tribes which inhabited the forest area and the mountainous areas of the north.

The Beni and Yoruba, on the other hand, had long-established states which at various times reached a much higher standard of organization and culture than the other purely Negro peoples attained. When the first Portuguese ships reached the Nigerian coast in the 15th century, the Beni had long been an important nation, and the *oba* (king) of Benin was a powerful monarch whose authority extended over the Yoruba country and even farther west. Friendly intercourse and a certain amount of trade, mainly in slaves, were established between the Portuguese and the Beni. But the tribe gradually declined in power as the *oba* came under the influence of a theocracy of fetish priests who maintained authority by the terror created through wholesale human sacrifices. They discouraged contact with Europeans, trade dwindled, and by the beginning of the 18th century Benin had lost influence.

In the meantime the Yoruba (*q.v.*) had risen in importance. Little is known of their origin, but they supposedly came from the northeast and perhaps from upper Egypt. The first settlement of the Yoruba in Western Nigeria was probably at Ife (*q.v.*), which was to remain the spiritual headquarters of the people. The *alafin* of Oyo was originally the ruler of the whole tribe, but about 1810 the breakup of his kingdom began, each clan, under its own king, becoming practically independent although the *alafin's* nominal suzerainty continued to be recognized. The country was greatly weakened and suffered from repeated invasions from Dahomey, while the northern province of Ilorin (*q.v.*) fell to the Fulani from the north. The different clans—Oyo, Egba, Ife, Ijebu and others—became involved in internecine wars, prisoners of which were sold at Lagos as slaves.

3. **The Slave Trade.**—Traffic in slaves begun by the Portuguese proved so lucrative that other nations were soon in competition and the slave ships of several European nations flocked to the Guinea coast. British ships were visiting the coast of Nigeria by the 17th century. Much of the trade was with minor chiefs and tribes in the Niger delta and on the banks of other rivers, the slaves being obtained by these middlemen from the interior. Payment was made for the slaves in potable spirits and arms and ammunition, which encouraged intertribal warfare and debased the people. Throughout the long period of unrestricted slave trade no European nation attempted to bring any part of Nigeria under its control.

The slave trade was made illegal for British subjects in 1807 (*see* SLAVERY) but the trade was scarcely affected as ships of other nations continued to carry cargoes of slaves across the Atlantic. A British naval squadron was then stationed on the west African coast to intercept the slavers. British merchant ships continued to visit the estuaries of the Nigerian rivers and began a legitimate trade, buying palm oil and other products. This fact and the activities of the naval squadron greatly increased British influence among the coastal tribes.

4. **Exploration.**—At that time little was known of the interior of Africa, and it was not even appreciated that the numerous streams of the Niger delta were in fact the mouths of a great river. Existence of such a river had long been known, but its general direction and outlet were matters for speculation. Several explorers failed before Mungo Park, in 1796, established the fact that the general course of the upper Niger was easterly. Park lost his life

at the end of 1805 or early in 1806 in an attempt to follow up his first discovery. It was not until 1830 that the brothers Richard and John Lander ascertained that the Niger flowed into the Gulf of Guinea, through the delta which had been known to Europeans for more than 300 years. (*See* NIGER RIVER.)

Other explorers reached northern Nigeria by traveling across the Sahara from Tripoli. In 1823 Dixon Denham and Hugh Clapperton (*qq.v.*) reached Bornu, where they were received by the *mai* and by the *shehu* Lamino. They then visited Sokoto and met Sultan Bello, returning safely to England in 1825. Clapperton died near Sokoto in 1827 on a second journey made from the Bight of Benin. Another extensive exploration was carried out by the German Heinrich Barth (*q.v.*) on behalf of the British government. He crossed the Sahara in 1850, visited Bornu and the Hausa lands and returned safely across the desert in 1855.

Meanwhile an attempt had been made to follow up the discovery of the Lander brothers by a trading venture on the Niger to provide an alternative to the slave trade. A company was formed by a Liverpool merchant, Macgregor Laird (*q.v.*), who went in 1832 with two small steamers to a point above Lokoja, but disease decimated the crews and the expedition was abandoned. In 1841 a large party, including missionaries, was sent by the British government in four ships, under the command of naval officers, to explore the Niger and to try to make treaties for stopping the slave trade. In two months there were 48 deaths out of 145 Europeans in the ships, while a number of others became seriously ill, and this enterprise also was abandoned. It was not until 1854 that a single ship, commanded by W. B. Baikie (*q.v.*), with a crew composed largely of Africans, was able to explore the Niger and the Benue and to do a certain amount of successful trading without any loss of life, the success resulting from the prophylactic use of quinine.

5. The Beginnings of British Rule.—By that time the trade in palm oil, which the coastal Africans found remunerative, had greatly increased, while the slave trade declined in the Niger delta and on the Oil rivers to the east of it, although it was not until about 1840 that slave ships stopped visiting these rivers. To assist legitimate trade it was decided in 1849 to appoint a British consul for the Bights of Biafra and Benin, with his headquarters at Fernando Po. Selected for this post was John Beecroft, who had resided at Fernando Po for many years as superintendent of the naval base there.

Beecroft was soon engaged in negotiations with King Kosoko of Lagos (then the principal port in west Africa from which slaves were shipped) with a view to stopping the trade; but the negotiations were unsuccessful, and in 1851 the town was attacked by a naval force and captured after heavy fighting. Kosoko fled, and his uncle Akitoye, the legitimate ruler, was placed on the throne; he signed a treaty providing for the abolition of the slave trade and of human sacrifice and for the protection of missionaries. A British consul was appointed to Lagos with the king's consent.

In 1861 Akitoye's successor, Dosumu, who appeared unable to govern effectively or to prevent the revival of the slave trade, was required to sign a treaty ceding his possessions to the British crown in return for a pension, and Lagos was annexed as a British colony. For a time the existence of this colony, which effectively stopped the slave trade and provided a haven for runaway slaves, was strongly resented by the Yoruba in the hinterland of Lagos and especially by the Egba, who closed the trade routes and expelled all missionaries and European traders. At a later date, however, British influence increased in the Yoruba country; the civil wars which had raged for so many years among the Yoruba were brought to an end, and in 1888 a treaty with the *alafin* of Oyo placed the whole of the Yoruba country under British protection.

After his successful voyage in 1854 Baikie had established himself at Lokoja under the protection of the amir of Nupe and maintained his more or less official settlement from trading profits. A number of European companies also began to trade on the Niger. In 1879 George Goldie-Taubman (later known as Sir George Goldie; *q.v.*), who was interested in one of the companies, arranged a merger of all the British firms trading on the Niger; and a few years later he was able to buy out the rival French companies. Treaties were made with the chiefs of tribes inhabiting the banks of the Niger and the Benue and with the Fulani sultan of Sokoto, and at the Berlin conference of 1885 it was possible to claim that British interests were supreme on the Niger and the Oil rivers. This claim was admitted by the conference, and a British protectorate was then declared over the Niger districts, which included the Oil Rivers area and the hinterland.

The vague authority of the consul had gradually increased in the Oil Rivers area, and courts of equity, composed of the leading African and European traders on the different rivers, had been established. In 1872 an order of the queen in council had regularized the judicial and administrative position of the consul, but he had for a time little means of enforcing his authority. In 1887, however, Chief Jaja of Opobo was removed and deported in consequence of his interference with trade and defiance of the consul. In 1891 a commissioner and consul general was appointed to the Oil Rivers, with his headquarters at Calabar, and in 1893 the territory was renamed the Niger Coast protectorate.

6. The Royal Niger Company.—In 1886 a royal charter was granted to the company organized by Sir George Goldie, which later was called the Royal Niger Company, Chartered and Limited. The company was authorized to administer the delta and the country on the banks of the Niger and the Benue together with the hinterland but was forbidden to establish any monopoly of trade. The company at once set up courts of justice and the usual administrative services and raised an armed constabulary. Most of the Fulani empire was beyond its control; but in 1897, after a short campaign, the company's troops were able to subdue Ilorin and Nupe and to compel the amirs of these states to abandon slave raiding and recognize the suzerainty of the company.

Meanwhile, on the coast, the people of Brass—who were included in the Niger Coast protectorate and excluded (except on payment of prohibitive dues) from trading in their former markets on the Niger which lay within the company's territory—became increasingly hostile. In 1895 they raided the company's establishment at Akassa, killing many of the African employees of the company and carrying off others as prisoners, some of these being killed and eaten. This outrage was punished by a naval force.

7. Benin.—Another naval force, assisted by the protectorate constabulary, had captured (1894) Brohemie, on the Benin river the headquarters of the Jekri chief Nana, who had traded in slaves extensively. Nana was captured, tried and deported.

The principal centre of the slave trade in the Niger Coast protectorate was then the city of Benin, which was also notorious for human sacrifices. King Overami of Benin had failed to implement a treaty he had signed in 1892 for the abolition of human sacrifice and of the slave trade, and the acting consul general, J. R. Phillips, suggested that he should visit Benin to discuss the matter. The king replied that he would be willing to receive Phillips within a few months' time, but Phillips was not prepared to wait and decided, in spite of warnings, to go at once to Benin. He so informed the king, assuring him that his party would be unarmed. On in reply Overami promised to send guides to meet the party. Jan. 3, 1897, Phillips and his party landed at Gwato, where a friendly welcome was received through messengers sent by the king. The next day, however, the party started for Benin and within a few hours it was attacked and massacred, only two of the Europeans, badly wounded, and a few of the Africans escaping. Phillips and six of his European companions and more than 200 Africans perished.

A naval force was at once sent to the Benin river, and sailors and marines, with troops of the protectorate constabulary, captured Benin after severe fighting, about six weeks after the massacre. After a judicial inquiry, those who were directly responsible for the massacre were executed and Overami was deported.

8. Northern and Southern Nigeria.—On the western frontier, disputes with France (which were to be embittered in 1898 by the Fashoda crisis at the opposite end of the Sudan) nearly led to war, and an imperial force of African soldiers with British officers, the West African Frontier force, was raised in 1897 and placed under the command of Frederick Lugard (*see* LUGARD, FREDERICK JOHN DEALTRY LUGARD, 1st Baron). For a time the

situation was critical, but the dispute was finally settled without fighting. (*See* BORGU.)

These international difficulties and the complaint of the Brass people against the Royal Niger company led to the revocation of the company's charter, the British government assuming direct control of the company's territories on Jan. 1, 1900. The land in the Niger delta and along the lower reaches of the river, which had been included in the company's territories, was added to the Niger Coast protectorate, which was renamed Southern Nigeria. On May 1, 1906, the Lagos territories were amalgamated with Southern Nigeria, the whole country being styled the Colony and Protectorate of Southern Nigeria, with Lagos as the seat of government.

The northern part of the company's territories became the Protectorate of Northern Nigeria, with Lugard serving as the first high commissioner. The Fulani amirates still retained their independence, and slave raiding continued; but the principal slave raiders, the amirs of Kontagora, Nupe and Adamawa, were removed from office in 1901, and Bauchi and Bornu were brought under control the following year. The sultan of Sokoto refused friendly overtures. In spite of this the British administration was steadily extended, and a small garrison was stationed at Zaria. When the amir of Kano threatened to attack this garrison and also refused to surrender the murderer of a British official, a force of about 700 African soldiers, with British officers, advanced against the mud-walled city of Kano, which was taken with little difficulty on Feb. 3, 1903. There was subsequently severe fighting against the main Kano army and the army of the sultan of Sokoto, who fled before the battle. Sokoto was then occupied, and the chiefs nominated a new sultan, whose appointment was approved by the high commissioner.

The sultan and amirs who accepted British rule were installed with full ceremonial after agreeing to abolish slave raiding and to be guided by the advice of British officials. In return they were promised their religion would not be interfered with and that the existing system of Muslim law would be retained. Most of these amirs remained loyal and proved efficient administrators under British supervision. A rising of a few fanatics against the sultan of Sokoto in 1906 was suppressed by protectorate troops, and there was some fighting against the pagan tribes who resisted the enforcement of law; otherwise there was little serious trouble, and British administration was quickly made effective throughout Northern Nigeria. Slave raiding was suppressed and the legal status of slavery was abolished, although many slaves remained voluntarily with their masters.

In the administration of Northern Nigeria, Lugard used the indigenous authorities, the amirs and other chiefs, in what became known as indirect rule. The African administrations had their own treasuries and received a proportion of the tax.

9. The Amalgamation of Nigeria.—Lugard ceased to be high commissioner in 1906 but returned to Nigeria in 1912 as governor of both Northern and Southern Nigeria, charged with the duty of amalgamating the two territories. This amalgamation was effected on Jan. 1, 1914, the whole country being known thereafter as the Colony and Protectorate of Nigeria.

Seven months later, in Aug. 1914, World War I broke out, and Nigerian forces were soon in action against German troops in the Kamerun (*see* CAMEROONS). A combined Franco-British invasion of the Cameroons resulted in the conquest of the country by the beginning of 1916. In 1922 a small part of the Cameroons was mandated by the League of Nations to the United Kingdom and was attached for purposes of administration to Nigeria. (The mandate was replaced in 1947 by a trusteeship agreement with the United Nations.) Before the end of the war Nigerian soldiers had also taken part in the fighting in east Africa. In World War II, Nigerian troops served in east Africa against the Italians and in Burma against the Japanese.

10. Constitutional Changes.—Following the amalgamation of 1914 and particularly after the end of World War II, a number of territorial and constitutional changes took place in Nigeria. In 1914 the country was divided into three main areas, namely the Colony of Nigeria (corresponding to the former Colony of Lagos) and two groups of provinces in the protectorate, the Northern and Southern provinces. The Southern provinces were later divided into two groups, Eastern and Western. In 1951 these were officially renamed the Northern, Eastern and Western regions.

In 1914 a legislative council for the colony alone had been set up, affairs of the protectorate being beyond its purview. In 1923 a larger legislative council was established which for the first time included a limited number of elected members.

A radical change was made in the constitution of Nigeria in 1947. Houses of assembly for the three groups of provinces were set up, and there was also a house of chiefs for the Northern provinces. In each of the houses of assembly nonofficial members were in a majority over ex officio members. In addition there was a central legislative council for the whole of Nigeria.

Public opinion was still not satisfied, and a quasi-federal constitution, introduced in 1951, provided for a central legislative house of representatives. Resulting friction between central and regional legislatures caused the introduction of yet another constitution (the third in eight years) in 1954. This set up the Federation of Nigeria, comprising the Northern, Eastern and Western regions, the Southern Cameroons (part of the trust territory) and the Federal Territory of Lagos. A fourth region, the Mid-West, was established in 1963, by the separation of certain non-Yoruba areas from the Western region. The office of federal prime minister was created in Aug. 1957 (the post being filled by Alhaji Abubakar Tafawa Balewa, a northerner) as a result of the constitution conference of 1957–58, and internal self-government was achieved by the Eastern and Western regions in 1957, by the Northern in 1959.

The British government then announced its willingness to grant independence to the federation on Oct. 1, 1960, and on the request of the Nigerian federal legislature this undertaking was implemented by the United Kingdom parliament. On June 1, 1961, the northern part of the Cameroons trust territory joined the federation as part of the Northern region. Southern Cameroons united with Cameroun on Oct. 1, 1961, to form the Federal Republic of Cameroon. On Oct. 1, 1963, Nigeria became a republic.

11. Independent Nigeria.—Owing to the larger population and consequent greater representation of the Northern region in the federal legislature, the central government was largely under northern control and this was resented by the southern tribes. In May 1962 a political crisis occurred in Western Nigeria. There were disorders and electoral boycotts during the general elections of 1964, the first to be held after independence, and in Oct. 1965 further disorders took place in the Western region when a regional election was held there. There was strong evidence that this election was rigged by the political party in power, which was allied to the party that controlled the Northern region and, to some extent, the federal government.

In Jan. 1966 an army mutiny led by officers of the Ibo tribe overthrew the civil government and culminated in the death of the federal prime minister and the premiers of the Northern and Western regions. A military government was set up under Maj. Gen. Johnson T. U. Aguiyi-Ironsi, the officer commanding the Nigerian Army, who, himself an Ibo, had not been implicated in the mutiny. Attempts by the military government to abolish the regions and establish a unitary government led to disorders in the Northern region and to the killing of Ibos living and working there. At the end of July 1966 in another military coup, by Hausa officers, General Ironsi was killed and a new military government came into power under Lieut. Col. Yakubu Gowon, a northerner. Subsequently many Ibos were killed in the Northern region, and a movement of Ibos back to their homes in the Eastern region took place. Some Hausas were killed in the Eastern region.

On Sept. 12 representatives from all four regions and Lagos met to attempt to work out constitutional provisions that would make possible return to civil government. No agreement being reached—the Eastern region insisting on a weak central government—the meeting adjourned on Oct. 2. When it reassembled on Oct. 27, no delegate from the Eastern region was present, and the other delegates gave up in mid-October. Gowon on November 30 declared his determination to maintain the unity of the country, but on May 30, 1967, the Eastern region seceded and declared itself the Republic of Biafra. (A. C. Bs.; X.)

IV. POPULATION

The census conducted in 1952–53, the second to be held in Nigeria (the first was in 1931), gave the total population as 29,730,879. In 1960 it was estimated at 35,091,000. The results of the 1962 census were nullified and, according to the 1963 census, the total population was 55,670,052.

The distribution is uneven, with marked concentrations in each of the three regions. Densities of more than 700 persons per square mile exist in the Ibadan province of Western Nigeria, more than 800 in Owerri province in the Eastern region, and nearly 350 in Kano province in the Northern region. Over most of the middle belt of central Nigeria densities are less than 100 per square mile and large areas are virtually uninhabited.

About 10% of the population is urban. Most of the largest cities are in the Yoruba country; they include Lagos (the federal capital), Ibadan (capital of Western Nigeria), Ogbomosho, Mushin, Oshogbo, and Abeokuta. In Eastern Nigeria there are few large towns; they include Port Harcourt, Onitsha and the regional capital Enugu. Principal towns in Northern Nigeria are Kano, Ilorin, Zaria and the regional capital Kaduna. (X.)

V. ADMINISTRATION AND SOCIAL CONDITIONS

1. Constitution and Government.—The constitutional instruments that came into force on Oct. 1, 1963, provided for a federal republic consisting of the Federal Territory of Lagos and the regions of Northern, Western, Eastern and Mid-West Nigeria (*qq.v.*). The constitution sanctioned the establishment of further regions and the alteration of regional boundaries. Regional governments could execute and maintain their own constitutions and make laws within the region, but not so as to prejudice federal authority. The Mid-West region was constituted in 1963.

The head of state was a nonexecutive president elected to office for five years. The federal government included the council of ministers, the senate and the house of representatives, the last two forming the federal parliament. The council of ministers consisted of a federal prime minister and a number of ministers who might either hold portfolios or be ministers of state attached to ministries. Cabinet meetings were presided over by the prime minister, and the council decided policy. The prime minister was appointed by the president from the majority party in the house of representatives; members of the council were appointed on the advice of the prime minister.

The house of representatives consisted (1963) of 312 members elected for five years by full adult secret ballot, except in Northern Nigeria, where only males might vote. The house was presided over by a speaker appointed from among its members. The senate consisted of 56 members: 12 from each region, 4 from Lagos and 4 selected by the president on the advice of the prime minister.

Bills must be passed by both houses before being sent to the president for assent. Bills might originate in either house, except that the senate might not originate money bills and had limited delaying powers over other bills. The exclusive jurisdiction of the federal government embraced archives, aviation, external borrowing, control of capital issues, currency, defense, external affairs, immigration, maritime shipping and navigation, mines and minerals, museums, armed forces, telecommunications, trunk roads, railways and certain institutes of higher education.

Each region was subdivided into provinces (*see* Table), had its own constitution and had a bicameral legislature consisting of an elected house of assembly and a nominated house of chiefs. An individual could not be a member of a regional house and of the house of representatives. Each region had a premier and ministers and each parliament functioned similarly to the federal parliament, except that bills received assent from the regional governor. Regional authority extended over a "concurrent list" of matters which may have extraregional application and also over health, education, local government and development, local taxation and regional and local administration. Local authorities were in turn responsible for many social and economic services from which they derived revenue.

Northern Nigeria's provincial government was based on former traditional local authorities (rulers and their courts) but the elective principle was gradually being introduced. In the other regions traditional authorities had been largely replaced by local elected councils based on English models. The traditional chiefs were usually presidents of their local councils and were thus integrated into the system. The municipality of Lagos and other large towns (Ibadan, Enugu, Onitsha, Port Harcourt, etc.) were elected by adult suffrage. Civil-service functions were performed by officials controlled by regional public-service commissions, which were constitutionally established nonpolitical bodies empowered to appoint, promote and discipline public-service officials.

Political Parties.—The main parties are the Northern People's Congress (N.P.C.), based on Northern Nigeria; the Action Group (A.G.) and the United People's party (U.P.P.), based on Yoruba-speaking Western Nigeria; and the National Convention of Nigerian Citizens (N.C.N.C., formerly the National Convention of Nigeria and the Cameroons), based on Ibo-dominated Eastern Nigeria. The N.P.C. and the A.G. were formed in the late 1940s but the N.C.N.C. dates back to 1944 when its founder, Nnamdi Azikiwe, joined forces with Herbert Macaulay, "the father of Nigerian nationalism." The U.P.P. was formed in 1962 following a split in the A.G.

2. Taxation.—Most revenue is derived from import and export duties, affecting the prices of

*Nigeria: Area and Population**

Political and administrative subdivisions	Area (sq mi)	Population 1953 census	Density (per sq mi)	Population 1963 census	Density (per sq mi)
Regions and provinces, with capitals in parentheses:					
Eastern (Enugu)	29,484	7,215,251	244.7	12,394,462	420.3
Calabar (Calabar)	6,245	1,540,091	246.7	3,023,784	484.1
Ogoja (Ogoja)	7,485	1,082,211	144.6	1,602,533	214.0
Onitsha (Onitsha)	4,877	1,768,413	362.6	2,943,483	603.5
Owerri (Owerri)	3,869	2,077,891	536.9	3,280,348	847.8
Rivers (Port Harcourt)	7,008	746,645	106.5	1,544,314	220.3
Northern (Kaduna)	281,782	16,991,701	60.3	29,808,659	105.7
Adamawa (Yola)	31,786	685,728†	21.6	1,585,290	49.8
Bauchi (Bauchi)	26,120	1,423,439	54.5	2,476,329	94.8
Benue (Makurdi)	29,318	1,467,972†	50.1	2,641,960	90.1
Bornu (Yerwa-Maiduguri)	45,733	1,519,473†	33.2	2,853,553	62.3
Ilorin (Ilorin)	17,719	529,889	29.9	1,119,222	63.1
Kabba (Lokoja)	10,953	661,387	60.4	1,280,143	116.8
Kano (Kano)	16,630	3,820,348	229.7	5,774,842	347.2
Katsina (Katsina)	9,466	1,483,125	156.7	2,545,005	268.8
Niger (Minna)	28,666	715,169	24.9	1,398,527	48.7
Plateau (Jos)	11,272	824,700	73.2	1,367,448	121.3
Sardauna‡ (Mubi)		313,667	—	878,271	—
Sokoto (Sokoto)	36,477	2,679,841	73.5	4,334,769	118.8
Zaria (Zaria)	17,642	866,963	49.1	1,553,300	88.4
Western (Ibadan)§	30,454	4,593,650	150.9	10,265,846	337.0
Abeokuta (Abeokuta)	4,266	629,830	147.6	974,886	228.5
Colony (Ikeja)	1,354	237,928	175.7	778,321	574.8
Ibadan (Ibadan)	4,521	1,649,926	364.9	3,326,647	735.8
Ijebu (Ijebu Ode)	2,456	348,024	141.7	576,080	234.5
Ondo (Akure)	8,162	945,440	115.8	2,727,675	334.1
Oyo (Oyo)	9,695	782,502	80.7	1,882,237	194.1
Mid-West (Benin city)	14,922	1,491,415	99.9	2,535,839	169.9
Benin (Benin city)	8,482	900,886	106.2	1,354,986	159.7
Delta (Warri)	6,440	590,529	91.7	1,180,853	183.3
Federal Territory of Lagos	27	272,000	10,074.0	665,246	24,638.7
Total federation	356,669	30,564,017	81.6	55,670,052	156.1

*Table reflects 1963 reorganization. It includes former Northern Cameroons (British), now Sardauna province, incorporated into Nigeria June 1, 1961.
†Includes non-African population of former Northern Cameroons (British) portions of Adamawa, Benue and Bornu provinces.
‡Former Northern region of British Cameroons.
§Figures for Mid-West Nigeria have been deducted.

consumer goods and living costs; but from 1961 new scales of direct tax included many income earners hitherto exempt. Anyone with a deducible income became liable to pay a fixed rate of up to £N3, on incomes up to £N300, above which tax was levied on a graduated scale of up to 15*s.* in the pound. This had the effect of including women trading in their own right and the small farmers dependent on the sale of export produce.

3. Living Conditions.—These vary considerably between town and country. Major projects operate in the larger towns to clear congested areas, but the heavy expenditure involved and the drift of people from the rural areas retard efforts to raise living standards and to provide full employment. In rural areas there is a gradual provision of clinics and maternity centres but little change in the basic pattern of life. Contrasts range from modern air-conditioned residences of towns and villages served by electricity to mud-built villages in forest or rocky plateau.

Health.—The general level of health and the eradication of disease pose formidable problems, as the ratio of doctors to population is only about 1:35,000. Nevertheless, by the 1960s curative and preventive services were making headway through new hospitals and the building of dispensaries, maternity homes and clinics in all areas. There are localized campaigns to eradicate malaria, sleeping sickness, river blindness and other major tropical diseases, with help of units of the World Health organization and of the United Nations Children's fund, and local preventive campaigns against smallpox, yaws and tuberculosis. Health education occupies a prominent place in planning.

4. Trade Unions.—Development of trade unions is officially encouraged to harmonize employer-worker relations, but most existing unions have been formed as groups of employees within a specific firm or organization and not on the basis of trades. Most unions are affiliated to the United Labour congress. By the early 1960s there were 400 trade unions with 200,000 members.

5. Justice.—The federal supreme court is the highest, possessing original jurisdiction and appellate functions; it consists of the chief justice of the federation, at least three federal justices and the chief justice of each region. Each region, including Lagos, has a high court of justice comprising a chief justice and six regional judges (five in Lagos). Power to appoint officers in the judiciary rests with the president in each region. Customary courts (and Muslim courts in Northern Nigeria) exist alongside magistrates' courts presided over by qualified lawyers. The constitution contains entrenched clauses safeguarding fundamental human rights.

Police.—The Nigeria police is responsible for maintaining law and order and consists of about 14,000 officers and men, with a few women police. Former local authority police forces have been brought under the control of the Nigerian police.

6. Education.—Schooling was brought to Nigeria by the Christian missions, and most leading personalities of modern Nigeria (except Muslims) were educated in mission schools. In the early 1960s these schools provided over 50% of the primary and secondary education in the country. They receive government grants-in-aid and it is official policy for governments to take the controlling part in the educational system.

Universal primary education for children from the age of six years was introduced into Western Nigeria in 1955 and into the federal capital of Lagos and Eastern Nigeria in 1957. By the early 1960s there were about 16,000 primary schools with 3,000,000 pupils. But of these only about 250,000 pupils were in Northern Nigeria, where universal primary education was confined to an area of Kano authority, though it was hoped that by 1970 at least 50% of all children of school age in Northern Nigeria would be at school.

During the same period there were about 290 secondary grammar schools with 50,000 pupils, while Western Nigeria had in addition 420 secondary modern schools with about 65,000 pupils. Teacher-training institutions exceeded 300 with about 27,000 students (one-third of them women) and vocational and technical institutes numbered 44 with 8,000 students. The normal primary course is six years and the grammar school and technical courses are from four years. Evening classes are held at many technical institutes and regional governments conduct mass literacy campaigns to reach the older generations.

To fill the many vacancies for Nigerians in the professional and technical spheres, governments award numerous scholarships, tenable inside Nigeria and overseas in subjects ranging from architecture to zoology. Such scholarships normally entail an obligation to accept government service for five years on qualifying.

Within Nigeria the University college, Ibadan, was opened in 1948. Attached to it is a teaching hospital providing training for doctors and nurses to degree standards. The college was associated with the University of London but in 1963 it became an independent university, awarding its own degrees. The University of Nigeria was opened in 1960 at Nsukka, Eastern Nigeria, and the University of Ife in Western Nigeria was founded in the following year. In 1962 the federal government opened the University of Lagos, and Northern Nigeria established the Ahmadu Bello university at Zaria. By 1970 the university population was scheduled to reach 10,000. The new universities absorbed the branches at Zaria, Enugu and Ibadan of the Nigerian College of Arts, Science and Technology, which had degree courses in engineering and professional subjects. Within the federation there are about 25 public libraries controlling a stock of 350,000 volumes.

7. Defense.—The Nigerian army, formerly the Nigeria regiment of the Royal West African Frontier force, became a separate command as the Nigerian Military forces in 1956. On the declaration of the republic it was redesignated the Nigerian army. Its strength of about 7,000 comprises five battalions of the Queen's Own Nigeria regiment, a reconnaissance squadron, engineers, signals and normal administrative services. There are an officer-training school and a boys' company. The army has a list of battle honours dating back to the Ashanti Wars of the 19th century and which include the Burma campaigns of World War II. The Royal Nigerian navy, established as the Nigerian Naval force in 1958, consists of a frigate and a number of patrol vessels based on Lagos. A Nigerian air force was created in the early 1960s. (W. H. I.)

VI. THE ECONOMY

1. Production.—Like other countries of tropical Africa, Nigeria is dependent upon primary production. The economy is based on agriculture and likely to remain so; 80% of the working population is directly engaged in agriculture. Subsistence agriculture is still important in many parts but is being progressively modified by increasing internal trade and by expanding production for export. Agriculture is almost entirely small scale. Farmers cultivate on an average three to four acres, but total land requirements are greater to allow for fallow periods to restore fertility. Staple food crops are roots (yams and cassava) in the south and cereals (guinea corn and millets) in the north, with a considerable overlap of these crops in the central parts. Trypanosomiasis restricts livestock (particularly cattle) to the northern part of Nigeria.

Major cash crops for export are cocoa, oil palm products and rubber in the south and peanuts and cotton in the north. Nigeria makes a substantial contribution to world trade in some of these products. From the southern parts of the country hardwood timbers (obeche, abura, sapele) are exported, this trade having increased markedly since World War II.

Tin and columbite are mined chiefly on the Jos plateau, and poor-quality coal is mined near Enugu. Oil and natural gas in commercial quantities were found in the Niger delta in 1959, and production, with refining facilities at Port Harcourt, has expanded rapidly. There is much low-grade iron ore. Electric power generation is from petroleum, natural gas, coal or timber fuel. Some hydroelectric power is generated on the Jos plateau, and the Kainji dam project on the Niger upstream from Jebba was scheduled for completion in 1968.

Industrial development is restricted mainly to secondary industry and includes textile manufacture, oilseed crushing, sawmilling, and production of soap, margarine, plywood and furniture, canning of meat and fruit, brewing and manufacture of soft drinks and cigarettes, light metal fabrication, automobile and truck assembly, tire manufacture and cement production.

Fish is an important source of protein, and more than 150 vari-

eties are found in Nigeria's rivers, lagoons and creeks. Bonga nets are used along the coasts, and sea fishing is carried on by commercial trawlers, based at Lagos. Development of local inland and sea fisheries is encouraged by federal and regional authorities.

2. Trade and Finance.—Internal trade is chiefly in foodstuffs, particularly food staples, palm oil, kola nuts and dried fish. Cattle brought on the hoof from the north provide limited supplies of meat in southern Nigeria. The chief Nigerian imports in order of value are manufactured items, including textiles, machinery, foodstuffs, chemicals and fuels; about one-third come from the U.K. About two-thirds of exports by value are made up by petroleum, cocoa, peanuts and palm oil and kernels; other leading exports are cotton, rubber, timber, tin, hides and skins, and bananas. The U.K. takes the largest share of Nigerian exports, followed by the Netherlands, the Federal Republic of Germany and the United States. During the years immediately before and after independence, imports increased mainly through increased spending on capital equipment, while the low world prices for primary products failed to bring a corresponding increase in export income. In 1965, however, there was a balance of payments surplus due to improved exports. Agricultural exports are controlled by statutory marketing boards which use their reserves to subsidize producer prices and to finance research and development.

The Central Bank of Nigeria is the bank of issue, and the currency is based on the Nigerian pound (£N), linked at par with sterling by statute. General banking facilities are provided by both foreign and Nigerian banks. There is a stock exchange at Lagos. Revenue is derived from import and export duties and from income tax collected on a regional basis. A proportion of the total is allocated to the regions and the remainder retained by the federal government. More than £100,000,000 ($280,000,000) was spent on capital development during 1958–62, derived from loans from the World bank and from the U.K. Further economic expansion under the National Development plan for 1962–68 provided for an expenditure of more than £N700,000,000 ($1,960,000,000), of which about 60% was to be capital expenditure. £N150,000,000 ($420,000,000) was spent in the first two years, and the growth rate was higher than that projected.

3. Communications.—Railways, of 3-ft. 6-in. gauge and mainly single tracked, run inland over a total distance of about 2,500 mi. (4,000 km.) from Lagos and Port Harcourt to Kaduna, Jos and Kano, with railheads at Kaura Namoda, Nguru and Yerwa-Maiduguri. The road network covers about 40,000 mi. (64,400 km.), but only about 5,000 mi. (8,000 km.) are tarred and some routes are impassable during the wet season. Kano has for centuries been a great market and a focus of caravan routes from the Sahara and the Sudan. Navigation on both the Niger below Jebba and on the Benue, other than by canoe, is restricted to flood periods. Lagos (Apapa) and Port Harcourt are the chief ports. The Nigerian National line, formed in 1959 with Nigerian interests as majority shareholders, is one of about 30 shipping lines providing regular services between Nigeria and other parts of the world. International air services from Lagos and Kano are scheduled by several companies, including Nigeria Airways, which also maintains internal services. Radio broadcasting (including television) is conducted by federal and regional corporations. The press is the most highly developed in west Africa. *See* also references under "Nigeria" in the Index. (R. M. P.)

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NIGER RIVER, the greatest river of west Africa and the third longest of the continent (2,600 mi.) after the Nile and the Congo, drains an area of about 580,000 sq.mi. Apart from its common name Niger (probably from the Latin *niger*, "black," though possibly from the Berber *n'eghiren*, "stream") it is also known in its upper section by the Mandingo name Djoliba (Joliba), meaning "the great big river," and as the Kworra (Quorra, Kovarra or Kwara) farther downstream. The latter names were more widely in use during the 19th century.

The headwater streams of the Niger rise in the Fouta Djalon plateau in the Republic of Guinea near the frontier with Sierra Leone, at an altitude of about 2,500 ft. and less than 200 mi. from the Atlantic ocean. This area is referred to by the French as the "château d'eau" since it also has the sources of the Senegal and Gambia rivers and several streams that flow southwest and south. Much of the area traversed by the Niger in its long course to the sea in the Bight of Benin is composed of old crystalline rocks. The river, however, because of recent earth movements, changes in climate and river capture, exhibits many features of youthful development. Its profile is broken with stretches of falls and rapids and with fast-flowing water in narrow sections alternating with broad, open valley sections with a slow-moving stream. In width the river varies from a few hundred feet to a maximum of nearly two miles at the confluence of the Benue.

From its source the Niger flows in a general northeasterly direction through Mali toward the Sahara, and then turns in a great bend immediately below Tombouctou to flow to the east and southeast at Bourem, across the Republic of Niger and into Nigeria as far as the Benue confluence, and from there southward to the sea. These changes in direction are in part the result of two river systems which were originally distinct from one another. The upper section of the Niger at one time flowed out through the Senegal river and at a later stage terminated in a system of lakes, swamps and channels, the remnants of which now form the "inland delta" between Ségou and Tombouctou. This was joined in the Quaternary era to the present middle and lower sections of the river whose headwaters were at one time in the now arid regions of the Sahara. During and after the wet season floodwaters spread out in the "inland delta" to cover an area the size of England and Wales. In this section the Niger receives a major tributary, the Bani, which joins it at Mopti. Windblown accumulations of sand from the Sahara impede the flow of the river in the vicinity of Tombouctou causing a progressive diversion of the river course southward, and at Gao dry beds on the left bank of the river are evidence of former courses. Downstream from Tombouctou until it enters Nigeria the Niger receives few tributary streams and for some of the way the desert impinges directly on its left bank. The valley section to Yelwa varies, being broad and open where it is cut in Tertiary sandstones, and narrow and enclosed where the stream is flowing over crystalline rocks. Between Yelwa and Jebba there is a series of rapids extending for about 50 mi. The best known of these are at Bussa and they are in places virtually impassable even by canoe. They effectively cut off the middle from the lower section of the Niger. Upstream from Yelwa the Niger is joined by the Kebbi river, the first of its major Nigerian tributaries which all flow in from the north. At Mureji between Jebba and Lokoja, the Kaduna unites with the Niger which at Lokoja receives the Benue (*q.v.*), the greatest tributary of all and itself one of the major rivers of Africa. For some distance south of Lokoja the Niger flows in a restricted valley ex-

closed by hills and in some places flanked by sandstone cliffs up to 150 ft. high. The valley then opens again, and some way below Onitsha the great Niger delta begins. This is the largest delta in Africa and covers an area of 14,000 sq.mi. It extends along the coast for about 120 mi. from Forcados to Port Harcourt and inland for 140–150 mi., and is an area of innumerable interconnecting waterways and mangrove swamp, difficult to traverse and for the most part undeveloped. The main outlet channel of the delta is the Rio Nun. The delta is being gradually extended seaward by the increments of silt brought down by the river.

Navigation.—The broken profile of the river with its falls and rapids has prevented uninterrupted navigation. In the considerable navigable stretches, the flow of water fluctuates with the seasonal variations of the several rainfall regimes which control the amount of water entering the main river and its tributaries. The upper Niger is navigable from Kouroussa in Guinea to Bamako in Mali from July to October. Below Bamako there are the Sotuba rapids which are followed by a navigable stretch of about 1,000 mi. entirely within Mali from Kulikoro to Ansongo. This is open for vessels, other than canoes, from late July or August until December. There is a considerable time lag in the movement of flood water downstream, particularly with the slow progress of water through the "inland delta." Water from the previous wet season in the upper Niger does not reach the Djerma Ganda region (Republic of the Niger) in the middle section until mid-January, and Jebba in Nigeria until a month or more later. It is estimated that it takes a little less than a year for water from the upper reaches of the river to pass down to the sea. The flow of water near the mouth is never less than 1,000,000 cu.sec., which is about three times the maximum flow at Kulikoro. From Ansongo to Jebba in Nigeria the river is unnavigable, except for short stretches; *e.g.*, for 75 mi. between Niamey and Gaya. Below Jebba navigation is uninterrupted by falls or rapids but river craft, canoes excepted, are dependent on the amount of water in the river. At Jebba, apart from the upper Niger floodwater, there is local floodwater in the river from early August until mid-November. Powered vessels can operate this far upstream (550 mi. from the sea) from August to February. They can operate to Baro (400 mi. from the sea) from July until March. Below the Benue confluence at Lokoja (332 mi. from the sea) the river is open all the year, though operations are restricted in April and May when the flow of water is less than at any other time. With the best water conditions the greatest permissible draft for fully loaded vessels is 7 ft. 6 in. These are power-driven craft towing barges alongside. The journey from the delta to Baro takes eight days, and the return journey six days.

At Baro the river transport is linked with the Nigerian railway, through the 111-mi. branch line which joins the Lagos-Kano line at Minna. Burutu and Warri are the two ports in the delta which link the river transport with the sea. Both are approached from the sea by way of the mouth of the Forcados river. There a sandbar has limited the size of ships entering and leaving and the amount of cargo they can carry, but a channel was to be dredged in the 1960s to accommodate ships of up to 20-ft. draft, and was to be protected with extensive breakwaters. Investigations were also made of ways to improve navigation on the Niger within Nigeria.

River Fauna and Economic Aspects.—Fishing is everywhere important to the riverine communities and from the middle Niger alone (the main market is at Dioro) about 20,000 tons per annum of smoked and dried fish is sent off to markets as far as Ghana. The river fauna is rich and diverse, the largest species represented being the hippopotamus and the crocodile, and the manatee also occurs. Large numbers of crocodiles are killed and their skins exported. The Niger perch and the tiger fish are the two best-known fish. The former is found in many other African rivers; *e.g.*, the Nile, where it is known as the Nile perch. In the Niger the largest specimens of perch caught have been just under 200 lb.; tiger fish generally weigh less than 20 lb. In the Republic of Mali much of the crop cultivation is dependent on irrigation from the Niger and its tributaries. Population is frequently concentrated near the river, especially for some distance downstream from Tombouctou where the desert reaches the left bank.

After 1940 the French worked to control the water in the "inland delta" with both large and small projects. The main works are a large barrage at Sansanding and a smaller one at Sotuba, together with the building of irrigation canals and leveling of the land. The Sansanding barrage was begun in 1934 and completed in 1946; it is half a mile long with 500 sluice gates, and has a road across the top and a navigation canal leading round the dam. Irrigation water from these works has brought under cultivation land which was previously waste or poor seasonal pasture. Settlers have had to be attracted into these new areas and assisted to establish themselves; 100,000 ac. are under cultivation. It was intended originally to grow cotton on the irrigated land but, compared with the Nile valley, the soils are not rich enough and the annual deposit of silt is not as much. Rice is the main crop and occupies 60% of the cultivated area. There have been some experiments with mechanical cultivation. The reduction in the flow of the river has had some effect on the problem of sand accumulation farther downstream, and there has also been some conflict of interests between the new cultivators and pastoralists who have traditionally used the land for seasonal grazing. The pastoralists are now restricted in their movements by canals and cropland. Throughout much of its length the Niger valley attracts herdsmen seeking pasture and water for their flocks and herds during the dry season. In Nigeria there are many parts of the valley which are considered to be potential rice-growing areas provided that some means can be found for controlling floodwater. By mid-1960s work was in progress on a dam at Kainji (some distance upstream from Jebba) to control the river flow for the production of hydroelectric power, to improve navigation, to create a major fishing reservoir and to make agricultural development possible in the valley below Jebba. The delta area has been explored for oil for many years and there are several wells in production, the oil being exported via Port Harcourt.

Exploration.—The Niger is almost certainly the great eastward-flowing river reached by the young Nasamonians who had crossed the Sahara and whose journey is recorded by Herodotus. Vague references to a great river in west Africa are made in the writings of Pliny and Ptolemy. During the middle ages contradictory opinions were held as to the source, course and outlet of this river. Idrisi, the 12th-century Arab scholar, maintained that there was a common source for the Nile and the "Nile of the Negroes" (the Niger) in the Mountains of the Moon, and it is probable that he thought of the Shari (Chari), Lake Chad, Benue, Niger and Senegal as one great river flowing to the west into the Atlantic. This opinion was held by Henry the Navigator and when the Portuguese seamen discovered the mouth of the Senegal in 1445 they thought they had found its outlet. When it was proved that the Senegal was independent, there was a return to the idea of an eastward-flowing river which emptied itself into the Nile. In the 15th century Ibn Batutah, the Muslim traveler, was acquainted with the middle course of the Niger, from above Tombouctou to Gao. The great Arab traveler, Leo Africanus, who probably visited the western Sudan in 1513–15 and sailed on the Niger, for an unknown reason stated that it flowed westward and thus it was shown on maps of the 16th, 17th and 18th centuries. For much of this time access to the western Sudan from the north by way of the Sahara was impossible for Europeans because of the closing of the north African coast by Moorish pirates. European traders on the coast of the Gulf of Guinea were either not interested or were unable to penetrate inland from the south.

That the outlet of the great river was in the Gulf of Guinea, in the delta which was already known, does not seem to have been suspected until the end of the 18th century. In 1788 the African association was founded in London to promote discovery and trade and to attempt to determine the course of the Niger. Several unsuccessful attempts were made to penetrate the western Sudan from the north. Frederick Hornemann, the German explorer, undoubtedly reached the Niger about 1800, somewhere in central Nigeria, but he did not return to tell of his discoveries. In 1795–97 the Scotsman, Mungo Park, traveled inland from the Gambia to reach the Niger at Ségou, and to find it "glittering to the morn-

ing sun, as broad as the Thames at Westminster, and flowing slowly to the eastward." This established the direction of the river's flow. Park went downstream some distance and then up to Bamako before returning to the coast. In 1805 after an arduous journey he was back at Bamako to commence the great journey downstream which ended tragically with his drowning in the rapids, probably at Bussa. No record remained of this journey and so this great section of the Niger was still unknown in Europe. Park had believed that the Niger flowed to join the Congo; others, among them James Rennell, the English geographer, that it flowed into a great swamp, "the sink of North Africa." In 1802 a German, C. G. Reichard, suggested that it flowed into the Gulf of Guinea through the Rio Nun and he was supported in this opinion by an Englishman, James Macqueen. The explorations of A. G. Laing, W. Oudney, D. Denham, H. Clapperton, Richard L. Lander and R. A. Caillié in the 1820s further revealed the interior parts of west Africa. They contributed little to solving the problem of the Niger's termination, though Clapperton believed that it was in the Gulf of Guinea. Proof of this came in 1830 when Richard Lander, who had accompanied Clapperton in 1825–27, returned with his brother John and made the journey by canoe from Bussa to Brass at the mouth of the Niger delta. With this knowledge the river was used for voyages from the coast into the interior in the 1830s and 1840s, and in 1854 W. B. Baikie in the steamer "Pleiad" made extensive voyages on the Niger and the Benue. The middle section of the river, from Tombouctou to Say, was traveled by H. Barth during the course of his explorations, 1850–55. In the latter half of the 19th century the lower section of the river was used as a trade route by European companies of which the Royal Niger company (incorporated in 1886) was the most important. The company not only developed trade but also established British supremacy on this part of the river and laid the foundations for the administration of adjacent territories. In 1900 the British government assumed responsibility from the company and declared the Protectorate of Northern Nigeria.

In the western parts of the Niger basin the French advance from Senegal was initiated by L. L. C. Faidherbe. Ségou was reached in 1866 and forts established between the Senegal and the Niger between 1879 and 1881. A railway was begun in the following year and reached Kulikoro in 1904 to link the Niger with the upper limits of navigation on the Senegal. The through line from Dakar to Bamako was not completed until 20 years later. In 1883 the French launched a gunboat, the "Niger," on the upper reaches of the river and this made the voyage downstream to Tombouctou in 1887. Nine years later M. Hourst navigated the river from Tombouctou to its mouth. In the late 19th century and early 20th century the Niger basin away from the river was explored—particularly by the German, G. A. Krause (1886–87), from the Gold Coast and by the Frenchman, L. G. Binger (1887–89), from Senegal through to the Ivory Coast. These journeys revealed the considerable size of rivers (*e.g.*, the Volta and its tributaries) that were independent of the Niger system and flowed directly southward to the Gulf of Guinea. Though the upper reaches of the Niger and the Senegal in the west and the lower Niger in the east were of great importance for the French and British respectively in establishing their influence in west Africa, the Niger never fulfilled the expectations of some of its earlier explorers, as it proved to be unsuitable for uninterrupted navigation.

See also references under "Niger River" in the Index.

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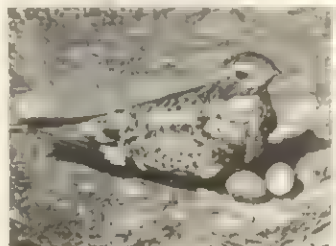
NIGGLI, PAUL (1888–1953), Swiss mineralogist whose *Lehrbuch der Mineralogie* (two volumes; 1924–26) set a new standard of achievement and provided a new vista of the content of modern mineralogy, was born at Zofingen, Aargau canton, on June 26, 1888. He graduated as an engineer at the Zürich technical high school but turned immediately to the field of mineralogy and petrology. His early researches dealt with the chloritoid schists of the northeast edge of the Gotthard massif, and were pioneer studies applying physicochemical principles to the subject of stress metamorphism. He moved to a chair at Leipzig university (1915) and later at Tübingen (1918). This period saw the production of his *Geometrische Kristallographie des Diskontinuums* (1919), which provided the idea of a systematic deduction of the space group by means of X-ray data and supplied a complete outline of methods that have since been used for the determination of space groups. He succeeded to the chair of mineralogy and petrology at the University of Zürich in 1920. He served as rector of the Federal Institute of Technology in Zürich (1929–32) and of the University of Zürich (1940–42). Niggli died in Zürich on Jan. 13, 1953.

In the field of igneous petrology, Niggli was active in the study of petrographic provinces and he published, with Conrad Burri, *Die jungen Eruptivgesteine des mediterranen Orogens*, two volumes (1945–49). Niggli's contributions to Swiss mineralogy are contained in the two-volume *Die Mineralien der Schweizeralpen* (1940), written in collaboration with others. Other publications include *Das Magma und seine Produkte* (1937), *Gesteine und Minerallagerstätten* (1948) and *Die kristallinen Schiefer*, revised edition, volume 1 (1924), with U. Grubenmann. (C. E. T.)

NIGHT BLINDNESS: *see* VISION: *Dark Adaptation and Rhodopsin, the Rod Pigment.*

NIGHTHAWK, a name applied to certain American birds of the genus *Chordeiles*. Unrelated to true hawks, they belong to the nightjar or goatsucker family (Caprimulgidae). Nighthawks live on insects caught, as the bird flies about, in the open capacious, whisker-bordered mouth. The common nighthawk (*C. minor*) inhabits most of North America, migrating south in winter. Less exclusively nocturnal than other nightjars, it often flies about and migrates all day. Two protectively coloured eggs are laid among gravel or on flat gravel roofs. In courtship the nighthawk plunges toward the earth and pulls out of the dive with a loud "zoom" of air through its quills It also utters a nasal *peent* repeated in flight. *See* also NIGHTJAR. (DN. A.)



PATRICIA WITHERSPOON FROM NATIONAL AUDUBON SOCIETY

COMMON NIGHTHAWK (CHORDEILES MINOR)

NIGHTINGALE, FLORENCE (1820–1910), English nurse, generally accepted as the originator and founder of modern nursing, whose achievements in public health were almost equally important, was born in Florence, Italy, on May 12, 1820, the second daughter of wealthy and cultured parents. Her socially ambitious mother intended that she should make a brilliant marriage, but such ambitions were vain. In 1837, at the age of 17, Miss Nightingale heard, as Joan of Arc had heard, the voice of God calling her to service. A period of perplexity followed as to the form of service she was to undertake, but by 1844 her vocation had become clear: she was to nurse the sick.

A desperate struggle with her family ensued. Nursing at that time was disreputable, and nurses frequently were drunken prostitutes. In spite of the furious opposition she met, Miss Nightingale would not be turned from her determination. When Richard Monckton Milnes, later Lord Houghton, repeatedly pressed her to marry him, she refused, even though he was "the man I adore." Everything had to be sacrificed to her vocation. Years passed in misery and frustration, and it was not until 1851 that she was allowed to gain her first nursing experience, with the Protestant deaconesses at Kaiserswerth in Germany, and not until 1853 that she left home to take her first post, the reorganization of a small hospital in Harley street, London, the Institution for the Care of Sick Gentlewomen in Distressed Circumstances.

The reorganization was a brilliant success, and it was her work in Harley street that led Sidney Herbert, secretary of war in the British cabinet, to invite her to undertake a mission to the Crimea. War with Russia had been declared in March 1854; by October England was ringing with the horrible state of the British military hospitals revealed by the special correspondent of the *Times* (London). Florence Nightingale sailed for the Crimea with 38 nurses

on Oct. 21, 1854, and within a month found that she had more than 5,000 men in her charge. The so-called hospitals were vast dilapidated buildings, filthy, bare, not merely lacking medical equipment but destitute of every convenience for common decency. By superhuman efforts she brought order out of chaos, working day and night, often on her feet for 20 hours at a stretch and hindered at every turn by official jealousy and intrigue. Every night she made a personal inspection of the vast wards. But she did more than make the hospitals sanitary; she revolutionized the treatment of the private soldier, and the army regarded her with something approaching worship.

When the story of her achievements reached home, a great outburst of enthusiasm made her a national heroine, and £45,000 was raised by public subscription as a testimonial and placed at her disposal. But when she returned from the Crimea she insisted on going into retirement. She had dedicated her life to the welfare of the private soldier, and she believed that her popularity would prejudice the government against her. She retired so completely that when in 1907 she was awarded the Order of Merit the announcement came as a surprise; most people thought she had died half a century before.

In fact, however, with Sidney Herbert's help, she had embarked on a movement for army reform, and in 1857, encouraged by Queen Victoria, she obtained a commission to inquire into the sanitary condition of the army. For the first time in history the food, housing and health of the soldier in peacetime were scientifically examined. In 1858 she published an immense volume, *Notes on Matters Affecting the Health, Efficiency and Hospital Administration of the British Army.* In 1859 a commission was set up to inquire into the sanitary condition of the army in India, and in 1863 its report was submitted to Miss Nightingale. Work for the army had become only a part of her activities. Military hospitals had led her to civil hospitals, military nursing to civil nursing, military health to public health. In July 1860, with the sum subscribed as a testimonial, she opened the Nightingale training school for nurses at St. Thomas' hospital. From that date modern nursing may be said to begin. Every probationer entering the school was interviewed by Miss Nightingale and remained under her close supervision. The strain of this, however, was too great, and her health, shaken by her enormous exertions in the Crimea, gave way. Though an invalid, she continued to work, nevertheless, and became a ruthless taskmaster to others. The war office leaned on her advice, all sanitary papers were sent to her, she drew up regulations, framed warrants, reported on barrack plans. She was an acknowledged authority on India, though she had never been there, and viceroy after viceroy came to her for his "Indian education." As the years went by thousands of nurses came under her control, after 1862 district nursing was developed under her guidance; the work involved in that alone would have occupied the whole time of an ordinary woman. Not until 1872, when she "went out of office," did the fury of her work slacken. Then she became interested in mysticism, assisted Benjamin Jowett in the translation of the dialogues of Plato and compiled a book of extracts from the Christian mystics. Personal relationships, especially with young people, became of increasing importance, and she enjoyed a tranquil old age, darkened only by the gradual loss of her sight. She died on Aug. 13, 1910. By her express wish the offer of a national funeral and burial in Westminster abbey was refused, and her coffin was carried to the family grave in the little country churchyard of East Wellow, Hampshire, by six sergeants of the British army.

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(C. W.-SH.; X.)

NIGHTINGALE, the bird celebrated beyond all others for the vocal powers that, contrary to usual belief, it exercises at all hours of the day and night, during several weeks after its return from its winter quarters in the south. The song itself is indescribable, being variations on a complex plaintive air, though many attempts, from the time of Aristophanes to the present, have been made to express in syllables the sound of its many notes. Poets have descanted on the bird (which they nearly always make of the feminine gender) leaning its breast against a thorn and pouring forth its melody in anguish. But the cock alone sings, and there is no reason to suppose that the cause and intent of its song differ in any respect from those of other birds' songs (*see* SONGBIRD).


ERIC HOSKING
EUROPEAN NIGHTINGALE (LUSCINIA MEGARHYNCHOS)

In contrast with the nightingale's voice is the inconspicuous coloration of the bird's plumage, which in both sexes is of a reddish brown above and dull grayish white beneath, the breast being rather darker and the rufous tail showing the only bright tint.

No nightingale (genus *Luscinia*) is found in America, but it is closely related to the American thrush (*q.v.*) and a member of the same family, the Turdidae. The European nightingale (*Luscinia megarhynchos*) is abundant as a summer visitor, breeding in suitable localities in southern England and in Wales. On the continent of Europe it does not occur north of a line stretching irregularly from Copenhagen to the northern Urals. Over south Europe otherwise it is abundant. The nightingale reaches Iran, and is a winter visitor to the Arabian peninsula and Africa. The larger eastern *L. philomela*, russet brown in both sexes, is a native of eastern Europe. *L. hafizi* of Iran is probably the Perso-Arabic bulbul of poets.

The nightingale reaches its English home about the middle of April, the males (as is usual among migratory birds) arriving several days before the females. On the cocks being joined by their partners, the work for which the long and hazardous journey of both was undertaken is speedily begun, and before long the nest is completed. This is of a rather uncommon kind, being placed on or near the ground, the outworks consisting chiefly of a great number of dead leaves ingeniously applied together so that the plane of each is mostly vertical.

In the midst of the mass is wrought a deep cuplike hollow, neatly lined with fibrous roots, but the whole is so loosely constructed, and depends for lateral support so much on the stems of the plants among which it is generally built, that a slight touch disturbs its beautiful arrangement.

In this nest four to six eggs of a deep olive colour are laid and the young subsequently hatched. The nestling plumage of the nightingale differs much from that of the adult, the feathers above being tipped with a buff spot, just as in the young of the European robin, hedge sparrow and redstart, thereby showing the natural affinity of all these forms. Toward the end of summer the nightingale migrates to its African winter haunts.

The name nightingale has been applied to several other birds. The so-called Virginian nightingale is a species of grosbeak; the Pekin nightingale or Japanese nightingale is a small babbler (*Liothrix luteus*) of the Himalayas and China, found also in Hawaii.

NIGHTJAR (GOATSUCKER), *Caprimulgus europaeus*, a bird erroneously believed since very ancient days to have the habit implied by its second name. The family to which it belongs (Caprimulgidae) is almost cosmopolitan, but is not represented in New Zealand and Polynesia. The nightjar is characterized by its flat head, wide mouth fringed with bristles, large eyes and soft plumage which results in noiseless flight. It arrives in Europe from Africa late in the spring, returning in the early autumn. Its food consists of insects, chiefly moths and cockchafers, which it catches on the wing at night.

When resting the nightjar usually sits parallel to the length of a bough. In this position the cock bird utters his curious loud burring song. The two eggs are laid on the ground; the young are clad in dark-spotted down, rendering them, like their parents, exceedingly difficult to see when they crouch on the ground.

The red-necked nightjar (*C. ruficollis*) is very similar to the

common nightjar in appearance but has a reddish-buff collar and white throat patch and is somewhat larger. It occurs in Spain and Portugal. The Egyptian nightjar (*C. aegyptius*) closely resembles the common nightjar. Others are found throughout the old world.

In America their place is taken by the allied species, *Caprimulgus vociferus*, the whippoorwill (*q.v.*). The nighthawk (*q.v.*) is another common American species, with a voice quite different from that of the whippoorwill.

ERIC HOSKING

EUROPEAN NIGHTJAR (CAPRIMULGUS EUROPAEUS)

NIGHT SCHOOL or EVENING SCHOOL, a form of continuing education usually conducted by the public schools for older adolescents and adults through evening classes and other educational activities offered outside of regular working hours. Night schools, especially in industrial cities, often stress vocational education (*q.v.*) and offer cultural and recreational programs as well as general education. In the early 20th century in the United States and Canada many night schools provided courses in English for new immigrants and in Canada such courses were again in demand after World War II. (*See* also AMERICANIZATION.) Communist countries, especially the U.S.S.R. and Communist China, have used night schools extensively. *See* ADULT EDUCATION.

NIGHTSHADE, a general term for plants of the genus *Solanum*, of the nightshade family (Solanaceae), and to certain similar plants in the Solanaceae and other families. The species to which the name of nightshade is commonly restricted in North America and England is *Solanum dulcamara*, also called bittersweet or woody nightshade. It is a native of Europe, north Africa and temperate Asia and is widely naturalized, being a common plant in damp hedgebanks and thickets, scrambling over underwood and hedges, all over eastern and central North America and throughout England.

It has slender, slightly woody stems, with alternate lanceolate leaves, more or less heart shaped, with two leafy lobes at the base. The flowers are arranged in drooping clusters and resemble those of the potato (to which it is related) in shape, although they are much smaller. The flower clusters spring from the stems at the side of, or opposite to, the insertion of a leaf. The corolla is wheel shaped, of a lilac-blue colour with a green, or sometimes white, spot at the base of each segment, and bears the yellow stalkless anthers united at their margins so as to form a cone in the centre of the flower.

JOHN MARKHAM

FRUITING BRANCH OF DEADLY NIGHTSHADE (ATROPA BELLADONNA)

The flowers are succeeded by egg-shaped scarlet berries, one-half inch long. Both the berries and the foliage are poisonous, due to the presence of solanine, sometimes causing convulsions and death if ingested in large doses. The plant derives its names of bittersweet (not to be confused with false or climbing bittersweet [*q.v.*] or waxwork, *Celastrus scandens*, highly prized for its decorative coloured fruit) and dulcamara from the fact that its taste is at first bitter and then sweet.

The black nightshade (*S. nigrum*), also poisonous, differs from the common nightshade in having white flowers in small umbels and globose black berries. It is a common and almost cosmopolitan weed in gardens and waste places, growing about 12 or 15 in. high, and has ovate leaves with the edge entire, sinuate or toothed. The plant is common in eastern North America. From the black nightshade have been derived the garden huckleberry (*S. intrusum*) and the wonderberry (*S. burbanki*), both with edible fruit.

Deadly nightshade or dwale is the belladonna (*Atropa belladonna*), a tall bushy herb of the same plant family and the source of several alkaloid drugs.

The name enchanter's nightshade is applied to weak-stemmed plants of the genus *Circaea*, of the evening primrose family (*see* ONAGRACEAE). Malabar nightshade refers to twining herbaceous vines of the genus *Basella*.

See also SOLANACEAE. (N. TR.; X.)

NIHILISM is a philosophy of skepticism that originated in 19th-century Russia during the early years of the reign of Alexander II and was most clearly expressed in the literary criticism of Dmitri Pisarev. The term (from the Latin *nihil*, "nothing") was first used by Nikolai I Nadezhdin in an article in the *Messenger of Europe*, and it later was popularized by Ivan Turgenev in his celebrated novel *Fathers and Sons* (1862).

The philosophy of nihilism has often been associated erroneously with regicide and the policy of terror employed by a clandestine political organization against the imperial administration. Fundamentally nihilism represented a philosophy of negation of all forms of aestheticism; it advocated utilitarianism and scientific rationalism. The social sciences and classical philosophical systems were rejected entirely. Nihilism represented a crude form of positivism and materialism, a revolt against the established social order; it negated all authority exercised by the state, by the church or by the family. It based its belief on nothing but scientific truth; science became the cure-all for social problems. All evils, nihilists believed, derived from a single source, ignorance, which science alone would overcome. Prince Peter Kropotkin, the leading Russian anarchist, defined nihilism as a struggle against all forms of tyranny, hypocrisy and artificiality in favour of individual freedom. It was a revolt of an adolescent generation that cherished infinite faith in scientific truth.

The thinking of nihilists was profoundly influenced by such men as Ludwig Feuerbach, Charles Darwin, Henry Buckle and Herbert Spencer. Since nihilism denied the duality of man as a combination of body and soul, of spiritual and material substance, it came into violent conflict with ecclesiastical authorities. Since nihilists questioned the validity of the divine right doctrine, they came into similar conflict with secular authorities. Since they scorned all social bonds and family authority, the conflict between fathers and sons was equally immanent, and it is this theme that is best reflected in Turgenev's novel. A comparison between Turgenev's hero, Bazarov, and Leonid Andreyev's Savva, created during the early 20th century, reveals the deterioration of nihilist philosophy, which changed from a faith in science into a justification of destruction. (A. G. M.)

NIHONGI, also known as *Nihon-shoki*, both of which terms mean literally "Written Chronicles of Japan," was compiled in A.D. 720 under imperial proposal and consists of 30 volumes, all written in Chinese. This compilation contains traditional myths, legends and historical records of several of the politically powerful clans as well as those of the imperial family. Chinese and Korean materials were also collected, amplified and reclassified according to the ancient history of Japan. The *Nihongi* includes, therefore, an abundant amount of material concerning Japan's historical period.

The other comparable ancient work, the *Kojiki* (*q.v.*), deals primarily with the divine and prehistoric ages. The *Nihongi* continues the story of the mythical origins down to A.D. 697, just before the Nara period. It describes the impact of early Chinese civilization, the introduction of Buddhism and the Taika reforms, the latter being strongly influenced by the Sui and T'ang dynasties. The *Nihongi* is the first of six officially compiled chronicles (*Rikkoku-shi*) which continued to A.D. 887 by imperial command. The *Nihongi* was read ceremonially before the emperor at the imperial court during the Heian period and fragments survive of the anno-

tations of some of the government scholars of that time. The first printing of the part entitled "Divine Age" appeared in 1599; the most complete commentary, *Nihon-shoki-tsūshaku*, was published in 1899 by Iida Takesato. The English translation of the *Nihongi* was completed by William G. Aston in London in 1896.

See also JAPANESE MYTHOLOGY. (I. H.)

NIIGATA, a *ken* (prefecture) on the Sea of Japan coast of central Honshu, Jap. It includes the offshore islands of Sado and Ao. Area 4,855 sq.mi., pop. (1960) 2,442,037. Combined deposition of the Shinano and Aka rivers in the central part of the long coastline has created Niigata's key lowland, the Echigo plain. The rest of the prefecture is mountainous except for small southern coastal plains and lowlands along river courses. Niigata is Japan's largest rice producer and normally has the largest rice surpluses for shipment to city markets. Bad drainage and heavy winter snow cover prohibit winter cropping in most areas. Coastal fishing is practised. Cheap and plentiful hydroelectric power generated in the interior mountains has stimulated industrial growth (especially chemicals, metals and machinery) since 1940 in such cities as Niigata, Kashiwazaki, Naoetsu, Sanjō and Takada. Niigata produces large amounts of petroleum (Nagaoka and Kashiwazaki) and natural gas.

NIIGATA CITY, the prefectural capital and largest city (pop. [1960] 314,528), is located on the sea edge of the Echigo plain at the mouth of the Shinano river. It was an important rice port in feudal times and has continued as the leading Sea of Japan port in spite of silting, strong winds and stormy winters. Coal and raw materials imports predominate. In addition to its port, general commercial and administrative functions, Niigata is a growing industrial city (chemicals, cotton textiles, metals, machinery, paper and shipbuilding). Excellent local deposits of natural gas and available hydroelectricity have attracted many large factories. An earthquake, Japan's most severe since 1923, struck the city and surrounding area in June 1964, causing loss of life, many injuries and extensive property damage. (J. D. EE.)

NIJHOFF, MARTINUS (1894–1953), Dutch poet and critic whose work had great influence on modern Dutch poetry, was born April 20, 1894, at The Hague. He studied law at Amsterdam and literature at Utrecht, and was for many years editor of the long-established literary periodical, *De Gids*. He died at The Hague, Jan. 26, 1953.

Nijhoff began his literary career with *De Wandelaar* (1916), a collection of symbolical poems expressing an essentially modern anguish and despair in traditional poetic forms. It was followed by *Pierrot aan de lantaren* (1919), a poetic dialogue between Harlequin and Pierrot. His best-known collection, *Vormen*, appeared in 1924. He returned to more serious themes in *Nieuwe Gedichten* (1934) and *Het uur U* (1941). In Nijhoff's poetry simple everyday words are charged with power, and this makes his work almost untranslatable. In his prose sketch, *De pen op papier* (1927), he deals playfully with the process of poetic creation. He also wrote plays—*De Vliegende Hollander* ("The Flying Dutchman") (1930), written for an open-air performance by undergraduates, and a biblical trilogy, *Het heilige hout* (1950)—and translated both classical and modern works.

See T. de Vries, *M. Nijhoff, wandelaar in de Werkelijkheid* (1946). (GD. W. HS.)

NIJINSKY, VASLAV (WASLAW) (1890–1950), Russian dancer, whose remarkable performances with the Diaghilev ballet brought him an almost legendary fame. Born in Kiev, Feb. 28, 1890, Nijinsky studied under Legat and Oboukhov in the Russian Imperial Ballet school, St. Petersburg, graduating in 1908. Almost immediately, Sergei Diaghilev selected him as leading dancer of the company he presented in Paris in 1909. Diaghilev deeply influenced Nijinsky's entire career. Endowed with phenomenal technique and a genius for characterization, Nijinsky scored triumphs in *Petrouchka*, *Carnaval*, *Scheherazade* and *Le Spectre de la Rose*, all of which were created by Michel Fokine. A daringly original choreographer, Nijinsky created *L'Aprés-midi d'un Faune*, *Le Sacre du Printemps*, *Jeux* and *Till Eulenspiegel* (the latter produced in America without Diaghilev's personal supervision), all for the Diaghilev ballet. In 1913 Nijinsky married Romola de Pulzky. His brief career was terminated in 1917 by the threat of insanity, which shadowed the rest of his life. He died in London on April 8, 1950.

Nijinsky's sister, Bronislava Nijinska (1891–), became a distinguished choreographer.

See Romola Nijinsky, *Nijinsky* (1934). (LN. ME.)

NIJMEGEN (Ger. NIMWEGEN), the oldest town of the Netherlands and the largest in Gelderland province, extends along the Waal (southern arm of the Rhine) 10 mi. S.S.W. of Arnhem near the German border. Pop. (1960) 127,172. An important industrial centre (metal products, machinery, electrical and heating apparatus, paper, artificial fibres, soap, clothing and shoes are among its manufactures), it has excellent railway and inland water communications with western Europe.

Nijmegen, the Roman Noviomagus, like Rome, was built on seven hills rising from the riverside. It was a free imperial city and later a member of the Hanseatic league; in 1579 it joined the Utrecht Union and the peace treaty between Louis XIV, the Netherlands, Spain and the Holy Roman empire was signed there in 1678. Until 1874 it served mainly as a frontier fortress. The old town walls were demolished (1877–1884) and were replaced by a promenade and gardens. Subsequently a fine new town grew up on the south side. During World War II the town centre was badly damaged (it has since been rebuilt along contemporary lines), and later Nijmegen was the scene of a U.S. airborne landing.

A beautiful park, the Valkhof, contains some remains of Charlemagne's palace. This was destroyed by Norsemen but was rebuilt by Frederick Barbarossa in 1155 and was finally demolished (1796). Only two portions remain; the choir of the 12th-century palace-church and a 16-sided baptistery, probably constructed between 800 and 1400. Both these have been restored several times. Close-by is the lofty 17th-century watchtower of the Belvedere (now a restaurant). The fine Renaissance Grote Kerk of St. Stephen, enlarged in the 15th and 16th centuries, was severely damaged in 1944; partly rebuilt, its renovated tower is again one of the town's most striking features. The Renaissance Raadhuis or town hall also sustained war damage but has been splendidly restored; a collection of 17th-century Gobelins forms the *pièce de résistance* of its art collection. Other notable buildings include Latijnse school (1544–45), the Laekenhal (Cloth hall, now a restaurant), the Waag or Weighhouse (1612), the chapel of the old cloister Marienburg (now the municipal museum), the restored 16th-century Besienderhuys, the Brewershouse, the Protestant Children's orphanage and the modern church of St. Peter Canisius (1960). The Rijksmuseum Kam houses an important collection of Roman antiquities.

Nijmegen is the seat of a Roman Catholic university (founded 1923) with an important medical faculty and hospital.

NIJMEGEN, TREATIES OF (1678, 1679), the treaties of peace terminating the great war that Louis XIV of France had begun in 1672 (*see* DUTCH WARS). Negotiations having begun in 1676, the first treaty was concluded between France and the estates-general of the United Provinces of the Netherlands on Aug. 10, 1678. France agreed to return Maastricht and to remove the protectionist discrimination against the Dutch contained in J. B. Colbert's tariff of 1667. This was dependent on the second agreement, which was concluded between France and Spain on Sept. 17, 1678, by which Spain renounced Franche-Comté and agreed to frontier changes in Flanders, Hainaut and Artois. The peace represented a defeat for the French attempt to subdue the United Provinces politically and commercially, but was otherwise a substantial achievement: Louis XIV had withstood a powerful coalition and obtained important concessions from Spain. The estates-general made peace against the advice of William III of Orange, stadholder of Holland, who saw the European as well as the Dutch interest, and without the agreement of the Holy Roman emperor Leopold I, who continued fighting for some months longer. At length Leopold too accepted French terms, by the treaty of Feb. 5, 1679, keeping Philippsburg (which his forces had taken) but renouncing Freiburg im Breisgau and granting free access to it from Breisach (French since 1648). France also continued to occupy Lorraine, since the duke, Charles V, refused the conditions

imposed for his restoration. Two further treaties in 1679 terminated hostilities between France and Brandenburg (peace of St. Germain, June 29) and between France and Denmark (peace of Fontainebleau, Sept. 2). Brandenburg and Denmark restored to France's ally Sweden territories taken by them. (I. F. B.)

NIKE, the Greek goddess of victory (Lat., VICTORIA). She does not appear personified in Homer. In Hesiod she is the daughter of the giant Pallas and of the infernal river Styx, and is sent to fight on the side of Zeus against the Titans. Nike does not appear to have been the object originally of a separate cult at Athens. She was at first connected and confounded with Pallas Athena, the dispenser of victory, but gradually separated from her. As an attribute of both Athena and Zeus, Nike is represented in art as a small figure carried in the hand by those divinities. Athena Nike was always wingless, Nike alone winged. She also appears carrying a palm branch or a wreath (sometimes a Hermes staff as

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NIKE, FROM A BRONZE VESSEL, PROBABLY MADE IN A GREEK CITY OF SOUTHERN ITALY, ABOUT 490 B.C.

the messenger of victory), erecting a trophy or recording a victory on a shield, or, frequently, hovering with outspread wings over the victor in a competition; for her functions referred to success not only in war but in all other undertakings. In fact, Nike gradually came to be recognized as a sort of mediator of success between gods and men.

At Rome, Victoria was worshiped from the earliest times. The legendary Evander was said to have erected a temple in her honour on the Palatine before the foundation of Rome itself. She was identified with the obscure Sabine goddess Vica Pota and others. Special games were held in her honour in the circus, and generals erected statues of her after a successful campaign. She came to be regarded as the protecting goddess of the senate, and her statue in the Curia Julia (originally brought from Tarentum and set up by Augustus in memory of the battle of Actium) was the cause of the final combat between Christianity and paganism toward the end of the 4th century.

Victoria had altars in military camps, a special set of worshipers and colleges, a festival on Nov. 1, temples at Rome and throughout the empire. Representations of Nike-Victoria are numerous.

NIKISCH, ARTHUR (1855–1922), Austro-Hungarian conductor who followed the tradition of Hans von Bülow. Born at Lebenyi Szant Miklos on Oct. 12, 1855, he studied in Vienna from 1866 to 1873 under J. Hellemesberger, W. Schenner and F. O. Dessoff. In 1878 he was appointed coach at the Leipzig opera and in the following year he became principal conductor there. He was conductor of the Boston Symphony orchestra (1889–93) and of the Gewandhaus orchestra at Leipzig from 1895 until his death there (Jan. 23, 1922). During this time he was also conductor of the Berlin Philharmonic orchestra, with which he toured widely. In 1897 he succeeded von Bülow as conductor of the Philharmonic concerts at Hamburg. He toured the U.S. with the London Symphony orchestra in 1912 and conducted the *Ring* at Covent Garden in 1913. He excelled in performances of Wagner. His style was marked by intensity of romantic expression and his technique by severe precision and economy of gesture. As an accompanist at the piano he appeared in recitals with his pupil Elena Gerhardt, the *Lieder* singer.

See F. Pfohl, *Arthur Nikisch* (1925).

NIKKŌ, a small town in Tochigi prefecture, one of the chief centres of pilgrimage and sightseeing in Japan, lies in the Kwanto region of Honshu about 90 mi. (145 km.) N. of Tokyo, at the edge of Nikkō National park. Pop. (1960) 33,348. A Shintō shrine seems to have existed at Nikkō as early as the 4th century A.D., and in 767 a Buddhist temple was founded there by Shōdō Shōnin. Since the 17th century, however, Nikkō has been dominated by the great Tōshōgu shrine dedicated to the first of the Tokugawa shoguns, Tokugawa Ieyasu, who was buried there in 1617, and the Daiyuin mausoleum dedicated to his grandson Iemitsu (Iyemitsu), the third Tokugawa shogun, who died in 1651. The shrines and associated buildings are notable for their gorgeous colour and detail, but are thought by some to be overdecorated and often weak in design. Their magnificent setting, especially the grove of giant Japanese cedars in which they stand, greatly enhances the attractiveness of Nikkō. There are scores of hot mineral springs in the scenic Nasu volcanic area of the national park which also includes mountain peaks, waterfalls and lakes. The Nikkō Botanical garden of alpine flora is maintained by Tokyo university. (R. M.)

NIKOLAYEV, an *oblast* of the Ukrainian Soviet Socialist Republic, U.S.S.R., formed in 1937, covers an area of 9,614 sq.mi. Pop. (1959) 1,013,839. The *oblast* lies on the Black sea plain (Prichernomorskaya Nizmennost), which slopes down gently from the Dnieper uplands in the extreme north to the Black sea coast. The northern part is very much cut up by gullies, and soil erosion generally is severe. The Southern Bug river crosses the *oblast* and enters the sea by a long, winding estuary. There is little other surface water and even the larger rivers, such as the Gniloi Yelanets and Ingul, nearly dry out in summer. The coast has many lagoons and drowned valleys, often sealed off by sandbars. The whole area is steppe, with chernozem soils developed on loess, and a high proportion is plowed up for winter wheat, maize (corn), sunflowers and sugar beet. Vineyards and gardens are widespread, especially on the left bank of the Bug. Cattle and sheep are kept in large numbers. Only 400,310 (39%) of the people are urban. Apart from the administrative centre of Nikolayev, the 4 towns and .. urban districts are all small. Industry is chiefly concerned with processing agricultural products. In the north much granite is quarried. (R. A. F.)

NIKOLAYEV, a town and administrative centre of an *oblast* in the Ukrainian Soviet Socialist Republic, U.S.S.R., stands on the left bank of the estuary of the Southern Bug, at the Ingul outfall, about 40 mi. from the Black sea and 65 mi. from Odessa. Pop. (1959) 226,207. It was founded, near the site of the ancient Greek Olbia, in 1788 as a naval base, after the Russian annexation of the Black sea coast. In the 1870s a railway was built to the port. It is now one of the most important Soviet Black sea ports and a major shipbuilding centre specializing in tankers, trawlers, dredgers and diesel-propelled craft. Other engineering products include cement- and road-making machinery, equipment for metallurgical and coke-chemical factories, pumps, roller bearings and conveyer belts. There are also clothing, footwear and food industries. Nikolayev has shipbuilding and pedagogic institutes and an observatory. The port has rail links southeast to Kherson and the Crimea, northeast to Dnepropetrovsk and north to Kiev and central Russia. It was held (1941–43) by the Germans during World War II. (R. A. F.)

NIKOLAYEVSK-ON-AMUR, a town and port of Khabarovsk *krai* of the Russian Soviet Federated Socialist Republic, U.S.S.R., stands at the head of the Amur estuary, on its northern bank. Pop. (1959) 30,923. Founded in 1850, it was for a few

years thereafter the main Russian settlement of the far east. It declined, however, and is now overshadowed by the new port and naval base of Sovetskaya Gavan, 300 mi. S., which has rail communication with the interior. Transshipment from seagoing to river craft takes place at Nikolayevsk and there are shipbuilding and repair yards. A fishing fleet is based there. Other industries include furniture, brick and confectionery making, and brewing. Iron ore is mined in the vicinity and sent to the steel mill at Komsomolsk-on-Amur. Nikolayevsk is the focus for local air services.

(R. A. F.)

NIKON (Nikita Minin) (1605–1681), Russian patriarch and the leader of a reform movement that caused the schism in the Russian Orthodox Church, was born in the village of Vel'demanovo in the province of Nizhni Novgorod (now Gorki), the son of a peasant of Finnic stock. After acquiring the rudiments of an education in a nearby monastery, Nikon married, entered the clergy and settled in Moscow; but the death of all three of his children caused him to seek repentance and solitude. For the next 12 years (1634–46) he lived as a monk, as a hermit and finally as an abbot in several northern localities. In 1646 he came on monastic business to Moscow, where he made so favourable an impression on the young tsar Alexis and on the patriarch Joseph that they appointed him archimandrite (abbot) of the Novospasski monastery in Moscow, the burial place of the Romanov family. During his stay there, Nikon became closely associated with the circle led by the tsar's confessor, Stefan Vonifatiev, and the priests Ivan Neronov and Avvakum Petrovich (all natives of the Nizhni Novgorod province), which strove to revitalize the church by bringing about closer contact with the mass of the faithful and to purify religious books and rituals from errors and Catholic accretions. With their help Nikon became first metropolitan of Novgorod (1648) and then patriarch of Moscow and all Russia (1652).

Nikon accepted the highest post in the Russian church only on condition that he should receive full authority in matters of dogma and ritual. In 1654, when the tsar departed for the campaign against Poland, he asked Nikon to supervise the country's administration as well as watch over the safety of the tsar's family; and in 1657, with the outbreak of the new war with Poland, he endowed him with full sovereign powers. Nikon, enjoying the friendship of the tsar, the backing of the reformers and the sympathy of the population of Moscow, stood at the pinnacle of his career.

It was not long, however, before Nikon alienated his friends and infuriated his opponents by his high-handed methods and brutal treatment of all those who disagreed with him. On assuming the patriarchate he consulted Greek scholars employed in Moscow and the books in the patriarchal library and concluded not only that many Russian books and practices were badly corrupted but also that the revisions which the circle of Vonifatiev had promulgated introduced new corruptions. He now undertook a thorough revision of Russian books and rituals in accord with their Greek models to bring about uniformity in the whole Orthodox Church. When his onetime friends rejected his reforms, Nikon had them exiled. Assisted by Greek and Kievan monks and supported by the Greek hierarchy, he now carried out several reforms of his own: he altered the form of bowing in the church, replaced the two-fingered manner of crossing with the three-fingered one and ordered that three alleluias be sung where tradition called for two. An ecclesiastical assembly that he convened in 1654 authorized him to proceed with the revision of liturgical books. He next began to remove from churches and homes icons that he considered incorrectly rendered. To quell mounting opposition to these moves he called in 1656 another assembly, which excommunicated those who failed to adopt the reforms.

Though all the changes introduced by Nikon affected only the outward forms of religion, some of which were not even very old, the population and much of the clergy resisted him from the beginning. The relatively uneducated clergy refused to relearn prayers and rituals, while the mass of the faithful was deeply troubled by Nikon's contempt for practices regarded as holy and necessary for Russia's salvation. This was the origin of the *Raskol* or great schism with the Russian Orthodox Church. Yet what really brought about Nikon's downfall was the hostility of the tsar's family and the powerful boyar families; they resented the autocratic manner in which he exercised authority in the tsar's absence and also objected to his claims that the church was superior to the state.

When Alexis returned to Moscow in 1658, relations between tsar and patriarch were no longer what they had been. Grown in self-confidence and incited by relatives and courtiers, Alexis ceased to consult the patriarch, though he avoided an open break with him. Nikon finally acted after several boyars had insulted him with impunity and the tsar failed to appear at two consecutive services at which Nikon officiated. On July 20 (new style; 10, old style), 1658, he announced his resignation to the startled congregation in the Church of the Assumption in the Kremlin; shortly afterward he retired to the Voskresenski monastery.

Nikon had apparently hoped in this manner to compel the tsar, whose piety was well known, to recall him and to restore his previous influence. This did not happen. After several months in self-imposed exile, Nikon began to regret his decision and attempted a reconciliation, but the tsar either refused to answer his letters or urged him to formalize his resignation. Nikon refused to do so on the ground that he had resigned merely from the Moscow see, not from the patriarchate as such. For eight years, during which Russia was effectively without a patriarch, Nikon stubbornly held on to his post, while Alexis, troubled by lack of clear precedent and by the fear of damnation, could not decide on a formal deposition. Finally, in Nov. 1666, Alexis convened a council attended by the patriarchs of Antioch and Alexandria to settle the dispute. The charges against Nikon were presented by the tsar himself. They concerned largely his behaviour in the period of the tsar's absence from Moscow, including his alleged arrogation of the title of "grand sovereign"; many of the charges were entirely without foundation. The Greek hierarchy now turned against Nikon and decided in favour of the monarchy. A Greek adventurer, Paisios Ligaridis (now known to have been in contact with Rome), was particularly active in bringing about Nikon's downfall. The council deprived Nikon of all his sacerdotal functions and on Dec. 23 (N.S.) exiled him as a monk to Beloozero. It retained, however, the reforms he had introduced and confirmed the excommunication of those who had opposed them and who were henceforth known as Old Ritualists (or Believers). In his last years Nikon's relations with Alexis improved. The succeeding tsar, Fedor III, recalled Nikon from exile; but Nikon died on Aug. 27 (N.S.), 1681, on the way back to Moscow.

Nikon was one of the outstanding leaders of the Russian Orthodox Church, an able administrator and firm in his principles. His ultimate failure was due to two main factors: (1) his effort to establish the hegemony of church over state had no precedent in Byzantine or Russian past and could not be enforced; and (2) he had an uncontrollable temper and an autocratic character that alienated all who were in contact with him and enabled his opponents first to disgrace and then to defeat him.

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(R. E. Pi.)

NIKOPOL, a town in Pleven *okrug* (district), northern Bulgaria, picturesquely situated on the bank of the Danube, east of the mouth of the Osum tributary, 23 mi. N.E. of Pleven city. Pop. (1963 est.) 5,817. It had in the past been confused with Nicopolis ad Istrum, founded by Trajan, but in 1871 the site of the latter was established as the village Nikyup on the Rositsa river about 50 mi. S.E. of Nikopol and the Roman town was largely uncovered by the 1960s. Nikopol was an important Danubian stronghold (ruined fortresses still dominate the town) founded by the Byzantine emperor Heraclius early in the 7th century. It was the scene of many battles. There in 1396 Sultan Bayazid I defeated a crusader's army led by King Sigismund of Hungary, an event that decided the fate of the Balkan peoples for centuries. During the Russo-Turkish Wars the Russians under Gen. N. P. Krudener stormed and captured the town (1877). Farming, viticulture and fishing are the main means of livelihood. (An. Be.)

NIKOPOL, a town in Dnepropetrovsk *oblast* of the Ukrainian Soviet Socialist Republic, U.S.S.R., stands on the northern shore of the Kakhovka reservoir (Kakhovskoye Vodokhranilishche) on the Dnieper, and on the Zaporozhe-Krivoi Rog railway 65 mi. S.S.W. of Dnepropetrovsk city. Pop. (1959) 82,992. Founded as Nikitin Rog in the 1630s at a strategic crossing of the river, it was renamed Nikopol in 1782. It is important as the centre of the world's largest deposit of manganese, first mined there in 1886. Reserves are estimated at more than 500,000,000 tons. The metallurgical industry produces steel tubes, cranes and agricultural machinery, and food processing and brewing are also important. A dam protects the lower part of the town. (R. A. F.)

NILE, an African river whose basin is the dominant feature of the northeastern quarter of the continent. Its length as the water flows from its most distant source to the entry of the Rosetta branch of the Nile delta into the Mediterranean is about 4,157 mi. This source is the head of the Luvironza in latitude 3° 40′ S. and about 30 mi. E. of Lake Tanganyika. The Nile is probably the longest river in the world. The Mississippi-Missouri was once taken to be the longest but the U.S. army engineers later gave the length from the most remote source of the Missouri to the sea as 3,860 mi. The Amazon also may be more than 4,000 mi. long, but its length is taken from maps on a scale of 1:1,000,000, while the Nile has been measured from maps on scales ranging from 1:100,000 to 1:250,000. More detailed maps of the Amazon on a larger scale would be likely to increase its estimated length because of the effect of sinuosity. The name Nile comes from the Greek Neilos (Latin Nilus), whose origin is unknown. Aiguptos in the Odyssey is the name of the Nile (masculine) as well as of the country of Egypt (feminine) through which it flows and survives both in the name Egypt and in the name Copt (*gupti* in the Arabic of upper Egypt). At the present time the Nile in Egypt and in the northern Sudan is called En Nil, El Bahr ("the river") or El Bahr en Nil (Nahr an Nil).

The basin covers approximately 1,100,000 sq.mi., or about one-tenth of the area of Africa. It embraces parts of Uganda, Kenya, Tanzania, Rwanda and Burundi, the Republic of the Congo, most of the Sudan, part of Ethiopia and the cultivated portion of Egypt (U.A.R.). It supports a rapidly increasing population, estimated at more than 50,000,000 in the mid-1960s, of whom about half live in Egypt. It is possible to travel by car in the dry season over most of the basin; but south of latitude 15° N. over the plains of the Sudan, motor transport is not usually possible from May to November. There are all-weather roads on the Lake plateau (around Lake Victoria in the Great Rift valley) and in the higher country leading to it and the Nile-Congo watershed.

Three principal streams form the Nile. The largest in volume is the Blue Nile (Al Bahr al Azraq, Sudan; Abay, Ethiopia), which draws practically all of its water from Ethiopia and contributes four-sevenths of the total supply of the main stream. Next comes the White Nile (Al Bahr al Abyad), which is the longest branch and supplies two-sevenths of the total; its headstreams flow into Lakes Victoria and Albert; and lower down in the Sudan it receives the Sobat, which obtains its water mainly from Ethiopia. The White Nile and Blue Nile join at Khartoum. Last there is the Atbara, draining the northwestern part of Ethiopia and joining the main stream 200 mi. N. of Khartoum, which contributes the remaining one-seventh. The Blue Nile and Atbara are both muddy rivers in flood time and bring down the soil that has made the cultivable land of Egypt and is still adding to it. From the Atbara junction over the great S-shaped bend to the Nile delta and to within a few miles of the Mediterranean there is not enough rain to produce any crops, and so this area depends entirely on irrigation by Nile water. The river is navigable from the sea to the high Aswan dam and then to Wadi Halfa (about 950 mi.), and the Aswan dam and the barrages are passed by locks. Between Halfa and Khartoum the river is broken up by the cataracts, and ordinarily navigation is possible only in short stretches. From Khartoum the White Nile is navigable for 1,104 mi. to Rejaf, 100 mi. from the Uganda border, the Jebel Aulia (Jabal al Awliya') dam, 25 mi. S. of Khartoum, being passed by a lock. From Rejaf to the Uganda border the river is again beset with rapids, but there is navigation from Nimule on the border into Lake Albert and up the Victoria Nile to the foot of the Murchison falls. Between Lakes Albert and Victoria there are two successions of rapids with a navigable stretch which includes Lake Kyoga (Kioga) between them. The Blue Nile is navigable during flood for 385 mi. as far as Roseires (Er Roseires; Ar Rusayris), though it is interrupted by the Sennar dam which has no lock. During the flood season the Sobat is navigable up to Gambela and the Bahr el Ghazal up to Wau (Waw). Regular air services operate on important routes throughout the Nile basin, including Ethiopia.

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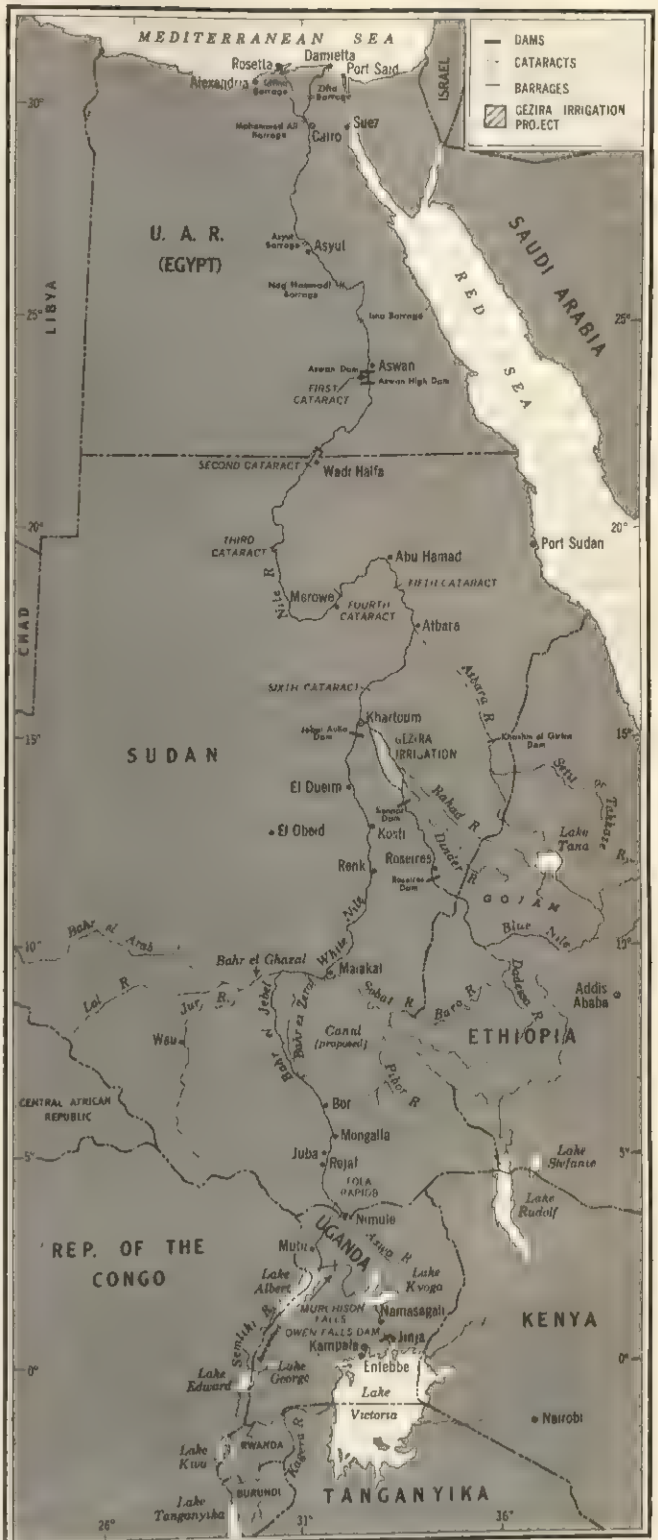
DHOW ON THE NILE AT ASWAN, UPPER EGYPT

White Nile.—The main stream of the White Nile begins on the Lake plateau of east Africa, where there are two separate river systems, the Victoria Nile and the Lake Albert system. Most of this country lies 4,000 ft. or more above sea level and thus enjoys a pleasant climate. Two rivers, the Niavarongo (Nyawarongo) and Ruvuvu, may justly be considered the headwaters of the White Nile, since they join together to form the Kagera (*q.v.*), the most important tributary of Lake Victoria. The Kagera is a stream 510 mi. long from the source of the Luvironza to its mouth, near which it is 80 yd. wide. Of the other tributaries of Lake Victoria (*q.v.*), the largest from the point of view of discharge is the Nzoia in the northeast, which has rather less than half the discharge of the Kagera and is torrential, with only a small flow in the dry season; it draws its water from Mt. Elgon and the high country to the northeast of Lake Victoria. The lake has an area of about 26,800 sq.mi. inclusive of islands and is like a small sea as it is subject to considerable storms. The Nile leaves Lake Victoria by the Ripon falls, which are now submerged because of the dam at the Owen falls a mile or more lower down.

At this point the supposed connection between the level of Lake Victoria and sunspots may be mentioned. From 1896 to 1927 maximum and minimum lake levels coincided with maximum and minimum sunspot numbers, thus giving rise to the theory of a connection. Later, however, this regularity disappeared. Moreover, on theoretical grounds the connection is unlikely, so the coincidence in the first of the records must be considered as accidental. Indeed, by the middle of the 20th century no connection between sunspot activity and any portion of the Nile had yet been established. The river below the lake, known as the Victoria Nile, is first beset with rocks and rapids but becomes navigable just above Namasagali (50 mi. from the lake). Below this are the combined Lakes Kyoga and Kwania, which are shallow with many

arms filled with papyrus-reed swamp. Masses of papyrus are broken loose by strong winds and sometimes have closed the Victoria Nile completely. Navigation has been abandoned and is being replaced by extensions of railways. Below Kyoga the Nile is navigable until it turns westward, after which there is a series of rapids finishing with the Murchison falls. There the Nile passes through a narrow cleft in the rock and falls a distance of about 120 ft. A short distance from the Murchison falls the Victoria Nile enters Lake Albert (*q.v.*). Lake Albert is at the tail end of another river system which starts from near some of the Kagera sources but on the northern side of the Mfumbiro, or Virunga, volcanoes. The principal headstream of this system is the Rutshuru river, which runs along the Rift valley northward to Lake Edward (*q.v.*). Lake George, which is much smaller, is joined to Lake Edward by a broad channel. The Semliki river, a fair-sized river, connects Lake Edward with Lake Albert. It flows in places through thick forest along the western side of the Ruwenzori range, of which it receives the drainage. Lake Albert lies between the high escarpments of the Rift valley, which in places come down abruptly to the water. It has an area of about 2,050 sq.mi. Below Lake Albert the river is known as the Albert Nile or Bahr el Jebel ("river of the mountain"), by which name it is known in the Sudan. For about 140 mi. the Bahr el Jebel is a placid stream, often with swampy edges abounding in mosquitoes; but at Nimule, on the Sudan-Uganda boundary, it ceases to be navigable for nearly 100 mi. as it descends from the plateau to the Sudan plains. Just below Nimule are the Fola (Fula) rapids, a fine sight, where the river rushes through a confined channel between rocks. After its arrival in the plains of the Sudan the country is flat except for rare rocky hills outcropping from the plain. Between Lake Albert and the plains the river receives some tributaries of a torrential nature, of which the principal is the Aswa from the southeast. The principal feature of the Bahr el Jebel when it reaches the plain is the large swamps of the Sudd region, where half its water is lost. Through these swamps the river winds between walls of high vegetation, papyrus, reeds and elephant grass, which except for lagoons and side channels extend from the river to the dry ground on either side, which may be miles away. Very few people are seen when once the river enters the swamps since only occasionally does it touch the higher ground. The country on the edge of the swamps provides good grazing, which lasts into the dry season, as the river, when high, floods a lot of country that is not permanent swamp. Most of the tribes of these southern plains, Nuers, Dinkas and Shilluks, are cattle-owning people living in a very primitive fashion. In the 19th century the Bahr el Jebel was frequently closed by blocks of vegetation (Arabic, *sudd*). Between 1899 and 1904 the river, which had been completely blocked over long distances, was cleared. Since navigation became regular and frequent these blocks have only very rarely been formed in the main stream, though less-frequented streams are occasionally blocked. About halfway through the swamps a separate channel, known as the Bahr ez Zeraf (Bahr az Zaraf) ("river of giraffes"), has been formed near the edge of the dry ground on the east and follows an independent course to the White Nile. In former times it was sometimes connected with the Bahr el Jebel, and a permanent connection has been made by means of two cuts dredged where the two streams are close together. At the tail end of the swamps the Bahr el Jebel is joined by the Bahr el Ghazal from the west and the two together flow eastward as the White Nile, being joined later by the Bahr ez Zeraf. The Bahr el Ghazal ("river of gazelles") is formed by the junction of a number of torrents coming from the southwest and west. The main stream is the Jur, which is navigable in flood up to a point south of Wau, the capital of the Bahr el Ghazal province. Next to the Jur in size is the Lol, into which a number of tributaries flow. It ends in swamps to the west of the Jur, as also does the Bahr el 'Arab; other streams end in swamp to the east. The effect of the swamps is that very little water flows out of the mouth of the Bahr el Ghazal into the White Nile. In the southern part of the Bahr el Ghazal basin the principal tribe is that of the Azande, who came originally from the Congo and are agriculturalists and craftsmen.



ADAPTED FROM A MAP COMPILED BY THE SURVEY OF EGYPT

THE NILE RIVER AND ITS TRIBUTARIES

The Sudd region of large permanent swamps ends at the junction of the Bahr el Ghazal and the Bahr el Jebel, although there is some swamp fringing the White Nile nearly as far as the mouth of the Sobat. The Sobat draws the greater part of its water from the Ethiopian plateau, though a little comes from the south. It is formed of two main streams, the Baro flowing from east to west and the Pibor from the south. From the Ethiopian mountains to the White Nile the country is flat grass plain liable to be flooded in the rains and in parts waterless in the dry season. The Sobat is in flood from July to October on its headwaters and, as a result

of the inflow from flooded areas, remains high at its mouth until December. It is navigable in flood to Gambela on the Baro and to Pibor Post on the Pibor, but the journey for the greater part is monotonous. The Pibor is occasionally blocked by vegetation. From the Sobat mouth to Khartoum the White Nile is a wide placid stream with a very small slope and often a narrow fringe of swamp. After Jebelein (Al Jabalayn) the country gradually becomes more arid and savanna forest gives place to thorn scrub, until near Khartoum it is almost desert. At Kosti the railway from Khartoum that follows the Blue Nile southeastward to Sennar and then turns southwestward on its way to El Obeid crosses the White Nile on a bridge with an opening span. Twenty-five miles from Khartoum is the Jebel Aulia dam, containing a lock, which forms a reservoir the effect of which, when full, extends beyond Renk, 280 mi. upstream.

Between Malakal and Khartoum end the regions of Negro people speaking their own languages—Bantu in the far south and then Sudanic—and begins a region where the people are of mixed Arab and Negro descent and speak Arabic. In fact, Arabic is understood by riverside people and people on the main routes all over the southern Sudan, while in Uganda and east central Africa the lingua franca is Swahili.

Blue Nile.—This is the source of nearly 70% of the Nile flood. The reputed source of the Blue Nile is a spring to the south of Lake Tana (*q.v.*) in Ethiopia, from which flows the Little Abbai or Abbai, the principal tributary of the lake. The lake is in a basin at an altitude of about 6,000 ft. (1,840 m.), but with high mountains at no great distance. It has an area of about 1,418 sq.mi. (3,673 sq.km.) and is shallow. The Blue Nile leaves the lake over a series of rapids and very soon drops into a deep gorge in places 4,000 ft. below the general level of the plateau. Tracks descend to the river at places where at low stage there are fords. It is usually a two days' journey with mules to descend, cross the river and climb up the other side of the canyon. Tributary streams have cut similar ravines, and the scenery is magnificent both in scale and ruggedness. It is not possible to travel along the bottom of the gorge and the river is continually interrupted by rocks and rapids. There is a bridge at Shafartak where the road from Addis Ababa to Gojam crosses the river. Only a small portion of the Blue Nile water comes out of Lake Tana; by far the greater part is from tributaries, some of which are important streams, for example the Bashilo, Jamma, Guder, Dadessa (Didessa), Dabus, Balas, Dinder and Rahad. The water is derived from the rain that falls on the Ethiopian plateau and not from melting snow as sometimes stated. The highest mountains in Ethiopia reach 15,000 ft. but snow seldom falls on them.

A dam was under construction in the 1960s at Roseires and halfway between there and Khartoum is the Sennar dam, by means of which an area of 1,000,000 ac. in the Gezira between the Blue and the White Niles is irrigated. The water is impounded in flood and used in February and March. It is a good example of co-operation —originally between the government, a foreign company holding a concession and the Sudanese tenants, then, after the concession had terminated, between the government and the tenants only. The Gezira project is well planned, and irrigation is based on careful measurement by weirs and other devices of the quantities of water entering the feeders from the main canal. The principal crops are cotton, millet and *lubia* (a kind of bean). Between Sennar and Khartoum the Blue Nile receives two tributaries: the Dinder and the Rahad. These, like the Blue Nile, are torrential but, unlike it, dry up entirely except for pools (though both are considerable streams in flood).

Main Nile.—The main stream, from Khartoum northward, flows between deserts with a narrow strip of vegetation on either side. Where the soil permits, the banks and neighbouring flatland are cultivated by the use of Nile water and support a small population. These conditions continue to Aswan and a little farther north. In this stretch the Nile receives its last tributary, the Atbara river (*q.v.*), which in flood is a large muddy river and in the dry season is a string of pools. A dam was under construction at Khashm el Girba (Khashm al Jarbah). The Atbara's principal tributaries are the Setit, or Takkaze, and the Bahr as Salam (Angareb). From Abu Hamad onward the valley is often rocky and desolate, particularly in the neighbourhood of the Fourth cataract and for more than 100 mi. S. of Wadi Halfa, where the country is known as the Batn al Hagar ("belly of stones"). Wadi Halfa is just below the Second cataract and is within the area affected by the heightened Aswan reservoir, which ponds water up as far back as the cataract. The low Aswan dam, which has been raised twice, has a height of nearly 53 m. (174 ft.) and a length of 2 km. (1½ mi.) and stores 5,300,000,000 cu.m. of water. (The high Aswan dam is discussed under *Irrigation, Flood Control and Water Utilization*, below.)

From Aswan northward to Cairo the river is bordered by a flood plain of alluvium gradually increasing to a maximum width of about 12 mi. which is cultivated by irrigation. Outside this is the desert. At the beginning of the 20th century basin irrigation was practised down to the head of the delta. In this system the land is watered by short canals, which can receive water only when the river is in flood. These deliver the muddy water on to the land, which is divided into compartments or basins by cross-banks running from the river bank to the higher desert edge. The water is held in these basins to a depth of several feet for some weeks and deposits its mud. During this time the land is well soaked, the river falls and the remaining water is then returned. After this seeds are planted in the mud to produce the single annual crop, which gets only such extra water as can be lifted from wells. This system was in use for thousands of years without any deterioration of the soil; but with an uncontrolled river the area that could be watered was variable and liable to be reduced in a low flood, with the possibility of famine. In perennial irrigation as distinguished from flood irrigation much smaller quantities of water are run on to the land every two or three weeks and two or three crops are grown in the year. This began to develop on a large scale from canals in the time of Mohammed Ali Pasha toward the middle of the 19th century. A necessary feature is the barrages or low dams which have been built across the Nile at various points to enable its level to be raised so that it can flow at all times into main canals, whose heads are just above the barrages. From the main canals there are branch canals, and these again divide into smaller canals called distributaries, which deliver the water to irrigation ditches and so to the land. By the end of the 19th century cultivation in the delta itself was all perennial, depending on the Mohammed Ali barrage (below Cairo at the head of the delta), above which the three main canals of lower Egypt begin; in 1903 an auxiliary barrage was built at Zifta (*q.v.*) 54 mi. downstream. During the 20th century barrages were built at Nag' Hammadi and Asyut in upper Egypt, by means of which a large part of upper Egypt was converted to the perennial system and another barrage at Isna improved basin irrigation. During the time of low supply, when all the water is needed for irrigation, the Rosetta (Rashid) branch is closed at the barrage and the Damietta (Dumyat) branch nearly so, while both are completely closed near the sea: the first by the Idfina barrage with its sluices, the second by an earth bank built each year by February and washed away by the rising flood in August (during this time waterborne traffic in the delta follows the canals). The crops grown during the low stage of the river are cotton, rice, sugar cane, peanuts, sesame and millet. In the flood season the principal crop is maize (corn) and in the winter the crops are wheat, barley, clover, beans, flax, onions and lentils. Cotton is the most valuable crop and occupies more than one-quarter of the total cultivated area. It is also Egypt's principal export. The Nile from Aswan to the sea is controlled in the interests of irrigation, though control is not complete in flood time. (*See* also *Hydrology*, below, and the *Physical Geography* and *Economy* sections of EGYPT.)

Climate and Health.—In Egypt the months May to October are hot in the daytime, but there is a considerable drop in temperature after sunset. The winter months usually have clear bright days with cool or even cold nights. The climate of the northern Sudan is similar except that the temperatures are higher. Upper Egypt and the northern Sudan are characterized by low humidities, and the region from Halfa to Atbara is one of the driest in the world. In the central Sudan from Khartoum to Renk

or Roseires during the months of December, January and February the days are not unduly hot, and the nights are cool, while the humidity is low; then the temperature increases until May or June, after which the onset of the rains causes it to drop; September and October are liable to be oppressive. In the southern Sudan the average temperature is lower than farther north and varies less through the year; the highest temperatures occur from January to April and the lowest are in July and August. The climate of the high country of Ethiopia and central Africa is temperate, and above 5,000 ft. the nights are cold. Around Lake Victoria the temperature does not vary much through the year.

The principal features of the rainfall are as follows: (1) There is a little rain on the Mediterranean coast (from 5 to 8 in. annually) and over the delta, but this decreases rapidly with distance from the sea, being about 1 in. in Cairo; it falls usually in the months from November to March. (2) A region extending from just south of Cairo to just north of Atbara is practically rainless. (3) There is next a steady increase of rainfall southward of the rainless region. (4) Regions of fairly heavy rainfall are found on the Ethiopian and Lake plateaus, where a total of more than 72 in. is reached in places, the average rainfall of both plateaus being about 50 in. On the whole the rainfall of the Nile basin is scanty, and hence for the size of its basin the discharge of the Nile is small. From Khartoum southward over the Sudan plain and in Ethiopia the maximum of rainfall is in July and August, but the rainy season is increasingly long toward the south and as the altitude of the country increases. On the Lake plateau there is no month when rain may not fall. There are two minima and maxima, the minima being in January and June–July.

In the southern and central parts of the basin, malaria, carried by the anopheline mosquito, is common. All over the basin dysentery and typhoid fevers are endemic. The parasites that cause these are usually taken in food, while water and flies are also agents of infection. In Egypt and some other parts of the basin schistosomiasis (bilharziasis) and ancylostomiasis, diseases caused by microscopic worms, are widespread. They are either contracted by drinking infected water or by wading or bathing in it. In certain districts relapsing fever occurs, transmitted by the bite of a tick that lives in cracks in the ground or in houses and comes out at night. Sleeping sickness in the southern Nile basin was formerly responsible for many deaths. However, as a result of stringent control measures, it has practically disappeared. It is carried from one person to another by the bites of species of tsetse flies. Flies of the same genus carry trypanosomiasis of animals and so cause mortality among cattle, horses and donkeys.

Vegetation.—The desert region outside the Nile valley extends from the Mediterranean to about the latitude of Atbara. Much of this area is almost rainless, and there is no vegetation except in favoured places such as the oases, where underground water comes to the surface, or along drainage lines where after rain the subsoil may remain moist for a long period. As regions of scanty but regular rainfall are reached, the country becomes dotted with small thorny shrubs, mostly acacias. These begin about the latitude of Atbara and grow increasingly thickly toward the south. After rain the country becomes green with grasses and small herbs but these rapidly dry up after the rain ceases.

South of this are types of savanna country. The first is thorny savanna containing small thorny trees and after the rains grass and herbs. This covers much of the central Sudan from latitude 10° to 15° N.

South of this is found true savanna country, consisting of open grass plains on which trees are rare except in a few places near the rivers, and on which the grass may grow from 6 to 10 ft. high. During the rains these plains are often swampy. True savanna covers a good deal of country from Malakal to Bor and from the Bahr el Jebel to the foothills of the Ethiopian plateau. During the dry season, which lasts about half the year, the grass dries, and over parts of the Lake plateau and most of the southern Sudan it is burned every year. This kills many species of trees and stunts the growth of the remainder, so limiting the vegetation. In the savanna zone the rivers are often fringed with reed swamp, more particularly the Bahr el Jebel in the Sudd region from Lake No to Bor and also the lower Bahr el Ghazal. In this swamp grow papyrus, tall reeds, and floating plants such as *Vossia cuspidata*, *Echinochloa* and *Pistia stratiotes*. Papyrus swamps are also found in the valleys of the Lake plateau. In 1958 the water hyacinth (*Eichhornia*), a dangerous pest, appeared on the White Nile and is now found from Juba to Jebel Aulia, and on the Sobat and Bahr el Ghazal. It is also found in the drains of lower Egypt.

The true savanna country changes into savanna forest, which fringes the Blue Nile near Roseires and southward and covers the western slopes and parts of the plateau of Ethiopia, the southern parts of the Bahr el Ghazal basin and large areas of Uganda, the Lake plateau and its slopes. Savanna forest consists of trees of medium height casting little shade, while the ground is covered with grass and perennial herbs. Tropical rain forest does not exist in great quantity in the Nile basin, but it is found in river valleys along the Nile-Congo divide and in patches on the Lake plateau and in Ethiopia. Rain forest is characterized by a large number of species and several strata of vegetation, so that practically all the space is utilized and a wonderful luxuriance of plant life results.

(H. E. Ht.)

River Fauna.—At least 55 genera and 112 species of fishes are known from the Nile system, but only 16 species are endemic to the area. The greater number of species is recorded from the White and lower Niles, only about one-third of these also occurring in the Blue Nile and then mostly below Roseires. The Blue Nile has, however, a slightly greater proportion of endemic species, all of the genus *Barbus*, and confined to its upper reaches. The Aswa river, a tributary of the upper Nile, has a peculiar ichthyofauna composed of typical Nilotic species and others characteristic of the Lake Victoria basin. Nonendemic Nilotic species are widely distributed in east and west Africa, particularly the Niger system. Notable species are the perchlike *Tilapia nilotica*, the giant Nile perch (*Lates niloticus*), which may weigh more than 200 lb., and several species of catfishes including the Raad or electric catfish capable of producing a discharge of 300–400 volts, *Synodontis batensoda* which habitually swims upside down, and the air-breathing catfish *Clarias lazera*. The common eel penetrates as far as Khartoum. Fishes feature in the graphic art of ancient Egypt and certain species were apparently venerated; *e.g.*, the snoutfish (*Mormyrus caschive*) and the Nile perch.

The reptiles most intimately associated with the Nile are the Nile crocodile, found in most parts of the river, the soft-shelled turtle, and three species of monitor lizard: *Varanus griseus*, an essentially Asian and north African species, ranges along the Nile to about the Atbara where it meets the northerly limit of distribution of the savanna species (*V. exanthematicus*); the Nile monitor (*V. niloticus*), occurs throughout the river system, except in lower Egypt. About 30 species of snakes, of which less than half are harmless, are associated with the Nile river; the range of some has been extended by ship transportation.

The hippopotamus was common throughout the Nile system in historical times but is now extinct except south of Khartoum.

(P. H. Gr.; A. G. C. G.)

History of Exploration.—The earliest traces of man are stone implements found in many parts of the basin, some of which were made perhaps 100,000 years ago. The most recent in Egypt are found with early pottery and come down to *c.* 4500 B.C. The historical period begins *c.* 3400 B.C. and follows a period known as predynastic in which metal instruments began to be used as well as those of stone. When the early flint-implement people lived, the climate of north Africa was warm and humid. Lakes and rivers existed in what is now desert and the country was covered with vegetation and inhabited by animals now only found in tropical Africa. The mildness of the climate allowed men to live in shelters made of reeds or branches and did not force them to live in caves, as in northern countries, where traces of their occupation would have been preserved. Consequently the only remains of these early men are their durable flint instruments, which are widespread over northeastern Africa. Gradually the climate became drier, the rivers shrank and ultimately, perhaps 20,000 years ago, desert conditions were established as they are at present. The result of this change was to concentrate people on the edges of the

Nile valley. In the valley itself the river probably covered most of the land when in flood and left huge marshes when it fell again and retired to its trough. In these marshes primitive people living on the edges of the valley hunted hippopotamuses, water-loving antelopes and wild fowl. As the rainfall over north Africa decreased and the country became arid, the Nile shrank to something like its present volume, and the beginnings of agriculture probably started on the edges of the valley.

Actual history in the basin begins in Egypt 5,000 or 6,000 years ago and is based on deductions from pottery and utensils found in tombs. Later there are the inscriptions, pictures and carvings on the monuments which record contemporary events, and so down through ancient Egyptian, Greek, Roman and Arab times to the present. Little is known of the early history of the Nile basin outside Egypt and this comes from the excavations in the northern Sudan and occasional references on Egyptian monuments to people farther south. It seems likely that the ancient Egyptians, although they traded down the Red sea as far as Somalia and up the Nile beyond Khartoum, knew nothing of the source of the river which they deified as Apis (Hapi), who irrigated and nourished their crops. Herodotus, who visited Egypt *c.* 460 B.C. and traveled up to Aswan, has left some account of the country and a little about what lay to the south as far perhaps as the beginning of the Sudd region. He observed that Egypt was a land given to the Egyptians by the Nile. By the 1st century A.D. trade down the Red sea to India and the east coast of Africa was well established, and this must have led to trade with the interior. It was probably due to this that rumours of snow-capped mountains and great lakes in the interior reached the Mediterranean. Because of the difficulties of travel in the Sudan it seems unlikely that the connection of the Nile with these was actually established; it was probably an intelligent guess. Strabo about the beginning of the era says that it was well known that the annual rise of the Nile was due to rain on the high mountains of Ethiopia. Ptolemy, who lived in Alexandria in the 2nd century A.D. and wrote treatises on astronomy and geography, thought that the White Nile came from the high snow-covered mountains in central Africa, called the Mountains of the Moon (commonly identified with the Ruwenzori range), and passed through two lakes. His map corresponds in a general way with what actually exists and must have been a collation of information then current as travelers' tales.

With Portuguese expeditions to Ethiopia in the 15th and 16th centuries more definite knowledge was obtained. The first European to see the source of the Blue Nile was Father Pedro Páez, a Spanish Jesuit, who visited it in 1613. Later, about 1770, James Bruce, the British explorer, spent some time near Lake Tana and the headwaters of the Blue Nile and then returned from Gondar to the Blue Nile at Sennar and so down the Nile to Cairo.

Modern exploration of the Nile basin begins with the conquest of the northern and central Sudan by Mohammed Ali Pasha and his sons from 1821 onward. As a result of this the Blue Nile was known as far as its exit from the Ethiopian foothills, and the White Nile as far as the Sobat mouth. During his last visit to the Sudan about 1837 Mohammed Ali gave orders for the exploration of the White Nile so as to solve the problem of its origin, which had interested the civilized world for 2,000 years. Three expeditions under a Turkish officer, Selim Bimbashi, were made between 1839 and 1842 and two got to the point about 20 mi. beyond the present port of Juba, where the country rises and rapids make navigation very difficult. These expeditions were accompanied by Georges Thibaut (Shawki Ibrahim), Jacques Pons d'Arnaud (Arnaud Bey) and Ferdinand Werne who published accounts of their journeys. After these expeditions traders and missionaries penetrated the country and established stations in the southern Sudan. From an Austrian missionary, Ignaz Knoblecher, in 1850 came reports of lakes farther south. In the 1840s the missionaries Johann Ludwig Krapf, Johannes Rebmann and J. Erhardt, traveling in east Africa, saw the snow-topped mountains Kilimanjaro and Kenya and heard from traders of a great inland sea which might be a lake or lakes.

These reports led to fresh interest in the Nile source and to an expedition by Richard Francis Burton and John Hanning Speke (*qq.v.*), who followed a trade route of the Arabs from the east coast and reached Lake Tanganyika. On the return journey Speke went north and reached the southern end of Lake Victoria, which he thought might be the origin of the Nile. This was followed in 1860 by another expedition by Speke and J. A. Grant under the auspices of the Royal Geographical society. They followed the previous route to Tabora and then turned toward Karagwe, the country west of Lake Victoria. There they saw the high Mfumbiro, or Virunga, mountains 100 mi. to the west (they thought that they might be the Mountains of the Moon) and discovered the Kagera river. From the information that he was able to collect Speke thought that the Kagera must be the principal tributary of the lake. Continuing around the lake he finally reached the Ripon falls (1862), at which point he wrote "I saw that old Father Nile without any doubt rises in Victoria Nyanza." Speke then made his way northward with Grant, for part of the way along the Nile, until they reached Gondokoro, nearly opposite the present Juba. They heard rumours on the way of another large lake to the west but were unable to visit it and passed the information on to Sir Samuel White Baker (*q.v.*), who met them at Gondokoro, having come up from Cairo. Baker then continued his journey south and discovered Lake Albert. Neither Speke nor Baker had followed the Nile completely from the Ripon falls to Gondokoro, and Baker, who saw the northern half of Lake Albert, was told that it extended a very long way to the south. The discoveries of Speke and Baker are now commonly held to have settled the origin and course of the Nile, but at the time the unexplored gaps and the very elementary state of the science of hydrology led people to think that there was still an element of doubt. The question was settled when, between 1874 and 1877 Gen. C. G. Gordon and his officers followed the river and mapped part of it. In particular Lake Albert was mapped and Col. Charles Chaillé-Long, an American, discovered Lake Kyoga. In 1875 Henry (later Sir Henry) Morton Stanley (*q.v.*) traveled up from the east coast and circumnavigated Lake Victoria. His attempt to get to Lake Albert was not successful, though he traveled up the Katonga swamps and got as far as the escarpment above Lake George, from which he was forced to turn back by tribal unrest. Finally he marched to Lake Tanganyika and traveled down the Congo to the sea. In another memorable journey in 1889 to relieve Emin Pasha, Stanley traveled up the Congo and across to Lake Albert, where he met Emin and persuaded him to evacuate his Equatorial province, which had been invaded by the Khalifa's forces (*see* EMIN PASHA, MEHMED). They returned to the east coast by way of the Semliki valley and Lake Edward, and Stanley saw the snowy peaks of Ruwenzori for the first time.

Thus by 1890 the main features of the Nile basin were known, though there still remained much to be explored and also the business of map making, which 60 years later was still not fully complete in detail. After 1900 the expansion of perennial irrigation in Egypt and its beginnings in the Sudan created demands for more water when the river was low. These led to hydrological studies, and irrigation projects described below.

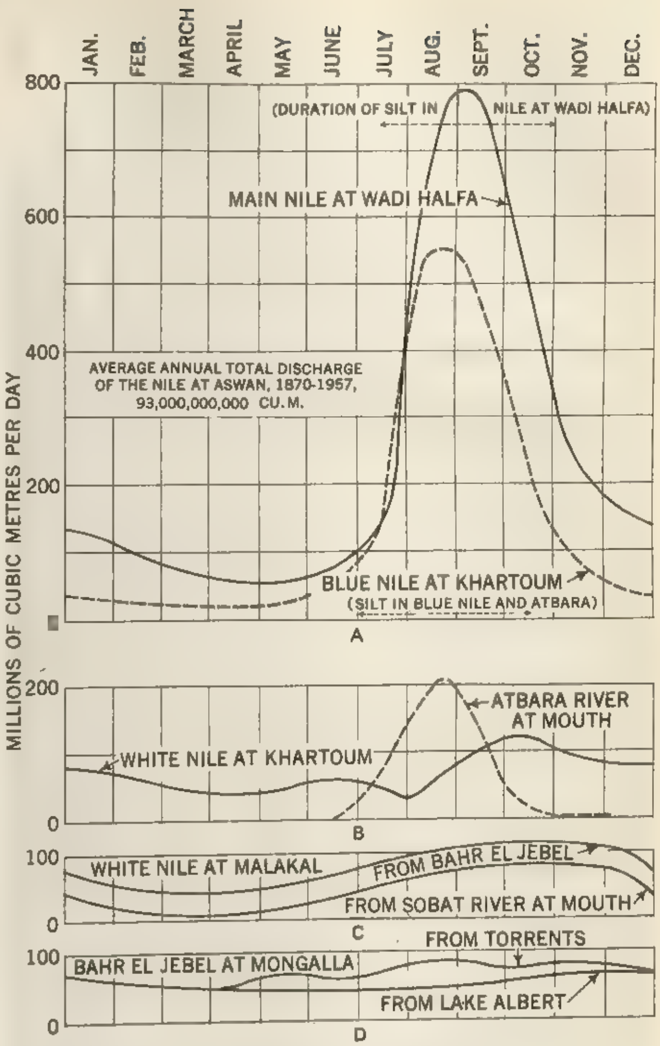
Hydrology.—Nile studies may be said to have begun at a very early date, as the ancient Egyptians recorded river levels on Nilometers, some of which still remain. However, before the 20th century there was very little detailed knowledge about the Nile water supply and its origin, and the greatest developments took place after World War I. The levels and discharges of the principal tributaries and of the main stream are now measured at many points from the Kagera, beyond Lake Victoria, to the sea, with the exception of the Blue Nile beyond the Sudan boundary. Between 1901 and 1904 Sir William Edmund Garstin made a hydrological reconnaissance of the White Nile from Lake Victoria to Khartoum, and C. E. Dupuis examined the Atbara and the Rahad and the Dinder (tributaries of the Blue Nile) and visited Lake Tana. The results of these reconnaissances, with recommendations for the improvement of Egypt's water supply were published in 1904 in a report on the basin of the upper Nile. In 1906 Sir Henry Lyons published his *Physiography of the Nile Basin*, in which was collected all the information from travelers and scientific explorers available at the time. In the previous

year the Sudan branch of the Egyptian Irrigation service had been formed, which with the Physical department was to continue studies of the upper Nile. In 1925 the Sudan formed an irrigation service, and in 1947 Uganda started a hydrological survey.

The principal feature of the Nile regime is the annual flood. The river at Wadi Halfa, where it enters Egypt, usually begins to rise in June, reaches its maximum at the beginning of September and then falls away at a decreasing rate. It is low from February to the middle of July, and during this time its natural supply is insufficient for the irrigation requirements of Egypt. Although the flood is a fairly regular phenomenon it varies both in volume and in date. These variations are important, since a very high flood brings danger of flooding in Egypt and the northern Sudan, and a low one may mean a shortage of irrigation water later.

The flood is caused by the Blue Nile and Atbara rivers whose waters come from rainfall on the Ethiopian highlands and bring down mud washed off the land surface into the many small streams that they form. The two rivers come down in flushes, which are gradually smoothed as they travel down the river. The average flows of the Nile and its principal tributaries are shown in the accompanying graphs. It is clear that the greatest part of the total flow is contributed by the Blue Nile and the least by the Atbara, but at the low time of the year the White Nile is the most important stream. The White Nile also receives some water from the Ethiopian highlands, which altogether produce 84% of the Nile supply, while the remaining 16% comes from the Lake plateau of central Africa. When the Blue Nile is rising rapidly it holds up the White Nile discharge, which begins to increase only when the rise slows down. The effect of the Blue Nile is therefore to make a natural reservoir of the White Nile, and this effect is now produced artificially on a greater scale by the Jebel Aulia dam, situated south of Khartoum a short distance up the White Nile, which adds 2,000,000,000 cu.m. to Egypt's low-stage supply. The Atbara draws its supply from the northern part of the Ethiopian plateau, but little is known of the hydrology of its tributaries. The rainfall that causes its flood comes from the same source as that falling in the Blue Nile basin, and this is probably the South Atlantic (*see* below). In flood its level fluctuates rapidly like that of the Blue Nile, and after the flood it soon ceases to flow. The Blue Nile receives two tributaries in the Sudan, both coming from Ethiopia, the Rahad and the Dinder. They are strong streams in flood but, like the Atbara, are reduced to pools later. When at their maximum, they produce together about 10% of the Blue Nile's discharge. Of the tributaries of the Blue Nile outside the Sudan practically nothing is known from a hydrological point of view. Lake Tana has been studied and only produces about 7% of the discharge of the Blue Nile. The lake is important because it offers the possibility of an economical reservoir for the joint use of the Sudan and Egypt and power for Ethiopia, where excess evaporation losses would be small.

About half of the discharge of the White Nile is provided by the Sobat, about half by the Bahr el Jebel and an insignificant portion by the Bahr el Ghazal. The Sobat is formed by two main streams, the Baro coming from Ethiopia and the Pibor coming from the south, though its main tributaries also come from Ethiopia. Flushes occur on the headstreams of the Sobat, but when they reach the plains they overflow and flood large areas of country. The effect of this is to smooth out all the peaks and to delay the arrival of the maximum at the mouth by a couple of months. The Sobat, like the Blue Nile and Atbara in flood time, brings down mud from Ethiopia, though only a small amount gets into the main White Nile. The graph C shows the average contributions to the White Nile of the Sobat and Bahr el Jebel. It will be noticed that the Bahr el Jebel's discharge varies very little throughout the year. This is due to the regulating effect of the large swamps of the Sudd region on the Bahr el Jebel. When a rise occurs upstream of the swamps, most of it flows out of the river into the marshes and only a very small part of the increase is left at their tail. As large areas are below the river level, the water that enters them is lost by evaporation and by transpiration from the luxuriant vegetation, with the result that the Bahr el Jebel loses



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AVERAGE DISCHARGES OF THE NILE

nearly half its water in the swamps. In the case of the Bahr el Ghazal, which drains a large area having a fair rainfall, the tributary streams in their upper courses carry considerable volumes of water in flood (from July to October) although they are practically dry from January to April. Of this quantity that drains into the tributaries, estimated to be rather more than the discharge of the Sobat, only a trickle reaches the mouth of the Bahr el Ghazal. The Bahr el Jebel derives its water mainly from the equatorial lakes, but there is in addition a contribution averaging about 17% of the total from torrential tributaries joining between Lake Albert and Mongalla, which rise and fall quickly. During the dry season their contribution is negligible. The Bahr el Jebel immediately below Lake Albert does not fluctuate rapidly, since it is entirely controlled by the lake, which because of its size can only change its level slowly. Lake Albert receives supplies from two main sources, the Victoria Nile and the Semliki. The latter comes from Lake Edward and receives on its way the drainage from the western side of Ruwenzori and some small streams from the Republic of the Congo. The Victoria Nile comes from Lake Victoria through Lake Kyoga and provides about 80% of the inflow into Lake Albert. There is a small amount of drainage from swampy valleys into the Victoria Nile and Lake Kyoga, which in seasons of heavy rain may be considerable; but on the average the system is a source of loss.

Lake Victoria has an annual average outflow of 21,000,000,000 cu.m. A water balance sheet for the lake shows that rainfall and evaporation are approximately equal and about five times the outflow by the Victoria Nile or inflow from tributaries. The approximate equality of rainfall and evaporation makes the large lakes

of central Africa valuable as potential storage reservoirs. Lake Victoria was made into a reservoir (1954) by the Owen Falls dam on the Victoria Nile, just below its outfall from the lake. In this the surplus discharges of high years can be stored to meet the deficit of low ones. The fall from the lake is harnessed by a hydroelectric plant to provide power for industries in Uganda.

Origin of the Nile Flood.—It is known that the greater part of the Nile water comes from rainfall in Ethiopia. The development of meteorology in the 20th century made it clear that the causes of such phenomena as the Indian monsoon and other tropical rains must be sought in the general circulation of the atmosphere. In 1910 J. I. Craig put forward the theory that the Ethiopian rainfall is caused by a current of moist air coming from the South Atlantic across Africa. The following is the evidence. The possible sources of rain in Ethiopia are the Mediterranean sea, the Red sea, the Indian ocean and the South Atlantic ocean. The Mediterranean and Red seas are ruled out because of intervening deserts and the fact that there is no stream large enough to reach the sea on the eastern side of the highlands. On the whole the winds of the rainy season blow across Africa from the Gulf of Guinea to Ethiopia. The rainfall is heaviest over the coast and the Congo basin, diminishes over the Sudan plains and is again fairly heavy on the Ethiopian plateau. South and east of the plateau, rainfall is scanty and large areas are desert or semidesert.

Periodicity and Prediction.—Much work has been devoted to the search for periodicities in natural phenomena and the long series of records of the Roda (Cairo) Nilometer have afforded valuable material. The most complete portion extends, with gaps, from A.D. 622 to A.D. 1522 and gives maximum and minimum levels. In spite of uncertainties because of repairs and renewals of the gauge, to changes of the river channel, to vagaries of gauge observers and to defects in the records, much useful information can be extracted from them. When the maximum levels are plotted in order, the principal feature is the occurrence of terms of years when, on the whole, floods are above the average and of others when they are below; but there is no obvious regularity about their occurrence. Low floods may occur among high ones and vice versa. For example, in the latter half of the 19th century a very low and a very high flood occurred in successive years, with a difference at Aswan of 9 ft. between their peaks. Many people have analyzed the records, and periodicities have been found varying from 2 to 240 years in length, but all of them have small amplitudes of the order of 10 cm. The largest so far found has an amplitude of 17 cm., or 34 cm. between minimum and maximum floods. These periodicities are completely masked by the irregularities and, although they may have theoretical importance, are of no use for the practical business of attempting to forecast the flood.

Forecasts of the river, when they can be made, are of considerable value in the practice of irrigation. The flood of the Nile occurs when the tropical rain belt has moved north of the equator. Following the theory put forward by J. I. Craig (*see* above), many attempts have been made to find numerical relations between the Nile flood and other meteorological phenomena chosen from all over the globe, as a means of forecasting. Although some relations have been found nothing of practical value has emerged.

Two other types of forecast are successful and in regular use. The first depends on the time taken by rises or falls of the river to travel downstream and on the flattening that they undergo as they proceed. Past records of river levels have been analyzed, and from this analysis curves and tables have been made showing how long a well-marked change of level takes to travel over the various reaches of the river and how much is lost on the way. This varies with the height of the river. For example, the time from Roseires on the Blue Nile to Aswan, a distance of 1,540 mi., varies from 10 days at the top of the flood to 35 days at the lowest levels. This type of forecast is very useful when the Blue Nile and Atbara begin to rise, and plans must be made for the sowing of crops. The amount of these depends on the amount of available water, of which some must be retained in the Aswan reservoir so that it is not empty before the natural supply of the rising river is sufficient for the crops. If the flood is a high one, this type of forecast is again useful to predict the height to which the river is likely to rise in lower Egypt, so that suitable measures can be taken to prevent breaches of the river banks. The other successful type of forecast is based on the fact that when the rains in Ethiopia are over, usually by the end of October, the Blue Nile falls regularly in much the same manner each year. Consequently the discharge in one month influences those in the following months, and a forecast can be made in November for the following months up to May or even June. This forecast is extremely useful as it gives an idea of the water that will be available for summer crops and whether the prospects are favourable for a large area under rice.

Irrigation, Flood Control and Water Utilization.—In Egypt in the early 1960s about 6,000,000 ac. were cultivated by irrigation, of which 700,000 ac. were on the basin system of flood irrigation (derived from the pharaonic system of agriculture) and the remainder were on perennial irrigation utilizing dams and reservoirs and of great economic importance (see *Main Nile*, above; *see also* EGYPT: *The Economy*). In the Sudan about 1,000,000 ac. were irrigated in the Gezira (*q.v.*) by water taken into a canal just above the Sennar dam; about 1,200,000 ac. were irrigated by pumps drawing from the river; and an area in Northern province of about 90,000 ac. in good years was watered by flooding. Elsewhere in the basin of the Nile cultivation by irrigation is practically nonexistent.

The irrigation year may be divided into two parts, which are roughly from August to January when the river supply is in excess of requirements, and from February to July when it is necessary to add to the natural flow of the river by water stored from the previous time of excess. The storage of water in the Jebel Aulia reservoir begins in August when there is definitely an excess in Egypt. This is White Nile water, which is free from silt, and it is used for irrigation in Egypt as soon as the natural river is insufficient. The Sennar dam is in use from the middle of July to the end of March. Its reservoir is first of all filled to the level required to supply the Gezira canal and later to full storage level. During February and March the canal takes only water previously stored in the reservoir, since at this time Egypt has a right to all the natural flow. Further water is stored for Egypt in the Aswan reservoir from October, and this is drawn upon after the supply from the Jebel Aulia reservoir is exhausted. At the height of the flood the silt content of Nile water averages about 2,500 parts per 1,000,000 by weight, and for the whole flood period from July to October about 1,600 parts per 1,000,000. This is much less than is carried by many other rivers, for example the Colorado, the Missouri and the Indus. Most of this has passed by the time that the Aswan reservoir begins to be filled. It occasionally happens, however, that the reservoir is partially filled at the top of a high flood to reduce the maximum levels in Egypt. So far only an insignificant amount of mud has been deposited in the reservoir by this procedure. Nile water contains on the average about 170 parts per 1,000,000 of dissolved salts. This is not a great amount and is only about half that in the Thames, but more than in many other British rivers.

By the middle of the 20th century the rapidly increasing populations in Egypt and the Sudan had made further conservation works on the Nile urgent. Proposals for these were made in 1946 in *The Nile Basin*, vol. vii, by H. E. Hurst, R. P. Black and Y. M. Simaika, and were accepted as the policy of the Egyptian government in 1949. They involved as a main principle over-year storage, the theory of which was worked out by Hurst (*Transactions of the American Society of Civil Engineers*, Paper 2447 [1951] and *Proceedings, Institution of Civil Engineers*, part 1, vol. v [1956]). Over-year storage was essential, since in 1913–14, for instance, the whole discharge of the river had been less than were the requirements of Egypt and the Sudan in the middle of the 20th century. The projects comprised, in the first place, a large reservoir in Lake Victoria, produced by the Owen Falls dam, which would form the main reservoir for over-year storage and would also provide hydroelectric power for use in Uganda; by means of this, reservoir water would be stored in good years to supplement the supply of bad ones. An adjunct to this reservoir was to be a

regulator or low dam near the outlet of Lake Kyoga. Third, a reservoir in Lake Albert was required to control water from the Semliki river and the large quantity coming in seasons of unusually heavy rainfall from the tributaries of Lake Kyoga and the amount of water sent down to the Sudan and Egypt. Fourth, in view of the losses of water in the swamps of the Bahr el Jebel, as it was obviously useless to provide large storage reservoirs if half their outflow would be lost, the Jonglei diversion canal was designed to bypass the swamps; this would leave the Bahr el Jebel at Jonglei below Bor and join the White Nile between the mouths of the Bahr ez Zeraf and the Sobat. A regulator would divert about half the discharge down this canal, and the remainder would flow down the Bahr el Jebel at a level that would reduce the losses to normal, so that there would be a gain of water in addition to the regulated distribution produced by the lake reservoirs. The Jebel Aulia reservoir was to continue to act as it already did and to store water mainly from the Sobat flood. Fifth, a projected dam at the outlet of Lake Tana, if the lake could be used to its full capacity, would provide water for the increase of cultivation in the Sudan, a measure of over-year storage and also a reserve in case of emergency in Egypt, such as might be caused by a very low flood, as well as hydroelectric power for Ethiopia.

Finally, a large dam on the main Nile below the Atbara would provide a reservoir for flood protection with, in addition, some stored water from all floods except the low ones, for use in the following low stage. Nothing was planned to reduce the losses in the Bahr el Ghazal basin, the only large source still remaining.

These projects could only be carried out after agreements between Egypt, the Sudan, Ethiopia, the Republic of the Congo and the east African territories. The Owen Falls dam has been built and the Sudan carried out a far-reaching investigation into the effects of the Equatorial Nile projects on the country and its people. (See *Report on the Equatorial Nile Project and Its Effect on the Southern Sudan*, 1954.)

The Equatorial Nile project would develop storage of White Nile water nearly to its maximum, but could do little to store the floodwaters of the Blue Nile and Atbara, which at present flow to sea. From the point of view of capacity the best situation for a reservoir to do this would be on the main Nile below the Atbara junction, where it would deal with the combined flow. To meet this need a proposal was made for a high dam (Sudd al Aali) at Aswan, and surveys showed that the valley had no outlets and was of a favourable shape with a large capacity. A project was drawn up by Egypt for a rock-fill dam with tunnels round its ends in the granite river bank to carry the flow, at a site about 4 mi. upstream of the present dam. The maximum water level would be about 60 m. above the top level of the present reservoir, and the reservoir when full would extend about 90 mi. beyond Wadi Halfa (which would be inundated), and would have a capacity of 157,000,000,000 cu.m., of which the lowest 30,000,000,000 would be used as a silt trap, the next 97,000,000,000 for over-year storage and the top 30,000,000,000 for flood protection for Egypt. Evaporation is heavy in this region, but the Aswan site is the most favourable so far found, and high evaporation is inseparable from storage of a large part of the flood. Work on the Aswan high dam was in fact begun in 1960 with Soviet financial and technical assistance after agreement between Egypt and the Sudan was reached regarding sharing of water and indemnities to the Sudan for flooded lands. In 1964 the Nile was diverted through the tunnels.

The project can be of use both to Egypt and the Sudan and forms an essential part of any comprehensive scheme for Nile conservation. It would also produce a large amount of hydroelectric power. The Sudan government also prepared a Nile Valley plan which provided, in addition, for dams at Roseires, Atbara and on the Baro in Ethiopia for annual storage, and dams at Semna (within the Aswan high dam reservoir) and in the Blue Nile canyon in Ethiopia for over-year storage. It has employed an electronic computer to try out the working of the plan based on the years 1905–52. A hydroelectric power scheme on the low Aswan dam began working in 1960. Any of the dams already mentioned offers a possible site for the development of power, but a drawback in some cases is the distance between the place where the power could be produced and that where it could be usefully employed. The primary need is for water for irrigation.

See also references under "Nile" in the Index. (H. E. Ht.)

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NILE, BATTLE OF THE, was fought between the British and French fleets in Abu Qir bay, near Alexandria, on Aug. 1, 1798.

The British government, having heard that a large-scale expedition was to sail from Mediterranean ports under the command of Napoleon Bonaparte, ordered the earl of St. Vincent, the commander in chief of the main British fleet, which was at that time based on Lisbon, to detach ships under Rear Admiral Sir Horatio Nelson to reconnoitre off Toulon and to watch enemy movements. But Nelson's own ship, the "Vanguard," was dismasted in a storm on May 20, 1798, and his frigates, dispersed, returned to Gibraltar. Meanwhile, St. Vincent had sent him a further detachment which joined Nelson on June 7, bringing his strength up to 14 ships of the line and one brig.

The French expedition eluded the British warships, sailed first for Malta, which was seized early in June, and established a garrison at Valletta. After a week at the island Bonaparte sailed with his armada for his main objective, Egypt. Finding Toulon empty, Nelson was left to guess the French purpose. He guessed right but, having no frigates for reconnaissance, missed his quarry, reached Egypt first, found the port of Alexandria empty, and impetuously returned to Sicily, where he revictualed. Then, baffled but determined, he made for Egypt once more and on Aug. 1 at last descried the main French fleet of 13 sail of the line and 4 frigates under Adm. F. P. Brueys at anchor in Abu Qir bay.

Although there were but a few hours before nightfall, and although Brueys, with his ships securely ranged in a sandy bay flanked on one side by a battery mounted on Abu Qir Island, was in a strong defensive position, Nelson gave orders to attack at once and to concentrate on the French van. He left full initiative to his subordinates with great success. Captain Thomas Foley in the "Goliath" led in and, when he saw how the French were disposed, decided to risk finding sufficient depth of water to get his ship round the head of the French line and thus inside and behind their position. He succeeded, and was followed by Samuel Hood in the "Zealous," by Davidge Gould in the "Audacious" and by Sir James Saumarez, Nelson's second-in-command, in the "Orion." Nelson himself, in the "Vanguard," was the first to attack the French from the seaward side and he was followed by each succeeding ship except the unlucky "Culloden" which struck on a shoal. Thomas Troubridge, her captain, was able to signal a safe course to the "Alexander" and the "Swiftsure," which were the last to come into action, after nightfall.

For some hours the battle was fierce, Nelson himself being wounded in the head. The climax came about 10 P.M. when Brueys' 120-gun flagship "L'Orient," by far the biggest ship in the bay, blew up with most of her ship's company, the admiral included. Shortly afterward the fight was resumed and it continued for the rest of the night.

Only two French ships of the line, "Le Généreux" and Rear Admiral Villeneuve's flagship "Le Guillaume Tell," escaped capture or destruction. Together with two frigates, they beat out of the bay during the morning of Aug. 2, no British ship being then in a condition to dispute their passage, though none, not

even the "Culloden," had actually sunk. Nelson's losses were 218 killed and 677 wounded. The French lost about ten times that number. "Victory," said Nelson, "is not a name strong enough for such a scene."

The effect of the battle of the Nile was manifold. It heartened Europe to resist French expansion and isolated Bonaparte's army in Egypt, ensuring its ultimate disintegration. It also ensured that Malta would in due time be retaken from the French, and restored British prestige throughout the Mediterranean. Nelson himself was rewarded with a peerage.

See Oliver Warner, *The Battle of the Nile* (1960). (O. M. W. W.)

NILGIRIS ("blue mountains"), a hill system in south India giving its name to an administrative district of Madras. The Nilgiris form a plateau at a general elevation of 6,500 ft. above sea level, rising abruptly from the plains except on the north where their base rests upon the Wynaad and Mysore uplands, at about 2,000–3,000 ft. The general aspect of the higher parts is grassy and downlike, interspersed with *shola* or woodland. The Wynaad (partly included in the administrative district) and the Ochterlony valley comprise broken valleys, once wholly forested, now dotted with tea and coffee plantations, whose output provides the chief commerce of the district. The timber forests include teak; eucalyptus and Australian wattle have been planted extensively on the higher Wynaad country. Animal life includes the Nilgiri ibex (*wariatu*), tiger, panther (including the black variety), wild boar, bear, muntjac (barking deer) and chital (spotted deer); quail, partridge, snipe, wood snipe and woodcock, spur fowl and the indigenous jungle fowl are among the game birds. The Nilgiris are detached from the main Deccan plateau by the deep Moyar river valley. Other streams are the Bhavani, the Pykara and the Calicut; none is navigable but with their tributaries they are fished for mahseer, Carnatic carp and trout. Archaeological monuments abound. The Nilgiris are inhabited by the tribal Kota and Toda (*qq.v.*).

The Nilgiris are increasing in importance for hydroelectric power. The Pykara project (70,200 kw. installed capacity) and the Moyar valley power station (36,000 kw.) are the main plants.

NILGIRIS DISTRICT is the smallest in Madras: area 984 sq.mi.; pop. (1961) 409,308. The administrative headquarters are at Ootacamund (*q.v.*), the chief summer resort of south India, at the terminus of a branch line, 41 mi. N.N.W. of Podanur junction on the main Southern railway (Madras to the west coast). The line is rack metre-gauge from Mettupalayam, 30 mi. below Ootacamund. The mean annual temperature is 14° C. (58° F.); there are night frosts in December–January above 6,000 ft., at only 11° from the equator. The mean annual rainfall is 49 in. Besides Ootacamund other main towns are Coonoor, Wellington, Dotacamund and Kotagiri. (L. D. S.)

NILO-HAMITES, a cluster of peoples of east Africa, defined by their languages which are mainly Nilotic with influence from Cushitic or Hamitic sources (*see* NILOTES). The Nilo-Hamitic-speaking peoples include several groups, each defined by closely related languages and customs. Most Nilo-Hamites are pastoralists, and it is certain that all these groups have been pastoralists at one time or another; all lack centralized political authority but in most cases recognize the partially secular authority of prophets or rainmakers; and almost all have a system of age sets based upon circumcision as the basis of political organization (*see* AGE SET).

The most northerly Nilo-Hamites are pastoral groups of the southeastern Sudan, of whom very little is known: they include the Didinga, Murle, Longarim and Nyangiya, with a combined population of about 35,000 in the 1960s. To their west are the Bari-speaking tribes west of the Nile, who practise agriculture and seem to have adopted much of the culture of their Sudanic-speaking neighbours. They comprise the Bari (*q.v.*; 35,000), Kakwa (with whom may be counted the Fajelu and Nyangbara, in all 125,000), the Kuku and Nyefu (30,000), the Mandari (36,000) and smaller groups. East of the Nile near the Uganda border are the Lotuko-Lokoiya group of tribes (about 70,000).

The central Nilo-Hamites are mostly pure pastoralists and include the Karamojong (56,000), Jie (18,000) and Dodoth (20,000) of northeastern Uganda, the Topotha, Donyiro and others of the southeastern corner of the Sudan (in all 45,000), the Turkana (about 80,000) of the northern Kenya desert. The Teso (463,000) and Kumam (56,000) of central Uganda and the outlying Teso group known as Tesio in Kenya (about 45,000) have forsaken pastoralism and today practise sedentary agriculture.

The southern Nilo-Hamites speak either Nandi or Masai. The former include the Nandi (*q.v.*; 117,000), Kipsigis (Lumbwa; about 160,000), Keyo (Elgeyo; 40,000), Tuken (Kamasya; about 67,000), Suk (Pokot; 45,000), Marakwet and Endo (together 30,000), Sabaot, Pok and Kony (in all 24,000), all of whom live in north and central Kenya, and the Sebei (24,000) on the northern slopes of Mount Elgon in Uganda. Far to the south in Tanganyika are the Tatoga and Barabaig (64,000). Except for these last, all Nandi tribes have adopted agriculture, the Marakwet-Endo, Keyo and some Pokot having complex irrigation works; the Nandi and Kipsigis especially are highly progressive farmers. The Masai (*q.v.*) speakers include the Masai of the rift valley, in both Kenya and Tanganyika (180,000), the Arusha of northern Tanganyika (63,000) and the Samburu (22,000), Njemps (Njemusi) and others of northern Kenya who are really to be counted as outlying Masai tribes; the Baraguyu or Kwavi of central Tanganyika are dispersed across a wide region living in small communities amid settled Bantu tribes; they number 20,000, and are often considered to be Masai. All the Masai speakers wholly or mainly depend on pastoralism. *See* also AFRICA: *Ethnography* (*Anthropology*): *Northeast Africa* and *East Africa;* DIDINGA; LOTUKO.

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NILOTES, a number of east-central African tribes living in the southern Sudan and north Uganda and extending into neighbouring territories. The name refers to their habitat, mostly the region of the upper Nile and its tributaries, and to a linguistic unity that distinguishes them from Nilo-Hamitic neighbours with similar physique and culture (*see* NILO-HAMITES).

Four subdivisions of the Nilotic languages are generally recognized: the closely related languages of the Dinka and Nuer (*qq.v.*); the northern Lwoo languages spoken by such groups as the Shilluk, Anuak, Burun, Maban, Jo Luo, Thuri and Bor, and the southern Lwoo languages of the Acholi, Lango (*q.v.*), Alur, Jopadhola, Ja Luo and lesser known groups. Nilotic languages are closely related to the Nilo-Hamitic languages, particularly in vocabulary, but their affinities in a wider classification of African languages are obscure and there is considerable disagreement in the literature (*see* AFRICAN LANGUAGES).

The genetic origins of the Nilotes are likewise uncertain and disputed. A mixture of Hamitic and Negro ethnotypes in the ancestry is a basic assumption. Blood group studies suggest that a very high frequency of the Rh chromosome, cDe, may be a special Nilotic character. There is considerable genetic divergence between the northern and southern groups both in ABO blood group frequency and the presence of the sickle-cell trait. Nilotes tend to be dolichocephalic with frizzy hair and dark complexion; northern Nilotes are tallest (average 1.78 m., or 5 ft. 10 in.) with slender build. They have been said to show proud, individualistic and aggressive behaviour, scorn for foreigners and dislike of innovation. Although a distinctive ethnic group, Nilotic tribes vary in culture and exceptions to any generalization can be found among one or more tribes. The southern Luo (*q.v.*) tribes in particular are divergent because of admixture with Nilo-Hamitic and Bantu neighbours.

Men and unmarried girls traditionally go naked, except for ornaments; a skin cloak is sometimes knotted over the shoulder. Married women usually wear leather aprons back and front, suspended from the waist. Cicatrization and the extraction of lower incisor teeth have been common; the forehead is often scarred. Elaborate hair styles are produced with grease and cattle dung and the body is sometimes coated with ashes. Material culture is poor, although the Jo Luo were noted ironworkers.

Most Nilotes occupy savanna country alternately subject to flooding and drought. They pursue a mixed economy of pastoralism and hoe cultivation, supplemented by fishing, hunting and a little food gathering. Although they may cultivate out of necessity, except for the Anuak, they are pastoralists with a great love of cattle; cattle enter into every aspect of society. Milk and milk products, with grain, are staple foods. Cattle are not slaughtered indiscriminately for meat; they are paid in compensation and bride wealth, and their ownership determines status and wealth. Nilotic peoples have a rich cattle vocabulary; they spend much time caring for the herds and erecting large stables or kraals for their protection. It is common for a man to train and decorate the horns of his favourite ox, and in many cases he is addressed by the animal's name. Cattle assume ritual importance, being dedicated and sacrificed to ancestors or spirits.

Nomadic or transhumant movements are especially pronounced among the Nuer and Dinka. In the wet season they live in permanent village settlements above flood level and cultivate and herd in the vicinity of well-built, circular houses. In the dry season they occupy temporary cattle camps near permanent water supplies and pasture, living in windbreaks, for fishing and herding. Other Nilotic tribes are more sedentary.

The Shilluk are the most highly organized, having a divine king who symbolizes the whole realm. Organized chieftainships, associated with rainmaking, court ceremonial and royal emblems, are found also among the Anuak, Acholi and others. In contrast, the Nuer, Dinka and Luo of Kenya are classified as tribes without rulers, their egalitarian society being based on a relationship between lineage segments co-ordinated with territorial segments. A dominant clan is associated with a tribal territory; dominant lineages of this clan are found in subdivisions of the tribe. The principle of opposition between segments and their fusion in relation to larger segments is marked; descent is patrilineal.

Ritual experts are often rainmakers; among the Dinka and Nuer they act also as mediators and peacemakers in feuds between lineages and between territorial subdivisions. There are strong ancestor cults and belief in a supreme being. Totemism exists in some tribes but is important only among the Dinka. *See* also AFRICA: *Ethnography* (*Anthropology*); NEGRO; KAVIRONDO.

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(A. J. BT.)

NIMAR, East and West, are two districts in the Indore administrative division, southwest Madhya Pradesh, India.

EAST NIMAR (area 4,132 sq.mi.; pop. [1961] 685,150) forms a "bridge" nearly 50 mi. wide between the Narmada (Narbada) river and the Vindhya mountains in the north and the Tapti river and the Satpura range in the south. Forest covers 44% of the area. The principal crops are jowar, cotton, rice and peanuts. A thermal power station at Chandni serves the western parts of the district. There are a cotton textile mill and a paper and straw mill at Nepanagar. The district headquarters are at Khandwa (*q.v.*), a railway junction on the Central railway. Burhanpur (*q.v.*), a textile trade centre, was the Deccan headquarters of the Mogul empire (1559–1636). At Mandhata (*q.v.*), 31 mi. N.W. of Khandwa, are noted Hindu temples.

WEST NIMAR (area 5,206 sq.mi.; pop. [1961] 990,464) extends from the Satpura range to the Narmada valley. The valley portion has fertile lava soil but the rest is broken by spurs of the Satpura range. Bijagarh fort (25 mi. S.W. of Khargone) is of historical interest. Of the total area 57% is arable and 12% forested. The chief crops are jowar, wheat, rice, cotton and peanuts. Large-scale industries are lacking, but there are numerous medium- and small-scale factories in the district. Maheshwar has some handlooms and a match factory. The district headquarters are at Khargone (pop. [1961] 30,652), which lies 35 mi. E. of Jalwania, a town on the Indore-Bombay road. Khargone became important under the Moguls, when it was the chief town of a mahal (revenue division) and then of the Bijagarh sircar, or sarkar (administrative district), under Akbar. (S. M. A.)

NIMBUS: *see* GLORY.

NÎMES, a town of southern France, capital of the *département* of Gard and seat of a bishopric, lies 267 km. (166 mi.) S.S.W. of Lyons by road, between Avignon and Montpellier. It is also connected by rail with the Paris-Lyons-Marseilles line and with Clermont-Ferrand. Pop. (1962) 85,884.

Nîmes lies at the foot of the Monts Garrigues, a chain of barren hills to the north and west. The highest of them is the Mont Cavalier on the summit of which stands the Tour Magne (Turris Magna), a ruined Roman tower. To the south and east the town dominates the plain of the Vistre brook, which is largely covered with vines. The central and oldest part of the town is encircled by boulevards along the sites of the old fortifications. It is there that most of the Roman remains, for which Nîmes is celebrated, are to be found. The most famous is the amphitheatre (Les Arènes) which is the best-preserved in France. It dates from the 1st or 2nd century A.D. and was used as a fortress at various times during the succeeding centuries. During the middle ages it was a separate quarter of the town with its own church; it was cleared in 1809. It is built of large stones put together without mortar and forms an ellipse with external measurements of about 440 by 330 ft. The arena is 227 by 126½ ft. The elevation (70 ft. in all) is composed of a ground floor with 60 arches, an upper floor, also with 60 arches, and an attic with corbels pierced with holes, to keep up the *velarium* or awning. The building, which holds 24,000 people, has four main entrances, one at each of the cardinal points, and 124 exits which lead from the 35 rows of the amphitheatre into the interior galleries. The arena was originally intended for gladiatorial shows, naval spectacles, chariot races and wolf or boar hunts, and for some time has been used for bullfights.

The famous Maison Carrée, a Roman temple 82 ft. long by 40 ft. wide, was dedicated, according to an inscription, to Gaius and Lucius Caesar, adopted sons of Augustus, and dates from the beginning of the Christian era. It houses a collection of sculpture and classical fragments. The temple of Diana, near the Fountain garden (Jardin de la Fontaine), was certainly attached to the baths, the remains of which are visible nearby. Two Roman gateways, the Porte d'Auguste, formed of two main arches flanked by two smaller ones and dating from A.D. 16, and the Porte de France, still stand. The Tour Magne is 92 ft. high and was once higher. It is the oldest monument in Nîmes, but its original function is not known. It was used as a watchtower and was subsequently turned into a fortress by the counts of Toulouse in the middle ages. Near the Tour Magne is the reservoir from which the water carried by the Roman aqueduct, Pont du Gard, was distributed throughout the town. With its status as a capital, and with the temple of Augustus, the basilica of Plotina (erected under Hadrian), the temple of Apollo, the pools, the theatre and the circus (erected in Nero's reign), the Campus Martius and the fortifications of Augustus, Nîmes must have been one of the richest Roman towns in Gaul.

The cathedral (St. Castor) which is thought to occupy the site of the temple of Augustus, is partly Romanesque and partly Gothic in style; the churches of St. Paul and St. Baudile are modern; the Fountain gardens owe their name to a spring which varies considerably in volume and flows into the Vistre; the town's water comes from the Rhône. The novelist Alphonse Daudet (1840–1897) and the Provençal poet Jean Reboul (1796–1864) were natives of the town. It is the seat of a bishopric (under the archbishop of Avignon), a prefect, a court of appeal, an assize court, county courts and commercial courts and a chamber of commerce.

At the end of the middle ages the crafts of Nîmes, which derived fresh energy from the arrival of a colony from Lombardy and Tuscany, preserved their importance so well that before the Revolution about half the total community was engaged in manufacture, chiefly of products derived from silk. Woven cloths,

shawls, carpets, handkerchiefs, ribbons and braids, clothes, boots and shoes, brandy, leather goods, candles and machinery are now manufactured there, and there are some foundries. Nîmes also has an important trade in wine and brandy, grain, groceries and overseas produce. Limestone quarries which supplied the amphitheatre and other buildings are still worked in the vicinity.

Nîmes, the ancient Nemausus, was so called after the sacred wood in which the Volcae Arecomici (who submitted to Rome in 121 B.C.) held their assemblies. Strabo asserts that it was the capital of a region containing 24 vassal towns and was independent of the proconsuls of Gallia Narbonensis and that it was established as a veterans' college by Augustus and endowed with numerous privileges. The town erected a temple and struck a medal in honour of its founder. The medal, which later furnished the design for the armorial bearings granted to the town by Francis I, bears on one face the heads of Caesar Augustus and Marcus Vipsanius Agrippa (Augustus' head is crowned with laurel) and on the other a crocodile tied to a palm tree (suggesting that the original settlers were veterans of the Roman Egyptian army), with the legend COL NEM (Colonia Nemausis). Agrippa built the public baths, the temple of Diana and the Pont du Gard. The walls (built by Augustus), 30 ft. high and 10 ft. broad, extended for almost 4 mi. in circuit, flanked by 90 towers and pierced by 10 gates. Hadrian erected two monuments of his benefactress Plotina at Nîmes. At the height of its prosperity the town was ravaged by the Vandals (407); the Visigoths followed (720) and turned the amphitheatre into a fortress which at a later date was burned with the town gates when Charles Martel drove out the Saracens. Nîmes became a republic under the protection of Pippin the Short. In 1185 it passed to the counts of Toulouse who enclosed the town with ramparts less vast than those of Augustus (which became part of the boulevards). The town took part in the crusade against the Albigenses in the early 13th century. In the reign of Louis VIII it housed a garrison of the king's soldiers in the amphitheatre; under Louis XI it was taken by the duke of Burgundy and retaken by the dauphin (Charles VII) in 1420. On a visit to Nîmes, Francis I enriched the town with a university and an art school. By 1558 about three-fourths of the inhabitants had become Protestants and on Sept. 29, 1567 (St. Michael's day), there was a massacre of Catholics. From the time of Henry IV's accession to the throne until the revocation of the Edict of Nantes (1685) the Protestant community was active in industry; but after this disastrous event a great number of Protestants went into exile or joined the Camisards. Louis XIV built a fortress (1687) to halt the disturbances caused by the rival religious sects. Nîmes emerged unscathed from the troubles of the Revolution, but in 1815 Trestaillons and his bandits burned the town and massacred Bonapartists and Protestants.

NIMITZ, CHESTER WILLIAM (1885–1966), U.S. naval officer, commander of the U.S. Pacific fleet in World War II, was born in Fredericksburg, Tex., on Feb. 24, 1885. He graduated from the U.S. Naval Academy, Annapolis, Md., in 1905, and during World War I served as chief of staff to the commander, U.S. Atlantic submarine force. Appointed chief of the Bureau of Navigation of the U.S. Navy in 1939, he became commander in chief of the Pacific fleet following the Japanese attack on Pearl Harbor in December 1941.

Nimitz' command of the Pacific Ocean areas, with headquarters at Pearl Harbor, complemented the Southwest Pacific area command of Gen. Douglas MacArthur and brought land as well as naval forces under his authority. Under his direction and that of his subordinates, Admirals William F. Halsey, Marc A. Mitscher, Richmond K. Turner, Raymond A. Spruance, and Thomas C. Kinkaid, were fought the Battles of Midway (1942); the Solomons (1942–43); the Gilbert Islands (1943); the Marshalls, Marianas, Palaus, and Philippines (1944); and Iwo Jima and Okinawa (1945). Nimitz participated for the United States in the Japanese surrender aboard his flagship, the USS "Missouri," in Tokyo Bay on Sept. 2, 1945. (*See* WORLD WAR II: *The War in the Pacific*.) In December 1944 he had been promoted to the Navy's newest and highest rank—fleet admiral. After the war he served for two years as chief of naval operations (December 1945–December 1947). In 1947, in answer to interrogatories by German Adm. Karl Dönitz, on trial for war crimes, Nimitz gave his justification for the unrestricted nature of U.S. submarine warfare in the Pacific during World War II. He did not write memoirs but collaborated with E. B. Potter in editing *Sea Power a Naval history* (1960). Nimitz died near San Francisco, Calif., on Feb. 20, 1966.

NIMROD (in the Douai version of the Bible, NEMROD) is described in Gen. x, 8–12 as "the first on earth to be a mighty man. He was a mighty hunter before the Lord." Apart from I Chron. i, 10, which quotes this description, the only other reference to Nimrod in the Old Testament is Mic. v, 6, where Assyria is called the land of Nimrod. Unlike the other names in the Genesis context which are names of people, Nimrod is that of an individual. The beginning of his kingdom is said in Genesis to be Babel, Erech and Akkad in the land of Shinar. Babel is Babylon; Erech is an ancient Sumerian city of Mesopotamia (Uruk, Orchoë, modern Warka, in southeastern Iraq); and Akkad (Agade), the royal city of Sargon I, was the capital of a district of the same name in Mesopotamia. Shinar, which the Old Testament sometimes identifies with Babylonia, was, as Egyptian and Hittite records show, a distinct country, probably in northern Mesopotamia, which was prominent *c.* 1500–1200 B.C. Nimrod is said to have built Nineveh, Calah (modern Nimrud; an old Assyrian town on the left bank of the Tigris, south of Nineveh), Rehoboth-Ir and Resen, the latter two unknown. It is in accordance with historical truth that Assyria was developed from Babylonia. The description of Nimrod as a "mighty hunter before the Lord" is an intrusion in this context, but probably, like the historical notices, derived from some old Babylonian saga; the Assyrian kings were noted for their prowess in hunting.

Though one may feel reasonably sure that the Nimrod traditions were derived from Babylonian sources, no equivalent of the name has yet been found in the cuneiform records. In character there is a certain resemblance between Nimrod and the hero Gilgamesh (*q.v.*). (W. L. W.; X.)

NIMRUD, the modern name of the site of the ancient Assyrian city of CALAH (KALHU, KALAKH). Calah was situated on the east bank of the Tigris about 22 mi. S. of ancient Nineveh and of modern Mosul (in Iraq). The city was first excavated by A. H. Layard during 1845–51 and afterward principally by M. E. L. Mallowan during 1949–58 on behalf of the British School of Archaeology in Iraq; he was assisted by David Oates, who became field director in 1958. Founded by Shalmaneser I in the 13th century B.C., Calah remained unimportant until King Ashurnasirpal II (883–859 B.C.) decided to make it his royal seat and the military capital of Assyria. He spent the first five years of his reign building the Acropolis; within it were concentrated his palace, the principal temples and the ziggurat which was dedicated to Ninurta, god of war and the chase, patron of the city. The famous northwest palace was decorated with gypsum bas-reliefs which depicted the king's military triumphs and the magical genii protective figures who guarded his person. In addition to the Acropolis, which covered about 65 ac. of ground, there was an outer walled town, and the whole city was nearly 900 ac. in area.

The work begun on Calah by Ashurnasirpal II was completed by his son Shalmaneser III and other monarchs; Adad-nirari III, Tiglath-pileser III and Esarhaddon added palaces of their own. The most important religious building, founded in 798 B.C. by Queen Sammu-ramat (Semiramis of Greek fame), was Ezida, which included the temple of Nebo (Nabu), god of writing, and of his consort Tashmetum (Tashmit). The ancient library discovered within it contained many religious and magical texts, and in an annex to the building a throne-room, occupied by Esarhaddon, produced tablets which embodied "treaties" ratified in the year 672 B.C. Incorporated within these documents was the last will and testament of the king of Assyria. Several paragraphs clearly defined the succession: his son Ashurbanipal, to be king after him in Assyria, and Shamash-shum-ukin in Babylon. Many other documents were also found. Of the buildings in the outer town the most important is Fort Shalmaneser, an arsenal which occupied at least 12 ac. of ground. This and other buildings have yielded

thousands of carved ivories, mostly made in the 9th and 8th centuries B.C., now the richest collection of ivory in the world. The technique of cutting and the sensitive artistry display the astonishing level of craftsmanship which had been achieved after generations of experiment in Syrian, Phoenician and Assyrian workshops. Of these pieces perhaps the most famous are the ivory head known as the Mona Lisa and a pair of chryselephantine plaques depicting a lioness killing a Negro against a background of papyrus and lilies which are incrusted with carnelian and lapis lazuli and overlaid with gold.

In the 7th century B.C. Calah declined in importance, for the Sargonids tended to use Nineveh as their residence, but nonetheless the place continued to be extensively occupied down to the fall of Nineveh in 612 B.C., Calah having previously been sacked in the year 614. Perhaps the most interesting historical record unearthed in the city was a sandstone stela of King Ashurnasirpal II which celebrated the opening of the city in the fifth year of his reign and gave a list of the important buildings, gardens and irrigation schemes, as well as of the flora and fauna which he had acquired, and finally recorded a feast which he gave to 69,574 persons over a period of ten days. The menu was written down in detail.

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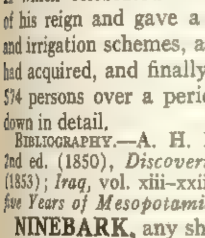
NINEBARK, any shrub of the genus *Physocarpus* of the rose family (Rosaceae). One of the best known is *P. opulifolius*, with oval or roundish leaves, native from Quebec to Minnesota, south to South Carolina and Colorado, and commonly planted for ornament. It grows from five to ten feet high, with strong, recurving stems, shedding bark and small, white or pinkish flowers, in umbellate clusters, followed by clustered, inflated, reddish follicles. There are variegated and dwarf varieties. *P. monogynus*, of the western U.S., is shorter and has somewhat kidney-shaped leaves.

NINE MEN'S MORRIS, a game played with counters on a board, also known as Muhle (Germany and Austria), Marelle (France), Mylla (Iceland), Siegen Wulf Myll (Poland) and The Mill, Morelles, Merry Peg, etc., in England.

The board (*see* diagram) comprises three concentric squares and several transversals, making 24 points of intersection. Two players, each provided with nine counters of his own colour, lay pieces alternately upon the points, the object being to get three in a row upon any line. On doing so, the player is entitled to remove from the board one adverse counter, but not one that is in a "mill," a row of three. Having placed all their counters, the players continue moving alternately, with the same object. A "mill" may be opened by moving one piece off the line; returning the piece to its original squares counts as a new "mill." The player who first captures all the adverse pieces wins. A move is limited from one point to the next along a line, but the rule is often made that when a player has only three pieces left he may move them from any point to any point regardless of the lines. In modern play the diagonal lines of the board are usually omitted, to lessen the advantage of the first player.



THE MILL BOARD
In modern play the diagonal lines are usually omitted

The mill game was often played by shepherds with stones upon a diagram cut into the turf. Shakespeare alludes to this practice in *A Midsummer Night's Dream* (act ii, scene i):

> The nine men's morris is fill'd up with mud,
> And the quaint mazes in the wanton green
> For lack of tread are indistinguishable.

"Morris" (*i.e.*, Moorish) is the name of a square dance to which the game bears a fanciful resemblance. (G. MH.; X).

NINETEENTH-CENTURY ARCHITECTURE: *see* MODERN ARCHITECTURE.

NINETEENTH-CENTURY ART. The 19th century was remarkable for a medley of artistic styles and attitudes. If the broad tendencies can be loosely contained within the categories of classicism and romanticism, the characteristic spirit which informed the significant art of the whole century was a militant and creative individuality.

Classicism.—In the opening years, the classical tendency was in the ascendant. In France, out of the Revolution, came a rigid and conscientious neoclassicism with J. L. David as its chief exponent. This resurgence was, on the one hand, the culmination of a prevailing vogue for Greek and Roman antiquities and, on the other, an active repudiation of the Arcadian frivolities of rococo. At the same time, neoclassical pictures fulfilled the purpose of Revolutionary propaganda by relating the solid virtues of republican Rome with those of the new republic of France. When Napoleon became emperor in 1804, David was designated first painter and the concept of imperial majesty, ever present in the emperor's mind, became David's ruling obsession. His influence was decisive, not only in painting, but in the formulation of appropriate styles of décor and furniture, of which the so-called Empire style became popular throughout Europe and even in the United States. (*See* NEOCLASSICAL ART.)

In architecture, Napoleon's hankerings for Roman grandeur, satisfied by the work of P. F. L. Fontaine and C. Percier, were consummated in J. F. Chalgrin's design for the Arc de Triomphe de l'Étoile. For the most part, however, the 19th century's attempts to create a style consisted of quotations from the Greek. In Germany the Greek revival was a wholehearted and enthusiastic movement which produced some distinguished classical adaptations by L. von Klenze and K. F. Schinkel. In England, Sir John Soane's Bank of England had commendable originality and John Nash created an *architecture parlante*, a style for every occasion, classical for the Regent's park and Regent street frontages, Hindu for Brighton pavilion, Gothic for his own country house. (*See* MODERN ARCHITECTURE.)

Romanticism.—David's direction was generally sustained by his pupils J. A. D. Ingres, A. L. Girodet-Trioson, F. Gérard and A. J. Gros, but with the fall of Napoleon, David was exiled. The neoclassical movement, deprived of both leadership and propagandist significance, was confronted with fiercely critical attacks by the romanticists on the grounds that it was sterile and repetitive. By the end of the first quarter of the century, romanticism had spread through Europe like an epidemic, emerging as a reaction from the repressive nature of 18th-century rationalism. As such, it offered an escape for the emotion from an insistent cult of reason and a release for the personality from disciplined compliance with convention. The first aim of the romantic artist was self-expression and his typical expression tended to be evocative of more than it stated. The movement, literary in origin and character, exploited a repertoire of constantly recurring themes, such as the feelings of the artist in the presence of nature, nostalgia for an irretrievable past, the whole gamut of emotional states and every aspect of liberty. In England, romanticism was innocently present in the verse and graphic work of William Blake, dramatically apparent in the apocalyptic visions of John Martin and the macabre nightmares of Henry Fuseli, gently appealing in the Shoreham period (1826–35) of Samuel Palmer. In Germany, there were the brilliant romantic writings of Friedrich von Schlegel, the folklore researches of Jacob and Wilhelm Grimm, and the pictures of K. F. Schinkel, C. D. Friedrich and P. O. Runge. In France, J. L. A. T. Géricault depicted the terror, pity and horror of the wreck of the frigate "Medusa" and E. Delacroix glorified freedom and expressed wide-eyed admiration for Lord Byron in his "Massacre at Chios."

Toward the middle of the century the Gothic style revived with more animation in England than elsewhere. Victorian Gothic was a romantic expression both of a partiality for medievalism and of a revulsion from an insistent and pervasive industrialism. John Ruskin, its advocate, genuinely believed that the Gothic style would be an inspiring liberation from the enslavement of classical traditions. Yet its revival was only further proof that architectural design had become an incoherent sham. Industrial design exemplified by the Great exhibition of 1851 had reached its nadir (*see* DESIGN, 19TH-CENTURY). Artists like the Pre-Raphaelites

attempted to escape from the hideous present. Others sought self-justification in the comfortable theory of art for art's sake. William Morris witnessed their withdrawal. A hater of machinery, he maintained that the artist must once again become a craftsman and the craftsman an artist, that art must be made by and for the people. "What business have we with art at all," he asked, "unless all can share it?" (*See* Arts and Crafts Movement). However, the absence of any organized patronage had given rise to the 19th-century notion of the artist inevitably in conflict with his own age. With no specific social function, the painter worked prophetlike in isolation. The general public were his patrons; the salons and academies, each dictating their own preferences and prejudices, were his showrooms. The tremendous popularity of works by Sir David Wilkie, Sir Edwin H. Landseer and W. P. Frith was indicative of the average level of appreciation.

Realism.—The classical and romantic movements had one area of common ground: both were idealist in their refusal to accept the world as they found it. Midway between both, a realist tendency was in evidence throughout the 19th century. Goya, with his uncompromising assessments of man and his behaviour, was its starting point. His unflinching observation was later matched by that of H. Daumier, who invested the capacity with a kindlier derisiveness. Last of the great realists was G. Courbet, who chose to paint only what he could see and what he saw was the rich variety of his immediate world.

Impressionism.—The final significant movement of the 19th-century was Impressionism and the approach to Impressionism was by way of landscape painting. Early in the century, J. M. W. Turner and J. Constable had anticipated the work of J. B. C. Corot and the Barbizon school by a wholly new conception of landscape painted in the open air and based on natural vision. Impressionism was the direct consequence of this innovation. Of the Impressionists, C. Monet was unique in pursuing his analysis of colour and light to its furthest conclusions. P. Cézanne's comment, "Monet is only an eye. But, my God, what an eye!" was a shrewd summary of the Impressionists' shortcomings and achievements. But, by the 1880s, the very brilliance of their accomplishment had pushed representational painting into a cul-de-sac along which progress seemed impossible. Furthermore, the development of photography had undermined any assumption that the future of painting would be concerned with the imitation of appearances. The response to this situation emerged in Cézanne's methodical "constructions after nature," in the acutely personal romanticism of V. Van Gogh and the decorative symbolism of P. Gauguin. At the close of the century, largely on the foundation of their work, the modern movement began and developed. *See* also Painting; Sculpture.

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NINEVEH, the most populous and the oldest city in Assyria, lay on the east bank of the Tigris opposite modern Mosul (in Iraq). From time immemorial, roads from the foothills of Kurdistan debouched there, and a tributary of the Tigris, the river Khawsar, added to the value of the fertile agricultural and pastoral lands in the district. The first to survey and map Nineveh was C. J. Rich in 1820, a work later completed by Felix Jones and published by him in 1854. Excavations have been undertaken intermittently since that period by many persons. A. H. Layard during 1845–51 discovered the palace of Sennacherib and took back to England an unrivaled collection of stone bas-reliefs together with thousands of tablets inscribed in cuneiform from the great library of Ashurbanipal II. Hormuzd Rassam continued the work in 1852. During 1929–32 Campbell Thompson excavated the temple of Nebo (Nabu) on behalf of the British museum and discovered the site of the palace of Ashurnasirpal. In 1931–32 together with M. E. L. Mallowan, he made a sounding for the first time from the top of the acropolis (Quyunjik), 90 ft. above the level of the plain down to virgin soil. It was then proved that over four-fifths of this great accumulation is prehistoric.

The first settlement, a small Neolithic hamlet, was probably founded not later than the 6th millennium B.C. An obsidian blade industry suggests that there was contact with Van in eastern Armenia from the beginning. Samarran and Halaf painted pottery of the subsequent Early Chalcolithic phases, characteristic of the north, was succeeded by gray wares such as occur westward in the Jebel Sinjar. In the course of this period the farmers used clay sickles of a type found in the 'Ubaid period, and these implements imply contact with the south. A little before and after 3000 B.C. unpainted Ninevite pottery was similar to that used in Sumerian cities such as Ur and Erech. At Nineveh a number of large mud-brick burial vaults, unfortunately plundered, up to nine feet in height, suggest that the city was rich in Early Dynastic times; thousands of beads similar in type to hoards found in tombs in the neighbouring site of Tepe Gawrah were probably associated with the Ninevite burials. The most remarkable object of the 3rd millennium B.C., however, is a realistic bronze head, life-size, cast and chased, of a bearded monarch. It is probable that this, the finest piece of metal sculpture ever to be recovered from Mesopotamia, may represent the famous King Sargon of Agade, *c.* 2350 B.C.

Surprisingly, there is no large body of evidence to show that Assyrian monarchs built at all extensively in Nineveh during the 2nd millennium B.C., certainly not during the four centuries that succeeded Shamshi-Adad I when Assyria was of little account owing to the power of the superior Hittite, Kassite and Mitannian dynasties. An interesting historical document however describes a victorious campaign of Ashur-uballit I (1365–30 B.C.) against a Kassite usurper, during a period of Assyrian renascence. The fame of Ishtar of Nineveh had indeed reached the ears of the Pharaoh before that, for her statue was sent to Egypt by Tushratta, king of Mitanni, in order to restore his health. Later monarchs whose inscriptions have appeared on the acropolis include Shalmaneser I (1275–45 B.C.) and Tiglath-pileser I, both of whom were active builders in Ashur; the former had founded Calah (Nimrud). But Nineveh had to wait for the neo-Assyrians, particularly from the time of Ashurnasirpal II onward, for a considerable architectural expansion. Thereafter successive monarchs kept in repair and founded new palaces, temples to Sin, Nergal, Nanna, Shamash, Ishtar and Nebo (Nabu). Unfortunately owing to severe depredation little remains of these edifices.

It was Sennacherib who made Nineveh a truly magnificent city laid out fresh streets and squares and built within it the famous "palace without a rival," the plan of which has been mostly recovered and has overall the dimensions of about 600 by 630 ft. It comprised at least 80 rooms, of which many were lined with sculpture. A large part of the famous "K" collection of tablets was found there; some of the principal doorways were flanked by human-headed bulls. At this time the total area of Nineveh comprised about 1,800 ac., and there were 18 great gates which penetrated its defensive walls. An elaborate system of 18 canals brought water from the hills to Nineveh, and several sections of a magnificently constructed aqueduct erected by the same monarch were discovered at Jerwan about 25 mi. distant.

His successor Esarhaddon built an arsenal in the Nebi Yunus south of Quyunjik, and either he or his successor set up at its entrance as trophies statues of the Pharaoh Taharqa (Tarku) to celebrate the conquest of Egypt. These were discovered by Fuad Safar and Mohammed Ali on behalf of the Iraq antiquities department in 1954.

Ashurbanipal constructed a new palace at the northwest end of the acropolis. It was this king who founded the great library and ordered his scribes to collect and copy ancient texts throughout the country. The "K" collection included over 20,000 tablets or fragments of tablets and incorporated the ancient lore of Mesopotamia. The subjects are literary, religious, administrative, and

there are large numbers of letters. Various branches of learning represented include mathematics, botany, chemistry and lexical texts. The library in fact is still a mass of information about the ancient world and will exercise scholars for many generations to come. (*See* also BABYLONIA AND ASSYRIA: *Language and Literature.*) Extensive traces of ash which represent the sack of the city by Babylonians, Scythians and Medes in 612 B.C. have been observed in many parts of the acropolis. Thereafter the city ceased to be important, although there are some Seleucid and Greek remains. Xenophon in the *Anabasis* recorded the name of the city as Mespila. In the 13th century A.D. the city seems to have enjoyed some prosperity under the atabegs of Mosul. Subsequently houses continued to be inhabited at least as late as the 16th century A.D. In these later levels imitations of Chinese wares have been found.

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(M. E. L. M.)

NINGPO (formerly Yin Hsien or Ninghsien), the name of a district and of its administrative seat, commonly called Ning-po shih (city), an important port near the mouth of Hangchow bay in northeastern Chekiang province of China. The city (pop. [1953] 237,500) is about 12 mi. above the mouth of the Yung Chiang at the confluence of the Feng-hua and Yuyao tributaries. The old walled city lies between these, but suburbs have been built across both tributaries which are bridged. Hills rise in back of the fertile plain in which the city is situated. The river is navigable to vessels up to 20 ft. draft and 350 ft. length as far as the anchorage opposite Ningpo. The old foreign settlement was situated on the left bank of the Yung Chiang across the Yuyao from the walled city. Chenhai is an outport for Ningpo at the mouth of the Yung and is protected from sea storms by Tinghai and other islands.

Ningpo is an ancient seat of learning and Buddhist religion. It has occupied its present site since A.D. 713 and was one of the earliest sites of European settlement in China. The Portuguese arrived there in 1520, but were driven out by the Chinese 25 years later because of their illegal activities. Subsequent restrictions made foreign trade with Ningpo virtually impossible. During the Chinese-British war of 1840–42, British warships blockaded Ningpo, but in 1842 the treaty of Nanking opened the port to foreign trade. However, the superior situation of Shanghai at the gateway to the Yangtze valley greatly restricted Ningpo's commercial hinterland. On the seaward side, Ningpo acts as the market centre for the Chou-shan Islands, and a national fish market was established at Ningpo in the 1950s for the productive sea fisheries in the area. After the outbreak of the Chinese-Japanese war in 1937 Ningpo was one of the few ports to remain open until after 1940. The city exports cotton grown in neighbouring districts; other products shipped include native drugs, tea, reed mats and fish, most of these going to Shanghai. Ningpo imports large quantities of sugar, largely from Fukien province, and textiles and other manufactures from Shanghai. It has some foreign trade but its domestic trade is far more important. Ningpo manufactures cotton and silk yarns and cloth, electrical supplies, canned goods, knitwear, candles and soap. The city has canal, railroad and highway connections with Hangchow in the west. The railroad was destroyed during World War II, but restored in 1955, and extended about 25 mi. E. to the town of Ts'ai-ch'iao. A highway leads southward to Chekiang coastal towns. (H. J. Ws.)

NINGSIA (NINGHSIA), former province of China, in western Inner Mongolia. Upon its abolition in 1954, the province was merged with Kansu (*q.v.*). In 1956, most of former Ningsia, settled by Mongols, passed to the Inner Mongolian Autonomous Region (Nei Mengku Tzu-chih Ch'u). The rest of former Ningsia, inhabited largely by Hui (Chinese Muslims), was constituted in 1958 as the Ningsia Hui Autonomous Region, equivalent to a province (capital, Yinchwan; area 30,039 sq.mi.; pop. [1958 est.] 1,822,000, of whom one-third were Chinese Muslims). *See* also MONGOLIA, INNER. (T. SD.)

NINIAN (NINIAS, RIGNA, TRIGNAN), **SAINT,** early British bishop of the church known as Candida Casa (at Whithorn, Scot.), was the first to preach Christianity among the southern Picts. He lived before the missionary activities of St. Columba, who arrived from Ireland about 563. Some scholars, misunderstanding a phrase in the authentic writings of St. Patrick, placed Ninian's career in the last years of the 4th century and stated that he had dedicated his church to the memory of Martin of Tours on hearing of the latter's death (397), which is impossible, as there were then no dedications of churches except in honour of a martyr. The idea of Ninian's having trained in Rome, though found already in Bede's ecclesiastical history, is almost certainly imaginative propaganda from the Anglian clergy, who had then recently replaced the Celtic churchmen in the present Wigtownshire. Ninian later became a principal patron in Scotland. His feast day is Sept. 16.

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NINO (NINA), **SAINT** (fl. *c.* A.D. 330), a holy woman who converted the Iberians (Georgians) of the Caucasus to Christianity during the reign of Constantine the Great. The earliest account of her apostolate stems from the church historian Rufinus, who evidently heard it from a Georgian prince. Nino was a captive woman, who cured a sick child by the power of prayer, and then healed the Georgian queen. The king was later convinced of the truth of her preaching by an eclipse of the sun, which plunged him and his followers into dense murk, until he thought of appealing to the God of Nino. A church was erected at the old Iberian capital of Mtskheta; its main pillar was raised into position by supernatural agency. These events are supposed to have taken place *c.* A.D. 330.

The story of St. Nino has since been overlaid with fabulous embellishments, some of them anachronistic, including the miraculous destruction of the Georgian pagan idols. Nino is represented in later Georgian tradition as niece of the patriarch Juvenal of Jerusalem (d. 458), and as a companion of the holy Ripsime and her company of virgins, martyred by the Armenian king Tiridates III (d. 330). The shrine of St. Nino is at Bodbe in Kakhetia (now part of the Georgian Soviet Socialist Republic); her feast day is Jan. 14 in the Georgian Orthodox Church and Dec. 15 in the Roman Catholic Church.

See D. M. Lang, *Lives and Legends of the Georgian Saints* (1956). (D. M. LA.)

NINUS, in Greek mythology, the eponymous founder of the city of Nineveh; also the name of the city itself. He was said to have been the son of Belos or Bel; to have conquered in 17 years the whole of western Asia with the help of Ariaeus, king of Arabia; and to have founded the first empire. During the siege of Bactra he met Semiramis, the wife of one of his officers, Onnes, whom he took from her husband and married. The fruit of the marriage was Ninyas; *i.e.*, "the Ninevite." After the death of Ninus, Semiramis, who was accused of causing it, erected to him a temple tomb nine stades high and ten stades broad near Babylon. The legendary aspects of this story were disproved in 1910. For the historical aspects, *see* SEMIRAMIS.

Another Ninus is described by some authorities as the last king of Nineveh, successor of Sardanapalus.

NIOBE, in Greek mythology, the daughter of Tantalus and wife of King Amphion of Thebes, is the typical sorrowful woman, weeping for the loss of all her children. According to the *Iliad* she had six sons and six daughters and boasted of her superiority in this respect to the Titaness Leto (*q.v.*), who had only two children, the twin deities Apollo and Artemis. As punishment for her pride Apollo killed all Niobe's sons and Artemis killed all her daughters. The bodies lay for nine days unburied because Zeus had turned all the Thebans to stone, but on the tenth day they were buried by the gods. Niobe went back to her Phrygian home, where she was turned into a rock on Mt. Sipylus (Yamanlar Dag, northeast of Izmir) which continues to weep when the snow melts above it. Both Pausanias and Quintus Smyrnaeus refer to this

rock of Niobe as one which resembled a weeping woman when they saw it from a distance.

The story of Niobe well illustrates the favourite Greek theme that the gods are quick to take vengeance on human pride and arrogance (*hybris*). Niobe is the subject of lost tragedies by both Aeschylus and Sophocles, and Ovid tells her story in his *Metamorphoses*. The number of her children, which varies with different authors, is generally given after Homer as seven sons and seven daughters. In certain late accounts one son and one daughter were said to have survived. The name Niobe may be of non-Greek origin and derive from Asia Minor, which seems also to be the source of her story.

See Pauly-Wissowa, *Real-Encyclopädie der classischen Altertumswissenschaft*, vol. 17, col. 644–706 (1936).

NIOBIUM, a metallic element closely associated with tantalum in ores and in properties, was named in 1844 by German chemist Heinrich Rose after the goddess Niobe, daughter of Tantalus. Actually, it was first discovered in 1801 in a New England mineral by British chemist Charles Hatchett, who called the element columbium (*see* COLUMBITE). International agreement among chemists in 1949 established the name niobium with symbol Nb, but the name columbium, symbol Cb, persisted strongly in the U.S. metallurgical industry.

The pure metal looks like steel and has a combination of properties that make it a valuable engineering material. Alloying additions enhance its usefulness. Its melting point of 2,468° C. (4,474° F.), combined with a density of 8.57 (only slightly more than iron), excellent ductility and good strength, makes it attractive as an alloy base for high-temperature applications. Although it has excellent corrosion resistance, niobium needs protection against oxidation above about 400° C.; hence, alloying, a protective coating or operation in vacuum or inert atmosphere is needed for prolonged high-temperature use. Because of its relatively low resistance to thermal neutrons, compatibility with uranium, corrosion resistance and strength, some niobium alloys are used in atomic-energy reactors. An early application has been for cladding fuel elements in atomic-powered submarines. Niobium is a useful alloying addition to many other metals. As ferroniobium (ferrocolumbium) it is added to some stainless steels to give stability on welding or heating. Additions of only 0.05% niobium raise the yield strength and refine the grain size of some carbon steels. Many hundreds of miles of gas pipeline, for example, are made from steel containing niobium.

Principal sources of niobium are the minerals columbite and the low-grade but more abundant pyrochlores, a series of complex oxides containing essentially calcium, sodium, niobium, tantalum and fluorine, with Africa, Brazil, Canada and Norway among the chief suppliers. Natural abundance is estimated to be somewhat less than that of nickel. A chief difficulty in preparation of the pure metal has been separation from tantalum. This is done commercially by solvent extraction in a hydrofluoric-sulfuric acid, methyl isobutyl ketone system, although fractional distillation of chlorides resulting from chlorination of ferroniobium is an alternate method. Among methods for reducing the purified compounds to metal are reduction of the oxide by carbon or niobium carbide in vacuum, hydrogen or magnesium reduction of the chloride, sodium reduction of double fluorides and fusion electrolysis. Niobium is consolidated and purified further by electron-beam or vacuum-arc melting. Vacuum sintering of powder is also used for consolidation.

Compounds of niobium are of minor importance. However, the carbide, usually blended with tantalum or tungsten carbides, is used in the making of some cemented carbide items, or cermets, for high-temperature use. In the chemical industry the metal is useful because of corrosion resistance although it is inferior to heavier, more expensive tantalum in hydrochloric acid, hot concentrated sulfuric acid and concentrated alkalies. In electronics, the superconductivity of niobium-zirconium and niobium-tin, together with ease of fabrication, is of interest in making fine wire for magnetic coils.

Niobium has the atomic number 41; its atomic weight is 92.906. One stable form of the element, Nb^{93}, is known, and 12 radioactive isotopes (89, 90, 91, 92, 94, 95, 96, 97, 98, 99, 100 and 101) have been prepared. The electron arrangement in the outer unfilled orbits (N and O) is: $4s^2$, $4p^6$, $4d^4$, $5s^1$.

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NIOBRARA, the largest river in northern Nebraska, U.S., rises near Lusk, Wyo., flows east across the High Plains, the northern fringe of the Nebraska sandhills and the low eastern plains to join the Missouri river at Niobrara. The name is of Indian origin and means "running water" or "spreading water." Both designations are apt: the Niobrara has a more uniform flow than do most plains streams, because of steady groundwater contributions from tributaries in the sandhills; in its lower course it is wide and shallow. It is 447 mi. long, drains 12,000 sq.mi. and has an annual flow of 1,100,000 ac.ft., with a peak in late spring and summer. In the late 1950s, about 24,000 ac. in the river basin were irrigated, mainly in the western reach where Box Butte reservoir served 12,000 ac. at Mirage flats. Ranching, concentrated in the sandhills, has traditionally been the most important activity in the Niobrara basin. Additional sources of farm income have been hogs, corn and wheat. *See* also NEBRASKA: *Physical Geography*; *The Economy*. (D. S. Sr.)

NIORT, a market town of western France, *préfecture* of the *département* of Deux-Sèvres, is situated 63 km. (39 mi.) E.N.E. of La Rochelle by road on the Sèvre river, above its silted estuary. Pop. (1962) 36,265. Below Niort the Sèvre, navigable for small craft, now traverses an amphibious tract of reclaimed marshland (Marais Poitevin), which occupies a former re-entrant of the sea. The town grew up on the left bank of the river in the shelter of Henry Plantagenet's castle, erected in 1155, the keep of which dominates the river by two square towers. Françoise d'Aubigné, marquise de Maintenon (1635–1719), second wife of Louis XIV was born in Niort. The town was one of the centres of Protestantism in western France and suffered severely by the revocation of the Edict of Nantes in 1685. It has old tanning and leather working industries, but is chiefly a market and rural service centre for the productive Marais Poitevin and other neighbouring farmlands of Poitou and the southern part of Vendée. South and north of the castle the tall spires of the church of Notre Dame (14th–1540) and the 19th-century church of St. André overlook the old town near the river. Back from the river the street system focuses upon the spacious Place de la Brèche. (AR. E. S.)

NIPPON, the Japanese pronunciation of the Chinese name of Japan, "sun origin." *See* JAPAN.

NIPPUR, an ancient sacred city of Mesopotamia, was situated on the Euphrates river about 45 mi. S.E. of Babylon; the site, the modern name of which is Niffer (Nuffar), lies about 100 mi. S.S.E. of Baghdad in the Diwaniyah *liwa* of Iraq. Although it was never a political capital, Nippur played a dominant role in the religious life of Mesopotamia. Long since, the river has moved miles westward and the ruins of the city resemble a series of low hills rising from the surrounding alluvial plain.

In Sumerian mythology Nippur apparently existed from the beginning of time. It was the home of Enlil, the storm god, the representation of force, the god who carried out the decrees of the assembly of gods that met at Nippur to determine the course of events and the destiny of all beings. It was at Nippur that Enlil, according to one account, created man. As the god of force and the executor of the divine assembly's will, Enlil could delegate his authority to the temporal ruler of any of the Sumerian city-states and, in later times, to the kings of Babylonia and Assyria. Although a king's armies could subjugate the country, the transference to that king of Enlil's divine power to rule had to be sought and sanctioned. The necessity of this confirmation from the divine assembly at Nippur made the city and Enlil's sanctuary there especially sacred, regardless of which dynasty ruled Mesopotamia. (*See* also BABYLONIA AND ASSYRIA: *Religion: Sumerian Pantheon: Farming Regions*.)

The first archaeological expedition from the United States to Mesopotamia excavated at Nippur from 1889 to 1900; the excava-

tions were resumed in 1948. The southwestern half of the city was a residential and business district; the records of the commercial house of the Murashu family (*c.* 445–*c.* 403 B.C.) were found there. The eastern section, also residential, has been called the scribal quarter because so many cuneiform tablets were found in the houses. Most of the tablets were business documents, but many copies of Sumerian hymns, myths and wisdom texts were also recovered. In fact, the excavations at Nippur have been the primary source of the literary writings of Sumer. The northern section of the city, the religious quarter, contained temples to Enlil and other gods and goddesses of the Sumerian pantheon.

Very little is known about the prehistoric town except that it did exist. It probably was centred beneath the religious quarter of the town. By the mid-3rd millennium B.C. the city probably had reached the extent of the present ruins and was fortified. The most important temple, dedicated to Enlil, undoubtedly underlies the existing ziggurat to the same god. Naramsin, king of Akkad from *c.* 2267 to 2230 B.C. (or 2291–55), rebuilt the city walls and temples, but most of his work was obliterated by the extensive and monumental constructions of Ur-Nammu, the first king of the 3rd dynasty of Ur, who reigned from *c.* 2130 to *c.* 2112 B.C. (or 2113–2096). Ur-Nammu laid out Enlil's sanctuary, the Ekur, in its present form. The sacred enclosure was oriented with its corners to the cardinal points of the compass. A ziggurat or temple tower, probably three stories high, and a temple were built in an open courtyard surrounded by casemated walls which contained shrines, priests' quarters and storerooms. The following kings of Ur, Isin and Larsa kept the sacred buildings in repair but there is little evidence of temple construction by the kings of Babylon (*c.* 1800–1600 B.C.), although Nippur was a thriving city at that time. Later, the Kassite and Assyrian kings made extensive repairs and restorations. Minor changes in Neo-Babylonian times brought the glories of Nippur to an end. The Parthians constructed a massive citadel that completely buried Enlil's sanctuary and its enclosure walls. From the close of the Parthian period in the 3rd century A.D. the city fell into decay and probably was no more than a village until it was abandoned in the 12th or 13th century A.D.

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NIRVANA, a Sanskrit term (Pali NIBBANA), names the ultimate goal of Buddhist thought, aspiration and practice. Literally, it means "waning away" (as of a flame when the fuel is exhausted). What is here implied is the waning away of deluded egocentricity, with its attendant passionate, sensual and selfish desires. According to the Buddha's analysis of the human situation, these deluded desires fetter man, together with all sentient beings, to the round of rebirth and consequent ill or suffering (*dukkha*), one afflicted existence succeeding another. When these desires are transcended by those who follow the Path which he announced, there is the experience of spiritual freedom and enlightenment that is Nirvana. The corresponding term, Nibbana, in the Pali Buddhist scriptures, is held by some expositors to refer explicitly to the negation (*ni*) of the "jungle of lust, ill-will and delusion" (*vana*). In a sense, therefore, Nirvana means extinction. But most Buddhists emphasize that this does not mean annihilation; Nirvana is not the end of life, but rather the end of all that confuses life and hinders well-being; it is "the extinction of afflictions."

As such, it is poetically described in the Buddhist scriptures as the harbour of refuge, the further shore, the cool cave, the matchless island amid the floods, the home of ease, the holy city. It is also said to be changeless, deathless and without limitation. It is the "not born, the not-become"; it is "neither origination nor annihilation." The reality beyond all change and suffering, it is peace, security, supreme joy, unspeakable bliss.

While interpretations vary in different contexts of Buddhist thought, there is general agreement that Nirvana is an exalted spiritual state that may be realized here and now. In the Theravada (Hinayana) tradition, the nature of the goal is indicated to some extent by the degrees of moral and spiritual mastery set forth in the Noble Eightfold Path and by what is said of the character and condition of the saint (the *arahat*) who has followed this Path: Nibbana is "the state of him who is worthy." In the Mahayana tradition, to realize Nirvana is to realize one's own inherent Buddha-nature, and this is generally interpreted as a change of outlook rather than a change of being. In Vedanta (Indian) thought Nirvana is identified with union with Brahman. *Parinirvana*, used sometimes with particular reference to the state after death, signifies complete achievement but in itself implies neither immortality nor annihilation—one of the questions to which the Buddha is said to have given "indeterminate" answers. For Nirvana is "deep, unfathomable." As it means enlightenment there is, apart from this enlightenment, no knowing until the goal itself is reached. Nirvana has to be experienced. All that can be defined is the Path. *See* also METEMPSYCHOSIS: *Eastern Thought*.

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NIS (NISH), chief town of the Nis *srez* (district) in the Socialist Republic of Serbia, Yugos., stands on the Nisava river not far from its confluence with the southern Morava, 246 km. (153 mi.) S.S.E. of Belgrade by road via Kragujevac. Pop. (1961) 84,741. The town is important both commercially and also strategically since it commands the only two valleys affording easy access from central Europe to the Aegean; it is the meeting point of several Balkan highways; and the main railway from Belgrade and the north divides there for Sofia, Bulg., and Salonika, Greece. It has railway workshops and light industries. Good coal supplies are within easy reach. A university was founded in 1960.

The ancient Roman city Naissus, which probably superseded a Celtic settlement, was mentioned as an important place in the second century in Ptolemy's *Guide to Geography*, and the old fortress on the right bank of the river is believed to have been built on its site. Under its walls in A.D. 269 the emperor Claudius destroyed the army of the Goths, and Constantine the Great was born there (*c.* 280). The emperor Julian improved its defenses but the town was destroyed by the Huns under Attila in the 5th century, and restored by Justinian. In the 9th century the Bulgarians conquered it, but ceded it in the 11th century to the Hungarians, from whom the Byzantine emperor Manuel I took it in 1173. Toward the end of the 12th century the town was in the hands of the Serbian prince Stephen Nemanya (Stevan Nemanja), who there received hospitably the German emperor Frederick I Barbarossa and his crusaders. In 1375 the Turks captured Nis from the Serbians. In 1443 the Hungarians and the Serbs retook it from the Turks, but in 1456 it again came under Turkish rule and remained for more than 300 years the most important Turkish station on the road between Hungary and Constantinople. In the first Serbian uprising, 1809, the Serbians, led by Stephan Sindjelic, resisting the Turkish onslaught near Nis, fired their powder magazine and destroyed both themselves and the enemy. The Turks built a brick tower about 1¼ mi. S.E., in which they embedded more than 900 Serbian skulls. The ruins are still called Cele Kula ("Tower of Skulls"). The Serbian army liberated Nis in 1877 and the town was ceded to them by the treaty of Berlin (1878). In World War I, Nis was for a period the capital of Serbia, and on Nov. 24, 1914, the Serbian parliament and government issued their declaration of war aims: liberation and unification of all Serbs, Croats and Slovenes. In World War II Nis was severely damaged by bombing and many streets in the old Turko-Byzantine style were destroyed. (V. DE.)

NISHAPUR (NEYSHABUR), a town in Khurasan *ostan* (province) of Iran, lies 46 mi. W. of Meshed (Mashad), and 3,920 ft. above sea level. The town, which has shifted its position repeatedly in historic times, is situated in a wide, well-watered and

fertile plain at the southern foot of Kuh-e Binalud. Pop. (1964 est.) 33,397. The surrounding area produces grain and cotton. Besides the marketing and other activities of a local centre there is some manufacturing and processing including leather, carpets, vegetable oil, cotton ginning and pottery. At Ma'dan, 32 mi. N.W. of Nishapur at 5,100 ft., are the famous turquoise mines which have supplied the world for at least 2,000 years. Nishapur is linked by road, and since 1958 by railway, with Teheran and Meshed.

Nishapur derived its name from its alleged founder Shapur (A.D. 241–272). It was once one of the four great cities of Khurasan, rivaling Ray (Rhages), and was an important place in the 5th century as the residence of Yazdegerd II (438–457). But when the Arabs came to Khurasan (641–642) it was of such minor importance that it did not even have a garrison. Under the Tahirids it became a flourishing city again and rose to importance under the Samanids (874–999). Tughril (Toghrul), the first Seljuk ruler, made Nishapur his residence in 1037. The decline set in in 1153 when the Ghuzz Turkmens partly destroyed the town. In 1208 most of it was devastated by earthquake and was hardly rebuilt when it was ravaged by the Mongols. Rebuilt, it suffered again from Mongol invasion (1269) and from another earthquake, and never again achieved its former greatness.

The Gadam Gar (1643), a fine domed mausoleum, lies a few miles to the east. Excavations by the Metropolitan Museum of Art, New York, in 1934–40, disclosed rich, significant architectural and artistic remains of both the Seljuk and pre-Seljuk periods. Adjacent to the mosque of the Imamzadeh Mahruk, 4 mi. S.E. of Nishapur, is the tomb of the astronomer-poet Omar Khayyam, who was born in Nishapur—a fine marble shaft and sarcophagus built in 1934. Nearby is the grave of the celebrated poet and mystic Farid ud-din 'Attar. (H. Bo.)

NISHIDA KITARŌ (1870–1945), leading Japanese philosopher in the first half of the 20th century, was born April 19, 1870, in a village near Kanazawa. He taught philosophy in Kanazawa and Tokyo and then was appointed professor of philosophy at Kyōto University (1913–28).

From his Kanazawa days, and for some time after he moved to Kyōto, Nishida was deeply engaged in Zen meditation. In his *Study of Good* (1911), he advocated the idea of "pure experience," which knows events as they are without the addition of thought or reflection. In *Intuition and Reflexion in Self-consciousness* (1917), he investigated more logically and thoroughly, under the influence of H. Bergson and Neo-Kantianism, the relation between thought and pure experience. This led to the idea of a self-developing system of self-consciousness, as in Fichte's philosophy. His mystical nature, however, induced him to break the shell of transcendental idealism in order to gain a new understanding of ultimate reality.

After his *From the Acting Self to the Seeing Self* (1927), Nishida named his mystical conception of reality, in accordance with Buddhist tradition, "Nothingness" (*mu*). As this means the ultimate identity of subject and object, he sought to derive the individual reality of everything in the world—things as well as selves—from this ultimate, all-enveloping Nothingness. In his last stage (cf. *Philosophical Essays*, 7 vol. 1935–46) he further developed this idea into a philosophy of history. He died July 7, 1945, at Kamakura.

The following works of Nishida are available in English translation: *A Study of Good*, translated by V. H. Viglielmo (1960); *Intelligibility and the Philosophy of Nothingness*, translated by R. Schinzinger (1958); and excerpts from *The Problem of Japanese Culture*, translated by M. Abe, in *Sources of Japanese Tradition*, pp. 857–872 (1958), in the "Introduction to Oriental Civilizations" series.

See further JAPANESE PHILOSOPHY: *Modern Japanese Philosophy*. (T. Y.)

NISHINOMIYA, Japanese city of Hyōgo prefecture, located midway between Kōbe and Ōsaka in the continuous urban-industrial belt along the eastern Inland seacoast of Honshū. Pop. (1960) 262,608. It occupies a narrow lowland between Ōsaka bay and interior Mt. Rokkō. Nishinomiya is famed for its fine sake (rice wine) and produces 30 different brands. Its coastal sections are assigned to industry (metals, machinery, chemicals, rubber goods, soap, cosmetics and beer) and to bathing resorts. It has a large professional baseball stadium and excellent railway and road connections with adjacent eastern and western urban areas. (J. D. Ee.)

NISUS, the name of two figures in classical mythology and literature.

1. Nisus, in Greek mythology, was a son of Pandion, king of Megara, and is eponymously connected with the Megarian port of Nisaea. Nisus had a purple lock of hair with magic power: if preserved, it would guarantee him life and continued possession of his kingdom. When Minos (*q.v.*) besieged Megara, Nisus' daughter Scylla fell in love with Minos or was bribed; she betrayed her city by cutting off her father's purple lock. Nisus was killed or killed himself and became transformed into a sea eagle. Minos despised Scylla and brought about her death either by dragging her, tied, after his ship or by abandoning her, so that she desperately swam after him and drowned. Scylla then changed into a sea bird (Gr. *keiris*, Lat. *ciris*), possibly a heron, constantly pursued by the sea eagle. The story appears as early as Aeschylus, but the most famous accounts occur in the *Ciris*, often attributed to Virgil, and in Ovid's *Metamorphoses*, 8, 1 ff.

2. Nisus in Virgil's *Aeneid* is a Trojan, son of Hyrtacus close friend of Euryalus. In the funeral games, when he slips and falls, he helps Euryalus win the foot race by tripping the leader (*Aeneid* 5, 315 ff.). Later, fighting the Italians, he sacrifices himself vainly to rescue Euryalus from the enemy, but earns poetic immortality (*Aeneid* 9, 176 ff.). (WM. S. A.)

NITERÓI, a city and port of Brazil, and capital of the state of Rio de Janeiro, is located on the eastern side of the entrance to Guanabara bay opposite the city of Rio de Janeiro, with which it is connected by ferry. Pop. (1960) 228,826. Like Rio de Janeiro, this city is located on low ground at the heads of the numerous bays that indent the shore. The several sections of the city are separated by steep rocky ridges that extend into the water. Niterói is separated from the open ocean by the steep slopes of the main ridge running parallel to the coast.

In addition to serving as capital of Rio de Janeiro state since 1835 (except for the period 1894–1903 when Petrópolis was the capital), Niterói is also a residential suburb of Rio de Janeiro city. The best residential districts include Icaraí and São Francisco, both of which are bordered by fine beaches. In and around Niterói there are important manufacturing industries, including Brazil's chief shipbuilding and repairing yards and metal industries which use steel manufactured at Volta Redonda (*q.v.*). There are textile mills and food processing plants; other manufactures include flat glass, matches, tobacco products, furniture, chemicals, explosives and pharmaceuticals. There is a large cement plant nearby. The central business district is in the part of the city known as São Lourenço.

The first settlement on the eastern side of the bay was made by the Portuguese in 1671. At this time a chapel was built in Praia Grande near an Indian village, not far from one of the present ferry terminals. The settlement became a village in 1819 when it was named Villa Real da Praia Grande. In 1834 the city of Rio de Janeiro and the federal district were separated from Rio de Janeiro state; the following year Praia Grande became the capital of the state. In 1836 it became a city and was renamed Niterói, a name derived from the Indian word *Nyterõi*, "hidden water." In spite of the new residential suburbs and industrial districts, Niterói remains even more characteristically Portuguese than its neighbour across the mouth of the bay; the narrow irregular streets and the architecture of the buildings are little changed. The name of the city was formerly spelled Nictheroy. (P. E. J.)

NITHARD (d. 844), Frankish count whose historical work gives an invaluable narrative of the dissension between the sons of the emperor Louis I the Pious, was the son of Charlemagne's daughter Bertha by Angilbert, head of Charlemagne's chancery and poet (called the "Homer" of the court). Through his mother, therefore, Nithard was the cousin of Louis I's sons, and when war broke out between them on their father's death, he emerged as the valued counselor of the youngest of them, Charles II the Bald

A formidable military strategist, he played an important part in the battle of Fontenoy (June 25, 841), when Charles defeated his eldest half brother Lothair I. In the same year Charles asked Nithard to write an account of contemporary events. Heavily biased against Lothair, Nithard's history (*Historiarum libri iv*) is nevertheless a work of considerable interest, almost the sole source on the war. He had important sources and official documents at his disposal, providing, for example, the full text of the Strasbourg oaths of Feb. 842, sworn by Charles in German and by his half brother Louis the German in French. Nithard rarely had leisure to write until some time after the events that he describes; even so, his account of the battle of Fontenoy, written four months after it took place, is remarkably vivid.

In 843 Nithard was made lay abbot of St. Riquier (east of Abbeville) by Charles the Bald, but held this benefice for a few months only: he was killed on June 14, 844, in a fierce battle against the forces of Pepin II of Aquitaine, who was trying to prevent reinforcements from reaching Charles at the siege of Toulouse. The text of his work is printed in *Monumenta Germaniae historica*, series *Scriptores*, 3rd ed. (1907), and, with French translation, by P. Lauer, *Histoire des fils de Louis le pieux* (1926). (J. De.)

NITHSDALE, WILLIAM MAXWELL, 5TH EARL OF (1676–1744), Scottish Jacobite chiefly remembered for being rescued by his wife from the Tower of London, was the only son of Robert (d. 1683), 4th earl, to whom he was served heir in 1696 (*see* also MAXWELL). He married Winifred, daughter of William Herbert, 1st marquess of Powis. Nithsdale soon became known as a Jacobite and in 1712, anticipating the possible consequences of his support for the Stuarts, he resigned his estate to his son William. He took part in the Jacobite rising of 1715, was captured at Preston and was tried and condemned to death in Jan.–Feb. 1716. The countess, on hearing of her husband's capture, went to London, traveling in very difficult conditions, and there gained access to the king. George I, however, refused to receive her petition, and when she knelt before him and took hold of the skirts of his coat he dragged her half across the room before he could break away. Finding that no pardon could be obtained, the countess laid a plan to rescue her husband from the Tower of London. With the help of two Jacobite ladies, she cleverly helped her husband escape from his cell on the night before the day fixed for the execution (Feb. 24) by disguising him as a woman.

The earl escaped from England and was followed by his wife after she had gone back to Scotland to rescue important legal papers. After a short stay in France, the earl and countess went to Rome, where they lived in poverty and obscurity. The earl died there on March 20, 1744, and the countess in 1749.

NITON: *see* RADON.

NITRA (Ger. NEUTRA; Hung. NYITRA), a town in the West Slovak *kraj* (region) of southern Slovakia, Czech., lies at the foot of the small Zobor massif above the east bank of the Nitra river and 116 km. (72 mi.) E.N.E. of Bratislava. Pop. (1961) 36,479. It was important from the 9th century onward as a strongpoint and a religious centre. The first Christian church of Slovakia was established there (830) and was consecrated by the missionary saints Cyril and Methodius. The ramparts of the medieval castle still surround the upper town, now crowned by the 18th-century bishop's palace. The railway constructed during the 19th century up the west (opposite) bank of the river bypassed the town but this has been compensated in part by a road bridge and a good road network. To the south is a rich region of Slovak arable farming on chernozem soils and the town has food-processing industries and an agricultural college. Nearby at My.narce is a factory for industrial ceramics. (H. G. S.)

NITRE, naturally occurring potassium nitrate, or saltpetre; "cubic nitre," or Chile saltpetre, is sodium nitrate. A source of nitrogen compounds, nitre was employed in the earliest recorded preparation of nitric acid (*see* NITRIC ACID AND NITRATES) and was used in the manufacture of gunpowder, fireworks, etc. It occurs as crusts on the surface of the earth, on walls, rocks, etc., and in caves. It forms in certain soils in Spain, Italy, Egypt, Iran and India. It occurs with sodium nitrate in Chile, and in the United States it has been found in caves in the Mississippi valley. The colour is white and it has a vitreous lustre. The composition is KNO_3, with 46.5% K_2O (potash) and 53.5% N_2O_5. *See* also POTASSIUM: *Potassium Nitrate*.

NITRIC ACID AND NITRATES. Nitric acid, HNO_3, an important mineral acid, was one of the earliest of the nitrogen compounds to be prepared and used. Its preparation by the distillation of a mixture of nitre (potassium nitrate), alum and blue vitriol is ascribed to Geber (*q.v.*). A similar method was described by Albertus Magnus in the 13th century and by Raimon Lull, who prepared the acid by heating nitre and clay and called it *eau forte*.

In 1648 J. R. Glauber devised the process in common use for many years, viz., by heating a nitrate with concentrated sulfuric acid. The true nature of nitric acid was not determined until the 18th century when A. L. Lavoisier (1776) showed that it contains oxygen. In 1784 H. Cavendish synthesized it by passing a stream of sparks through humid air, proving that nitrogen is also a constituent of the atmosphere. J. L. Gay-Lussac and C. L. Berthollet established its exact composition in 1816. Nitric acid has been known as *aqua dissolutiva, aqua prima, spiritus acidus nitri, spiritus nitri fumans Glauberi* and aqua fortis.

Free nitric acid, formed in moist air by the discharge of atmospheric electricity (lightning), is found to a very slight extent in rain water and is also formed in the soil by the oxidation of nitrogenous organic matter. It is neutralized by the basic substances in the soil to form nitrates, principally saltpetre, KNO_3, and Chile saltpetre, $NaNO_3$, the latter being found in greater abundance and concentrations.

Physical Properties.—Pure 100% nitric acid is a colourless liquid whose specific gravity at 25° C. relative to water at 4° C. is 1.50269, melting point −41.59° C., and boiling point 86° C. at one atmosphere of pressure. It fumes strongly on contact with moist air and is miscible with water in all proportions.

A water solution containing 68% of the acid, which is the approximate composition of the concentrated acid of commerce, is a constant-boiling or azeotropic mixture at atmospheric pressure with a boiling point of 120.5° C. and a specific gravity of 1.41. A solution containing less than 68% nitric acid may be separated by distillation at atmospheric pressure into the constant-boiling mixture and a distillate of more dilute acid; one with more than 68% nitric acid yields a residue of the constant-boiling mixture and a distillate of the more concentrated acid.

The very concentrated or pure acid undergoes decomposition when boiled and, with the water formed, may be converted to the constant-boiling mixture by repeated distillation. The composition of the constant-boiling mixture varies with the pressure at which it is distilled.

Chemical Properties.—Pure nitric acid or its concentrated solutions decompose slowly into water, nitrogen dioxide and oxygen: $4HNO_3 \rightarrow 2H_2O + 4NO_2 + O_2$; the rate of the decomposition is increased by light and by higher temperature. The concentrated acid is therefore usually coloured yellow because of the presence of the nitrogen dioxide, some of which remains in the solution. Nitric acid forms two compounds with water in the solid phase, the monohydrate, $HNO_3 \cdot H_2O$, melting point −37.68° C., and the trihydrate, $HNO_3 \cdot 3H_2O$, melting point −18.47° C.

Nitric acid may be considered to be the hydrate of nitrogen pentoxide although it is almost never prepared by hydration of the oxide. Conversely the pentoxide is normally prepared by dehydrating the concentrated acid with phosphorous pentoxide: $2HNO_3 + P_2O_5 \rightarrow N_2O_5 + 2HPO_3$. Nitrogen pentoxide is a white solid that sublimes at 32.4° C. and decomposes readily into nitrogen dioxide and oxygen.

Nitric acid is a strong acid; in dilute water solutions it is almost completely ionized to hydrogen ions, H^+, and nitrate ions, NO_3^-. Its salts with strong bases are not hydrolyzed in aqueous solution and are neutral to indicators. It neutralizes hydroxide bases and salts of weak acids to form nitrates (*see* below). Because of its strong oxidizing properties, a dilute solution of the acid does not yield hydrogen when treated with metals but is reduced to one of the oxides of nitrogen, to nitrogen or to ammonium ion. How-

ever, with very active metals (magnesium, for example), some hydrogen is liberated along with the other reduction products.

Most of the nitric acid produced is consumed in the manufacture of fertilizers, explosives, plastics, lacquers, synthetic fabrics and dyes by the reaction of the acid on organic compounds. Fuming nitric acid is used as an oxidizer in rocket propellants.

In one type of reaction, organic nitrates and water are formed when alcohols and other compounds containing OH groups react with the acid. Nitroglycerol, commonly called nitroglycerin, is made by the treatment of glycerol with a mixture of concentrated nitric and sulfuric acids: $C_3H_5(OH)_3 + 3HNO_3 \rightarrow C_3H_5(NO_3)_3 + 3H_2O$. The sulfuric acid combines with the water, increasing the concentration of nitronium ion (NO_2^+), a powerful nitrating agent. Cellulose in the form of cotton or wood fibres is similarly treated to obtain cellulose nitrates. The extent of nitration (*i.e.*, the number of nitrate radicals combining with a unit of the cellulose) is controlled to produce either guncotton (smokeless powder) or, with less nitration, the base for pyroxylin lacquers and plastics and certain types of fibres. In organic nitrates the nitrogen atom is bonded to an oxygen atom, which in turn is linked to a carbon. Another type of reaction of nitric acid and organic compounds involves the formation of nitro compounds in which the nitrogen atom of the group $-NO_2$ is bonded directly to the carbon atom.

Toluene (methylbenzene) reacts with nitric acid in the presence of concentrated sulfuric acid to form trinitrotoluene, more commonly known as TNT: $C_6H_5CH_3 + 3HNO_3 \rightarrow CH_3C_6H_2(NO_2)_3 + 3H_2O$. (*See* EXPLOSIVES.)

Nitric acid is a powerful oxidizing agent; it oxidizes nearly all of the metals except platinum, rhodium, iridium, tantalum and gold. Most metals yield nitrates, but with tin, arsenic, antimony, tungsten and molybdenum the oxides of the metals are formed. The behaviour of the acid as an oxidizing agent is complex because of the number of possible reduction products that may be obtained. The oxidation or valence number of the nitrogen in nitric acid is $^+5$; it may be reduced to nitrogen dioxide, NO_2 ($^+4$), nitric oxide, NO ($^+2$), nitrogen, N_2 (0), or to ammonium ion, NH_4^+ ($^-3$), depending upon the temperature, the concentration of the acid, the presence of catalysts and the activity of the metal or other reducing agent involved.

In general, the more concentrated the acid the less the change in the oxidation number of the nitrogen. For example, copper reduces the concentrated acid to NO_2: $Cu + 4HNO_3$ (concentrated) $\rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$, and the dilute acid to NO: $3Cu + 8HNO_3$ (dilute) $\rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$. A stronger reducing agent may cause a greater change in the oxidation number of the nitrogen, as:

$$4Zn + 10HNO_3 \text{ (dilute)} \rightarrow 4Zn(NO_3)_2 + NH_4NO_3 + 3H_2O$$

wherein the reduction product is ammonium nitrate.

On the other hand, the concentrated acid may oxidize the metal or nonmetal to a higher valence stage than does the dilute acid, as:

$$S + 6HNO_3 \text{ (concentrated)} \rightarrow H_2SO_4 + 6NO_2 + 2H_2O, \text{ and}$$
$$3S + 4HNO_3 \text{ (warm, dilute)} \rightarrow 3SO_2 + 4NO + 2H_2O$$

When iron, copper or chromium is placed in contact with concentrated nitric acid it becomes inactive or passive to the acid and to certain other substances with which it normally reacts; passive iron reduces neither hydrogen ion nor cupric ion, and passive copper does not reduce silver ion. Passivity may be destroyed by scratching the surface, by the action of reducing agents, or by the effect of a strong magnetic field. It was thought at mid-20th century that the formation of an oxide film on the surface of the metal was the cause of the phenomenon.

Nitric acid is highly toxic if taken internally, producing a widespread gastroenteritis, burning pain in the esophagus and abdomen, and bloody diarrhea. Death may occur from collapse or from secondary destructive changes in the intestinal canal. On the skin a characteristic yellow staining appears, due to the formation of xanthoproteic acid. Copious quantities of water and mild bases such as sodium bicarbonate solution will assist in neutralizing the effects of internal and external exposures.

Manufacture.—In the laboratory pure anhydrous nitric acid is prepared by gently heating an equimolal mixture of pure concentrated sulfuric acid and pure sodium nitrate under vacuum and condensing the evolved gaseous acid at a temperature near or below its melting point. The reaction is $H_2SO_4 + NaNO_3 \rightarrow NaHSO_4 + HNO_3$ (gas).

Commercially, nitric acid is manufactured by three processes. The older method, practically obsolete at mid-20th century is similar to the laboratory method. Chile saltpetre, a commercial form of sodium nitrate, is heated with an equimolal amount of concentrated sulfuric acid under reduced pressure in iron retorts. Nitric acid boils out of the reaction mixture and is condensed in glass containers. An attempt to bring about a reaction between another molecule of sodium nitrate with the second hydrogen in the sulfuric acid molecule results in decomposition of the nitric acid because of the high temperatures necessary to make the reaction go.

The second and most common method of manufacturing nitric acid is by catalytic oxidation of ammonia. Ammonia can be synthesized as cheaply per pound of nitrogen as Chile saltpetre can be mined and purified, and as a result it largely supplanted the latter as a source material. A mixture of 10% ammonia and 90% air is heated to 300° C. and passed over a platinum gauze catalyst, which is heated initially to 900°–1,000° C. Heat liberated in the reaction is sufficient to maintain the catalyst temperature. About 90% of the ammonia is oxidized to nitric oxide: $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$. From the catalyst the gases pass into absorption towers where two reactions take place: $2NO + O_2 \rightarrow 2NO_2$ and $3NO_2 + H_2O \rightarrow 2HNO_3 + NO$.

The third method of nitric acid manufacture involves the direct union of atmospheric oxygen and nitrogen in an electric arc: $N_2 + O_2 \rightarrow 2NO$, followed by the last two reactions of the ammonia process. Equilibrium in the arc reaction favours formation of nitric oxide only at very high temperatures. For example at 3,900° C. the reaction is only 10% complete at equilibrium. However, if the reaction mixture is quenched quickly to a temperature below 1,000° C. it may be frozen at the high-temperature equilibrium proportions. Under the most favourable conditions, the yield of nitric oxide is only about 2.5%. The process is not commercially competitive with the ammonia oxidation process even in locations where electric power is cheap. (*See* NITROGEN, FIXATION OF.)

Nitrates.—Inorganic nitrates are chemical compounds with the type formula $Me(NO_3)_n$, where Me represents a metal atom and n may be one, two, or more depending on the valence of the metal. Nitrates are crystalline solids at ordinary temperatures. They may be white or coloured, depending on the metallic constituent. As a group they are the most water soluble of all metallic salts. Nitrates are prepared by reaction of the desired metal, its oxide or its carbonate with nitric acid.

Nitrates of base metals decompose according to the equation $2NaNO_3 \rightarrow 2NaNO_2 + O_2$ when heated, whereas nitrates of the less active metals are converted to oxides under the influence of heat: $2Zn(NO_3)_2 \rightarrow 2ZnO + 4NO_2 + O_2$. Anhydrous cupric nitrate, ferric nitrate and mercuric nitrate may be sublimed under careful heating, but uranyl nitrate, nickel nitrate, cobalt nitrate, cadmium nitrate and manganous nitrate decompose like zinc nitrate upon heating to form their oxides, nitrogen dioxide and oxygen. When heated to high temperatures, nitrates are strong oxidizing agents comparable to nitric acid.

Many nitrates are hygroscopic; *i.e.*, they absorb atmospheric moisture if left unprotected. Potassium nitrate is an important exception. Some nitrates contain water of crystallization when precipitated from aqueous solution, one or more water molecules per nitrate molecule forming an integral part of the crystalline structure of the solid material. The amount of water varies with the substance and the temperature. Heating the hydrated salts causes partial to complete conversion to oxide, depending on the metallic constituent. Nitric acid is driven off as a gas.

The nitrate ion has the structure of an equilateral triangle, with oxygen atoms surrounding the central nitrogen atom. Nitrates are determined qualitatively by reduction with ferrous ion, Fe^{2+}, to nitric oxide and subsequent formation of $FeNO^{2+}$, a complex

ion with a characteristic deep-brown colour. The reaction takes place in the presence of concentrated sulfuric acid, which is added to a solution of the unknown and ferrous sulfate in such a way that the two solutions do not mix. A brown layer at the interface indicates the presence of nitrate ion. Quantitative determination of nitrate ion is usually accomplished by reduction to ammonia by aluminum in alkaline solution, distillation of the ammonia into excess standardized sulfuric acid and back titration with standardized sodium hydroxide solution. Nitrate ion forms an insoluble salt with nitron (4,5-dihydro-1,4-diphenylimino-1,2,4-triazole), permitting the gravimetric determination of nitrates. For other nitrogen compounds *see* NITROGEN. *See* also references under "Nitric Acid and Nitrates" in the Index.

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NITRIDES are binary compounds of nitrogen with the elements. They apparently do not occur in nature, although F. A. Bannister reported the presence of titanium nitride, TiN, in the mineral osbornite, found in the Busti, India, meteor. The simple nitrides may be regarded as derivatives of ammonia in which the hydrogen atoms are replaced by a metallic or nonmetallic element. Their composition may be represented by formulas corresponding to the normal valence (oxidation number) of the elements based upon their position in the periodic classification; for example, Group I, Li_3N; Group II, Mg_3N_2; Group III, AlN; Group IV, Si_3N_4. Where an element is capable of existing in several oxidation states, corresponding nitrides may be capable of existence; for example, PN and P_3N_5.

In addition to these simple nitrides, compounds with nitrogen are formed by such transition elements as chromium, iron and cobalt, whose structure and composition are more complex and do not conform to valence rules.

Reference is also made to three classes of binary nitrogen compounds that differ markedly from the simple nitrides: (1) the hydronitrogens, compounds of hydrogen and nitrogen, which formally resemble the hydrocarbons (*see* AMMONIA); (2) compounds with the more electronegative elements such as oxygen, sulfur and the halogens, which are discussed under the respective elements, and (3) the trinitrides, containing the N_3 radical, which are derivatives of hydrazoic acid, one of the hydronitrogens (*see* HYDRAZOIC ACID).

Preparation.—Many of the nitrides can be prepared by direct combination of the elements with nitrogen, but such reactions take place much less readily, and then usually only at higher temperatures, than the corresponding oxidation reactions. A few elements, notably lithium, magnesium and the alkaline earth metals, burn in air to give mixtures of the oxides and nitrides. Nitride formation is aided by using active nitrogen, by reducing the elements to a fine state of subdivision, by employing the amalgams and by using catalysts, such as lithium nitride. Nitride formation by direct combination has been observed to take place with the following elements: Mg, Ca, Sr, Ba, Li, Be, B, Al, La, Ce, Pr, Nd, Ti, Zr, Th, V, Cb, Ta, Cr, Mo, W, U, Mn, Fe, Co, Ni, Si, Ge and P. Despite their high reactivity, sodium, potassium, rubidium and cesium do not appear to form nitrides by direct combination. In general, elements of the B subgroups of the periodic classification show little inclination to react directly with nitrogen.

Nitrides may also be prepared by indirect methods, of which the following are the more important:

1. Mixtures of the oxides with carbon can be converted to nitrides by heating in a nitrogen atmosphere. This procedure is used for the preparation of aluminum nitride in accordance with the equation $Al_2O_3 + 3C + N_2 \rightarrow 2AlN + 3CO$ and constitutes the basis for the Serpek process for the fixation of atmospheric nitrogen (*see* NITROGEN, FIXATION OF). In some cases carbides can be heated directly with nitrogen as in the production of beryllium nitride: $3Be_2C + 2N_2 \rightarrow 2Be_3N_2 + 3C$.

2. Gaseous ammonia may serve as the nitriding agent for conversion of certain metals, oxides, sulfides and, in some instances, halides into nitrides. Cuprous oxide reacts with ammonia at 300° C. to yield some cuprous nitride, Cu_3N; at 600° C. zinc is converted into zinc nitride, Zn_3N_2.

3. Amides and imides of many elements undergo thermal decomposition to yield the nitrides. Nonmetallic halides, in particular, react with gaseous or liquid ammonia at ordinary temperatures to give the amides or imides, which may be heated to effect deammonation (removal of ammonia, analogous to dehydration by which hydroxides are converted to oxides) and eventually to give the nitrides. Thus, treatment of boron trichloride with ammonia gives first the diboron tri-imide, $B_2(NH)_3$, which on heating loses ammonia to form the nitride, BN.

$$BCl_3 \xrightarrow{NH_3} B_2(NH)_3 \xrightarrow[125^\circ\ C.]{above} BN$$

The amides of such metallic elements as magnesium, calcium, strontium, barium, zinc, cadmium, nickel and cobalt precipitate when potassium amide is added to solutions of their salts in liquid ammonia. These products likewise undergo deammonation at higher temperatures.

$$M^{2+} \xrightarrow{KNH_2} M(NH_2)_2 \xrightarrow{heat} M_3N_2$$
$$\text{(where } M = Mg, Ca, Sr, Ba, Zn, Cd, Ni, Co)$$

The amides of the alkali metals, with the exception of lithium, do not give nitrides on heating.

4. Reaction of certain metallic salts with potassium amide in liquid ammonia as the solvent medium affords a procedure whereby may be obtained nitrides that are unstable at the temperatures required to effect direct combination of metal with nitrogen. The following nitrides are precipitated from liquid ammonia solution under these conditions: mercuric nitride, Hg_3N_2, thallous nitride, Tl_3N, and bismuth nitride, BiN.

$$\left.\begin{matrix} Hg^{2+} \\ Tl^{+} \\ Bi^{3+} \end{matrix}\right\} \text{ in liquid } NH_3 + NH_2^- \text{ (from } KNH_2) \rightarrow \begin{matrix} Hg_3N_2 \\ Tl_3N \\ BiN \end{matrix}$$

(*See* also AMMONIA; SOLUTIONS.)

5. Aqueous ammonia converts the oxides of silver, gold and the platinum metals into highly explosive compounds that are assumed to be nitrogen compounds, possibly nitrides. These are often referred to as the fulminating metals.

6. Careful heating of the alkali and alkaline-earth azides (*see* HYDRAZOIC ACID) gives nitrides of the respective metals. A large number of nitrides have thus far been described in the chemical literature. These may be listed conveniently on the basis of type formula with M representing the element with which nitrogen is combined.

Nitrides of the Elements

Type formula	Where M represents
MN	B, Al, Sc, Y, La, Ce, Pr, Nd, Sm, Er, Ga, In, Si Te, Zr, P, As, Sb, Bi, V, Ta, Cb, Cr
MN_2	V, W
M_2N	Cb, Cr, W, Fe
M_3N	Li, Na, K, Rb, Cs, Cu, Tl
M_3N_2	Be, Mg, Ca, Ba, Sr, Ra, Zn, Cd, Hg, Ge, Zr, Cr, Mo, Mn, Co, Ni
M_3N_4	C, Si, Ti, Zr, Th, Ge, U
M_3N_5	P, Cb, Ta

A number of other nitrides have been described, but the identity of some of these is questionable: Si_2N_3, U_5N_4, U_5N_2, W_2N_3, Mn_5N_2, Mn_7N_2, Fe_8N and Fe_4N.

Properties and Uses.—Nitrides, like oxides, vary considerably in their stability and reactivity.

The nitrides of the noble metals (for example, Hg_3N_2 and BiN) decompose explosively into the elements on heating, whereas the nitrogen compounds of boron, silicon, titanium, zirconium, vanadium, tantalum and molybdenum (as examples of the nitrides of Groups III, IV, V and VI) are characterized by their remarkable stability at high temperatures.

Most nitrides react with water to liberate ammonia, as, for instance, $Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3$, although the tendency to do so depends not only on the specific nitride but also on

the method of preparation and the subsequent thermal history of the compound.

Thus, many of the nitrides prepared at lower temperatures by deammonation of the amides or imides hydrolyze rapidly; if these same nitrides are sintered by heating to a high temperature, they become relatively inert to attack by chemical agents (*e.g.*, boron nitride, BN). Structural changes to highly polymerized aggregates are involved. High-temperature treatment in some instances changes the composition of the nitrides to products of lower nitrogen content; *e.g.*, trititanium tetranitride, Ti_3N_4, is converted into titanium nitride, TiN.

Certain nitrides such as those of boron, BN, silicon, SiN, titanium, TiN, zirconium, ZrN, and tantalum, TaN, are extremely refractory materials with melting points near or above 2,500° C. Where this property is combined with chemical inertness such nitrides have found use in the manufacture of equipment that must withstand chemical action at high temperatures. Crucibles of titanium nitride are especially resistant to attack by various molten ferrous metals. The nitrides of titanium, zirconium and tantalum are furthermore characterized by their extreme hardness and are used either alone or in admixture with borides and/or carbides for hard-metal alloys and abrasive compositions.

Boron nitride has long been known to form hexagonal crystals that resemble graphite in structure and physical properties. Special experimental techniques entailing application of very high pressures (85,000 atm.) and high temperatures (1,800° C.) result in formation of the cubic form, known as "Borazon," which is as hard as the diamond but is more stable toward oxidation. (The patent literature must be consulted for specific disclosures concerning compositions used for such purposes.)

Formation of interstitial or metalliclike nitrides is involved in the nitriding process in which steel and its alloys are heated in an atmosphere of ammonia above 800° C. to produce a surface film possessing great hardness and resistance to wear and to chemical attack.

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NITRIDING, a process for the surface hardening of steel. It consists in heating special alloy steels in contact with ammonia at temperatures below the transformation range for steels, usually between 950° F. and 1,050° F., for periods of from 5 to 100 hr. depending upon the depth of hardened "case" desired. The steels used must contain nitriding-forming elements (such as aluminum, chromium or molybdenum) dissolved in the iron. During the nitriding cycle nitrogen from the ammonia diffuses into the steel and forms alloy nitrides, which are precipitated along the crystal planes of the iron. This precipitation causes an increase in hardness, which is dependent upon temperature and the amount and nature of the nitride-forming elements in the steel. Aluminum is the most effective hardening element. A steel containing approximately 1% aluminum and 1% chromium nitrided at 975° F. will have a surface hardness of approximately 1,100 Vickers-Brinell.

The advantages of nitriding compared with other methods of surface hardening are as follows: (1) A much harder and more wear-resistant case is produced. (2) Distortion is low primarily because the process is carried out below the transformation range. (3) The resistance to fatigue failures, particularly notch fatigue, is greatly increased because nitriding results in surface compressive stresses which resist crack formation. The disadvantages of the process are: (1) An alloy steel must be used, which is more expensive than plain carbon steels. (2) The time required to produce a case is long compared with other methods such as carburizing, cyaniding or induction hardening. (C. F. F.)

NITROBENZENE, the simplest aromatic nitrocompound, $C_6H_5NO_2$, was first isolated in 1834 by E. Mitscherlich and is prepared commercially by the action of a mixture of concentrated nitric and sulfuric acids upon benzene at a temperature of 50°–55° C. The oily product, which separates, is washed with alkali and then distilled. It is a highly poisonous yellowish liquid possessing a strong smell similar to that of oil of bitter almonds. It boils at 210.9° C. and melts at 5.7° C. The products of its electrolytic reduction vary with the conditions: in 50% sulfuric acid solution it yields *p*-aminophenol (L. Gattermann, 1893) in alkaline solution it yields azoxybenzene, azobenzene, hydrazobenzene or aniline, depending upon the material used for the cathode, upon the solvent, upon the applied voltage and current density and upon the total amount of current allowed to pass through the solution; in an approximately neutral aqueous or alcoholic solution, it yields β-phenylhydroxylamine; and, in acid alcoholic solution, it yields some benzidine together with other products. With chlorine, in the presence of iodine or antimony chloride, it yields meta-chloronitrobenzene. It occasionally acts as an oxidizing agent, as in the preparation of quinoline and fuchsin (magenta). It is used commercially for the preparation of aniline (*q.v.*) and of benzidine (*q.v.*), and in perfumery (oil of mirbane).
(G. W. Wn.)

NITROCELLULOSE (or cellulose nitrate) is the name given to the nitric esters of cellulosic materials, in practice largely cotton linters and wood pulp.

T. J. Pelouze discovered in 1838 that cotton could be converted into a violently inflammable substance by the action of concentrated nitric acid. C. F. Schönbein in 1845 demonstrated the use of this material as an explosive and improved the manufacturing method by adding sulfuric acid to the nitric acid. The form of nitrocellulose known as guncotton came into use as an ingredient of gunpowders (bulk powders) in the 1860s; gelatinized nitrocellulose propellants were introduced in the 1880s. E. A. Brown discovered in 1868 that dry and even moist nitrocellulose could be exploded by a detonator, thus starting the use of the substance as a high explosive.

The history of its uses is punctuated by many disastrous explosions, caused largely by the failure to appreciate that nitrocellulose is an unstable material and is subject to catalytic decomposition caused by its own decomposition products. This reaction, if not checked in time, results in explosions. Sir Frederick Abel demonstrated in 1868 that the then prevalent methods of washing nitrocellulose after nitration were inadequate and that the residual acid was causing high instability. The introduction of the pulping process and other changes in the washing procedure led to significantly improved nitrocellulose. However, explosions of smokeless powder magazines continued; and in modern practice, which goes back to the researches of Paul Vieille, special stabilizers are added to nitrocellulose; the function of these is to neutralize catalytically active decomposition products. The results of this are the modern stable and reliable propellants.

Cellulose molecules consist of thousands of anhydroglucose units, $C_6H_{10}O_5$, linked into chains; therefore the nitration process may be schematically represented by the equation:

$$C_6H_{10}O_5 + xHNO_3 \rightarrow C_6H_{10-x}O_{5-x}(NO_3)_x + xH_2O$$

Here x is a variable quantity which depends on the composition of the nitrating mixture and on the time and temperature of nitration. Theoretically x can reach the value of three, corresponding to 14.14% nitrogen in the product; but with mixtures of sulfuric and nitric acids such a high degree of nitration is seldom achieved.

The manufacture of nitrocellulose, in principle if not in practice, is a relatively simple process. Cotton linters or sulfite-process wood pulp are dipped into a large excess of nitric-sulfuric acid mixture; after a prescribed length of time, the product is separated from the bulk of the acid, for instance by centrifuging. The nitrocellulose is then "drowned" quickly in excess water and is subjected to boiling in acidified water to eliminate unstable byproducts of nitration.

The next step consists in pulping to disintegrate the fibres and to facilitate a subsequent washing, in which the last traces of acid must be removed. Cotton linters were for a long time preferred for the manufacture of gun propellants; but, starting in World War I, wood pulp became more and more accepted. A high content of alpha-cellulose in wood pulp appears to be essential

ensure high quality of smokeless powders.

Nitrocellulose is a fluffy, white substance, retaining some of the fibrous structure of untreated cellulose. It is rather unstable to heat and even carefully prepared samples will ignite on a brief heating to temperatures in excess of about 150° C.

Nitrocellulose is insoluble in water and in hydrocarbon solvents. It is soluble in acetone, in ethyl acetate, etc. Only the material with a low content of nitrogen is soluble in alcohol or ether, but intermediate grades are soluble in ether-alcohol mixtures.

Collodion or pyroxylin nitrocellulose, with a nitrogen content not in excess of 12%, is used chiefly for lacquers and celluloid plastics. Materials with a nitrogen content in the neighbourhood of 11.5% were used once, after denitration, as artificial silk, but have been replaced in this role by other materials, such as viscose rayon. This same material continued to be used for the manufacture of photographic films, although the use of safety film, made of cellulose acetate plastics, undermined its popularity.

Collodion nitrocellulose with 12% nitrogen finds much use in the manufacture of propellants and of gelatin dynamites. The highest degree of nitration which still gives a product soluble in mixed alcohol-ether solvents is 12.6%. This material, discovered by Dmitri Mendeleyev and known as pyrocellulose, is extensively used for the manufacture of propellants. Guncotton, with more than 13% nitrogen and soluble in acetone only, is also used for propellants, either alone or in combination with lower grades of nitrocellulose. Moist guncotton was once widely used as a high explosive, but it has been replaced by safer materials.

The nitration of cellulose is accompanied by a varying degree of depolymerization of the large molecules. For the manufacture of gun propellants the depolymerization is largely avoided, but with materials intended for the manufacture of lacquers it is deliberately encouraged since depolymerized nitrocellulose gives solutions of low viscosity which are desirable for this application.

See EXPLOSIVES; PROPELLANTS. *See* also references under "Nitrocellulose" in the Index.

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NITRO COMPOUNDS. Organic compounds in which one or more hydrogen atoms are replaced by the nitro (NO_2) group are called nitro compounds. Two main classes are recognized: aromatic and aliphatic.

Aromatic Nitro Compounds.—Aromatic hydrocarbons are substances which contain only carbon and hydrogen and which have at least one benzene ring of six carbon atoms; the parent member of this group is benzene, C_6H_6. Replacement of a hydrogen atom by a nitro group produces an aromatic nitro compound; *e.g.,* from benzene, C_6H_6, nitrobenzene, $C_6H_5NO_2$, is obtained. Substitution of two or more hydrogens by a corresponding number of nitro groups is also possible. An important example is the replacement of three of the hydrogens of toluene, C_7H_8, which gives trinitrotoluene (TNT), $C_7H_5(NO_2)_3$.

Replacement of a hydrogen atom by a nitro group is known as nitration and is most commonly effected by treating the aromatic compound with a mixture of concentrated nitric and sulfuric acids. The equation for the nitration of benzene is

$$C_6H_6 + HONO_2 \rightarrow C_6H_5NO_2 + H_2O$$

For a long time it was thought that the sulfuric acid facilitated nitration by combining with the water formed, but this is now known not to be the case. Instead, the sulfuric acid, by reacting with the nitric acid, converts it into the nitronium ion, NO_2^+, and this is the actual nitrating agent.

Nitrations are carried out on a commercial scale in large cast-iron vessels equipped with devices through which cooling water can be circulated to remove the heat of reaction. As much as 1,000 gal. of benzene is nitrated at one time. As successive nitro groups are introduced into an aromatic compound, more drastic conditions must be employed. Thus, the preparation of TNT (*q.v.*) is usually carried out in three successive steps in each of which higher temperatures and stronger acids are used.

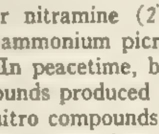
Many aromatic nitro compounds cause pronounced physiological reactions and care should be taken to avoid breathing their vapour and also to avoid contact with the skin. Aromatic nitro compounds are heavier than water and practically insoluble in it. Most are solids, although a few, including nitrobenzene, are liquids. Commercial preparations of nitrobenzene, trinitrobenzene and TNT usually have a yellowish colour, but the highly purified substances are colourless.

Nitrobenzene (*q.v.*) was first prepared in 1834 by E. Mitscherlich. Because of its characteristic odour it was called artificial oil of bitter almonds and was formerly employed as a flavouring principle and as an adulterant of oil of bitter almonds. It is highly toxic and such uses have been discontinued. Nitrobenzene was also used as a solvent for shoe dyes because it penetrates leather, but poisoning resulted by absorption of the vapours through the skin. Such formulations are now prohibited in most countries. Nitrobenzene is an excellent solvent for a wide variety of organic compounds.

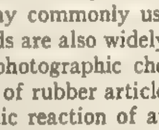
A number of polynitro aromatic compounds are used as explosives; *e.g.,* tetryl, or nitramine (2,4,6-trinitrophenylmethylnitramine); TNT; and ammonium picrate, a salt of picric acid (2,4,6-trinitrophenol). In peacetime, by far the major fraction of aromatic nitro compounds produced is converted into various derivatives. Aromatic nitro compounds are the starting point in the manufacture of many commonly used dyes. Derivatives of aromatic nitro compounds are also widely used as pharmaceuticals and to some extent as photographic chemicals and as chemicals used in the manufacture of rubber articles.

The most characteristic reaction of aromatic nitro compounds is reduction. A variety of reducing agents convert nitrobenzene, $C_6H_5NO_2$, into the aromatic amine aniline, $C_6H_5NH_2$. By use of milder reducing agents and control of the acidity or alkalinity of the reaction mixture, it is possible to stop the reduction at various intermediate stages. Consequently, a variety of compounds, in addition to amines, is readily available by controlled reduction of aromatic nitro compounds.

Aliphatic Nitro Compounds.—Aliphatic hydrocarbons contain only carbon and hydrogen and may be considered as derived from methane, CH_4. Replacement of a hydrogen atom by a nitro group gives aliphatic nitro compounds (commonly called nitroparaffins). Typical examples are: nitromethane, CH_3NO_2; 1-nitropropane, $CH_3CH_2CH_2NO_2$; 2-nitropropane,



and 2-methyl-2-nitropropane,



In contrast to the other hydrogen atoms, those hydrogen atoms attached to the carbon atom holding the nitro group are somewhat acidic; *i.e.,* they are removed under the influence of bases. The resulting salts are highly reactive, and many of the characteristic reactions of nitroparaffins proceed via these salts.

Nitroparaffins are classified as primary, secondary or tertiary. Primary nitroparaffins have two (or three) hydrogen atoms attached to the carbon holding the nitro group; *e.g.,* 1-nitropropane, nitromethane and nitroethane, $CH_3CH_2NO_2$. Secondary nitroparaffins have but one hydrogen atom on the carbon holding the nitro group, *e.g.,* 2-nitropropane, while tertiary nitroparaffins have no hydrogen atoms attached to the carbon holding the nitro group; *e.g.,* 2-methyl-2-nitropropane. Tertiary nitroparaffins do not react with bases and, hence, they fail to exhibit many of the common reactions of primary and secondary nitroparaffins.

Aliphatic hydrocarbons are much more resistant to direct nitration than the aromatic hydrocarbons, and because of this it was not until 1940 that nitroparaffins were produced commercially. The nitration of aliphatic hydrocarbons employs nitric acid alone and relatively high temperatures (300°–500° C.) are required. A

mixture of products results. For example, when propane, C_3H_8, is nitrated the products 1-nitropropane, 2-nitropropane, nitroethane and nitromethane are all formed. While satisfactory for the production of these simple nitroparaffins, the aliphatic nitration process is not suitable for the synthesis of higher members of the nitroparaffin series.

The reaction by which aliphatic nitro compounds were first prepared in 1872 is useful only for the synthesis of primary nitroparaffins. The synthesis of 1-nitrodecane is illustrative:

$$\underset{\text{1-bromodecane}}{CH_3(CH_2)_9Br} + \underset{\text{silver nitrite}}{AgNO_2} \rightarrow \underset{\text{1-nitrodecane}}{CH_3(CH_2)_9NO_2} + \underset{\text{silver bromide}}{AgBr}$$

In 1955 it was discovered that, contrary to the accepted view, if sodium nitrite ($NaNO_2$) is employed in place of silver nitrite, then the reaction is valuable for the production of primary and secondary nitroparaffins.

Tertiary nitro compounds are best obtained by oxidizing the corresponding amines with potassium permanganate ($KMnO_4$).

The lower nitroparaffins are colourless liquids of mild odour. In contrast with the aromatic nitro compounds the nitroparaffins have about the same toxicity as petroleum naphtha. The nitroparaffins are only slightly soluble in water. Boiling points of the four lowest members are: nitromethane, 101.2° C.; nitroethane, 114° C.; 2- and 1-nitropropane, 120.3° C. and 131.6° C.

The aliphatic nitro compounds are excellent solvents. They have also found use as fuels and as starting materials in synthesis.

A sensitized form of nitromethane is used as an explosive. Chloropicrin, $Cl_3C.NO_2$, is a grain fumigant, being especially effective against weevils. Chloropicrin is also a powerful lachrymator and this leads to its use as a tear gas and as a warning agent for other fumigants. Tetranitromethane, $C(NO_2)_4$, a colourless liquid, when mixed with organic compounds is liable to produce a violent explosion.

Nitroparaffins are readily reduced to amines; *e.g.*, nitroethane, $CH_3CH_2NO_2$, gives ethyl amine, $CH_3CH_2NH_2$. This reaction greatly extends the utility of the nitroparaffins by making numerous aliphatic amines readily available. *See* also BLASTING; EXPLOSIVES; NITROGLYCERIN; TNT. (N. KM.)

NITROGEN is a colourless, odourless, tasteless gas that is incombustible, does not support combustion or respiration, and is one of the most widespread elements. It occurs free in the atmosphere and also as an ingredient of various compounds, some of which are found in the proteins of plants and animals and others of which constitute important drugs, dyes and other chemicals. Symbol N, atomic number 7, atomic weight 14.0067. The free element consists of nitrogen molecules, N_2. Its existence was first recognized by C. W. Scheele (1772), who showed that common air is a mixture of two gases, which he called "foul air" (nitrogen) and "fire air" (oxygen). He obtained the foul air by removing the fire air in combination with various combustible or oxidizable materials, and showed that the residue would not support combustion or respiration. Nitrogen was discovered independently by Joseph Priestley and Daniel Rutherford about the same time. Antoine Lavoisier named the gas "azote" because of its inability to support life and recognized that it is an element. The name nitrogen was introduced by J. A. C. Chaptal (1790) to indicate that the element is a constituent of nitre (potassium nitrate, or saltpetre).

Nitrogen occurs in the atmosphere to the extent of approximately 78% by volume and 75.5% by weight, and serves to dilute the oxygen. Free nitrogen is also found in many meteorites, in volcanic gases and gases in mines and from some mineral springs; its presence in the sun and in certain stars and nebulae is shown by the spectroscope. In combination, it is found in nitre, Chile saltpetre (sodium nitrate), ammonia and ammonium salts in the atmosphere, in rain, soil and guano, and as complex organic compounds (proteins), with an average of 16% of nitrogen, in living organisms.

Preparation and Uses.—Nitrogen may be prepared (1) from atmospheric air by removal of the oxygen, or (2) from its compounds. Atmospheric nitrogen contains about 1% of group VIII-A gases (argon, etc.).

1. The oxygen is removed from air by exposure to phosphorus at ordinary temperature (burning phosphorus is not so effective), moist iron filings, an alkaline solution of pyrogallol, an acid solution of chromous chloride or cuprous chloride, or metallic copper in presence of hydrochloric acid or ammonia, or by passing air over red-hot copper.

On the large scale, nitrogen is made almost entirely by the fractional distillation of liquid air, in which process, since it has a lower boiling point than oxygen, it tends to evaporate first. The gas is marketed in gray cylinders under a pressure of about 120 atm. This gas contains most of the helium and neon present in air (*see* ATMOSPHERE), but the argon, which has nearly the same boiling point, mostly remains with the oxygen.

2. Pure nitrogen is made from its compounds: (*a*) by passing chlorine into ammonia solution, $2NH_3 + 3Cl_2 \rightarrow N_2 + 6HCl$; (*b*) by heating a solution of ammonium nitrite (or a mixture of sodium nitrite and ammonium chloride), $NH_4NO_2 \rightarrow N_2 + 2H_2O$; (*c*) by heating ammonium dichromate, $(NH_4)_2Cr_2O_7 \rightarrow N_2 + Cr_2O_3 + 4H_2O$; (*d*) by passing a mixture of nitric oxide and ammonia gas over red-hot copper, $6NO + 4NH_3 \rightarrow 5N_2 + 6H_2O$; (*e*) in a very pure state by heating sodium or barium azide in a vacuum, $Ba(N_3)_2 \rightarrow Ba + 3N_2$. The gas may be collected over water.

Nitrogen gas is used in filling the larger or cheaper kinds of electric bulbs (argon [*q.v.*] is used for the smaller, more expensive ones) to prevent blackening of the bulb by volatilized metal from the filament, which can thus be run at a higher temperature. High-temperature mercury thermometers may contain compressed nitrogen. Large quantities of nitrogen are used to make synthetic ammonia and other nitrogen compounds (such as nitric acid), which are needed in the production of dyes, drugs, explosives and fertilizers.

Properties.—Nitrogen gas is only slightly soluble in water but one volume of liquid oxygen dissolves about 450 vol. of the gas. On strong cooling under pressure, nitrogen forms a colourless liquid, boiling at −195.84° C., at which temperature its specific gravity is 0.8042. The critical temperature is −147.13° C. and the critical pressure 33.49 atm. On rapid evaporation under reduced pressure the liquid freezes to a colourless solid melting at −210.02° C. The density of nitrogen gas at 0° C. and 760 mm. pressure is 1.25051 g. per litre when gravity acceleration = 980.60 cm./sec.[1]

The element has two stable isotopes with masses 14 and 15, enrichment in N^{15} being achieved by an exchange reaction between ammonia gas and ammonium sulfate solution. Rutherford showed that the nitrogen atom is disintegrated by the impact of swift alpha particles, and protons (hydrogen nuclei) are expelled from its nucleus. Radioactive isotopes N^{13} and N^{16} are formed artificially in various ways; *e.g.*, N^{13} by bombarding carbon with deuterons.

Nitrogen gas is somewhat inert, since the heat of dissociation of the nitrogen molecule into atoms is large (170, or 225, kg.cal. per mole), but it can unite directly under certain conditions with several elements, including hydrogen, oxygen, boron, silicon, lithium, magnesium, calcium, barium, titanium, vanadium, tantalum, tungsten and manganese. The compounds with metals (nitrides) may be decomposed by water under various conditions, with evolution of ammonia.

Active Nitrogen.—When a current of nitrogen gas containing a trace of oxygen or other impurity is exposed at low pressure to a high-tension electric discharge, the gas beyond the discharge glows with a yellow light and is more active chemically than ordinary nitrogen (Lord Rayleigh, 1911). It does not react with molecular hydrogen or oxygen but forms ammonia with atomic hydrogen, combines with sulfur, phosphorus and several metals forming nitrides, decomposes nitric oxide into oxygen and nitrogen, and forms hydrocyanic acid with acetylene. The nature of this so-called active nitrogen is still uncertain, but it probably contains nitrogen atoms, both normal and excited. In a bulb coated with metaphosphoric acid, the glow persists for several hours.

The Nitrogen Cycle.—Animals derive the nitrogen of their

tissue proteins partly from animal proteins and partly (sometimes wholly) from vegetable proteins of food. Plants synthesize their proteins from inorganic compounds in the soil and to some extent from free nitrogen in the atmosphere. P. E. M. Berthelot found that sterilized soils do not take up nitrogen from the air, hence he concluded that microorganisms are concerned with the assimilation.

Leguminous plants such as peas, beans and clover can utilize atmospheric nitrogen by the action of a bacterium, *Rhizobium* (or *Pseudomonas radicicola*), of which there are several strains. The process takes place through the root hairs and involves the production of nodules on the roots, which contain Y-shaped associations of bacteria that are called bacteroids. Free-living anaerobic bacteria in the soil that are able to fix nitrogen are *Clostridium pasteurianum* (S. Vinogradsky, 1893) and *Azotobacter chröococcum* (M. W. Beijerinck, 1901). Certain algae also fix nitrogen and are of importance in tropical soils. The amount of nitrogen fixed by bacteria increases by 30% if certain protozoa are present in the soil, although protozoa feed on bacteria.

Ammonium salts in the soil are oxidized to nitrates by the agency of microorganisms, the process being called nitrification (S. Vinogradsky, 1890). They are first oxidized to nitrites by organisms belonging to the genera *Nitrosomonas*, and the nitrites are then oxidized to nitrates by another bacterium called *Nitrobacter*. The processes depend on free aeration and a neutral or alkaline reaction in the soil. The nitrate is assimilated but is reduced in the plant to ammonia.

Other kinds of bacteria decompose nitrogen compounds in the soil and, by this process of denitrification, return free nitrogen to the air. The combined nitrogen content of cultivated soil is generally enriched and renewed by means of nitrogenous fertilizers such as nitrates and ammonium salts.

Nitrogen is also fixed in the form of oxides by electrical discharges in the atmosphere, and conveyed to the soil in the form of nitric and nitrous acids by rain, these acids forming nitrates and nitrites in the soil. Altogether about 250,000 tons of nitric acid are said to be formed in this way in 24 hours. Some observations show, however, that the combined nitrogen content of rain does not increase during a thunderstorm.

Compounds of Nitrogen and Hydrogen.—Nitrogen forms three compounds with hydrogen, ammonia (*q.v.*), NH_3; hydrazine, N_2H_4; and hydrazoic acid or azoimide, HN_3. Ammonia and hydrazine normally function as bases and form secondary compounds, N_4H_4 and N_5H_5, respectively, with hydrazoic acid. With alkali metals, ammonia and hydrazine form compounds in which part of their hydrogen is replaced by a metal.

Hydrazine (*q.v.*), N_2H_4, with the structure $H_2N{\cdot}NH_2$ (diamide), was originally obtained by T. Curtius (1887) from organic compounds containing two nitrogen atoms linked together. It is made commercially by a process devised by Friedrich Raschig (1907). Sodium hypochlorite solution is mixed with a small quantity of glue and warmed with excess of concentrated ammonia. An intermediate compound called chloramine, NH_2Cl, is formed, which reacts with the excess of ammonia to form hydrazine. After addition of sulfuric acid and cooling, hydrazine sulfate, $2N_2H_4{\cdot}H_2SO_4$, crystallizes. When this is distilled under reduced pressure with concentrated potassium hydroxide solution, a colourless fuming liquid, called hydrazine hydrate, is obtained. From this, anhydrous hydrazine is obtained by distilling with solid sodium hydroxide or barium oxide (which remove water) under reduced pressure. It is a colourless liquid, boiling point 113.5° C., which freezes to a white crystalline solid, melting point 2° C. Hydrazine decomposes on heating, $3N_2H_4 \rightarrow N_2 + 4NH_3$, and reacts violently with halogens, forming nitrogen and halogen hydracids, $N_2H_4 + 2I_2 \rightarrow N_2 + 4HI$. Hydrazine rapidly destroys cork and rubber and when hot attacks glass. It is a weaker base than ammonia, forming two series of salts; *e.g.*, $N_2H_4{\cdot}HCl$ and $N_2H_4{\cdot}2HCl$. Hydrazine and its salts are poisonous. They are very powerful reducing agents, precipitating many metals from solutions of their salts.

Hydrazoic acid (*q.v.*), HN_3, also discovered by Curtius (1890), is formed by the action of an oxidizing agent, *e.g.*, nitric acid, on hydrazine, $3N_2H_4 + 5O \rightarrow 2HN_3 + 5H_2O$. The sodium salt is formed on passing nitrous oxide over heated sodamide, $NaNH_2 + N_2O \rightarrow NaN_3 + H_2O$. Pure hydrazoic acid is a colourless liquid (boiling point 37° C., melting point −80° C.), with a very unpleasant odour. It is very dangerously poisonous and explosive, decomposing with a blue flash on heating. The solution is acid and dissolves many metals, forming salts called azides, which, especially those of the heavy metals, are explosive; lead azide is used as a detonator instead of mercury fulminate. In its action on metals nitrogen is evolved (not hydrogen, except a trace with magnesium), and part of the acid is reduced to ammonia. With ammonia and hydrazine it forms the colourless crystalline compounds $NH_3{\cdot}HN_3$ (or N_4H_4) and $N_2H_4{\cdot}HN_3$ (or N_5H_5). The group $-N_3$ in hydrazoic acid behaves like a halogen; azides give a white precipitate of AgN_3 with silver nitrate. From X-ray spectra it is shown that the three nitrogen atoms in the group are in a straight line, not in a ring.

Oxides of Nitrogen.—The oxides of nitrogen are: nitrous oxide, N_2O; nitric oxide, NO; dinitrogen trioxide, N_2O_3; nitrogen dioxide, NO_2, and its polymer, dinitrogen tetroxide, N_2O_4; dinitrogen pentoxide, N_2O_5; and an unstable higher oxide of uncertain formula, perhaps NO_3.

Nitrous oxide, N_2O, was discovered by Joseph Priestley (1772) by exposing "nitrous air" (NO) to iron or alkali sulfides, when the gas diminished in volume and became a better supporter of combustion than common air. It was studied by Sir Humphry Davy (*q.v.*) (1799), who called it nitrous oxide and prepared it by heating ammonium nitrate, $NH_4NO_3 \rightarrow N_2O + 2H_2O$, the method now used. He showed that it has anesthetic properties, in some cases preceded by peculiar effects that led to its name "laughing gas." Nitrous oxide can be synthesized from its elements only with difficulty and under special conditions (D. L. Chapman, R. A. Goodman and R. T. Shepherd, 1926). It is produced by the reduction of nitric acid under certain conditions; *e.g.*, by the action of zinc on the dilute acid. It is made in the pure state by the action of hydroxylamine hydrochloride on sodium nitrite in equimolecular proportions in solution, hyponitrous acid being an intermediate product, $NH_2OH + HNO_2 \rightarrow N_2O + 2H_2O$. It is formed in special circumstances by the oxidation of ammonia.

Nitrous oxide is a colourless gas with a pleasant sweetish odour and taste, density 1.9777 g. per litre, 1½ times that of air. At 15° C. one volume of water dissolves 0.7778 vol. of nitrous oxide, forming a neutral solution. It is more soluble in alcohol (3.268 vol. at 15° C.). Nitrous oxide supports combustion better than common air (it kindles a glowing chip, like oxygen) because it decomposes into a mixture of one volume of oxygen and two volumes of nitrogen at a fairly low temperature (beginning at 520° C.). It is an endothermic compound; *i.e.*, contains more energy than its elements and can be decomposed into oxygen and nitrogen by the explosion of a detonator. The molecule is linear, the two nitrogen atoms being adjacent. On cooling or under pressure (50 atm. at 15° C.) it forms a colourless liquid, boiling point −88.7° C., on rapid evaporation of which a white solid, melting point −90.8° C., is formed. The critical temperature is 36.5° C. and the critical pressure 71.66 atm.

The chief use of nitrous oxide is as an anesthetic in operations of short duration, but prolonged inhalation of the pure gas causes death. About 22 l. is required to produce insensibility, and oxygen is usually administered as well. A very pure gas must be used; it is made by the decomposition of ammonia nitrate by heat, the temperature being carefully regulated to avoid the formation of ammonia and nitric oxide, and to minimize the formation of nitrogen. The gas is washed with solutions of ferrous sulfate and potassium hydroxide, and with milk of lime, and the gas is dried and liquefied by pressure in steel cylinders. One kilogram of ammonium nitrate gives 182 l. of the gas. Nitrous oxide also is used as a food aerosol.

Nitric oxide, NO, which is formed from its elements by the action of electric sparks or a high temperature, $N_2 + O_2 \rightarrow 2NO$, was first obtained by J. B. van Helmont about 1620, and R. Boyle

(1660), but was more carefully studied by Priestley (1772), who called it "nitrous air" and obtained it by the action of dilute nitric acid on copper or mercury, $3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$. Copper turnings and a mixture of equal volumes of nitric acid and water may be used. The gas so prepared contains nitrogen and nitrous oxide. The pure gas is obtained by shaking a mixture of nitric acid and concentrated sulfuric acid with mercury, or by dropping a solution of sodium nitrite and potassium ferrocyanide into dilute acetic acid, $Fe(CN)_6^{4-} + NO_2^- + 2H^+ \rightarrow Fe(CN)_6^{3-} + NO + H_2O$, or by the action of sodium nitrite solution on an acidified solution of potassium iodide, $2NO_2^- + 2I^- + 4H^+ \rightarrow I_2 + 2NO + 2H_2O$. The colourless gas may be collected over water, or, if required pure, over mercury. It has a density of 1.3402 g. per litre, slightly greater than that of air. At 15° C., one volume of water dissolves only 0.051 vol. of the gas. It is not easily liquefied and has a boiling point of −151.7° C. and a melting point of −163.6° C. The liquid and solid are distinctly blue. The critical temperature is −96° C. and the critical pressure 64 atm. The molecule contains an odd electron in its structure, and nitric oxide is paramagnetic, its susceptibility being half that of oxygen.

Nitric oxide, although it is endothermic, is the most stable oxide of nitrogen, being dissociated into its elements only to about 3.5% at 1,000° C. Consequently, burning substances continue to burn in the gas only if they have previously attained a high temperature. A taper, burning sulfur or feebly burning phosphorus is extinguished, but brightly burning phosphorus burns brilliantly in the gas. A mixture of nitric oxide and carbon disulfide vapour burns with a brilliant lilac-coloured light, very rich in actinic rays. Nitric oxide combines rapidly with oxygen to form the dioxide, NO_2, which appears as red fumes when nitric oxide is exposed to air. The reaction involves three molecules, $2NO + O_2 \rightarrow 2NO_2$, and slows down appreciably in its later stages, so that a short time of contact is necessary for complete oxidation, and with dilute gases several minutes may be needed. This is important in technology (*see* NITROGEN, FIXATION OF). Nitric oxide dissolves to form a black liquid in cold ferrous sulfate solution but is expelled again on warming. The best solvent is a slightly alkaline solution of sodium sulfite, when the compound $Na_2(NO)_2SO_3$ is formed. At the temperature of liquid oxygen, it reacts with fluorine to form *nitryl fluoride*, $4NO + F_2 \rightarrow 2NO_2F + N_2$, a halogen derivative of nitric acid (melting point −166° C., boiling point −72.4° C.). The compounds NO_3F and NO_2Cl are also known. Nitric oxide and all higher oxides of nitrogen are poisonous.

Dinitrogen trioxide (nitrous anhydride), N_2O_3, was obtained by J. R. Glauber (1648). When nitric acid (56%) is distilled with arsenious oxide or starch, and the red vapour cooled in a freezing mixture, dark-blue liquid N_2O_3 is obtained, $2HNO_3 + As_2O_3 \rightarrow N_2O_3 + H_2O + As_2O_5$. On evaporation, the liquid decomposes almost completely into nitric oxide and nitrogen dioxide, but these recombine on liquefaction by cooling: $N_2O_3 \rightleftarrows NO + NO_2$. Although the gas is mainly a mixture of nitric oxide and nitrogen dioxide, only about 2% of N_2O_3 being present at 15° C., it is absorbed by solutions of alkalies with formation of nitrites, and by concentrated sulfuric acid with formation of nitrososulfuric acid ("chamber crystals"), thus behaving as if it consisted of N_2O_3. As absorption proceeds, the equilibrium is displaced to the left in the above equation. Only traces of nitrous acid are formed by the action of water, since the acid is unstable and decomposes, partly into dinitrogen trioxide (to which the blue colour of the solution is due) and water, and partly into nitric oxide and nitric acid: $3HNO_2 \rightarrow HNO_3 + 2NO + H_2O$. According to H. B. Baker and M. Baker (1900), when liquid dinitrogen trioxide is dried by long exposure to phosphorus pentoxide, the vapour formed from it consists of N_4O_6 molecules, but other workers could not repeat this experiment.

Sodium nitrite, $NaNO_2$, an important salt used in many organic preparations (*e.g.*, of dyestuffs), is mostly manufactured by absorbing higher oxides of nitrogen formed by the oxidation of ammonia in alkali solutions. Older methods of preparation are by heating molten sodium nitrate with metallic lead, $NaNO_3 + Pb \rightarrow NaNO_2 + PbO$, or by adding sulfur to fused sodium nitrate and sodium hydroxide, $3NaNO_3 + S + 2NaOH \rightarrow 3NaNO_2 + Na_2SO_4 + H_2O$. Nitrites are reducing agents, forming nitrates, usually in acid solution, but they also liberate iodine from acidified potassium iodide, being reduced to nitric oxide (*see* above).

The chloride of nitrous acid, *nitrosyl chloride*, NOCl, is a yellow gas formed by the direct combination of nitric oxide and chlorine, by the action of phosphorus pentachloride on sodium nitrite, by heating nitrososulfuric acid with sodium chloride, or (together with chlorine) by heating a mixture of concentrated nitric and hydrochloric acids (aqua regia): $HNO_3 + 3HCl \rightarrow NOCl + Cl_2 + 2H_2O$. It has been used for bleaching flour.

Nitrogen dioxide, NO_2, and *dinitrogen tetroxide*, N_2O_4, exist in equilibrium in varying proportions as a red gas, the mixture being sometimes called "nitrogen peroxide." The gas is formed by the direct union of nitric oxide and oxygen (*see* above). Nitrogen dioxide is usually prepared by heating dry lead nitrate, $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$, and condensing the nitrogen dioxide to a liquid in a tube cooled in a freezing mixture, the oxygen passing on. A very pure gas is made by warming nitrososulfuric acid with potassium nitrate: $SO_2(OH){\cdot}O{\cdot}NO + KNO_3 \rightarrow KHSO_4 + 2NO_2$, or by adding fuming nitric acid and phosphorus pentoxide to liquid dinitrogen trioxide, and distilling: $N_2O_3 + N_2O_5 \rightarrow 2N_2O_4$. Dinitrogen tetroxide in a good freezing mixture solidifies to nearly colourless crystals (the liquid supercools), melting at −9.04° C. to a honey-coloured liquid. Both these forms consist mainly of N_2O_4. On warming, the liquid becomes red, because of formation of nitrogen dioxide molecules, $N_2O_4 \rightleftarrows 2NO_2$, and boils at 21.9° C. to form a red vapour. On heating, the colour of the gas deepens, because of further dissociation, and at 140° C. it is nearly black, dissociation being then complete. At still higher temperatures, nitrogen dioxide dissociates into nitric oxide and oxygen, this being complete at 620° C., when the gas is colourless, $2NO_2 \rightarrow 2NO + O_2$. On cooling, all these changes are reversed. Since the volume increases, the extent of dissociation may be calculated from the density of the gas. At atmospheric pressure it varies from about 15% at the boiling point to 89.3% at 100° C. and 100% at 140° C.

The gas kindles a glowing chip and supports the combustion of brightly burning phosphorus. A mixture with hydrogen is reduced to ammonia when passed over heated platinum. With water, the liquid, or gas, forms nitric and nitrous acids, $2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$, and the nitrous acid decomposes (*see* above). With ice-cold water, blue liquid dinitrogen trioxide separates.

In the absorption of nitrous fumes in water, as in the preparation of nitric acid by the oxidation of ammonia, the evolution of nitric oxide necessitates adequate oxidation space for its reoxidation to nitrogen dioxide. Alkalies absorb the gas with formation of nitrite and nitrate, $2NO_2 + 2KOH \rightarrow KNO_2 + KNO_3 + H_2O$, the process being somewhat slower than in the case of dinitrogen trioxide. The liquid forms a violently explosive mixture with gasoline or other hydrocarbons. The gas diluted with air has been used in bleaching flour.

Dinitrogen pentoxide (nitric anhydride), N_2O_5, was discovered by H. E. Sainte-Claire Deville (1849) by the action of dry chlorine on warm silver nitrate, $4AgNO_3 + 2Cl_2 \rightarrow 4AgCl + 2N_2O_5 + O_2$. It is best prepared by adding phosphorus pentoxide to a cooled concentrated nitric acid, then distilling the product in a current of ozonized oxygen, drying the gas with phosphorus pentoxide and condensing in a receiver cooled in solid carbon dioxide and ether: $2HNO_3 + P_2O_5 \rightarrow N_2O_5 + 2HPO_3$.

It is also formed by passing ozonized oxygen into cooled liquid dinitrogen tetroxide: $N_2O_4 + O_3 \rightarrow N_2O_5 + O_2$. The colourless crystals are stable below 0° C., but are very hygroscopic. On warming they sublime, but if not quite pure they melt with some decomposition into nitrogen dioxide and oxygen, and also decompose on exposure to light. Rapid heating causes explosion. Phosphorus and potassium burn in the liquid on warming, and charcoal burns if previously ignited. With water, nitric acid is formed.

Trinitrogen tetroxide, N_3O_4, is said to be formed as a greenish solid by passing nitric oxide into liquid oxygen, or by the action of

air on solid nitric oxide at the temperature of liquid air. It decomposes into dinitrogen trioxide and nitric oxide above the temperature of liquid air (R. L. Hasche, 1925). A higher oxide of nitrogen, perhaps NO_3, is apparently formed by the action of an electric discharge on a mixture of nitrogen and oxygen, and has a characteristic absorption spectrum.

Hyponitrous acid, $H_2N_2O_2$, with the structure $HO{\cdot}N{=}N{\cdot}OH$, is formed by the action of nitrous acid on hydroxylamine (*see* above), but is best obtained as a salt by the reduction of a solution of sodium nitrite with sodium amalgam: $2NaNO_2 + 4Na + 2H_2O \rightarrow Na_2N_2O_2 + 4NaOH$ (Edward Divers, 1871). The free acid is obtained in colourless crystals, which at once decompose with feeble explosion, $H_2N_2O_2 \rightarrow N_2O + H_2O$, by the action of dry hydrogen chloride in ether on silver hyponitrite, and evaporation at room temperature. The acid and its salts are reducing agents. An isomer of hyponitrous acid is ***nitramide***, perhaps with the formula NH_2NO_2. *Oxyhyponitrous acid* (hyponitric acid, or nitrohydroscylamine), $H_2N_2O_3$, is known in the form of salts.

Nitrogen Halides.—*Nitrogen trifluoride*, NF_3, is a colourless gas, melting point $-208.5°$ C., boiling point $-129°$ C., formed by the electrolysis of ammonium hydrogen fluoride (O. Ruff and L. Staub, 1928). *Nitrogen trichloride*, NCl_3, is a yellow, very explosive oil, formed by the action of chlorine on ammonium chloride solution, or the action of excess of chlorine on ammonia (P. L. Dulong, 1811): $NH_3 + 3Cl_2 \rightarrow NCl_3 + 3HCl$. In the last reaction, two intermediate compounds are formed, viz., ***monochloramine***, NH_2Cl, which has been obtained pure in colourless crystals, melting point $-66°$ C., and ***dichloramine***, $NHCl_2$, known only in solution, formed by acidifying monochloramine solution. Nitrogen trichloride boils at 71° C., but easily decomposes with violent explosion on heating or shock. The vapour has a pungent smell and attacks the eyes and mucous membranes. The liquid explodes on exposure to bright light, and in contact with turpentine and with many solids. It is decomposed by ammonia. A solution in benzene is fairly stable. The vapour can be used in bleaching flour (agene process).

Nitrogen tribromide, NBr_3, and the compounds NH_2Br and $NHBr_2$ have been reported. *Nitrogen iodide* was obtained by B. Courtois (1812) as a black powder by the action of ammonia solution on iodine, and drying at room temperature on filter paper. Its formula is NI_3NH_3 (F. D. Chattaway, 1900). It is very explosive, detonating when gently pressed, with evolution of violet fumes of iodine. It is an oxidizing agent. *Nitrogen tri-iodide*, NI_3, is a black powder obtained by the action of ammonia gas on potassium iodobromide, $KIBr_2$, washing with water, and drying (H. W. Cremer and D. R. Duncan, 1930). *See* also AMMONIA; HYDRAZINE; HYDRAZOIC ACID; HYDROXYLAMINE; NITRIC ACID AND NITRATES; NITROGEN, FIXATION OF; and the references under "Nitrogen" in the Index.

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NITROGEN, FIXATION OF. The term "fixation of nitrogen" has been given to any chemical process whereby "free" nitrogen, one of the elements, is caused to combine chemically with other elements to form nitrogen compounds. The atmosphere is a great reservoir of nitrogen, this element accounting for nearly four-fifths of the volume.

Nitrogen is chemically inert, and, under ordinary conditions, does not react with other elements. A number of rather drastic processes have been discovered for "fixing" nitrogen (*i.e.*, causing it to enter into chemical combinations) but these are processes one would not expect to find operative in nature. Yet, nitrogen in combined form is found in all fertile soils, in every living thing, in many foodstuffs, in silk, wool and feathers, in coal and in such naturally occurring chemicals as saltpetre and ammonia. Fixed nitrogen is found in the basic substance of living matter, the protoplasm; it is present in the nucleus of every living cell.

During the early decades of the 19th century, Nicolas Théodore de Saussure, Jean Baptiste Boussingault, Justus von Liebig and others demonstrated that growing plants obtain their fixed nitrogen from the soil. Animals, in turn, secure their fixed nitrogen through the consumption of plants or of other animals that use plants as food. The astonishing fact was discovered, however, that when crops were removed from a field, the decrease in the fixed-nitrogen content of the soil was less than the amounts accounted for by the crop removals. Liebig rightly concluded that the fixed-nitrogen supply of the soil was replenished from the atmosphere, but he contended that the process did not involve any fixation of free atmospheric nitrogen. Since he knew that rain water always contains traces of dissolved nitrogen compounds, and that both animal and vegetable matter release ammonia during decay, Liebig postulated that the released ammonia was returned to the earth in rain water. This "ammonia cycle," from earth to atmosphere and return to earth, does occur, but it accounts for only a small part of the fixed nitrogen that the soil receives from the atmosphere. Not until 1886 was it known that certain microorganisms are able to fix atmospheric nitrogen and thus replenish the soil's supply. Of these, the most important are the *Rhizobium* genera of bacteria and the *Azotobacter*. The former are found on the roots of leguminous plants and the latter live independently in the soil. In 1960 James E. Carnahan demonstrated that nitrogen is converted to ammonia by cell-free extracts of *Clostridium pasteurianum* in the presence of pyruvate.

In the mid-1960s, attention was focused on the function of pyruvate (*i.e.*, salts of pyruvic acid, such as sodium pyruvate). One of the tentative findings was that pyruvate can serve as a source of adenosine triphosphate (ATP) and at the same time act as a reducing agent. The enzyme or enzymes involved were not known, although it had been shown that ferredoxin (a protein) or methyl viologen (a dye) participate in electron transport.

(*See* also BACTERIA; LEGUMINOSAE: *Leaves and Roots;* NITROGEN: *The Nitrogen Cycle;* SOIL: *Nitrogen-Fixing Bacteria.*)

Although Liebig and his contemporaries did not arrive at a correct explanation as to the source of fixed nitrogen in the soil, they did make clear the importance of fixed nitrogen in agriculture. Nitrogenous materials long had been used as fertilizers although the reason for the beneficial effects was unknown. As a result of the new knowledge, ammonia released in making coke from coal was recovered and utilized as fertilizer, as was sodium nitrate from deposits in Chile. Wherever agriculture was practised intensively there developed a demand for nitrogen compounds to supplement the natural supply of the soil.

In addition to the demand for fixed nitrogen in agriculture, there were other urgent and growing needs for nitrogen compounds. The increasing quantity of saltpetre used in the manufacture of gunpowder led to a world-wide search for natural deposits of this nitrogen compound. Industrial demands and the advent of high explosives called for an ever-larger supply of fixed nitrogen. By the end of the 19th century it was clear that recoveries from the coal-carbonizing industry and the importation of Chilean nitrate could not meet future agricultural and industrial demands. Moreover, it was obvious that in the event of a major war a nation cut off from the Chilean supply soon would be unable to manufacture munitions in adequate amounts. It appeared that the fixation of atmospheric nitrogen offered the only solution. During the final decade of the 19th century and the opening decade of the 20th century, intensive efforts culminated in the development of commercial nitrogen fixation processes.

Fixation of Nitrogen as the Oxide.—Air is essentially a mixture of one volume of oxygen with four volumes of nitrogen. Both gases are in the free, or elemental, condition and do not react with each other under ordinary conditions. If, however, air or any other mixture of oxygen and nitrogen is heated to a very high temperature, a small portion of the mixture reacts to form the gas nitric oxide. On allowing the gas mixture to cool slowly, the nitric oxide decomposes almost completely into oxygen

and nitrogen. At any given temperature there exists a dynamic equilibrium among the three gases. This may be expressed chemically thus:

$$O_2 + N_2 + 43{,}200 \text{ cal.} \rightleftarrows 2NO$$

The arrows indicate that the reaction may proceed in either direction as conditions change. Although all chemical reactions are of this sort in theory, conditions are often such that the reaction proceeds almost exclusively in one direction. The chemical expression may then be written as an equation. In the reaction now under consideration, both the forward and reverse reactions must be taken into account. Change of pressure has no effect on the equilibrium, but when the temperature is increased the equilibrium shifts to the right; *i.e.*, a larger proportion of nitric oxide is formed. At ordinary temperatures practically no nitric oxide is present, but at the temperature of an electric arc a small percentage of nitric oxide is formed. Inasmuch as the nitric oxide decomposes into its elements on cooling, it would appear that an "arc" process could not serve as a commercial method of nitrogen fixation. It can serve as a practical process, however, when advantage is taken of the rates of the reactions involved. The chemical expression given above is for an equilibrium. It reveals nothing as to the time required to establish the equilibrium. It is well known that most chemical reactions are greatly accelerated as the temperature of the reactants is increased and, conversely, are retarded as the temperature is decreased. In the present case, equilibrium is reached quickly at the very high temperature of the arc. If the mixture of gases then is cooled rapidly, the rate of the reverse reaction drops to nil; *i.e.*, the decomposition of the nitric oxide virtually ceases, and the high-temperature equilibrium is, so to speak, "frozen."

The nitric oxide does not remain long as such in the cooled gas mixture but begins to react with the free oxygen present when the temperature falls below about 600° C., thus:

$$2NO + O_2 \rightleftarrows 2NO_2$$

The indicated reaction proceeds from left to right until nearly all the nitric oxide has been converted to the dioxide, NO_2. The latter polymerizes partially to set up another equilibrium, thus:

$$2NO_2 \rightleftarrows N_2O_4$$

And, when the $NO_2-N_2O_4$ mixture is brought into contact with water, nitric acid is formed. (*See* also NITRIC ACID AND NITRATES.)

The foregoing facts form the basis for a practical process of nitrogen fixation.

In 1772 the English chemist Joseph Priestley observed that the passage of an electric spark through a small volume of air confined over water brought a decrease in gas volume, and that the water became acidic. Priestley did not interpret this result correctly and two years elapsed before the correct interpretation was given by another English chemist, Henry Cavendish. Thus was discovered what later became known as the "spark" or "arc" method of nitrogen fixation. At that time, however, electrical energy was far too costly to permit the use of such a process.

By the end of the 19th century, mechanical means of generating large quantities of electric energy had been evolved, and the use of water power to drive electric generators finally brought the cost of electric energy down to a range where nitrogen fixation by the spark or arc method became economically feasible. Many experimenters then turned attention to the problem, and by 1902 Charles S. Bradley and D. R. Lovejoy had a small plant using a spark process in operation at Niagara Falls, N.Y. This venture failed commercially, however. In 1904 Christian Birkeland of Oslo, Nor., and Samuel Eyde, an engineer, used an arc method in a small plant that was the forerunner of large and commercially successful plants. In 1908 a large arc process plant was established at Notodden, Nor. In the Birkeland-Eyde process an electric arc was spread into a disk of flame by means of a magnetic field. Air was blown through the disk and then mixed immediately with cold air, thus "freezing" the high-temperature equilibrium.

Several modifications of the arc process were developed in the first two decades of the 20th century, and small plants were built in countries other than Norway. The arc process was, however, inherently inefficient in the use of energy, and the absorption towers required for the reaction of the nitrogen oxides with water were large and costly. Better methods of fixing nitrogen were soon discovered and the process was eventually abandoned.

In the decade 1940–50 new interest was aroused in the fixation of nitrogen as the oxide through the use of the high temperature and rapid heat exchange and heat economy possible in a "Royster stove." This piece of equipment is a modification of the heat-exchange stoves long in use on blast furnaces, the essential difference being the substitution of small pieces of highly refractory material for the usual brick checkerwork in the stoves. In the process two or more Royster stoves are used. The refractory filling in one such stove is brought up to a high temperature by burning gas therein. Air is then passed through the stove and, at the high temperature prevailing, a small portion of nitric oxide is formed. The high-temperature equilibrium is then "frozen" by passing the hot gas into an unheated stove. The nitric oxide in the cool gas issuing from the second stove may then be recovered. When most of the heat in the first stove has been transferred to the second stove, the direction of air flow through the two stoves is reversed. Inasmuch as the heat transfer between the two stoves cannot be quite complete without disturbing conditions necessary in the process, one stove must be reheated occasionally with gas.

Fixation of Nitrogen as a Cyanide.—Another chemical method of fixing nitrogen was discovered about 1828 by Desfosses, who observed that potassium cyanide was formed when a stream of nitrogen was passed through a red-hot mixture of potash and carbon in an iron tube. In 1842 a small plant using the cyanide method was built in France and was operated for a few years. Many other attempts were made to find a practical process based on cyanide formation, the latest during World War I, but no commercially successful cyanide process had been adopted at mid-20th century.

Fixation of Nitrogen as a Nitride.—At high temperatures nitrogen will combine directly with some metals to form their nitrides (*q.v.*), most of which can be hydrolyzed to form the metal hydroxides and ammonia. During the decade 1909–19, unsuccessful attempts were made to apply a nitride process developed by O. Serpek in which nitrogen, aluminum oxide and carbon were heated together to form aluminum nitride.

Fixation of Nitrogen as a Cyanamide.—During the period 1895–98, Adolph Frank and Nikoden Caro conducted investigations directed toward the improvement of methods for producing cyanides. In the course of this work they discovered that crude calcium carbide and nitrogen would react at 1,000° C. to form calcium cyanamide rather than a cyanide. The chemical reaction may be written thus:

$$CaC_2 + N_2 \rightarrow CaCN_2 + C$$

Pure carbide reacts slowly, if at all, but the reaction is catalyzed by alkalies or alkaline earths. Calcium fluoride is the catalyst commonly used. Crude calcium cyanamide may be used directly as a fertilizer.

A large calcium cyanamide plant was built in Italy in 1907. Within the next five years, large plants were built in Germany, Dalmatia, France, Switzerland, Norway, Canada and Japan. The cyanamide process was the first nitrogen fixation process to be so widely used. During World War I the United States government built a very large cyanamide plant near Wilson dam, Alabama.

Calcium carbide and nitrogen are the raw materials for the cyanamide process. The nitrogen may be obtained by the partial liquefaction and fractional distillation of air. The carbide is made by the heating of coke and high-grade lime in an electric furnace, the chemical reaction being:

$$CaO + 3C \rightarrow CaC_2 + CO$$

The carbon monoxide gas escapes from the furnace. The carbide is drawn off in molten form, cooled, ground and then heated to 1,000° C. and treated with nitrogen. The nitrifying reaction is exo-

thermic and continues spontaneously once started. The resultant mass of crude cyanamide is cooled, ground and granulated for use as a fertilizer, or the cyanamide may be hydrolyzed and the fixed nitrogen liberated as ammonia: $CaCN_2 + 3H_2O \rightarrow CaCO_3 + 2NH_3$.

The cyanamide process is an elaborate one. The electric energy required to produce the necessary carbide is relatively large per ton of fixed nitrogen finally obtained, although it is not so large as the energy required in the arc process.

The development of new manufacturing processes has been rapid during the 20th century. Within a decade after the erection of the first plant using the arc process, that process was fast becoming obsolete, and the cyanamide process was also to become obsolete within a decade after its development. Subsequent to World War I, no new cyanamide plants were built, although some of those then extant were still in operation at the beginning of World War II.

Fixation of Nitrogen as Ammonia.—The direct synthesis of ammonia from elemental nitrogen and hydrogen has proved to be the most economical method discovered for the fixation of nitrogen. This method is being utilized in many countries and has become one of the largest and most basic processes of chemical industry the world over.

During the closing decade of the 19th century and the early years of the 20th century many investigators studied the gaseous system nitrogen-hydrogen-ammonia. Among those prominent in this work in the period 1904–08 were Fritz Haber (*q.v.*), G. van Oordt, R. LeRossignol, W. Nernst, F. Jost and K. Jellinek.

The research of Haber and his associates convinced the Badische Anilin- und Sodafabrik that it was economically feasible to manufacture ammonia. The German firm then threw its great engineering and technical resources into the project and in 1910 a pilot plant was put into operation. This was the forerunner of a commercial plant that began production in 1913 with a capacity of 7,000 tons of fixed nitrogen per year.

It was well known when Haber and his associates began their research on ammonia synthesis that no ammonia is formed when nitrogen and hydrogen are brought together under ordinary conditions of temperature and pressure. It was known that a trace of ammonia is formed when a silent electric discharge is passed through a mixture of nitrogen and hydrogen. It had also been observed that complete decomposition of ammonia cannot be effected by heat. Regardless of these clues to the existence of a true equilibrium, such as represented by the expression

$$N_2 + 3H_2 \rightleftarrows 2NH_3 + 24{,}000 \text{ cal.},$$

several investigators of note contended that no such equilibrium could be found. The situation was, therefore, one of confusion until Haber and his co-workers clearly demonstrated the existence of the equilibrium and measured the concentrations of the gases under several conditions of temperature and pressure.

Inasmuch as the foregoing expression of equilibrium indicates that one volume of nitrogen and three volumes of hydrogen combine to form two volumes of ammonia, it follows, according to the Le Chatelier principle (*see* LE CHATELIER, HENRY LOUIS), that the higher the pressure on the system the larger the proportion of ammonia at equilibrium; that is, the equilibrium is shifted toward the smaller volume. It will be recalled that this effect of pressure is different from the case of the nitrogen-oxygen-nitric oxide equilibrium, on which a change in pressure had no effect. The effect of temperature on the equilibrium in the two cases is reversed. In the nitrogen-oxygen-nitric oxide equilibrium the higher the temperature the larger the proportion of nitric oxide, whereas in the nitrogen-hydrogen-ammonia equilibrium the higher the temperature the smaller the proportion of ammonia.

The table shows the effect of temperature and of pressure on the percentage of ammonia formed at equilibrium when one volume of nitrogen and three volumes of hydrogen are caused to react. From the table it is apparent that an ammonia synthesis process should be carried out at a temperature as low and at a pressure as high as may be practical and economical. Again, the rates of reaction toward equilibrium must be taken into account. At

Percentage of Ammonia at Equilibrium
(Data obtained by the U.S. Fixed Nitrogen Research Laboratory)

Temperature ° C.	Pressure in atmospheres						
	10	30	50	100	300	600	1,000
200 . . .	50.66	67.56	74.38	81.54	89.94	95.37	98.29
250 . . .	28.34	47.22	56.33	67.24	81.38	90.66	96.17
300 . . .	14.73	30.25	39.41	52.04	70.96	84.21	92.55
350 . . .	7.41	17.78	25.23	37.35	59.12	75.62	87.46
400 . . .	3.85	10.15	15.27	25.12	47.00	65.20	79.82
450 . . .	2.11	5.86	9.15	16.43	35.82	53.71	69.69
500 . . .	1.21	3.49	5.56	10.61	26.44	42.15	57.47
550 . . .	0.76	2.18	3.45	6.82	19.13	31.63	41.16
600 . . .	0.49	1.39	2.26	4.52	13.77	23.10	31.43
650 . . .	0.33	0.96	1.53	3.11	9.92	16.02	20.70
700 . . .	0.23	0.68	1.05	2.18	7.28	12.60	12.87

ordinary temperatures the rate of reaction is virtually zero and is negligibly low even at 500° C. unless a catalyst is used. Obviously, the use of a catalyst in ammonia synthesis is extremely important in permitting the reaction to be carried out at a lower temperature than would be practical with no catalyst. In commercial plants temperatures in the range 450° C. to 500° C. are used. The best catalyst known is prepared from pure iron plus small proportions of alumina and potash. The decision as to the pressure at which to carry out the ammonia synthesis is an economic matter. Plants have been built to operate at pressures as low as 100 atm. and as high as 1,000 atm., but most of the plants use pressures in the range 200 to 350 atm. (*See* also CATALYSIS: *Heterogeneous Catalysis*; CHEMICAL EQUILIBRIUM.)

Steps in the Synthetic Ammonia Process.—Four major steps are involved in the synthetic ammonia process as it is carried out in large commercial plants. The initial step comprises the preparation of nitrogen and hydrogen or a mixture of these two gases. Where natural gas is available at relatively low cost, this material is used as a source of hydrogen. Most of the plants, however, use air, steam and coke (or natural gas) to obtain a mixture of nitrogen and hydrogen along with carbon monoxide, carbon dioxide and other impurities. This mixture is then further processed with steam to convert most of the carbon monoxide to hydrogen and carbon dioxide. A few plants obtain hydrogen through the electrolysis of water, and a few others use coke-oven gas as a source of hydrogen. In all plants the necessary nitrogen is obtained from air.

In the second step of the process, the gas mixture is compressed and then freed from undesired gases by means of an elaborate system of equipment, leaving a purified mixture of nitrogen and hydrogen in the correct proportion for the ammonia synthesis.

In the third major step the nitrogen-hydrogen mixture is passed through a bed of catalyst at a temperature of about 500° C. and at a pressure from 100 to 1,000 atm. Some ammonia is thus formed, the proportion depending on the temperature and pressure used, the activity of the catalyst and time of contact of the gases with the catalyst.

In the fourth and final step the ammonia is removed, usually by refrigeration. The part of the gas mixture that remains uncombined is then recycled through the catalyst bed after the addition of sufficient fresh nitrogen-hydrogen mixture to compensate for the ammonia removed from the system.

Although the synthetic ammonia process may seem to be one of relative simplicity, it actually represents engineering achievement in the usage of materials and in construction unknown before the 20th century. Nevertheless, the process assures ample supplies of ammonia, which has become the cheapest form of fixed nitrogen available to industry and to agriculture, and is the raw material from which numerous nitrogenous chemicals are manufactured.

The success of the synthetic ammonia plants built in Germany during World War I led to a rapid expansion of the industry and the construction of plants in many countries other than Germany. The initial plant at Oppau, Ger., was expanded to a capacity of 120,000 tons per year during World War I and a second large plant built at Leuna, near Merseburg. Various modifications of the original Haber or Haber-Bosch process were devised, such as the Claude process in France, the Casale process in Italy, the American and the Nitrogen Engineering processes in the United States. During World War II ten new synthetic ammonia plants

were built in the U.S. to meet an anticipated demand for ammonia in the production of munitions. The output of some of these plants was diverted to the production of agricultural fertilizer in the form of ammonium nitrate. At the close of World War II most of the German synthetic ammonia plants lay in ruins; the United States had become the world leader in ammonia production, with a fixed nitrogen capacity of more than 1,000,000 tons per year. *See* also CHEMICAL INDUSTRY: *Haber Ammonia Process;* FERTILIZERS AND MANURES: *Nitrogen Fertilizers.*

(H. A. Cs.)

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NITROGEN HARDENING: *see* NITRIDING.

NITROGLYCERIN (GLYCERYL TRINITRATE) is a powerful explosive and an important ingredient of most dynamites. It is used also (with nitrocellulose) in some propellants, especially for rockets and missiles, and as a vasodilator in the easing of cardiac pain such as occurs in angina pectoris.

Properties.—Nitroglycerin is a heavy, oily liquid that is colourless when pure but usually is pale yellow in the commercial grades. Its specific gravity is 1.60 at 15° C. The chemical formula is $C_3H_5N_3O_9$ and the structural formula is $CH_2(ONO_2)$-$CH(ONO_2)$-$CH_2(ONO_2)$; the positive oxygen balance (*i.e.*, more than enough oxygen atoms are available for oxidizing the carbon and hydrogen atoms while nitrogen is being liberated) and the high nitrogen content (18.5%) account for the fact that nitroglycerin is one of the most powerful explosives known.

$$4C_3H_5(ONO_2)_3 \rightarrow 6N_2 + 12CO_2 + 10H_2O + O_2$$

Thus one pound (0.454 kg.) of nitroglycerin produces 156.7 cu.ft. (about 4,437 l.) of gas. The resulting detonation wave moves at approximately 7,700 m. per second; this compares with a rate of less than 7,000 m. per second for TNT (trinitrotoluene). Nitroglycerin is extremely sensitive to shock and to rapid heating; it begins to decompose at 50°–60° C., is significantly volatile at 100° C. and explodes at 218° C. It is only slightly soluble in water and in glycerol, is fairly soluble in ethyl alcohol and methyl alcohol, and is miscible in all proportions with ether, acetone, benzene, etc.

Preparation.—Nitroglycerin, the nitric acid triester of glycerol, was first prepared in 1846 by A. Sobrero by adding glycerol (glycerin) to a mixture of concentrated nitric and sulfuric acids at 10° C. or below. The main function of the sulfuric acid is to absorb the water formed in the chemical reaction. Continuous manufacturing processes developed in the 1940s by Mario Biazzi and others came to be widely used. These processes offer greater safety than older methods because the reactants and the explosive final product (nitroglycerin) literally trickle through the apparatus, rather than being concentrated in a large nitrator charge.

Uses.—The comparatively safe use of nitroglycerin as a blasting explosive became possible after Alfred B. Nobel developed dynamite in the 1860s. He mixed liquid nitroglycerin with an absorbent nonexplosive material such as charcoal or kieselguhr (diatomaceous earth), with more active sodium nitrate (and an absorbent) or even with nitrocellulose. The nitroglycerin gelatinizes the nitrocellulose to produce blasting gelatin, a very powerful blasting agent. Nobel's discovery of the ability of nitroglycerin to gelatinize nitrocellulose led to the development of ballistite, the first double-base propellant and a precursor of cordite; both ballistite and cordite contain 30%–40% of nitroglycerin. Similar double-base formulations are used extensively in rocket and missile propellants and in some gun propellants.

A serious problem in the use of nitroglycerin as an explosive is its relatively high freezing temperature (13.2° C., or 56° F.). This disadvantage is avoided by using nitrated mixtures of glycerol and closely related polyhydric alcohols such as ethylene glycol ($HOCH_2$-CH_2OH). For example, the eutectic nitrate mixture composed of 71% ethylene glycol dinitrate and 29% nitroglycerin has a freezing point of −29° C., compared with the 13.2° C. for nitroglycerin alone.

Biologic Effects.—Nitroglycerin has a sweet, burning taste and is somewhat poisonous; its vapour is absorbed readily through the skin and produces violent headaches, but repeated exposures reduce this effect to nil. Taken orally, usually as a sublingual tablet, it relaxes the smooth muscles of the blood vessels; hence it is administered to relieve or prevent cardiac pain.

See BALLISTICS: *Propellants;* EXPLOSIVES: *Dynamites;* NOBEL, ALFRED BERNHARD; PROPELLANTS: *Solid Propellants;* ROCKETS AND GUIDED MISSILES: *Rocket Propellants: Solid Propellants.*

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(B. E. AN.)

NITTI, FRANCESCO SAVERIO (1868–1953), Italian statesman, a left-wing Liberal who was prime minister for a critical year after World War I (*see* ITALY: *History*), was born at Melfi (Potenza) on July 19, 1868. He became a barrister and professor of public finance at the University of Naples and then entered parliament in 1904. He was minister of agriculture, industry and trade in Giovanni Giolitti's fourth cabinet (March 1911–March 1914) and minister of the treasury in V. E. Orlando's first cabinet (Oct. 1917–Jan. 1919). Four days after the fall of Orlando's second ministry (June 19, 1919) Nitti himself became prime minister. His adoption of the system of proportional representation (Aug. 15, 1919) resulted in an important increase in the Socialist and Christian Democratic (Popolari) deputies at the elections on Nov. 1919, but he failed to conciliate either group. An epidemic of strikes and disorders caused by the Communists, the Nationalists and the Fascists weakened his position, and on June 9, 1920, he finally resigned. Nitti was reelected to parliament in May 1921, but did not stand in the elections of April 1924, held under Mussolini's regime. He left for Switzerland, but from 1925 lived in Paris. During World War II he was arrested by the Germans in Aug. 1943 and interned in Austria. Freed in April 1945, he returned to Italy and attempted to reenter politics. In June 1948 he became a *de jure* member of the Italian senate. He died in Rome on Feb. 20, 1953.

Nitti published several books on economic and political questions. The best known was *L'Europa senza pace* (1921, Eng. trans. 1922), followed by *La Decadenza dell'Europa* (1922; Eng. trans. 1923), in which he recommended a radical revision of the treaty of Versailles. He also left memoirs: *Meditazioni dell'esilio* (1947) and *Meditazioni e ricordi* (1953).

NIVELLE, ROBERT GEORGES (1856–1924), commander in chief of the French armies on the western front for five months in World War I, whose career was wrecked by the failure of his prescription for a prompt and decisive victory, was born at Tulle on Oct. 15, 1856. An artilleryman who had passed through the École Polytechnique and the École Supérieure de Guerre, he served in Indochina and in Algeria. During the first phases of World War I he was in France commanding a brigade in 1914 and an army corps by the end of 1915. On May 2, 1916, he was appointed to command the 2nd army at Verdun, succeeding Gen. Pétain at the height of the battle. Nivelle inspired in October and December two French counterattacks which proved to be dazzling successes. The government and nation, despondent at France's great losses and small reward during the year, saw Nivelle as the man of the hour. Gen. Joffre, who had commanded the French armies since the beginning of the war, was removed, and

on Dec. 12 Painlevé, the French premier, promoted Nivelle over the heads of many seniors to take his place.

Nivelle at once proclaimed that the methods he had perfected at Verdun could win the war. He expounded the theory of great violence, particularly of artillery, allied with great mass. So enthusiastic was Lloyd George, the British prime minister, that he placed the British armies in France under Nivelle's command for his great offensive. Yet despite this backing and despite the brilliant success of the British diversionary attack at Arras, Nivelle steadily lost the confidence of his own chief subordinates and finally that of his government. The German retreat to the Hindenburg line disorganized the northern sector of his attack, but on April 16, 1917, in dreadful weather, he launched his offensive on the remaining sectors. His preparations failed to master the German defense in depth; and though the French took 20,000 prisoners and 147 guns in less than a week, they utterly failed to break through the German lines. The next month witnessed the outbreak of widespread mutinies in the French armies. On May 15, 1917, Nivelle was replaced by Pétain as commander in chief; and in December 1917 he was transferred to North Africa. He retired in 1921 and died in Paris on March 23, 1924. *See* also World War I: *The Penultimate Year.*

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NIVERNAIS, in France under the *ancien régime,* was the country administered from Nevers (*q.v.*). The province was bounded southwest by Bourbonnais, west by Berry, north by Orléanais, and northeast, east and southeast by Burgundy. Detached from Burgundy by the end of the 10th century, the countship of Nevers was held by the male descendants of Count Landry (d. 1028) till 1181; passed through marriages to the house of Dampierre, counts of Flanders, in 1280; went as part of the Flemish inheritance to a junior branch of the house of Burgundy in 1405; and was inherited by a junior branch of the house of Cleves in 1491. It was made a duchy of France in 1539. By marriage (1566), the duchy came in 1601 to a branch of the house of Gonzaga, which sold it to Cardinal Mazarin in 1659. Mazarin left it to his nephew Philippe Julien Mancini, whose descendants held it till the French Revolution as the last great fief still not reunited to the French crown. In 1790 most of Nivernais became the *département* of Nièvre.

NIXON, RICHARD MILHOUS (1913–), 36th vice-president of the United States, was born at Yorba Linda, Calif., Jan. 9, 1913, of Quaker parents. He graduated in 1934 from Whittier College, California, where he specialized in constitutional history, and from Duke University Law School, Durham, N.C., in 1937. Nixon practised law in Whittier for five years and, after serving as attorney in the Office for Emergency Management in Washington, D.C., January–August 1942, was commissioned lieutenant, junior grade, in the U.S. Navy; he left active service in 1946 as lieutenant commander.

Nixon was elected a Republican representative of the 12th congressional district of California in November 1946, unseating the veteran Democratic incumbent, H. Jerry Voorhis, after a series of joint platform discussions reminiscent of the Lincoln-Douglas debates. He was returned to Congress unopposed in 1948.

HENRI CARTIER-BRESSON FROM MAGNUM

RICHARD NIXON

In the house of representatives he helped draft the Taft-Hartley Labor Relations Act and played a prominent role in preparing the congressional investigation of Alger Hiss, a former state department official later convicted of perjury in connection with Communist espionage. In November 1950 Nixon defeated Helen Gahagan Douglas and became U.S. senator from California. He was nominated by the Republican national convention of 1952 as the vice-presidential running mate of Dwight D. Eisenhower and elected by a decisive margin. The campaign opened with charges that Nixon had illegally benefited from a private fund raised by his supporters. In answer to demands that he withdraw from the race, Nixon made a dramatic and successful defense in a nationwide television broadcast.

As vice-president Nixon became a leading spokesman of the Eisenhower administration, presiding over meetings of the cabinet and of the National Security Council in the president's absence. He and his wife also traveled throughout the world and were generally well received, although the vice-president was the victim of mob violence and threat of assassination in Caracas, Venez., in May 1958. On the occasion of Nixon's presence at the official opening of the first American exposition in Moscow, in July 1959, he engaged in a celebrated "kitchen debate" with Nikita Khrushchev. Nominated for the presidency at the 1960 Republican convention, Nixon campaigned vigorously but was defeated by a small margin in the November election by his Democratic opponent, Sen. John F. Kennedy of Massachusetts. In 1962, running for governor of California, Nixon was defeated by the incumbent, Edmund G. Brown. Nixon wrote *Six Crises* (1962), a personal account of the turning points of his political career. He moved to New York in 1963 and practised law there, but remained active in Republican Party affairs.

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NIZA, MARCOS DE (Fray Marcos) (*c.* 1495–1558), Italian Franciscan friar who reached the "seven cities" of the Zuñi (*q.v.*) Indians in western New Mexico in 1539, was born in Nizza (Nice) about 1495. He went to America in 1531 and served in Peru, Guatemala and Mexico. He was sent to Culiacán (at 24° N. in Mexico) and there freed Indian slaves from regions to the north. Later he was sent on an advance party under the Negro Esteban to cross the deserts to the stone-built cities of Cibola where Esteban was killed. Marcos claimed to have come within sight of the cities but then returned in haste and fear. From Indian reports made to please him he described large towns with precious stones, gold and silver, but F. V. de Coronado in 1540 found them to be small and poor. Marcos was made provincial of his order for Mexico in 1541. He died in Mexico on March 25, 1558.

His journey and the killing of Esteban reveal that Spanish slave raids north of Culiacán and the treatment of Indian women by the Spaniards had antagonized lands far to the north of those reached by Spaniards, and were a factor in limiting Spanish settlement to Mexico for a long time.

See Richard Hakluyt, *Divers Voyages,* ed. by J. M. Dent, pp. 136–178 (1928). (A. Ds.)

NIZAMABAD, a town and district of Andhra Pradesh, India. The town, formerly known as Indur, is the headquarters of the district, and lies 90 mi. N.N.W. of Hyderabad on the Hyderabad-Godavari valley line of the Central railway. Pop. (1961) 79,093. The fort on a hill to the southwest was originally a temple where a tank (reservoir) was built, now forming a source of water supply. The remains of a great fortified temple, known as the fort of Indur, also to the southwest, have been converted into a jail and college of arts and science. There are two old and richly carved Jain temples at nearby Yellareddipet. Industries include rice husking, khandsari sugar processing and the production of reinforced concrete water pipes.

Nizamabad District (area 3,105 sq.mi.; pop. [1961] 1,022,013) is bounded north by the Godavari river (which separates it from Adilabad district) and west by the Manjira, a tributary of the Godavari (which separates it from Nanded district). The climate is hot and slightly humid. The average annual rainfall is about 45 in. Rice, jowar, wheat, sugar cane and pulses are the principal crops. The Nizam Sagar project provides better irrigational facilities for large-scale production of sugar cane and rice; its reservoir was constructed by damming the Manjira. The dam, stretch-

ing across the two arms of the river, is more than 2 mi. long and carries an 84-ft.-wide motorable road. The main canal, 100 ft. wide and 10½ ft. deep, falls into a small lake, Ali Sagar, which, with its rugged mountain scenery, gardens and rest house, is a pleasant tourist resort. The district has large tracts of forests yielding valuable timber. At Bodhan, 16 mi. W. of Nizamabad town, are large sugar and alcohol factories, and at Kamareddy (southeast) is another alcohol factory. Armur, to the north, is known for its artificial silk cloth. There is a Christian mission hospital for lepers and a Vishnu temple at Dichpally. (S. AH.)

NIZAM AL-MULK ("Orderer of the Kingdom"; ABU ALI HASAN IBN ALI) (1018–1092), minister successively to Alp Arslan and Malik Shah (*qq.v.*), the great Seljuk rulers of Iran, was born, probably on April 10, 1018 (one authority has 1019/20), at Radkan near Tus in Khurasan. The Seljuks supplanted the Ghaznevids as rulers of Iran in 1040 and some time thereafter Nizam entered the service of Alp Arslan. By 1059 he was vizier of Khurasan. His fortunes rose with his master's and when Alp Arslan became sultan Nizam al-Mulk assumed charge of the whole administration. He also took part in military operations, being charged with reducing the rebellious province of Fars in 1067. As a great Iranian vizier he conspicuously exemplifies the chief minister's role of mediator between a despot, in this instance an alien Turk, and his Persian subjects. He kept Turkmen immigrants, who had entered Iran with the Seljuks, engaged in hostilities outside the country; he enhanced the dignity and prestige of the Seljuks by inculcating canons of royal behaviour and etiquette; and he tempered military harshness with lessons in judicious clemency and conciliation. He built up Seljuk power with the sultan as the keystone in an integrated administration and encouraged the recognition of local rulers as honourable vassals.

On Alp Arslan's death in 1073 Nizam al-Mulk was left with wider powers, Malik Shah being only a youth, but by 1080 the sultan had become less acquiescent. Nizam al-Mulk antagonized the sultan's favourite, Taj al-Mulk; he also made an enemy of the sultan's wife Turkan Khatun, preferring a son by another wife for the succession. The great vizier was assassinated on Oct. 14, 1092, while traveling with the court between Isfahan and Baghdad. His murderer was disguised as a Sufi but associated with the Assassins. The view is also held, however, that Taj al-Mulk and Turkan Khatun, if not Malik Shah himself, were privy to the plot.

Nizam al-Mulk in fact failed to achieve the order he had striven for. His hurried but important book on government, the *Siyasat Nama*, composed shortly before he died, proves this. It was a last effort at least to record the theory of a practice he hoped would be established. He did, however, restrain some abuses, and left them condemned, notably in connection with the granting of fiefs to soldiers of the sultan. (P. W. A.)

NIZAMI (JAMALUDDIN or NIZAMUDDIN ABU MOHAMMED ELYAS IBN YUSUF) (*c.* 1135–1203 or perhaps 1217), Persia's leading romantic poet, was born at Ganja (Kirovabad) in the Caucasus, where he spent the whole of his life. Although he enjoyed the patronage of a number of rulers and princes, he was distinguished by reluctance to indulge in extravagant panegyrics, as well as by his simple life and blameless character. Living at a time when Sunni fanaticism was at its height, he was a kindly and tolerant man and his poetry, which is full of reflections on life and people, reveals broad sympathies and deep insight into psychology. His wide learning is shown by his frequent references to historical, literary and scientific topics (he was especially interested in astronomy and music), while his love of nature is seen in his well-observed descriptions and his likable characterizations of animals.

Only a handful of his odes (*qasida*) and lyrics (*ghazal*) have survived; his reputation rests on his great quintet (*Khamsé*) of *mathnavi* (rhymed couplet) poems, totaling some 30,000 couplets. He drew his inspiration from both Firdausi and Sana'i (*qq.v.*) but is himself the first great dramatic poet of Persian literature. His first *mathnavi, Makhzan al-Asrar* (1174–75; English translation by Gholam Hossein Darab, *The Treasury of Mysteries*, 1945) is mystical and philosophical; it was followed by three romantic poems. His last work, possibly completed shortly before his death, was the *Eskandarname* (1200; Eng. trans. of part i by H. W. Clarke, *The Sikander Nama*, 1881), two full-length poems on the life of Alexander the Great.

Nizami is admired in Persian-speaking lands for his originality and his sweetness and clarity of style, though it must be admitted that his love of language for its own sake and of philosophical and scientific learning sometimes led him into obscurity.

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NIZHNI NOVGOROD: *see* GORKI.

NKOLE, an east African people, also known as Banyankole, Ankole or Nyankole, of the Interlacustrine Bantu group who occupy the area between Lakes Edward and George and the Tanganyika border in southwestern Uganda.

The present Nkole kingdom, with a population (1960s) of about 500,000, represents the traditional kingdom of that name with the addition of the neighbouring similar kingdoms of Mpororo, Igara, Buhwezu and Busongora. Together these form a modern administrative district with a common local government headed by the traditional ruler, the *mugabe*.

Although they speak a common language, the Nkole are divided into two quite distinct social groups: the pastoral Hima (Bahima), who constitute about 10% of the population, and the agricultural Iru (Bairu), who make up the remainder. These different economic pursuits give Hima and Iru quite different modes of life. The Hima dwelling is the kraal made up of thatched, beehive-shaped huts arranged in a circle with the intervening spaces filled with branches of thornbush to form a cattle pen. When the grazing in a particular area is exhausted, the kraal, which may house from 12 to more than 100 people, is moved to an area of fresh pasture. The Iru, on the other hand, are sedentary hoe-cultivators of millet, plantains and sweet potatoes who live dispersed in single, though often polygynous, family homesteads surrounded by their gardens and granaries. Both Hima and Iru are divided into patrilineal clans and lineages, though exogamy extends only to children of the same grandparents. Both groups marry with the payment of bridewealth, goats being the medium among the Iru and cattle among the Hima. Hima and Iru are commonly rather different physically—Hima being generally taller, more slender and lighter in colour—and much Nkole traditional history is concerned with explaining how the two groups came to form a single society. Originally, it is said, they lived separately, exchanging their economic products. Then there appeared a wonderful people, the *bacwezi*, who, like the Hima, were tall, light-skinned pastoralists and who conquered the Nkole and their neighbours, establishing a dynasty of kings.

At length the people began to disobey the *bacwezi* and the latter fled the country; however, one, Ruhinda, was persuaded by an Iru headman to remain. Ruhinda thus became the founder of the present dynasty. This legend provided an ideological foundation for the traditional composite society in which Iru lived in politically subordinate but economically symbiotic relationship with Hima. The relationship was further supported by a religious system in which the spirits of the departed *bacwezi* were communicated with by mediums. Marriage between Hima and Iru was prohibited, but Hima sometimes took Iru women as concubines.

Hima were bound to the *mugabe* by clientship—a bond formed by the client's swearing fealty to the *mugabe* and making periodic gifts of cattle to him. From among his clients the *mugabe* chose district chiefs, military captains and the prime minister, the *nganzi*. Often these officials rose in the ruler's service from the royal band of pages formed by boys sent by Hima families to the royal kraal. Iru headmen were appointed over communities of their fellows and through them Hima chiefs collected tribute in agricultural and craft products. *See* also UGANDA; BANTU (INTERLACUSTRINE).

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NKRUMAH, KWAME (1909–), dictator of Ghana until 1966 and pan-African statesman, was originally a teacher, trained at Achimota College. He was born at Nkroful on Sept. 18(?), 1909, and he went to the U.S. in 1935, graduating at Lincoln University, in Pennsylvania. He was active in African students' movements in the U.S. and, from 1945, in Britain, where he helped organize the fifth Pan-African Congress and became secretary of the West African National Secretariat. In 1947 he returned home as secretary of the United Gold Coast Convention, with which he broke in 1949, forming the Convention People's Party (CPP) demanding immediate self-government for the Gold Coast. Arrested in 1950, he was released from prison on his election to the Legislative Assembly in 1951. As prime minister from 1952, he led the colony to independence as the new state of Ghana in 1957. In 1960 Ghana became a republic, Nkrumah achieving unrivaled power as life president both of the country and of the CPP, now the sole political party. Nkrumah then concentrated his attention on campaigning for the political unity of Africa, and began to lose touch with realities in Ghana. His increasingly self-seeking administration became involved in magnificent but often ruinous development projects, so that a once prosperous country became crippled with debt. In February 1966, while Nkrumah was visiting Peking, his regime was overthrown by the army and police, Nkrumah himself finding sanctuary in Guinea. He published an autobiography (1957) and a number of expositions of his politics and philosophy. *See* also GHANA: *History*. (J. D. F.)

TOM SMITH FROM CAMERA PRESS

KWAME NKRUMAH

NOAH (in the Douai version of the Bible, NOE) appears in Genesis v, 29 as son of Lamech and tenth in descent from Adam. He is the hero of the story of the Deluge (Gen. vi–viii), being represented as the patriarch who, because of his blameless piety, was chosen by God to perpetuate the human race after his wicked contemporaries had perished in the flood. He receives a divine warning of the impending disaster, and is instructed to build an ark, in which he and his family are preserved alive. In accordance with God's instructions Noah took into the ark specimens of all animals, from which the stocks might be replenished. The story has close affinities with Babylonian traditions, in which Utnapishtim plays the part corresponding to that of Noah.

The narrative of Gen. ix, 18–27 belongs to a different cycle, which seems to know nothing of the flood story. In the latter Noah's sons are married, and their wives accompany them in the ark; but in this narrative they would seem to be unmarried, living in the tent with their father; nor does the shameless drunkenness of Noah accord well with the character of the pious hero of the flood story. Three different motives may be traced in Gen. ix, 18–27: first, the passage explains to whom agriculture, and in particular the culture of the vine, was due; second, it attempts to provide in the persons of Noah's three sons Shem, Ham and Japheth, ancestors for three of the races of mankind, and to account in some degree for their historic relations; third, by its censure of Ham (for whom it is almost certain that Canaan stood in the original text) it reprobates the licentious Canaanite civilization. *See* also GENESIS. (W. L. W.)

NOAHIDE LAWS, a talmudic term denoting seven biblical laws which were given prior to the revelation on Sinai. Addressed to Adam, and in a complete form to Noah, they are considered binding on humanity at large, while Israel, in addition, is to obey the Sinaitic commandments. Using Gen. ii, 16 as the starting point for its exegesis, the Babylonian Talmud (*Sanhedrin* 56–60) considers the Noahide laws to be the prohibition of idol worship and of blaspheming the name of God; the command to establish courts of justice; and the prohibition of murder, adultery and robbery. After the Flood a seventh law was added: the prohibition of eating flesh cut from a living animal (Gen. ix, 4). Some sages added such prohibitions as partaking of the blood drawn from a living animal, castration and sorcery, increasing the number of such laws to 30 (*Hullin* 92a). However, the "seven laws" with minor variations were accepted as the authoritative doctrine. As basic statutes for the safeguarding of monotheism and an ethical order of society, they provided the legal framework for the alien residing in Jewish territory (*Abodah Zarah* 64b). As primarily moral and rational laws, independent of national and denominational limitations, they provided postbiblical Judaism with the concept of universal human rights.

Moses Maimonides regarded a person "who observed the Noahide laws as commanded in the Torah" to be "one of the pious of the Gentiles, assured of a portion in the world to come" (*Mishneh Torah, Hilkhoth Melakhim* VIII, 11). Hugo Grotius recognized the importance of the Noahide concept for the idea of international law; the jurist John Selden noted the relationship between the Noahide laws and modern legislation; the deist writer John Toland saw in them a link between Judaism and Christianity; and the neo-Kantian philosopher Hermann Cohen stressed the moral implication of the concept.

See G. F. Moore, *Judaism in the First Centuries of the Christian Era*, vol. i, *passim* (1946); N. Isaacs, "The Influence of Judaism on Western Law," in E. Bevan and C. Singer (eds.), *The Legacy of Israel*, pp. 383–387 (1927). (N. N. G.)

NOAILLES, a great French family, taking its name from the lordship of Noailles, southeast of Brive, in Limousin (in the modern *département* of Corrèze). Tracing their descent back to the 13th century, members of the family attracted notice in the 16th: ANTOINE (1504–1562), seigneur de Noailles, became admiral of France in 1547 and was ambassador to England from 1553 to 1556; his brother FRANÇOIS (1519–1585), bishop of Dax from 1555, was ambassador to England (1556–57), to Venice (1558) and to Turkey (1572); and a third brother, GILLES (1524–1597), having preceded François in England, was ambassador to Poland and to Turkey before succeeding François as bishop of Dax. Antoine's son HENRI (1554–1623) was created comte d'Ayen in 1593 (Ayen is northwest of Brive). Henri's grandson ANNE (d. 1678), a protégé of Cardinal Mazarin and premier captain of Louis XIV's bodyguard from 1648, was created duc de Noailles and a peer of France in 1663; he also had the governorship of Roussillon, to which his descendants were usually appointed thereafter. His eldest son ANNE JULES (1650–1708), 2nd duc de Noailles, became a marshal of France in 1693 and was viceroy of Catalonia in 1694, during the War of the Grand Alliance. Anne's second son, LOUIS ANTOINE (1651–1729), bishop of Cahors (1679), then of Châlons (1680–95) and ultimately archbishop of Paris (from 1695), is remembered as the long-suffering cardinal de Noailles (from 1700): having approved Pasquier Quesnel's *Réflexions morales*, he was attacked by the Jesuits as pro-Jansenist; and his opposition to Pope Clement XI's bull *Unigenitus* ended ambiguously in 1728, when he accepted it unconditionally after signing a preliminary protest against any such acceptance.

ADRIEN MAURICE (1678–1766), 3rd duc de Noailles, eldest son of the 2nd duc, married Françoise d'Aubigné, niece of Mme de Maintenon, in 1698; fought well in Spain during the War of the Spanish Succession, earning the rank of grandee in 1711; presided over the council of finances from 1715 to 1718 during the regency, but quarreled with the chief minister, Guillaume Dubois; was made a marshal of France in 1734; lost the battle of Dettingen in 1743; and acted as minister of state from 1743 to 1756. His son LOUIS (1713–1793) became duc d'Ayen—a title subsequently borne by the eldest son of each successive duc de Noailles—in 1737; 4th duc de Noailles in 1766; and a marshal of France in 1775. The latter's brother PHILIPPE (1715–1794), duc de Mouchy, also became a marshal in 1775; he and his wife (Anne Louise d'Arpajon, nicknamed Mme Étiquette), having been favourites of the court of Versailles, were both guillotined during the Revolution (June 27, 1794).

JEAN PAUL FRANÇOIS (properly Jean Louis François Paul;

1739–1824), 5th duc de Noailles, did some military service before devoting himself to chemistry, for which he was elected to the Académie des Sciences in 1777: having emigrated during the Revolution, he was received into the reconstituted peerage in 1814. As he had no male issue (his daughter Adrienne was Lafayette's wife), the peerage passed to his grandnephew, PAUL (1802–1885), 6th duc de Noailles, the historian who produced four volumes on the life story of Mme de Maintenon (1848–58) and was elected to the Académie Française in 1849. Paul's grandsons were: ADRIEN MAURICE (1869–1953), 8th duc de Noailles, whose only son and grandson were killed in World War II; HÉLIE, marquis de Noailles (1871–1932), father of the 9th duc; and MATHIEU (1873–1942), whose first wife was the poetess the comtesse de Noailles.

The 1st duc de Mouchy (*see* above) had two sons: PHILIPPE LOUIS (1752–1819), 2nd duc de Mouchy and prince de Poix; and LOUIS MARIE (1756–1804), vicomte de Noailles. The former, deputy to the estates-general, was the sponsor and momentarily the commander of the national guard at Versailles in 1789, emigrated in 1791, returned to support Louis XVI in 1792, re-emigrated, returned to France in 1800 and was received into the reconstituted peerage in 1814. From him descend the later ducs de Mouchy and princes de Poix. The vicomte de Noailles, meanwhile, had served with Lafayette in America before being elected to the estates-general of 1789; he made his name by proposing the abolition of feudal privilege on Aug. 4. Emigrating in 1792, he went to the United States but took part in the French operations of 1803 in Haiti and died of wounds at Havana, Cuba, on Jan. 9, 1804. His son ALEXIS (1783–1835), comte de Noailles, a royalist and an upholder of the papacy against Napoleon (who arrested him for a time in 1809), played some part at the congress of Vienna in 1814 and in French politics from 1815 to 1830; his male line died out in 1926.

NOBEL, ALFRED BERNHARD (1833–1896), Swedish chemist and engineer, who is noted as the founder of the Nobel prizes, was born at Stockholm on Oct. 21, 1833. He spent only two terms in school and thereafter was taught by tutors. About 1850 he was sent on travels to complete his education as an engineer and spent about a year in the United States. He was in ill-health all his life. On his return to Sweden after a stay in St. Petersburg, he studied explosives, especially nitroglycerin. He found that when nitroglycerin was incorporated with an absorbent, inert substance like kieselguhr it could be safely used. In 1867 he was granted a British patent for dynamite and in 1868 a U.S. patent. Nobel next combined nitroglycerin with another high explosive, guncotton, and obtained a transparent, jellylike substance which was a still more powerful explosive than dynamite. Blasting gelatin, as it was called, was patented in 1876. It combined the high power of nitroglycerin with the comparative safety in handling of dynamite. About 13 years later Nobel produced ballistite, one of the earliest of the nitroglycerin smokeless powders and a precursor of cordite. Nobel's claim that his patent covered the latter was the occasion of vigorously contested lawsuits between him and the British government in 1894 and 1895; eventually the courts decided against Nobel. An accomplishment of importance equal to that of his explosives was his construction and perfection of detonators for such explosives as could not be made to explode by simple firing. His detonators contained fulminate of mercury. These detonators made it possible to set off the explosive energy of nitroglycerin, guncotton, etc., at will; without detonators such explosives could not be used at all. From the manufacture of dynamite and other explosives, and from the exploitation of the Baku oil fields, he amassed an immense fortune. He never married. He was lonely and this together with his ill-health imbued him with pessimism and a satirical view of mankind which was nevertheless combined with benevolence and belief in the future of humanity. At his death on Dec. 10, 1896, at San Remo, Italy, he left the bulk of his fortune in trust to establish five prizes in peace, physics, chemistry, physiology or medicine, and literature. *See* NOBEL PRIZES.

BIBLIOGRAPHY.—Fritz Henriksson, *The Nobel Prizes and Their Founder Alfred Nobel* (1938); Ragnar Sohlman and Henrik Schück, *Nobel, Dynamite and Peace,* trans. by Brian and Beatrix Lunn (1929); Hertha E. Pauli, *Alfred Nobel, Dynamite King, Architect of Peace* (1942); Henrik Schück *et al., Nobel: the Man and His Prizes,* ed. by Nobel Foundation (1950; 2nd ed. 1962), for a biographical sketch and accounts of the prizes of the Nobel Foundation. (R. E O., X.)

NOBELIUM is the name (with symbol No) that has been suggested for the synthetic chemical element with atomic number 102. In the periodic system of the elements nobelium is the 13th member of the actinide series (*see* PERIODIC LAW; TRANSURANIUM ELEMENTS).

A claim for the first synthesis and identification of this element was made in 1957 by an international team of scientists from the Argonne National Laboratory in the U.S., the Atomic Energy Research Establishment in England, and the Nobel Institute for Physics in Sweden. They suggested the name on the basis of experiments in which they felt they had succeeded in identifying an isotope of element 102 with a half-life of ten minutes, produced from the bombardment of Cm^{244} with C^{13} ions accelerated in the cyclotron at the Nobel Institute. However, subsequent repetition of the experiment in other laboratories failed to confirm the discovery. Credit for the discovery of the element then passed to A. Ghiorso, T. Sikkeland, J. R. Walton, and G. T. Seaborg on the basis of an experiment performed in 1958 at the University of California, Berkeley. Element 102 was produced there on an atom-by-atom basis by the bombardment of Cm^{246} with C^{12} ions accelerated in a heavy-ion linear accelerator. The isotope thus prepared, with mass number 254, was identified through the chemical characteristics of its known "daughter" Fm^{250} the atoms of the daughter element being separated from the parent element 102 by taking advantage of the recoil from alpha-particle decay of the parent element. This isotope of element 102 was subsequently shown to have a half-life of about a minute. A number of isotopes of element 102 were known in the late 1960s as the result of the work of scientists at the University of California and at the Dubna Laboratory in the U.S.S.R.

Isotopes of Element 102

Isotope	Half-life	Type† and energy of radiation (Mev)
102^{251}	~0.7 sec	α8.6
102^{252}	~3 sec.	α8.4
102^{253}	~1.7 min.	α8.0
102^{254}	~1 min.	α8.1
102^{255}	~3 min.	α8.1
102^{256}	~3 sec.	α8.4
102^{257}	~20 sec	α8.3

†α = alpha particle.

The chemical properties of element 102 had not been investigated by the late 1960s, even by the tracer method, due to the short half-lives of all of its known isotopes, and it seemed certain that it would not be possible to work with weighable amounts of the element. It was predicted that the III oxidation state would be found to be the predominant one. The II oxidation state may also be sufficiently stable to exist in solution and in solid compounds.

See G. T. Seaborg, *Man-Made Transuranium Elements* (1963). (G. T. Se.)

NOBEL PRIZES. These prizes, five in number, are awarded annually by four institutions (three Swedish and one Norwegian) from a fund established under the will of Alfred Bernhard Nobel (*q.v.*). Distribution was begun on Dec. 10, 1901, the fifth anniversary of the death of the founder, whose will specified that the awards should annually be made "to those who, during the preceding year, shall have conferred the greatest benefit on mankind" in the fields of physics, chemistry, physiology or medicine, literature and peace.

The institutions mentioned as prize awarders by Alfred Nobel in his will are: the Royal Swedish Academy of Sciences, physics and chemistry; the Royal Caroline Medico-Chirurgical institute, physiology or medicine; the Swedish Academy, literature (all in Stockholm); and the Norwegian Nobel committee, appointed by the Norwegian *storting* (parliament), in Oslo, peace. The Nobel Foundation, established in pursuance with the provisions of the will, is the legal owner and functional administrator of the funds and serves as the joint administrative body of the prize awarders, but it is not concerned with the prize deliberations or decisions, which

Table I.—*Nobel Prize Winners (Physics, Chemistry), 1901–1950*

Year	Physics			Chemistry		
1901	Wilhelm Röntgen	(Ger.)	Discovery of X-rays	Jacobus Van't Hoff	(Neth.)	Laws of chemical dynamics and osmotic pressure
1902	Hendrik Lorentz	(Neth.)	Investigation of the influence of magnetism on the phenomena of radiation	Emil Fischer	(Ger.)	Work on sugar and purine syntheses
	Pieter Zeeman	(Neth.)				
1903	Antoine Henri Becquerel	(Fr.)	Discovery of spontaneous radioactivity	Svante Arrhenius	(Swed.)	Theory of electrolytic dissociation
	Pierre Curie	(Fr.)	Joint work concerning investigations of the radiation phenomena discovered by A. H. Becquerel			
	Marie Curie†	(Fr.)‡				
1904	Lord Rayleigh	(Brit.)	Discovery of argon	Sir William Ramsay	(Brit.)	Discovery of inert gaseous elements and determination of their places in the periodic system
1905	Philipp Lenard	(Ger.)	Research on cathode rays	Adolf von Baeyer	(Ger.)	Work on organic dyes, hydroaromatic compounds
1906	Sir Joseph Thomson	(Brit.)	Researches into electrical conductivity of gases	Henri Moissan	(Fr.)	Isolation of fluorine; introduction of Moissan furnace
1907	Albert Michelson	(U.S.)‡	Spectroscopic and metrological investigations using precision optical instruments	Eduard Buchner	(Ger.)	Discovery of noncellular fermentation
1908	Gabriel Lippmann	(Fr.)	Photographic reproduction of colours	Lord Rutherford	(Brit.)	Investigations into the disintegration of elements and the chemistry of radioactive substances
1909	Guglielmo Marconi	(It.)	Development of wireless telegraphy	Wilhelm Ostwald	(Ger.)	Pioneer work on catalysis, chemical equilibrium and reaction velocities
	Karl Braun	(Ger.)				
1910	J. van der Waals	(Neth.)	Research concerning the equation of state of gases and liquids	Otto Wallach	(Ger.)	Pioneer work in alicyclic combinations
1911	Wilhelm Wien	(Ger.)	Discoveries regarding laws governing heat radiation	Marie Curie†	(Fr.)‡	Discovery of radium and polonium; isolation of radium
1912	Nils Gustaf Dalén	(Swed.)	Invention of automatic regulators for lighting coastal beacons and light buoys during darkness or other periods of reduced visibility	Victor Grignard	(Fr.)	Discovery of the so-called Grignard reagents
				Paul Sabatier	(Fr.)	Method of hydrogenating organic compounds in the presence of finely powdered metals
1913	H. Kamerlingh Onnes	(Neth.)	Investigation into the properties of matter at low temperatures; production of liquid helium	Alfred Werner	(Switz.)‡	Work on the linkage of atoms in molecules
1914	Max von Laue	(Ger.)	Discovery of diffraction of X-rays by crystals	Theodore Richards	(U.S.)	Accurate determination of the atomic weights of numerous elements
1915	Sir William Bragg	(Brit.)	Analysis of crystal structure by means of X-rays	Richard Willstätter	(Ger.)	Pioneer researches on plant pigments, especially chlorophyll
	Sir Lawrence Bragg	(Brit.)				
1916	(No award)	...	...	(No award)	...	...
1917	Charles Barkla	(Brit.)	Discovery of characteristic X-radiation of elements	(No award)	...	...
1918	Max Planck	(Ger.)	Discovery of the elemental quanta	Fritz Haber	(Ger.)	Synthesis of ammonia from its elements
1919	Johannes Stark	(Ger.)	Discovery of the Doppler effect in canal rays and of the division of spectral lines in the electric field	(No award)	...	...
1920	Charles Guillaume	(Switz.)	Discovery of anomalies in nickel steel alloys	Walther Nernst	(Ger.)	Work in thermochemistry
1921	Albert Einstein*	(Switz.)‡	Services to theoretical physics, especially the discovery of the law of the photoelectric effect	Frederick Soddy	(Brit.)	Chemistry of radioactive substances; occurrence and nature of isotopes
1922	Niels Bohr	(Den.)	Investigation of atomic structure and radiation	Francis Aston	(Brit.)	Work with mass spectrograph; whole-number rule
1923	Robert Millikan	(U.S.)	Work on elementary electric charge and the photoelectric effect	Fritz Pregl	(Aus.)	Method of microanalysis of organic substances
1924	Karl Siegbahn*	(Swed.)	Discoveries and investigations in X-ray spectroscopy	(No award)	...	...
1925	James Franck*	(Ger.)	Discovery of the laws governing the impact of an electron upon an atom	Richard Zsigmondy	(Aus.)	Elucidation of the heterogeneous nature of colloidal solutions
	Gustav Hertz	(Ger.)				
1926	Jean Baptiste Perrin	(Fr.)	Works on discontinuous structure of matter, especially the discovery of the equilibrium of sedimentation	Theodor Svedberg	(Swed.)	Work on disperse systems
1927	Arthur Holly Compton	(U.S.)	Discovery of wave length change in diffused X-rays	Heinrich Wieland	(Ger.)	Researches into the constitution of bile acids
	Charles Wilson	(Brit.)	Method of making visible the paths of electrically charged particles by vapour condensation			
1928	Sir Owen Richardson	(Brit.)	Discovery of Richardson's law (the dependency of the emission of electrons on temperature)	Adolf Windaus	(Ger.)	Constitution of sterols and their connection with vitamins
1929	Prince Louis de Broglie	(Fr.)	Discovery of the wave nature of electrons	Sir Arthur Harden	(Brit.)	Investigations on the fermentation of sugars and the enzymes acting in this connection
				H. von Euler Chelpin	(Swed.)‡	
1930	Sir C. Raman	(India)	Work on light diffusion; discovery of Raman effect	Hans Fischer	(Ger.)	Hemin, chlorophyll research; synthesis of hemin
1931	(No award)	...	...	Karl Bosch	(Ger.)	Invention and development of chemical high-pressure methods
				Friedrich Bergius	(Ger.)	
1932	Werner Heisenberg	(Ger.)	Creation of quantum mechanics	Irving Langmuir	(U.S.)	Discoveries and investigations in surface chemistry
1933	Paul Dirac	(Brit.)	Discovery of new fruitful forms of atomic energy	(No award)	...	...
	Erwin Schrödinger	(Aus.)				
1934	(No award)			Harold Urey*	(U.S.)	Discovery of heavy hydrogen
1935	Sir James Chadwick	(Brit.)	Discovery of the neutron	Frédéric Joliot	(Fr.)	Synthesis of new radioactive elements
				Irène Joliot-Curie*	(Fr.)	
1936	Victor Hess	(Aus.)	Discovery of cosmic radiation	Peter Debye	(Neth.)	Studies of dipole moments and the diffraction of X rays and electrons in gases
	Carl Anderson	(U.S.)	Discovery of the positron			
1937	Clinton Davisson	(U.S.)	Experimental discovery of the interference phenomenon in crystals irradiated by electrons	Sir Walter Haworth	(Brit.)	Research on carbohydrates and vitamin C
	Sir George Thomson	(Brit.)		Paul Karrer	(Switz.)	Research on carotenoids, flavins and vitamins
1938	Enrico Fermi	(It.)	Disclosure of artificial radioactive elements produced by neutron irradiation	Richard Kuhn	(Ger.)	Carotenoid and vitamin research (declined)§
1939	Ernest Lawrence	(U.S.)	Invention of the cyclotron	Adolf Butenandt	(Ger.)	Work on sexual hormones (declined)§
				Leopold Ruzicka	(Switz.)‡	Work on polymethylenes and higher terpenes
1943‖	Otto Stern	(U.S.)‡	Discovery of the magnetic moment of the proton	George de Hevesy*	(Hung.)	Use of isotopes as tracers in chemical research
1944	Isidor Rabi	(U.S.)‡	Resonance method for registration of magnetic properties of atomic nuclei	Otto Hahn	(Ger.)	Discovery of the fission of heavy nuclei
1945	Wolfgang Pauli	(Aus.)	Discovery of the exclusion ("Pauli") principle	Artturi Virtanen	(Fin.)	Invention of fodder preservation method
1946	Percy Bridgman*	(U.S.)	Discoveries in the domain of high-pressure physics	James Sumner	(U.S.)	Discovery of enzyme crystallization
				John Northrop	(U.S.)	Preparation of enzymes and virus proteins in pure form
				Wendell Stanley	(U.S.)	
1947	Sir Edward Appleton	(Brit.)	Discovery of Appleton layer in upper atmosphere	Sir Robert Robinson	(Brit.)	Investigations on alkaloids and other plant products
1948	Patrick Blackett	(Brit.)	Discoveries in the domain of nuclear physics and cosmic radiation using the Wilson cloud chamber	Arne Tiselius	(Swed.)	Researches on electrophoresis and adsorption analysis, researches on the serum proteins
1949	Hideki Yukawa	(Jap.)	Prediction of the existence of mesons	William Giauque	(U.S.)	Behaviour of substances at extremely low temperatures
1950	Cecil Powell	(Brit.)	Photographic method of studying nuclear processes; discoveries about mesons	Otto Diels	(Ger.)	Discovery and development of diene synthesis
				Kurt Alder	(Ger.)	

Note: Nationality given is the citizenship of recipient at the time award was made.
*Contributor to *Encyclopædia Britannica*. †Awarded two Nobel prizes: physics (1903); chemistry (1911). ‡Naturalized citizen. §Hitler forbade Germans to accept Nobel Prizes (Jan. 1937). ‖No awards made, 1940–42.

TABLE II.—*Nobel Prize Winners (Physiology–Medicine, Literature, Peace), 1901–1950*

Year	Physiology or Medicine			Literature		Peace	
1901	Emil von Behring	(Ger.)	Work on serum therapy	Sully Prudhomme†, poet	(Fr.)	Jean Henri Dunant Frédéric Passy	(Switz.) (Fr.)
1902	Sir Ronald Ross	(Brit.)	Discovery of how malaria enters an organism	Theodor Mommsen; historian	(Ger.)	Élie Ducommun Charles Albert Gobat	(Switz.) (Switz.)
1903	Niels R. Finsen	(Den.)	Treatment of skin diseases with light radiation	B. Bjørnson, novelist, poet, dramatist	(Nor.)	Sir William Cremer	(Brit.)
1904	Ivan Pavlov	(Russ.)	Work on the physiology of digestion	Frédéric Mistral; poet J. Echegaray y Eizaguirre; dramatist	(Fr.) (Sp.)	Institute of International Law	(Founded, 1873)
1905	Robert Koch	(Ger.)	Tuberculosis research	H. Sienkiewicz; novelist	(Pol.)	Baroness von Suttner	(Aus.)
1906	Camillo Golgi S. Ramón y Cajal	(It.) (Sp.)	Work on the structure of the nervous system	Giosue Carducci, poet	(It.)	Theodore Roosevelt	(U.S.)
1907	Alphonse Laveran	(Fr.)	Discovery of the role of protozoa in diseases	Rudyard Kipling, poet, novelist	(Brit.)	Ernesto Teodoro Moneta Louis Renault	(It.) (Fr.)
1908	Paul Ehrlich Elie Metchnikoff	(Ger.) (Russ.)	Work on immunity	Rudolf Eucken; philosopher	(Ger.)	Klas Pontus Arnoldson Fredrik Bajer	(Swed.) (Den.)
1909	Emil Kocher	(Switz.)	Physiology, pathology and surgery of thyroid gland	Selma Lagerlöf, novelist	(Swed.)	Baron d'Estournelles de Constant Auguste Beernaert	(Fr.) (Belg.)
1910	Albrecht Kossel	(Ger.)	Researches in cellular chemistry	Paul von Heyse, poet, novelist, dramatist	(Ger.)	International Peace bureau	(Founded, 1891
1911	Allvar Gullstrand	(Swed.)	Work on dioptrics of the eye	Maurice Maeterlinck; dramatist	(Belg.)	Tobias Asser Alfred Fried	(Neth.) (Aus.)
1912	Alexis Carrel	(Fr.)	Work on vascular suture; transplantation of organs and blood vessels	Gerhart Hauptmann; dramatist	(Ger.)	Elihu Root	(U.S.)
1913	Charles Richet	(Fr.)	Work on anaphylaxis	Sir R. Tagore; poet	(India)	Henri Lafontaine	(Belg.)
1914	Robert Bárány	(Aus.)	Physiology and pathology of vestibular apparatus	(No award)	...	(No award)	...
1915	(No award)	...	...	Romain Rolland; novelist	(Fr.)	(No award)	...
1916	(No award)	...	...	V. von Heidenstam; poet	(Swed.)	(No award)	
1917	(No award)	...	...	Karl Gjellerup; novelist H. Pontoppidan; novelist	(Den.) (Den.)	International Red Cross committee	(Founded, 1863)
1919‡	Jules Bordet	(Belg.)	Discoveries in regard to immunity	Carl Spitteler; poet, novelist	(Switz.)	Woodrow Wilson	U.S.)
1920	August Krogh	(Den.)	Discovery of capillary motor regulating mechanism	Knut Hamsun; novelist	(Nor.)	Léon Bourgeois	(Fr.)
1921	(No award)			Anatole France§, novelist	(Fr.)	Karl Branting Christian Lous Lange	(Swed.) (Nor.)
1922	Archibald V. Hill Otto Meyerhof	(Brit.) (Ger.)	Discovery relating to heat production in muscles Discovery of correlation between oxygen consumption and metabolism of lactic acid in muscles	J. Benavente y Martinez, dramatist	(Sp.)	Fridtjof Nansen	(Nor.)
1923	Sir F. G. Banting J. J. R. Macleod*	(Can.) Brit.)	Discovery of insulin	William Butler Yeats; poet	(Ire.)	(No award)	...
1924	Willem Einthoven	(Neth.)	Discovery of electrocardiogram mechanism	Wladyslaw S. Reymont; novelist	(Pol.)	(No award)	...
1925	(No award)	...	...	George Bernard Shaw; dramatist	(Ire.)	Sir Austen Chamberlain Charles Gates Dawes	(Brit.) (U.S.)
1926	Johannes Fibiger	(Den.)	Discovery of Spiroptera carcinoma	Grazia Deledda; novelist	(It.)	Aristide Briand Gustav Stresemann	(Fr.) (Ger.)
1927	J. Wagner von Jauregg	(Aus.)	Discovery of the therapeutic importance of malaria inoculation in dementia paralytica	Henri Bergson; philosopher	(Fr.)	Ferdinand Buisson Ludwig Quidde	(Fr.) (Ger.)
1928	Charles Nicolle	(Fr.)	Work on typhus	Sigrid Undset, novelist	(Nor.)	(No award)	
1929	Christiaan Eijkman Sir F. Hopkins	(Neth.) (Brit.)	Discovery of antineuritic vitamin Discovery of growth-stimulating vitamins	Thomas Mann, novelist	(Ger.)	Frank B. Kellogg	(U.S.)
1930	Karl Landsteiner	(U.S.)‖	Grouping of human blood	Sinclair Lewis, novelist	(U.S.)	Nathan Söderblom	(Swed.)
1931	Otto Warburg	(Ger.)	Discovery of nature and action of respiratory enzyme	Erik Axel Karlfeldt; poet	(Swed.)	Jane Addams Nicholas Murray Butler	(U.S.) (U.S.)
1932	Edgar D. Adrian* Sir C. Sherrington*	(Brit.) (Brit.)	Discoveries regarding function of the neurons	John Galsworthy; novelist	(Brit.)	(No award)	...
1933	Thomas Hunt Morgan*	(U.S.)	Heredity transmission functions of chromosomes	Ivan Bunin; novelist	(U.S.S.R.)	Sir Norman Angell	(Brit.)
1934	George R. Minot William P. Murphy George H. Whipple	(U.S.) (U.S.) (U.S.)	Discoveries concerning liver therapy against anemia	Luigi Pirandello; dramatist	(It.)	Arthur Henderson	(Brit.)
1935	Hans Spemann	(Ger.)	Organizer effect in embryonic development	(No award)	...	Carl von Ossietzky	(Ger.)
1936	Sir H. H. Dale* Otto Loewi	(Brit.) (Ger.)	Discoveries relating to the chemical transmission of nerve impulses	Eugene O'Neill; dramatist	(U.S.)	Carlos Saavedra Lamas	(Arg.)
1937	Albert Szent Györgyi	(Hung.)	Work on biological combustion	Roger Martin du Gard; novelist	(Fr.)	Viscount Cecil of Chelwood	(Brit.)
1938	Corneille Heymans	(Belg.)	Discovery of role of sinus and aortic mechanisms in respiration regulation	Pearl Buck¶; novelist	(U.S.)	Nansen International Office for Refugees	(Founded, 1931
1939	Gerhard Domagk	(Ger.)	Antibacterial effect of prontosil (declined)♀	Frans Eemil Sillanpää; novelist	(Fin.)	(No award)	...
1943‡	Henrik Dam Edward A. Doisy	(Den.) (U.S.)	Discovery of vitamin K Discovery of chemical nature of vitamin K	(No award)	...	(No award)	...
1944	Joseph Erlanger Herbert S. Gasser*	(U.S.) (U.S.)	Researches on differentiated functions of single nerve fibres	Johannes V. Jensen; novelist	(Den.)	International Red Cross committee	(Founded, 1863)
1945	Sir A. Fleming* Ernst Boris Chain Lord Florey*	(Brit.) (Brit.)‖ (Austr.)	Discovery of penicillin and its curative value in some infectious diseases	Gabriela Mistralδ; poet	(Chile)	Cordell Hull	(U.S.)
1946	Hermann J. Muller*	(U.S.)	Production of mutations by X ray irradiation	Hermann Hesse; novelist	(Switz.)‖	Emily Greene Balch John R. Mott	(U.S.) (U.S.)
1947	Carl F. Cori Gerty T. Cori Bernardo Houssay*	(U.S.)‖ (U.S.)‖ (Arg.)	Discovery of how glycogen is catalytically converted Pituitary hormone function in sugar metabolism	André Gide; novelist, essayist	(Fr.)	American Friends' Service committee Friends' Service council	(U.S.) (London)
1948	Paul Müller	(Switz.)	Properties of DDT	T. S. Eliot; poet, critic	(Brit.)	(No award)	
1949	Walter Rudolf Hess Antonio Egas Moniz	(Switz.) (Port.)	Discovery of function of middle brain Therapeutic value of leucotomy in psychoses	William Faulkner; novelist	(U.S.)	Lord Boyd-Orr	(Brit.)
1950	Philip S. Hench Edward C. Kendall* Tadeusz Reichstein	(U.S.) (U.S.) (Switz.)‖	Research on adrenal cortex hormones, their structure and biological effects	Bertrand Russell; philosopher	(Brit.)	Ralph Bunche	(U.S.)

Note. Nationality given is the citizenship of recipient at the time award was made.
*Contributor to *Encyclopædia Britannica*. †Real name: René François Armand Prudhomme. ‡No awards given in these categories in 1918, 1940–42. §Real name: Anatole François Thibaut. ‖Naturalized citizen. ¶Real name: Pearl (Sydenstricker) Buck Walsh. ♀Hitler forbade Germans to accept Nobel Prizes (Jan. 1937). δReal name Lucila Godoy Alcayaga.

TABLE III.—*Nobel Prize Winners (Physics, Chemistry), 1951–1967*

Year	Physics			Chemistry		
1951	Sir John Cockcroft Ernest Walton	(Brit.) (Ire.)	Work on transmutation of atomic nuclei by artificially accelerated particles	Edwin McMillan* Glenn Seaborg*	(U.S.) (U.S.)	Discovery of and research on transuranium elements
1952	Felix Bloch Edward Purcell	(U.S.)† (U.S.)	Discovery of nuclear magnetic resonance in solids	Archer Martin Richard Synge	(Brit.) (Brit.)	Method of identifying and separating chemical elements by chromatography
1953	Frits Zernike	(Neth.)	Method of phase-contrast microscopy	Hermann Staudinger	(Ger.)	Work on macromolecules
1954	Max Born Walther Bothe	(Brit.)† (Ger.)	Statistical studies on wave functions Invention of and studies with coincidence method	Linus Carl Pauling*‡	(U.S.)	Study of the nature of the chemical bond
1955	Willis Lamb, Jr. Polykarp Kusch*	(U.S.) (U.S.)†	Discoveries concerning the hydrogen spectrum Measurement of magnetic moment of electron	Vincent Du Vigneaud	(U.S.)	First synthesis of a polypeptide hormone
1956	William Shockley John Bardeen Walter Brattain	(U.S.) (U.S.) (U.S.)	Investigations on semiconductors and discovery of the transistor effect	Nikolai Semenov Sir Cyril Hinshelwood	(U.S.S.R.) (Brit.)	Work on the kinetics of chemical reactions
1957	Tsung-Dao Lee Chen Ning Yang	(Chin.) (Chin.)	Discovery of violations of the principle of parity (space reflection symmetry)	Sir Alexander Todd	(Brit.)	Work on nucleotides and nucleotide coenzymes
1958	Pavel Cerenkov Ilya Frank Igor Tamm	(U.S.S.R.) (U.S.S.R.) (U.S.S.R.)	Discovery and interpretation of the Cerenkov effect (emission of light waves by electrically charged particles moving faster than light)	Frederick Sanger	(Brit.)	Determination of the structure of the insulin molecule
1959	Emilio Segrè* Owen Chamberlain	(U.S.)† (U.S.)	Confirmation of the existence of the antiproton	Jaroslav Heyrovsky	(Czech.)	Discovery and development of polarography
1960	Donald Glaser*	(U.S.)	Development of the bubble chamber	Willard Libby*	(U.S.)	Development of radiocarbon dating
1961	Robert Hofstadter Rudolf Mössbauer	(U.S.) (Ger.)	Determination of shape and size of atomic nucleons Discovery of the "Mossbauer effect"	Melvin Calvin	(U.S.)	Study of chemical steps that take place during photosynthesis
1962	Lev D. Landau	(U.S.S.R.)	Contributions to the understanding of condensed states of matter (superfluidity in liquid helium)	John C. Kendrew Max F. Perutz	(Brit.) (Brit.)†	Determination of the structure of hemoproteins
1963	J. Hans D. Jensen Maria Goeppert Mayer* Eugene Paul Wigner	(Ger.) (U.S.)† (U.S.)†	Development of shell model theory of the structure of atomic nuclei Principles governing mechanics and interaction of protons and neutrons in the atomic nucleus	Giulio Natta Karl Ziegler	(It.) (Ger.)	Structure and synthesis of polymers in the field of plastics
1964	Charles H. Townes Nikolai G. Basov Aleksandr M. Prokhorov	(U.S.) (U.S.S.R.) (U.S.S.R.)	Work in quantum electronics leading to construction of instruments based on maser-laser principles.	Dorothy M. C. Hodgkin	(Brit.)	Determining the structure of biochemical compounds essential in combating pernicious anemia
1965	Julian S. Schwinger Richard P. Feynman Shin'ichirō Tomonaga	(U.S.) (U.S.) (Jap.)	Basic principles of quantum electrodynamics	Robert B. Woodward	(U.S.)	Synthesis of sterols, chlorophyll and other substances once thought to be produced only by living things
1966	Alfred Kastler	(Fr.)	Discovery and development of optical methods for studying Hertzian resonances in atoms	Robert S. Mulliken	(U. S.)	Work concerning chemical bonds and the electronic structure of molecules by the molecular orbital method
1967	Hans A. Bethe*	(U.S.)†	Discoveries concerning the energy production of stars	Manfred Eigen Ronald G. W. Norrish George Porter	(Ger.) (Brit.) (Brit.)	Studies of extremely fast chemical reactions

Note: Nationality given is the citizenship of recipient at the time award was made.
*Contributor to *Encyclopædia Britannica*. †Naturalized citizen. ‡Awarded two Nobel prizes: chemistry (1954); peace (1962).

TABLE IV.—*Nobel Prize Winners (Physiology–Medicine, Literature, Peace), 1951–1967*

Year	Physiology or Medicine			Literature		Peace	
1951	Max Theiler	(S.Af.)	Discoveries concerning yellow fever	Par F. Lagerkvist; novelist, poet	(Swed.)	Léon Jouhaux	(Fr.)
1952	Selman A. Waksman	(U.S.)†	Discovery of streptomycin	François Mauriac, poet, novelist, dramatist	(Fr.)	Albert Schweitzer	(Alsatian)
1953	Fritz A. Lipmann Sir H. A. Krebs*	(U.S.)† (Brit.)†	Discovery of coenzyme A Citric acid cycle in metabolism of carbohydrates	Sir Winston Churchill; historian, orator	(Brit.)	George C. Marshall*	(U.S.)
1954	John F. Enders Thomas H. Weller Frederick Robbins	(U.S.) (U.S.) (U.S.)	Cultivation of the poliomyelitis viruses in tissue culture	Ernest Hemingway; novelist	(U.S.)	Office of the United Nations High Commissioner for Refugees	(Founded, 1951)
1955	Axel Hugo Theorell	(Swed.)	Nature and mode of action of oxidation enzymes	Halldór K. Laxness; novelist	(Ice.)	(No award)	...
1956	Werner Forssmann Dickinson Richards* André F. Cournand	(Ger.) (U.S.) (U.S.)†	Discoveries concerning heart catherization and pathological changes in the circulatory system	Juan Ramón Jiménez; poet	(Sp.)	(No award)	...
1957	Daniel Bovet	(It.)†	Production of synthetic curare	Albert Camus; novelist, dramatist	(Fr.)	Lester B. Pearson	(Can.)
1958	George W. Beadle* Edward L. Tatum Joshua Lederberg	(U.S.) (U.S.) (U.S.)	Genetic regulation of chemical processes Genetic recombination; bacterial genetics	Boris Leonidovich Pasternak, novelist, poet (declined award)	(U.S.S.R.)	Dominique Georges Pire, O.P.	(Belg.)
1959	Severo Ochoa Arthur Kornberg	(U.S.)† (U.S.)	Discovery of enzymes for producing nucleic acids artificially	Salvatore Quasimodo; poet	(It.)	Philip J. Noel-Baker	(Brit.)
1960	Sir (Frank) Macfarlane Burnet* Peter B. Medawar	(Austr.) (Brit.)	Discovery of acquired immunity tolerance to tissue transplants	Saint John Perse‡; poet	(Fr.)	Albert J. Luthuli	(S.Af.)
1961	Georg von Békésy	(U.S.)†	Functions of the inner ear	Ivo Andric; novelist	(Yugos.)	Dag Hammarskjöld	(Swed.)
1962	Francis H. C. Crick James D. Watson Maurice Wilkins	(Brit.) (U.S.) (Brit.)	Discoveries concerning the molecular structure of deoxyribonucleic acid	John Steinbeck; novelist	(U.S.)	Linus Carl Pauling*§	(U.S.)
1963	Sir John C. Eccles Alan Lloyd Hodgkin* Andrew F. Huxley	(Austr.) (Brit.) (Brit.)	Study of the transmission of nerve impulses along a nerve fibre	George Seferis‖; poet	(Gr.)	International Red Cross committee League of Red Cross Societies	(Headquarters of both in Geneva)
1964	Konrad Bloch Feodor Lynen	(U.S.)† (Ger.)	Discoveries concerning cholesterol and fatty-acid metabolism	Jean-Paul Sartre; philosopher, dramatist (declined award)	(Fr.)	Martin Luther King	(U.S.)
1965	François Jacob André Lwoff Jacques Monod	(Fr.) (Fr.) (Fr.)	Discoveries concerning regulatory activities of the body cells	Mikhail Sholokhov; novelist	(U.S.S.R.)	United Nations Children's Fund (UNICEF)	(Founded, 1946)
1966	Charles B. Huggins Francis Peyton Rous	(U. S.)† (U. S.)	Research on causes and treatment of cancer	Samuel J. Agnon; novelist Nelly Sachs; poet	(Isr.)† (Swed.)†	(No award)	...
1967	Haldan Keffer Hartline George Wald Ragnar A. Granit	(U.S.) (U.S.) (Swed.)	Discoveries concerning the chemical and physiological visual processes in the eye	Miguel Angel Asturias; novelist	(Guat.)	(No award)	...

Note: Nationality given is the citizenship of recipient at the time award was made.
*Contributor to *Encyclopædia Britannica*. †Naturalized citizen. ‡Real name: Marie René Auguste Alexis Léger. §Awarded two Nobel prizes: chemistry (1954); peace (1962).
‖Real name: Giorgos Stylianou Seferiades.

rest exclusively with the four institutions. Each award consists of a gold medal, a diploma bearing a citation, and a sum of money; the amount depends on the income of the foundation and has ranged from about £11,000 ($30,000) to about £17,000 ($50,000).

The selection of the prize winners starts in the early autumn of the year preceding the awards, with the prize institutions sending out invitations to nominate candidates to those competent under the Nobel statutes to do so. The basis of selection is professional competence and international range; self-nomination automatically disqualifies. Prize proposals must reach the proper committee in writing before Feb. 1 of the year of the prize decision.

On Feb. 1 the Nobel committees start their work on the nominations received. If necessary, the committees may be authorized to call in experts, irrespective of nationality. During September and early October the committees submit recommendations to their respective prize-awarding bodies—only in rare cases has the question been left open. The final decision by the prize awarders must be made by Nov. 15. A committee recommendation is usually but not invariably followed. The deliberation and the voting are secret at all stages. Prizes may be given only to individuals, except the peace prize which may also be given to an institution. Work cannot be proposed posthumously, but a prize duly proposed may be so awarded, as with Dag Hammarskjöld (for peace; 1961) and Erik A. Karlfeldt (for literature; 1931). The awards may not be appealed against. Official support, diplomatic or political, for a certain candidate has no bearing on an award since the prize awarders, as such, are independent of the state.

A prize is either given entire to one person, divided equally between at most two works, or shared jointly by two or more (in practice never more than three) persons. Sometimes a prize is withheld until the following year; if not then awarded it is paid back into the funds, which happens also when a prize is neither awarded nor reserved. Two prizes in the same field can thus be awarded in one year; *i.e.*, the prize withheld from the previous year and the current year's prize. If a prize is declined or not accepted before a set date, the prize money goes back to the funds. Prizes have been declined and in some instances governments have forbidden their nationals to accept Nobel prizes. Those who win a prize are nevertheless entered into the list of Nobel laureates with the remark "declined the prize." The motives given for nonacceptance may vary, but in most instances the reason has been external pressure; *e.g.*, Hitler's decree of 1937 forbade Germans to accept Nobel prizes because the peace prize to Carl von Ossietzky in 1935 was taken as an affront. Whenever possible later, the onetime refuser has explained his situation and on application received the Nobel gold medal and the diploma—but not the money, which has already been paid back into the funds.

Prizes are withheld or not awarded when no worthy candidate in the meaning of Alfred Nobel's will can be found, or when the world situation prevents the gathering of information required to reach a decision, as happened during World Wars I and II.

The Nobel prizes are open to all, irrespective of nationality, race, creed or ideology. They can be awarded more than once to the same recipient. The ceremonial presentations of the prizes for physics, chemistry, physiology or medicine, and literature take place in Stockholm, and that for peace in Oslo, on Dec. 10, the anniversary of Alfred Nobel's death. The laureates usually receive their prizes in person.

The general principles governing awards were laid down by Alfred Nobel in his will. In 1900, supplementary rules of interpretation and administration were agreed upon between the executors, representatives of the prize awarders and the Nobel family, and confirmed by the king in council. These statutory rules have on the whole remained unchanged, but have been somewhat modified in application; *e.g.*, the ambiguous words in the will, "idealistic tendency" as qualification for the prize for literature, were in the beginning interpreted verbally, but have gradually been interpreted more flexibly, as the list of laureates shows.

The scientific and medical prizes have proved to be the least controversial, while those for literature and peace by their very nature have been the most exposed to critical differences. The peace prize has been most frequently reserved.

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NOBILE, UMBERTO (1885–), Italian aeronautical engineer and explorer, a pioneer of arctic aviation, was born at Lauro, Avellino, on Jan. 24, 1885. Trained as an engineer in Naples, he did much pioneer work for Italy during and after World War I in the field of aircraft construction. In 1926, together with Roald Amundsen and Lincoln Ellsworth, he flew in his semirigid airship the "Norge" over the north pole from Spitsbergen to Alaska. Nobile was promoted to general in the Italian air force and appointed professor of aeronautical engineering at the University of Naples. Although the type was criticized as being too small and delicate for use in the polar regions, it was with an almost identical airship, the "Italia," that Nobile undertook in 1928 a new series of flights over unexplored areas of the arctic. On the third flight the airship crashed on the ice north-northeast of Spitsbergen. A vast international rescue operation was launched; Nobile and seven of his companions were eventually rescued, but the catastrophe cost, directly or indirectly, 17 lives. Nobile's conduct was the subject of fierce controversy and an Italian commission of inquiry, in all probability partial, found him responsible for the disaster, whereupon he resigned his rank. In 1931 he took part in the arctic voyage of the Soviet vessel "Malygin," and from 1932 to 1936 he was concerned with the construction of dirigibles in the Soviet Union. He was reinstated in 1945 and resumed his teaching post at Naples. In 1946 he was a Communist deputy in the Italian constituent assembly.

Nobile published numerous works, both on aeronautics and his polar experiences, including *Posso dire la verità* (1945), a final statement of his view of the "Italia" tragedy. (P. A. B. G.)

NOBLE, SIR ANDREW, 1ST BART. (1831–1915), British physicist and artillerist whose classical researches with Sir Frederick Abel on fired gunpowder contributed greatly to the progress of gunnery, was born at Greenock, Renfrewshire, Scot., Sept. 13, 1831. Educated at Edinburgh academy and the Royal Military academy, Woolwich, London, he entered the royal artillery in 1849 and, as secretary of the select committee on smoothbore and rifled cannon, he devised an ingenious method of comparing the accuracy of fire of each type of gun. He became assistant inspector of artillery (1859), then served on the ordnance select committee and the explosives committee, but left the service to join the firm of Sir William (later Lord) Armstrong (*q.v.*) of which he became chairman in 1900. About 1862 he applied his chronoscope, a device for measuring very small time intervals, to determine the velocity of shot in gun barrels with different powders and charges. He was an advocate of nitro (smokeless) powders. Noble was elected a fellow of the Royal society (1870), awarded a royal medal of the society (1880) and created a baronet (1902). He died in Argyll, Scot., on Oct. 22, 1915. His papers were collected as *Artillery and Explosives* (1906). (D. McK.)

NOBRE, ANTÓNIO (1867–1903), Portuguese poet, whose *Só* ("Alone")—the only volume of his verse published during his lifetime—gives an intensely personal expression to the deep vein of melancholy in the national character, was born in Oporto on Aug. 16, 1867, the son of a well-to-do middle-class family. He studied law unsuccessfully for two years at Coimbra university and then, during 1890–95, attended the École Libre des Sciences Politiques in Paris. Having been a consumptive, Nobre spent the remaining years in travel. In Paris, where his memories of a childhood spent in the company of peasants and sailors of northern Portugal contrasted sharply with his impressions of the cosmopolitan drabness of the Left Bank, he wrote the greater part of the *Só* (1892; final version, 1898), in which he succeeded in blending the traditional trend of a genuine and simple lyricism with the more refined and subtle perceptiveness of the French Symbolists. This line of literary development evolves clearly from his early compositions, *Primeiros Versos* (1921), to the valedictory garland of *Despedidas* (1902).

The *Só* met with a mixed reception, but became one of the mo...

popular works of poetry in Portugal. Its originality springs partly from the creation of a personal mythology applied to significant place-names of a sentimental itinerary; a quasi-Franciscan acceptance of death adds the uneasy note of a subdued protest against the transiency of the world. Nobre's rejection of reality and his narcissism, however, engender a cloying sense of frustration. His vision of Portugal partakes of the bucolic enchantment that it describes in the fluent vein of a nursery tale. Herein lies its strength and its major weakness. Nobre died at Foz do Douro on March 18, 1903.

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NÓBREGA, MANUEL DA (1517–1570), was the Portuguese founder of the Jesuit mission of Brazil. In Bahia, where he arrived from Lisbon in 1549, he founded the first Jesuit college in the new world. He was the first provincial of the Brazilian province of the Society of Jesus (1553–59). He was again named provincial in 1570 but died in Rio de Janeiro before the news of the appointment reached him. Nóbrega was instrumental in establishing the Jesuit college around which São Paulo grew (1554) and is therefore known as the founder of Brazil's largest city. When the French under Nicolas de Villegagnon, including many Huguenots, settled in Rio (1555), Nóbrega moved heaven and earth against them. They were expelled in part because he won over to the Portuguese side the Tamóio Indians (1563).

"There is no individual," Robert Southey wrote, "to whose talents Brazil is so greatly and permanently indebted. . . ." In many ways because of Nóbrega, southern Brazil was destined to remain Catholic and Portuguese. *See* also BRAZIL: *History*. (M. CA.)

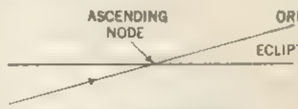
NOCERA INFERIORE (formerly NOCERA DEI PAGANI; ancient NUCERIA ALFATERNA), a town in Salerno province, Campania region, southern Italy, situated at the foot of Montalbino, 23 mi. E.S.E. of Naples, 135 ft. above sea level. Pop. (1961) 42,924 (commune). The origin of the epithet *dei Pagani* ("of the pagans") is not historically established and is sometimes attributed to Pagum village or to Pagano, the name of an important local medieval family. Nuceria Alfaterna, sacked by Hannibal in 216 B.C., was rebuilt by Augustus. In the old castle, Helen, widow of King Manfred of Sicily, died in captivity (1271) five years after the battle of Benevento. The city early became an episcopal see and in the 12th century it sided with Innocent II against Roger of Sicily suffering for its choice the destruction of its walled centre. In the nearby village of Nocera Superiore is the circular domed church of Sta. Maria Maggiore (dating from the 4th century). Other ancient ecclesiastical buildings include S. Antonio's (13th century, with an altar piece by Andrea da Salerno), Sta. Anna's monastery (with frescoes by Francesco Solimena), S. Andrea's convent (14th century) and S. Giovanni's convent (dating from the 11th century). Nocera Inferiore now ranks first economically in the province because of its agricultural exports, its well-established lumber mills, canning, macaroni and textile plants.

(LU. L.; AL. M.; SA. P.)

NOCTURNE, the name, principally found in the 19th century, of a form of music. It originated from the Italian *notturno*, an 18th-century form of music associated with, or to be played during, the night, as opposed to *serenata*, an evening piece. *Notturnos* for various combinations of instruments and in several movements were written by Haydn, Adalbert Gyrowetz and Mozart, whose *Eine Kleine Nachtmusik* also comes under this heading. The French form, *nocturne*, was first used in 1814 by John Field as the title of pieces for the piano in different styles, and later by Chopin who established the romantic or introspective character of the nocturne. A similar conception is seen in the nocturnes for piano by Gabriel Fauré. The term was also used by Mendelssohn for an interlude in his *Midsummer Night's Dream* music, and by Debussy as the title of three pieces for orchestra. The German form of the word, *Nachtstück*, was used for pieces by Schumann and Paul Hindemith.

NODDY, the name applied to seabirds of the genus *Anous*, of the tern (*q.v.*) subfamily, and especially to *A. stolidus*, showing so little fear of man as to be judged stupid. It is heavier in flight than most terns, with shorter wings and less forked tail. The plumage is of a uniform sooty hue, except the light gray crown of the head. The noddy is generally distributed throughout tropical and subtropical oceans. It breeds in astounding numbers, on low cays and coral islets, making a nest composed of seaweed or small twigs. Other birds of the same genus are the darker Pacific noddy (*A. s. sidgwayi*), the still darker Galapagos noddy (*A. s. galapagoensis*) and the white-headed noddy (*A. leucocapillus*).

NODE (from the Lat. *nodus*, "loop"), in astronomy, the intersection of the ecliptic (the apparent path of the sun among the stars) with the path of the moon or of a planet projected on the celestial sphere. The ascending node is the one where the body crosses from the south to the north side of the ecliptic, the opposite one being the descending node. An eclipse or transit of a planet has to occur when the moon or planet is at or near a node, for that is the only time that the sun, moon or planet and earth can be lined up suitably.



ASCENDING NODE

In the geometry of curves, a node is the name given to the loop formed by a continuous curve crossing itself. The point of crossing is termed a "double point," and at it there are two noncoincident tangents to the curve; the remaining species of double points—termed acnode, spinode or cusp—admits of two coincident tangents. *See* also CURVES. (H. M. LO.)

NODIER, CHARLES (1780–1844), French writer, an early master of the fantastic story, was born on April 29, 1780, at Besançon, and educated there. The political agitation of the time and his experience of the Terror made a deep impression on him; he escaped from reality into a world of fantasies fed by his omnivorous reading and his passion for natural history. The turmoil of these early years ended with his marriage to Désirée Charve in 1808; this was followed by periods of employment as secretary and librarian, and of writing and travel. In 1824 he was appointed curator of the library at the Arsenal. He died in Paris on Jan. 27, 1844.

Nodier is generally remembered for such stories as his *Histoire du Chien de Brisquet* (1830), *Le Songe d'or* (1832), *Jean François les Bas-Bleus* (1832) and *Trésor des fèves et fleur des pois* (1833), written in a prose always classically pure but with a simplicity that sometimes seems a little childish; and also for the literary *salon* in his rooms at the Arsenal, where from 1824 to 1830 he gathered round him the principal representatives of the newly formed romantic school. It is unjust, however, to recall only these two aspects of his many-sided career. He had an encyclopedic mind and studied a wide range of subjects—botany, entomology, linguistics, bibliography—in each of which he displayed extensive, though not always infallible, erudition. He wrote in many different literary kinds, publishing poems, critical studies, philosophical essays, books of travel, reminiscences of his youth, novels (*Jean Sbogar*, 1818; *Mademoiselle de Marsan*, 1829) and a fantasy which eludes classification (*Histoire du roi de Bohème et de ses sept châteaux*, 1830).

But it is his stories which remain outstanding, though the best are not those constantly anthologized for children. Nodier's originality was to find in the world of dreams an untapped source of literary inspiration. *Smarra ou les démons de la nuit* (1821) is a prose poem of nightmare; *Trilby* (1822), another prose poem, is a reverie of love; *La Fée aux miettes* (1832) describes the delusions of a "lunatic" in its root meaning of one made mad by the moon. By this revelation of the creative power of dream and by his equation of a state of innocence with certain conditions normally called mad, Nodier was rebelling against the tyranny of "common sense" (*le bon sens*) and opening up a new territory to literature. Gerard de Nerval, Lautréamont (*qq.v.*) and the surrealists explored the same realm and hailed him as a precursor of their own fantasies.

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l'oeuvre de Charles Nodier (1923); A. Béguin, in *L'Âme Romantique,* 2nd ed. (1946). (P.-G. C.)

NŌ DRAMA. Toward the end of the 14th century a father and son, Kan-ami and Zeami (*see* ZEAMI MOTOKIYO), by making innovations and refinements in *sarugaku-nō*—an entertainment derived from ancient native and foreign sources—created the nō theatre of Japan, which survives in modern times in much the same form as that in which it was conceived. Kan-ami's troupe, previously associated with a Shintō shrine, was taken under the patronage of the temporal ruler, the shogun Yoshimitsu. Thereafter and well into the 19th century the nō was a fashionable amusement of the aristocracy and the warrior class but certain performances, called subscription nō, were open to and popular with commoners. The nō thus greatly influenced the subsequent dramatic expression of the commoners, the puppet theatre and the kabuki, which appeared at the end of the 16th century.

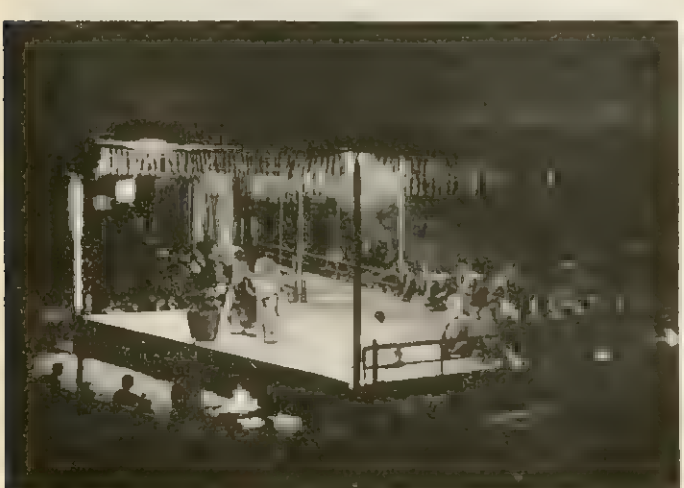
The nō is nonrealistic. The actors, all male, are singers and dancers. They wear theatrical versions of 14th-century costumes and in some roles are masked. The rhythmical basis of the performance is provided by two or three drummers and a flutist. A chorus of six or more men chants the narrative parts of the play and sometimes the words of the characters.

Classification of Nō Plays.—Out of more than 2,000 plays, about 240—the majority of which were written during the 15th century—constitute the modern repertoire. These are divided into five principal groups: (1) congratulatory pieces praising the prosperity of the country; (2) plays about warriors, as men and as ghosts; (3) those which usually have an elegant, beautiful woman as leading character; (4) plays (the largest group, containing various types) dealing with insanity, obsession and historical characters; (5) pieces concerning demons and gods. The traditional, daylong performance consisted of a play from each of the groups, in the above order, with comic interludes in colloquial language (*kyōgen*) played between them; after 1945 the usual program consisted of two or three plays with comic interludes.

Construction of Nō Plays.—Nō plays are written in poetic form, using a variety of complex, untranslatable literary devices. Usually there are only two important roles: the *shite* or principal character and the *waki* or secondary one. Considered apart from the Japanese classification, the plays are of two types: those set entirely in the "real" world, and those in which an apparition or supernatural being appears. The majority of the plays and those most frequently performed belong to the latter group. These vary in detail but the general form is this: The *waki,* often a priest or monk, enters first; he is joined by the *shite* at a place of historical or religious significance. The *shite,* though appearing to be an ordinary person, reveals unusual knowledge of the spot. The *shite* then exits. During a short interlude he changes costume and mask and reappears for the second part in his true form. He is described in his first appearance as the "before"-*shite,* in his second as the "after"-*shite;* there is often a complete contrast between the two, so that they are entirely different roles. The *shite* may first be a beautiful girl, then a serpent; an old village woman, then a demon; a boy, then the spirit of a warrior. On his second appearance the *shite,* with the help of the chorus, gives an account of his essential being, climaxed by his principal dance. A hunter dances his killing of birds in life and the punishment he later suffers in hell for this sin. The woman who in life had an illicit passion for a priest reveals her true nature by wearing the mask of a demon and a costume of stylized pattern suggesting the scales of a snake. The great warrior relives his last battle. All such characters are chained to their earthly passions, which bind them to the world of actuality and prevent their attainment of nirvana. They appeal to the priest or monk to pray for the repose of their spirits. Because the priest possesses knowledge of the likeness of all living things he receives requests for deliverance and enlightenment not only from the spirits of human beings, but also from the snow, a butterfly or the wisteria.

AUTHENTICATED NEWS INTERNATIONAL

NŌ ACTOR: CHORUS AND MEMBER OF THE ORCHESTRA IN BACKGROUND



BY COURTESY OF THE CONSULATE GENERAL OF JAPAN

"TAKIGI NŌ," TRADITIONALLY PLAYED IN THE LIGHT OF A BONFIRE AT NIGHT

Staging.—The stage has two principal areas: the stage proper about 18 ft. square; and the bridge (*hashigakari*), about 6 ft. wide and between 33 and 52 ft. long, which connects the dressing room with the stage proper and is used for entrances and exits by the principal characters. Lesser characters and musicians use a low door in the upstage corner of the stage. The chorus occupies an area to the left of the actors; the instrumentalists sit at the rear of the stage. Both playing areas are roofed, as they were in the earliest outdoor theatres, although most nō stages are now constructed within a building. The out-of-doors is also recalled in the stylized pine tree painted on the rear wall of the stage, the painted bamboo design on the narrow wall to the side of it, the strip of white pebbles between the playing areas and the auditorium and the three small pine trees in front of the bridge. The pillars supporting the roof have conventional spatial values and determine the pattern of the actor's movement. Scenic objects, rarely used, do not often resemble literal objects, but merely suggest them. Many properties are similarly sketchlike; the most frequently used is the folding fan, which—closed, partially closed or open—conveys any meaning suggested by its form or manipulation.

See also KABUKI THEATRE; MASK; and references under "Nō Drama" in the Index.

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NOEL-BAKER, PHILIP JOHN (1889–), British statesman and internationalist who advocated international disarmament in the cause of world peace and who was awarded the Nobel peace prize in 1959. Born in London, Nov. 1, 1889, of a Quaker family, he was educated at Bootham school, York; Haver-

ford college, Pennsylvania, and at King's college, Cambridge. President of the Cambridge Union society in 1912, he also captained the 1924 British Olympic Games team. During World War I he served with the Friends' and other ambulance units in France, Belgium and Italy, being decorated for distinguished conduct. After working at the peace conference in 1919 as a member of the British delegation, he joined the secretariat of the League of Nations. He assisted Fridtjof Nansen in his work for refugees, Lord Robert Cecil at sessions of the assembly and Arthur Henderson, the president, at the world disarmament conference at Geneva, 1932–33.

In the house of commons Noel-Baker represented Coventry (1929–31), Derby (1936–50) and South Derby after Feb. 1950, as a Labour member. Between 1945 and 1951 he was successively minister of state, secretary of state for air, secretary of state for Commonwealth relations and minister of fuel and power. Aided by a fluent command of seven languages, he campaigned for 40 years for peace through international disarmament. *The Arms Race: a Programme for World Disarmament* (1958) was acclaimed as a monumental survey of the whole disarmament problem. (L. R. A.)

NOETHER, (AMALIE) EMMY (1882–1935), German mathematician who specialized in higher algebra, was born at Erlangen on March 23, 1882. Her father Max Noether (1844–1921) was a distinguished mathematician; a younger brother, Fritz Noether, became professor of applied mathematics. She studied in Erlangen, later in Göttingen, where she passed her habilitation examination in 1919, after earlier objections from some members of the faculty opposed to woman lecturers.

In 1922 she became extraordinary professor in Göttingen, a position she held until 1933, when she left Germany to accept a professorship at Bryn Mawr college, Pennsylvania. She died on April 14, 1935.

Emmy Noether's studies on abstract rings and ideal theory have been of importance for the development of modern algebra; she also exerted great scientific influence through her many able pupils. (O. OE.)

NOGALES, a desert town in the Mexican state of Sonora, contiguous with and across the border from Nogales, Ariz., U.S., and port of entry into Mexico. Pop. (1960) 37,657. The Pacific highway leading to Mexico City (1,500 mi.) via Hermosillo, Guaymas, Mazatlán and Guadalajara begins at this point. A rail line follows the same route. Nogales is noted for its cavern restaurant, a cafe in a cave which was once used as a jail under Chureas hill. Nogales is a U.S.-Mexican trading centre in cattle and minerals. Irrigation of large areas of the state brought increased wealth to Nogales, but the main farm areas are to the south. (J. A. Cw.)

NOGARET, GUILLAUME DE (d. 1313), French magistrate, one of the most vigorous of the *légistes* or expositors of the royal power, especially in ecclesiastical affairs, was born between 1260 and 1270 at St. Félix-de-Caraman, the son of a bourgeois of Toulouse; his family, which was later accused by his enemies of having adhered to the heresy of the Cathari, held a small property at Nogaret nearby. He began his career as a teacher of jurisprudence at Montpellier in 1291, entered the royal service as *juge-mage* at Nîmes about 1294 and seems to have been with King Philip IV (*q.v.*) in Normandy in 1295. A member of the king's council, he was entrusted in 1296 with missions to Bigorre and to Champagne for the enforcement of the king's rights there. In 1299 he began to style himself *miles*, or knight.

Nogaret is chiefly remembered for his role in Philip IV's conflict with Pope Boniface VIII (*q.v.*). Little is known of his mission to Rome in 1300. On March 7, 1303, however, Philip authorized him to go to Italy to take measures against the pope; and five days later, on March 12, at a meeting in Paris, it was Nogaret who, after denouncing the pope (1) as irregularly installed, (2) as a heretic, (3) as a simonist and (4) as a notorious sinner, demanded the summoning of a general council of the church to try him. Proceeding to Italy, he established himself at Staggia in Tuscany, whence he made contact with the pope's enemies, including some cardinals. The pope, meanwhile, was spending the summer at Anagni, southeast of Rome; and there was a quarrel between Anagni and the neighbouring town of Ferentino. At dawn on Sept. 7, 1303, Nogaret and Rinaldo di Supino, captain of Ferentino, entered Anagni with a small force to arrest the pope (who was intending next day to issue his bull *Super Petri solio*, excommunicating Philip); but Sciarra Colonna, whose family was pursuing its own vendetta against Boniface, entered Anagni with his men at the same time, and the pope fell into their hands. Nogaret saved the pope's life, but the violence of the Colonna faction not only frustrated his carefully prepared show of legality but provoked the people of Anagni, who had at first connived at the coup, to rise on Sept. 9 in defense of the pope. Forced to abandon his enterprise and to flee to Ferentino, Nogaret returned to France early in 1304.

Nogaret had acted as a sincere Christian desirous of freeing the church from a pope whom he thought unworthy; but Boniface's successor Benedict XI, though he exculpated Philip, issued the bull *Flagitiosum scelus* (June 7, 1304), excommunicating Nogaret and 15 other participants in the outrage. Philip, however, raised Nogaret's pension from 300 to 800 livres and, on Sept. 22, 1307, appointed him keeper of the great seal.

Nogaret was from 1307 much occupied with the conduct of Philip's proceedings against the Templars (*q.v.*). After long appealing against his excommunication, he obtained absolution from Pope Clement V on April 27, 1311, with the proviso that he should go as a pilgrim to the Holy Land at the first opportunity and stay there until the pope should recall him. He died, however, before executing this proviso, in April 1313. His influence has been exaggerated, and it is a mistake to see his hand in all the state trials of Philip IV's reign.

See R. Holtzmann, *Wilhelm von Nogaret* (1898); R. Fawtier, "L'Attentat d'Anagni," *Mélanges d'archéologie et d'histoire*, lx (1948). (F. CT.; X.)

NOGINSK, a town of Moscow *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., stands on the Klyazma river, 54 km. (34 mi.) E. of Moscow city. Pop. (1959) 92,760. It developed in the 15th–16th centuries as Yamskaya settlement, and was known later as Rogozhi and, from 1781 (when it became a town) to 1930, as Bogorodsk. In the 19th century the textile industry developed there and it is now one of the most important textile centres of the U.S.S.R. Cottons form over three-quarters of its production, but wool and silk goods are also made. Other products include parts for tractor engines, needles and reinforced concrete. A branch railway joins Noginsk to the Moscow-Gorki line. (R. A. F.)

NOGUCHI, HIDEYO (1876–1928), Japanese bacteriologist, was born in Inawashiro, Fukushima, Japan, Nov. 24, 1876. He graduated from Tokyo Medical college in 1897 and two years later emigrated to Philadelphia. At the University of Pennsylvania he assisted Weir Mitchell in his studies on snake venoms. In 1904 Noguchi went to the Rockefeller Institute for Medical Research in New York city, where he worked the rest of his life. He was the first to demonstrate spirochetes of syphilis in the central nervous system of patients dying of paresis and tabes dorsalis, thereby proving the syphilitic origin of those diseases. He improved the technique and theory of the Wassermann reaction.

Adapting a method first employed by Theobald Smith, Noguchi devised ingenious means of cultivating microorganisms that had never before been grown in the test tube. He discovered a number of new microorganisms which he erroneously described as causes of infectious diseases now known to be caused by viruses; *e.g.*, poliomyelitis, trachoma and yellow fever. He succeeded in growing spirochetes which he believed to be those that cause syphilis.

During his lifetime, Noguchi was regarded as one of the world's greatest bacteriologists, but of his later "discoveries" only a few —*e.g.*, the cultivation of the parasite of Oroya fever (Carrión's disease) and verruga peruana, which he showed to be different manifestations of the same infection—have stood the test of time. He was a dedicated and indefatigable scientist, and no one who knew him could doubt the sincerity of his own belief in the validity of his claims. When he learned that other bacteriologists had

announced that yellow fever was caused by a virus, Noguchi went to British West Africa to join them, in order to resume his study of that disease. While doing so, he contracted yellow fever and died in Accra on May 21, 1928. (C. P. M.)

NOGUCHI, ISAMU (1904–), U.S. sculptor of Japanese descent, one of the strongest advocates of the expressive power of abstract shapes, was born at Los Angeles, Calif., on Nov. 7, 1904. To his terra-cotta and stone sculptures Noguchi brought some of the spirit and mystery of early art, principally Japanese earthenware, studied during residences in Japan. Trained as a premedical student at Columbia university, Noguchi sensed the interrelatedness of bone and rock forms, the comparative anatomy of existence, as seen in his "Kuros" (1945). Recognizing the appropriateness of sculptural shapes for architecture, he made many important contributions toward the aesthetic reshaping of physical environment. His garden for UNESCO in Paris (1958), his playground, lamp, chair and table designs have won international praise. He also designed a monument to the dead and a bridge for Hiroshima, but only the latter was actually built.

See C. Giedion-Welcker, ***Contemporary Sculpture*** (1955).
(A. E. EL.)

NOIR, VICTOR (properly YVAN SALMON) (1848–1870), French journalist whose death brought sensational discredit on the reigning dynasty in the last year of the second empire, was born at Attigny (Vosges) on July 27, 1848. With only a rudimentary education, he worked first as a watch repairer in his father's shop and later as a florist before joining *L'Époque*, a Paris newspaper, as a gossip writer. He subsequently wrote for many other journals, the last being the republican *Marseillaise*. On Jan. 10, 1870, he presented himself with a colleague, Ulric de Fonvieille, at the house of Prince Pierre Napoléon Bonaparte, a first cousin of the emperor Napoleon III, to deliver a challenge to a duel from another journalist, Paschal Grousset. An altercation ensued, during which the prince drew his revolver and killed Noir. Noir's funeral, on Jan. 12, became a riotous republican manifestation. The emperor ordered an inquiry. Tried by a special high court of justice at Tours, the prince was acquitted on March 25 on his statement that Noir had provoked him by slapping his face—an allegation which had been denied by Fonvieille.

NOISE AND ITS CONTROL. In acoustics noise is defined as any undesired sound. According to this definition, the sound of church bells may be music to some and noise to others. Usually, noise is a mixture of many tones combined in a nonmusical manner.

Measurement and Specification.—The measurement of any sound stimulus is commonly made with a sound-level meter and a frequency analyzer (*see* SOUND). The sound-level meter comprises a microphone and associated electronic equipment. The analyzer is an electronic device for separating the noise into its tonal components, or into groups of tonal components. The results of a measurement are given in decibels (db), which is called the sound-pressure level and is equal to 20 times the logarithm of the ratio of the sound pressure in the air to a reference sound pressure (usually 0.0002 dyne per square centimetre). For example, a sound pressure of one dyne per square centimetre has a sound-pressure level of 74 db. The decibel is to sound what the degree is to temperature. It indicates the magnitude of the sound, but not the reaction of human beings to it. Typical sound levels in decibels, considering all audible tonal components contained in the sound are shown in Table I. Outdoors, the sound levels decrease six decibels each time the distance between the source and the microphone is doubled. Conversely, the sound increases six decibels each time the distance is halved. Indoors, the acoustics of the room greatly modify this rule.

The intensity of a sound source may be indicated by the total power in watts that it produces in the air around it. Acoustic powers of common sound sources are shown in Table II. The total range is nearly 100,000,000,000,000 times the Table minimum.

Sounds may be divided into three classes: (1) those that are composed of one or more pure tones, such as a note from the piccolo: (2) those that contain a great many very closely spaced tones,

TABLE I.—*Typical Overall Sound Levels*
(As measured on an American standard sound-level meter)

At a given distance from noise source	Decibels* re 0.0002 microbar	Environmental
50-h.p. Victory siren (100 ft.)	-140 dbc-	
F-84 at takeoff (80 ft. from tail)		
Hydraulic press (3 ft.)	-130 dbc-	
Large pneumatic riveter (4 ft.)		Boiler shop (maximum level)
Pneumatic chipper (5 ft.)	-120 dbc-	
Multiple sand blast unit (4 ft.)		Engine room of submarine (full speed)
Trumpet auto horn (3 ft.)		
Automatic punch press (3 ft.)		Jet engine test room
	-110 dbc-	
Chipping hammer (3 ft.)		Woodworking shop
Cut-off saw (2 ft.)		Inside four-engine piston airliner
Annealing furnace (4 ft.)		Weaving room
	-100 dbc-	
Automatic lathe (3 ft.)		Can manufacturing plant
Subway train (20 ft.)		Inside Chicago subway car
Heavy truck (20 ft.)		
Train whistle (500 ft.)		Inside motorbus
	- 90 dbc-	
Small truck accelerating (30 ft.)		Inside sedan in city traffic
	- 80 dbb-	
Light truck in city (20 ft.)		Office with tabulating machines
Auto (20 ft.)		Heavy traffic (25 to 50 ft.)
	- 70 dbb-	
		Average traffic (100 ft.)
		Accounting office
Conversational speech (3 ft.)		Chicago industrial areas
	- 60 dbb-	
Transformer (200 ft.) (15,000 kva., 115 kv.)		
	- 50 dba-	Private business office (noisy)
		Light traffic (100 ft.)
		Average residence
	- 40 dba-	
		Private business office (quiet)
		Minimum levels for residential areas in Chicago at night
	- 30 dba-	Broadcasting studio (speech)
		Broadcasting studio (music)
	- 20 dba-	Studio for sound pictures
	- 10 dba-	
Threshold of hearing—young men	- 0 dba-	

*The suffixes attached to db, (dba, dbb and dbc) indicate the manner in which the sound-level meter was operated; *e.g.*, when the scale of the meter is set to "c," the meter ... the sound-pressure level as defined in the text. When set to "a" or "b" the meter ... into account, partially, the manner in which a human listener judges the loudness ... weaker sounds.
Source: *Handbook of Noise Measurement*, General Radio Co., Cambridge, Mass.

such as the noise of a waterfall or of a jet aircraft engine; (3) combinations of the first two, such as a whistle in a busy factory.

Effects on Man.—Noise may have a number of effects on man: it may annoy him or it can disturb his sleep; it can interfere with his ability to converse with someone else; it can damage his hearing. The operators of airports near large cities have learned that complaints about noise are related to the power and type of aircraft, the distance from the airport to the residents and the frequency of passage of the aircraft. Similar experiences for other types of noise are becoming available from factory owners and city p...

ners. Those tonal components of a noise that lie between 300 and 5,000 cycles per second interfere most with conversation (*see* HEARING).

Sudden damage to hearing may result from the noise of a blast or an explosion. Gradual damage may result from continued exposure to noise over a period of years. Other factors being equal, a steady sound (such as that of a textile mill) will be less likely to damage hearing than one that is impulsive (as that of a pneumatic hammer or a drop forge). People vary considerably in their susceptibility to such damage. Many companies periodically test the hearing of workers in noisy areas and transfer those who show signs of deafness. Those who work around jet aircraft, in boiler shops, in drop-forge shops or those who use metal-cutting, chipping and shaping tools are most likely to suffer gradual loss of hearing (*see* DEAFNESS AND IMPAIRED HEARING).

Solution of the Noise Problem.—In approaching a noise problem first consider the source. Can a quieter machine or operation be substituted? Can the noise intensity be reduced? Can a useful change be made in how the noise is directed? Are resilient pads beneath the noisy device of any use? Can a muffler be used? Second, consider the path from the source to the listener. Can the source or the listener readily be moved, so that the two are farther apart, to reduce the sound level? Should a barrier be erected between the source and the listener? Is a total enclosure for the source required? Will the addition of an absorbing acoustical material result in significant noise reduction? Third, consider the listener. Can he be induced to wear ear plugs or noise-reducing cushions or helmets? Can he be enclosed in a booth or other quiet space?

TABLE II.—*Acoustic Power for Various Acoustic Sources*

Power (watts)	Source
100,000	
	Ramjet Turbojet engine with afterburner
10,000	Turbojet engine, 7,000-lb. thrust
1,000	
	4-propeller airliner
100	
10	75-piece orchestra } peak r.m.s. levels in Pipe organ } 1/8-sec. intervals
	Small aircraft engine
1	
	Large chipping hammer Piano } peak r.m.s. levels in BB♭ tuba } 1/8-sec. intervals
0.1	Blaring radio
	Centrifugal ventilating fan (13,000 c.f.m.)
0.01	4-ft. loom Auto on highway
0.001	Vaneaxial ventilating fan (1,500 c.f.m.) Voice—shouting (average long-time r.m.s.)
0.0001	
0.00001	Voice—conversational level (average long-time r.m.s.)
0.000001	
0.0000001	
0.000,000,01	
0.000,000,001	Voice—very soft whisper

Source: *Handbook of Noise Measurement*, General Radio Co., Cambridge, Mass.

Ready-built mufflers are available for engines and air ventilating systems. Many types of sound-absorbing materials are available. Walls between rooms should be as heavy as possible and should be made of two isolated leaves with an intervening air space for maximum sound reduction between rooms. Sound-absorbing materials should be used on the ceiling or walls of a room to prevent the reinforcement of the noise due to room resonances. Rubber, cork or felt pads may be used under machines to reduce vibrations.

Barriers such as walls or pens between a sound source and a listener are effective only if they are high enough and if they are either very near to the source or very near to the listener. When a source or a listener is fully enclosed, careful attention must be taken to gasket all cracks around doors and to seal all joints.

See also ACOUSTICS OF BUILDINGS; VIBRATION CONTROL.

(L. L. B.)

AIRCRAFT NOISE CONTROL

Noise Aboard Aircraft.—In modern transport aircraft, with the cockpit located well forward of the engines, designers need be primarily concerned with only two sources of annoying cockpit noise: aerodynamic noises arising in the turbulent boundary air along the outside surface of the fuselage and in ventilating ducts and outlets, and noises associated with the operation of auxiliary mechanical and electrical equipment.

The passenger compartment also is exposed to noise from these sources and, frequently, to undue amounts of engine or propeller noise. Jet engine noise often is most noticeable in rear portions of the cabin. In both the cockpit and passenger compartment, properly designed and acoustically insulated ventilating ducts and outlets, and suitable treatment of walls, ceilings and floors with sound-absorbing or insulating materials, help greatly in reducing noise and vibration. In addition, the customary window design (small, rigid, double panes installed primarily for protection against decompression failures) helps reduce noise transmission from outside the aircraft.

External Aircraft Noise.—More difficult problems of noise control arise in connection with persons on the ground in the immediate vicinity of terminal buildings and maintenance facilities and in communities over which aircraft must pass at low altitudes when landing or taking off.

One serious annoyance is the engine intake noise produced by the sirenlike action of jet compressor blades, even at reduced rotor speeds. Furthermore, as an aircraft maneuvers to and from its ramp position, its jet blast may sweep the ramp adding dust, dirt and fumes to the irritating noise. Ground personnel therefore should be provided with adequate eye and ear protection, and passengers entering or leaving aircraft must be protected by air- or noise-deflecting barriers. Some terminals allow passengers to remain entirely indoors by providing movable, covered ramps, connecting the aircraft and terminal building, or mobile lounges traveling between aircraft and the terminal.

To complaints of disturbing noise lodged by residents of communities near airports, no fully satisfactory answers had been found in the 1960s. The noise produced by a propeller-driven airplane reaches a peak level in the low-frequency portion of the sound spectrum, whereas unsuppressed jet exhaust normally peaks at a higher frequency. However, the addition of noise suppressors may tend to shift the jet exhaust sounds still farther toward the higher frequencies, bringing them well within the speech-interference range. The result is that the suppressed-jet exhaust sound may be substantially more annoying to persons on the ground than is noise of equal intensity from a propeller-driven aircraft (*see* AIRCRAFT PROPULSION).

It was found that aircraft speed is a relatively unimportant factor except as it affects the time of exposure of a ground observer. Altitude is of prime significance, however, because the intensity

of transmitted noise varies inversely as the square of the distance between source and receiver. Power or thrust levels, of course, are also of great importance.

A partial solution to the problem is found in altering airport flight patterns and aircraft takeoff procedures. Complaints often are reduced when pilots are instructed to make an initially rapid climb at full thrust to some minimum altitude, such as 1,200 ft. (thus rapidly increasing the distance between the aircraft and persons on the ground), followed by a reduced rate of climb at reduced power or thrust to cruising altitude. Such a procedure, however, represents a compromise between the safest and most efficient combinations of engine power and aircraft speed and those combinations that result in the least annoying noise levels.

It is also possible to reduce complaints by directing low-flying aircraft over less densely inhabited areas, although at many airports such changes in flight patterns may not be effected without undesirable sacrifices in safety, especially as regards prevailing wind directions. A more satisfactory solution to the problem involves the development of devices to suppress jet engine sound at the source without too seriously affecting weight, drag or power output.

Another serious noise problem is the so-called sonic boom produced by airplanes traveling at speeds greater than Mach 1, the speed of sound. The phenomenon is the shock wave generated by the aircraft; traveling at the same speed as the aircraft, it produces at the ground a sudden pressure change audible as a sound like a thunderclap or an explosion. A sufficiently intense shock wave can impair hearing or damage buildings. (*See* also AERODYNAMICS: *Supersonic Aerodynamics*.) (W. Li.)

Law.—In law, noise may be defined as an excessive, offensive, persistent or startling sound. By the common law of England freedom from noise is essential to the full enjoyment of a dwelling house and noises that affect that enjoyment may be actionable as nuisances. But it has been laid down that a nuisance by noise, supposing malice to be out of the question, is emphatically a question of degree. The noise must be exceptional and unreasonable. Ringing of bells, building operations, vibration of machinery, fireworks, bands, a circus, merry-go-rounds, disorderly crowds, dancing, singing, etc., have been held under certain circumstances to constitute nuisances so as to interfere with quiet and comfort and have been restrained by injunction. The concept of legalized nuisance, such as the nuisance arising from noise produced by public transportation, has found some favour in U.S. courts.

In the United States, many cities have passed ordinances containing noise abatement provisions, conformity with which can be determined by readings from a sound-level meter and a frequency analyzer with frequency bands approximately one octave in width (the eight frequency bands commonly used are 20–75, 75–150, 150–300, 300–600, 600–1,200, 1,200–2,400, 2,400–4,800 and 4,800–10,000 cycles per second). Individual states have passed laws establishing means for measuring damage to hearing and schedules of compensation that are related to the percentage of hearing damage.

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NOLA, a town in Napoli province, Campania region, Italy, lies 23 km. (14 mi.) E.N.E. of Naples in the fertile and highly cultivated Campania plain. Pop. (1961) 24,523 (commune). There are traces of an amphitheatre, and a necropolis with frescoed tombs. Nearby is Cimitile where the bodies of Christian martyrs were buried, among them St. Felix. There are still traces of basilicas and constructions of the 4th and 5th centuries, to which the Cenobites withdrew. In the Seminary at Nola the Cippus Abellanus was discovered (1750), on which is engraved in Oscan the treatise governing the administration and laws of the area of Hercules' sanctuary, which lay between Abella (Avella) and Nola (2nd century B.C.). The Gothic cathedral (13th century) is dedicated to the town's patron St. Paulinus, patrician of Bordeaux, elected bishop in 410, in whose honour the Festa dei Gigli (festival of the lilies) is celebrated in June. The Orsini palace (1460) has Catalan doors and windows. The philosopher Giordano Bruno (1548–1600) was born at Nola. The town is on the Naples-Foggia-Avellino railway. The district produces vegetables, fruit, maize (corn) and hemp.

A city of the Aurunci, it had the Oscan name of Novla (new town) late in the 5th century B.C. In A.D. 14 Augustus died there. It was an episcopal see from the 3rd century and the birthplace of St. Felix. A fief of Guy de Montfort in 1269, it passed to the Orsini; from 1528 it followed the fortunes of Naples.

(M. T. A. N.)

NÖLDEKE, THEODOR (1836–1930), German philologist, whose work dealt with Semitic languages and the history of Islam, was born at Harburg, March 2, 1836, and studied at Göttingen, Vienna, Leiden and Berlin. In 1859 his history of the Koran won the prize of the French Académie des inscriptions; he rewrote it in German with additions (*Geschichte des Korans*, 1860). He taught at Göttingen (1861), Kiel (1868) and Strasbourg (1872). Nöldeke died Dec. 25, 1930, at Karlsruhe.

NOLLEKENS, JOSEPH (1737–1823), British sculptor, was born on Aug. 11, 1737, in Soho, London, where his father, a native of Antwerp (the "Old Nollekens" of Horace Walpole), was a painter of some repute. At the age of 13 Joseph entered the studio of the sculptor, Peter Scheemakers. In 1760 he went to Rome and his marble bas-relief, "Timoclea before Alexander," brought him a prize of 50 guineas from the Society of Arts in 1762. David Garrick and Laurence Sterne were among the first English visitors who sat for busts. On his return to England he became an associate of the Royal Academy (1771) and in 1772 a full member. By that time he had become known to George III, whose bust he executed and, until about 1816, he was the most fashionable portrait sculptor of his day. Other portraits were those of William Pitt, Charles Fox, the prince of Wales (afterward George IV), George Canning, Spencer Perceval, Benjamin West and Lords Castlereagh, Aberdeen, Erskine, Egremont and Liverpool. He himself preferred his imitations of the work of the ancients, such as the "Venus Anointing Herself." His work is remarkable for delicacy, but deficient in vigour and originality. Nollekens died in London on April 23, 1823.

See J. T. Smith, *Nollekens and His Times* (1949). (A. K. McC.)

NOLLE PROSEQUI, in Anglo-American law, the termination, at the prosecutor's instance, of proceedings against a person accused of crime by indictment or information where it appears that the interests of justice do not require him to be brought to trial. In English law, the power to enter a *nolle prosequi* is vested in the attorney general and is rarely used. In the United States the power is generally exercised by the prosecuting officer, typically the district attorney, and is an important adjunct to the administration of criminal justice. Particularly in large cities, many more criminal prosecutions are initiated than it is feasible to try. The *nolle prosequi* serves as a screening device by which the district attorney is enabled to exercise a measure of control over the criminal docket. It is also used to effect an informal settlement, as where a thief agrees to make restitution to his victim. In some states, the common-law rule that the entry of a *nolle prosequi* is within the sole discretion of the district attorney still obtains; in others, his discretion is subject to leave of court. When entered before trial, the *nolle prosequi* does not bar a subsequent prosecution on the basis of a new indictment or information. (H. L. P[illegible]

NOMADS (Gr. *nomas*, *-ados*, "roaming about for pasture"), peoples who lead a migratory life, having no fixed abode. Although the Greek *nomas* referred to pastoral nomads, the modern term nomad is applied to all wandering peoples, of which there are three main types: primitive nomads, pastoral nomads and tinker or trader nomads.

Primitive Nomads.—The most primitive peoples known today are nomadic, as were Stone Age people all over the world. A people which does not produce food, but only collects that which nature provides, cannot usually stay in one place for very long. After a day or two or a few weeks, depending on the natural resources, the game within walking distance of a camp is killed or frightened away, and the tubers, seeds, fruits and other vegetable food within the same radius will also be exhausted. When food becomes scarce, the primitive band must move to another [illegible]

ste. It is often assumed that nomads wander aimlessly, without a fixed territory. Actually the primitive nomad who depends for survival on what he can find to eat must know the territory in which he roams—location of waterholes, where certain plants grow and the habits of the game. Thus each nomadic band, of perhaps from 20 to 50 persons, establishes rights over the territory within which it migrates, although its members may visit bands in other territories. (*See* BUSHMAN.)

Pastoral Nomads.—Pastoralists in central Asia and the middle east who depend on domesticated livestock for a livelihood also migrate in order to find pasturage for their animals, and like primitive nomads they have an established territory. Pastoral nomads may be classified according to their economy and by their pattern of migration.

Economy.—The reindeer breeders of Siberia, such as the Urianghai of the Altai mountains, depended on hunting as well as reindeer breeding for subsistence, and the 12th-century Mongols also obtained their meat by hunting. In central Asia generally pastoralists could, and often did, subsist entirely on animal products, although they welcomed trade goods when these were available. On the fringes of the grasslands families which had lost their animals engaged in agriculture, but only grudgingly. Stockbreeding was the basis of the pastoral economy and nomadism the preferred way of life. In southwest Asia and north and east Africa (also in Tibet which, although geographically a part of central Asia has a nomadic pattern more like that of southwest Asia), pastoral nomadism and settled agriculture have always been interdependent. The camel-breeding Rwala Bedouin of Arabia practiced no agriculture, but they were dependent on grain and other products obtained from their settled neighbours in exchange for camels. The proud Masai of east Africa, who would not condescend to till the soil, obtain grain and other goods from subordinate tribes. A majority of the nomadic tribes in southwest Asia and north Africa practice some cultivation, planting crops and harvesting them between seasonal migrations. These peoples may be described as seminomadic or even semisedentary, for many have fixed abodes where they dwell for a part of each year.

Patterns of Migration.—The migration pattern of pastoral nomads depends to a considerable extent on topography and climate. Some Kazakh groups, for example, made migrations of many hundreds of miles between winter quarters in the south and summer pasturage in the north. Other Kazakh groups moved only a few miles between winter quarters at the foot of the mountains and high summer pastures. In the Altai region, where the pastures were rich, units followed the same route year after year. In the southern Urals, where pastures were more uncertain, a scout was sent ahead and the first to arrive at a suitable site established rights on the campsite for his group.

In Arabia the Bedouins camped during the hot summer months near a town or oasis, then moved out onto the desert after the rains. In arid Arabia there could be no fixed itinerary such as that of the Altaian Kazakhs, but each group had its established territory, and beyond that smaller groups owned certain wells. Seminomads have permanent dwellings where they plant crops before moving out with their livestock in search of grazing. In western Syria and parts of north Africa winter villages are at the foot of the mountains and the animals are taken into the uplands during the summer. In southern Somaliland the people dwell in fixed villages, but send their animals out with the men twice a year—to plateau grasslands in the rainy season and to the river banks at the height of the dry season.

Tinker and Trader Nomads.—In parts of Asia primitive nomads were caught up into a larger society in such a way that they remained nomadic but became dependent on other groups. In Arabia the Sulubba or Slebs are such a people. In addition to hunting, the Slebs breed white asses; the women are prostitutes, while the men do tinkering for the Bedouins and guide them into desert recesses unfamiliar to the camel breeders. In India and West Pakistan there are nomadic peoples who make and sell baskets and other simple products or hire out as labourers on construction jobs. The best-known tinker and trader nomads are the gypsies. Believed to have originated in India, gypsy bands migrated in various parts of Europe and the United States, tinkering, horse trading and telling fortunes.

Nomadism in the 20th Century.—Nomadism has been a way of life for many people, but it is on the wane. Few primitive nomads survived in mid-20th century, although a number were described during the preceding century. Pastoral nomads have been settling down through the centuries. Many groups have made a gradual transition from full nomadism to seminomadism to sedentary life, and whole peoples, under economic or political pressure, have taken up agriculture or, as in the Soviet Union, have become settled stockbreeders. By the 1960s most of the pastoral nomads in the Soviet Union had been settled, and in Iran the nomadic population had dropped from one-third to one-fifth in the first half of the 20th century.

The nomadic way of life dies slowly, however. In the 1960s pastoral nomads were numerous enough in Chinese central Asia (Sinkiang) to be a political force. Gypsies still migrated in the United States, although traveling in Cadillacs instead of carts. A few primitive Bushmen roamed the Kalahari desert of South Africa in search of game and plant food, and Australian aborigines went "walkabout" when they felt the strictures of sedentary life unendurable.

See also MIGRATION.

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NOME, a town of Alaska, U.S., on the south Seward peninsula shore of the Bering sea, 525 mi. W. of Fairbanks; at one time (1900) the largest settlement in the territory. Gulch gold was found near the site of Nome on Anvil creek in Sept. 1898; the town was established the following year and diggings on the ocean beach were first worked in July 1899. The rush to Nome in 1900 was one of the most remarkable stampedes in U.S. mining history; the town soon had hotels, banks, stores, several newspapers and weekly mails from the United States; for part of the year there were, it was estimated, 20,000 inhabitants. By 1903 the population had greatly decreased; in 1920 it was 852 by the federal census, growing to 2,316 residents in 1960 (principally Eskimos). In 1905 the gold output of the Nome region amounted to about $2,500,000, nearly all from placers. Gold remained the principal industry, although with reduced production, until the dredge fields were closed in 1962. Transportation, tourism, government construction and Eskimo fur and ivory production accounted for most of the town's employment. The town is served by several airlines and roads radiate into the tundra. A few miles of narrow-gauge railway are preserved as a tourist attraction. Nome adopted council-manager government in 1964.

Nome was first called Anvil City; the name Nome is derived from Cape Nome, first so called on a chart dated 1849, and said to have been a draftsman's mistake for the query "?Name" on the original chart. (J. E. CL.)

NOMENOË (d. A.D. 851), duke of the Bretons who fought successfully against the Frankish king Charles II the Bald. The Carolingian emperor Louis I the Pious, whose predecessors had never gained effective control of Brittany, appointed Nomenoë as duke or permanent *missus* (*see* MISSI DOMINICI) to keep order in Armorica; *i.e.*, the specifically Breton country west of Nantes and Rennes. Nomenoë quelled a serious revolt in 837, but refused to admit Frankish troops to his duchy. When Louis died and war broke out between his sons (840), Nomenoë at first promised loyalty to the youngest of them, Charles the Bald, and even, in 842, supplied him with troops. Soon, however, Nomenoë turned against Charles and occupied Rennes, which Charles had to besiege in Nov. 843.

During the next three years Nomenoë's raids into Maine and Anjou provoked vain counterattacks by Charles, who came to terms in 846. Nomenoë obtained a *de facto* independence which

enabled him to strengthen his authority in Brittany. Nevertheless he launched an offensive toward the Bessin country (around Bayeux) in 847. In 849 he substituted his own nominees for the pro-Frankish bishops in Brittany and severed the connection of their sees with the bishopric of Tours. In 849 also he ravaged Anjou; and in 850 he took Nantes. He died near Vendôme on March 7, 851.

See E. Durtelle de Saint-Sauveur, *Historie de Bretagne* (1935); F. Lot and L. Halphen, *Le Règne de Charles le Chauve (840–877)*, vol. i (1909). (J. De.)

NOMINALISM. Nominalists deny that universals (*q.v.*) exist, arguing that the existence of a general word does not imply the existence of a general thing named by it, though indeed there must be some similarity between the particular things to which the general word is applied. Extreme nominalists would withhold this concession (*e.g.*, perhaps Roscelin withheld it, but we have only his adversaries' word for this). But, unless it is granted, the application of general words to particulars is made to appear entirely arbitrary, which is absurd. Perhaps extreme nominalism, if anyone ever held it, might be explained as an excessive reaction against exaggerated forms of Platonic realism. Such a reaction was natural in the middle ages when enthusiastic Platonists verbally denied the reality of material objects. Whenever realists go too far in their depreciation of material objects an alliance between empiricism and nominalism is to be expected: the most notable medieval example of a synthesis of this kind was the work of William Ockham (but he can also be regarded as a conceptualist; *see* below).

In the middle ages, when Platonic and Aristotelian realist doctrines were associated with orthodox religious belief, nominalism could be made to seem heretical. But if nominalism is considered simply as a logical doctrine, stripped of these associations, it is more interesting for what it asserts than for what it denies. It denies that Platonic realism is needed in order to explain our ability to think and speak in general terms. It also seems to deny that Aristotelian realism is needed for this purpose; but this denial is not so unequivocal, since a moderate nominalist (*e.g.*, Hobbes, even though some of his dicta suggest extreme nominalism) would say that there must be some similarity between the particulars to which a given general word is applied, and this is very like saying that a universal must be present in them. What it asserts is, in Hobbes's words, that *ratio est oratio*, that thought is essentially the same kind of thing as speech. Now thought and speech would be impossible if the world did not contain series of similar things. But, given this condition, it is a further question how exactly thought and speech operate; and the nominalist's answer to this is that they both operate by using symbols, either linguistic symbols, or nonlinguistic symbols like mental images. This immediately brings him into conflict with some forms of conceptualism (*q.v.*), in which it is maintained that the ability to think correctly involves something more than the ability to use sets of symbols correctly; *i.e.*, that it involves the possession of concepts. Also, it is not clear in exactly what sense all thinking can be said to be the using of symbols. On the other hand, it is hard to see what the conceptualist adds to the nominalist's theory when he says that thinking depends on the possession of concepts. Perhaps he is drawing attention to such things as flashes of understanding. It might be possible to reconcile nominalism and conceptualism if the nominalist's analogy between thinking and using something were not pushed too far.

See also references under "Nominalism" in the Index.

(D. F. P.)

NOMOGRAPHY, the science of calculating charts. Its object is the general study of the representation, by means of diagrams called nomograms, of mathematical laws (Gr. *nomos*, "a law") which are expressed analytically by means of equations. Such graphical devices, once carefully drawn, yield the solutions of complicated problems with speed and with slight labour. They are especially helpful when many numerical problems of a similar sort are to be solved and when high accuracy is not required. They can be used by a person without special knowledge or experience and without the mastery of a difficult technique. Nomograms have been widely used in engineering, in industry and in the physical and natural sciences. Equations in many variables are handled by using a sequence of scale alignments or by employing networks of scales, and a great diversity of problems can be solved.

The use of graphic schemes for computation goes back to antiquity. The graphic solution of spherical triangles was in vogue in the time of Hipparchus, 150 B.C., and simple charts were designed by the mathematicians of the middle ages. The publication of René Descartes's *Discours de la méthode* (1637), which introduced analytic geometry to the world, gave a powerful impetus to graphical methods and provided their analytical background. The theory of nomograms rests largely on analytic geometry.

Co-ordinate Papers.—The use of squared paper for the representation of relations between two quantities is familiar in many fields. A point on the paper is located by giving its distance X to the right of a vertical axis and its distance Y above a horizontal axis (distances to the left and downward being reckoned negative). X and Y are called co-ordinates. An equation $f(X, Y) = 0$ is pictured by plotting the points whose co-ordinates satisfy the equation. The resulting graph is a line or curve from which corresponding values of X and Y may be determined visually. The eye is guided by the vertical rulings along which X is constant and the horizontal rulings along which Y is constant. The values of X and Y are commonly written along the axes.

It is clear that nothing is essentially changed if the values which are marked on the axes are not proportional to the distances from the origin but more or less arbitrary scales are used. Points whose co-ordinates satisfy a given equation can be plotted as before and a curve be drawn from which corresponding values can be read. The form of the curve can be altered and in some cases simplified. These notions were developed by Léon Lalanne in his *Anamorphose logarithmique* in 1842 and further advances were made by J. Massau and Charles Lallemand in the 1880s. A basic idea is to use such scales that the graphs of the equations under consideration become straight lines, which are easy to draw. The equation $af(x) + bg(y) + c = 0$, where a, b, c are constants becomes the straight line $aX + bY + c = 0$ if the distances X and Y along the axes to the marks x and y are determined by the functions in the equation; namely, $X = f(x)$, $Y = g(y)$.

Well-known examples based on this principle are the commercial logarithmic and semilogarithmic papers. The former papers use the scales $X = \log x$, $Y = \log y$ and are convenient for plotting the graphs of relations of the form $y^m = ax^n$. Since this may be written $m \log y = n \log x + \log a$, the graph on this paper is the straight line $mY = nX + \log a$. The semilogarithmic papers have the scales $X = x$, $Y = \log y$.

Fig. 1 shows a paper made with the scales $X = x^2$, $Y = y^2$.

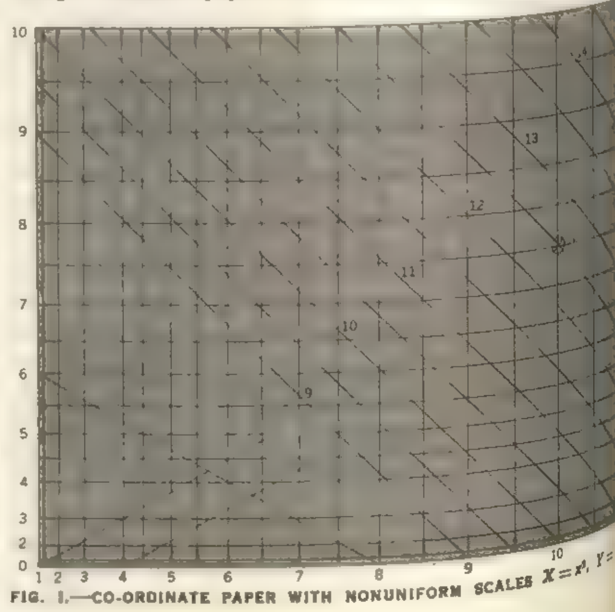

FIG. 1.—CO-ORDINATE PAPER WITH NONUNIFORM SCALES $X=x^2$, $Y=y^2$

Thus, the points marked 1, 2, 3, . . . on the axes are at distances 1, 4, 9, . . . from the origin. The graph of the ellipse

$$\frac{x^2}{64} + \frac{y^2}{36} = 1$$

is the broken line of the figure. The hyperbola

$$\frac{x^2}{16} - \frac{y^2}{9} = 1$$

and its asymptotes

$$\frac{x^2}{16} - \frac{y^2}{9} = 0$$

are the parallel lines made of short dashes. These simple graphs can be used for the usual purposes; *e.g.*, we read from the figure that the ellipse and hyperbola intersect at (6.3, 3.6).

An equation in three variables $F(X, Y, Z) = 0$ is represented in the cartesian system by a surface in three-dimensional space. To reduce the representation to a two-dimensional picture the use of contours is introduced. With Z held fixed, there is an equation in X and Y, whose graph is drawn. This is done for various values of Z and the values are written beside the curves. Other values of Z can be estimated visually. The resulting figure resembles a geographic map with contour lines upon it or a weather map showing isothermal lines or isobars.

Sometimes the contours can be reduced to straight lines by a happy choice of scales on the axes. An equation of the form $p(z)f(x) + q(z)g(y) + r(z) = 0$ yields a straight line for each fixed z, say z_0, using the scales $X = f(x)$, $Y = g(y)$, since the equation now is linear in the variables: $p(z_0)X + q(z_0)Y + r(z_0) = 0$. For example, a chart for solving right triangles can be made from the equation $x^2 + y^2 = z^2$ by drawing contours across fig. 1. Giving z the values 9, 9.5, 10, etc., we get the heavy slanting lines of the figure. To find the hypotenuse of a right triangle whose sides are 10 and 7.5 we are led to the point marked in the figure, from which $z = 12.5$.

Alignment Charts.—The word nomogram is sometimes restricted to a special type of chart which is used by bringing the points of three scales into alignment. In fig. 2 is shown an

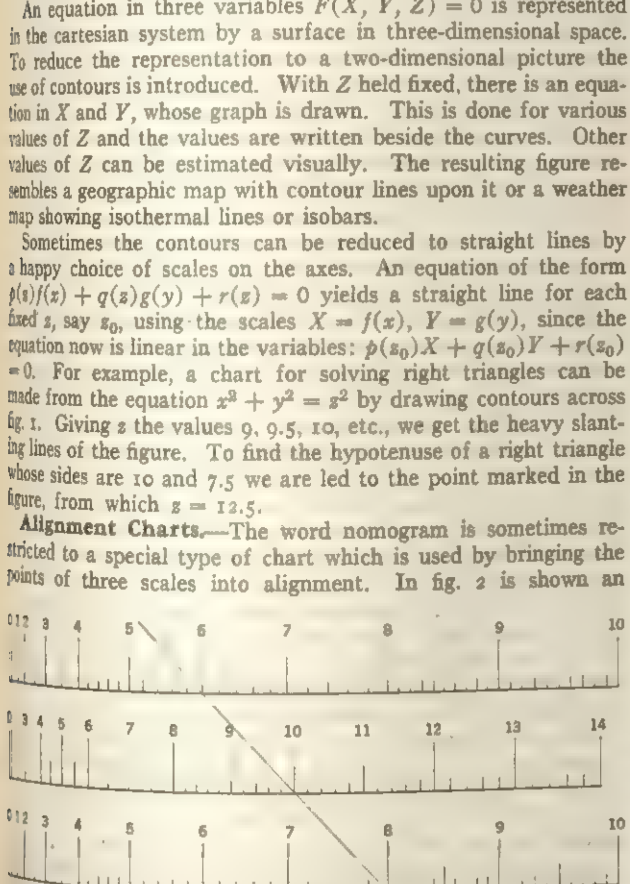

FIG. 2.—ALIGNMENT CHART FOR SOLVING $x^2 + y^2 = z^2$. FOR $X = 6$, $Y = 8$ THE LINE DRAWN SHOWS THAT $Z = 10$

alignment chart for the solution of $x^2 + y^2 = z^2$. On the upper and lower horizontal lines are laid off from a vertical axis the scales $X_1 = x^2$, $X_2 = y^2$ identical with those on the axes in fig. 1. Midway between is a line with a scale half as large, $X_3 = \frac{1}{2}z^2$. Now let a straight line be drawn across the figure cutting the scales at points marked x, y and z. It is seen from elementary geometry that $X_3 = \frac{1}{2}(X_1 + X_2)$, whence the equation $x^2 + y^2 = z^2$ is satisfied. The equation is solved for one of the variables by joining given values of the other two variables on the scales by a straight line and reading the solution where this line cuts the third scale.

A chart for solving any equation containing three variables can be made in a similar manner provided the variables can be segregated into three separate terms, $h(z) = f(x) + g(y)$. We have merely to plot the scales $X_1 = f(x)$, $X_2 = g(y)$ on the outside lines and $X_3 = \frac{1}{2}h(z)$ on the middle line. Thus, a scale for multiplication, $z = xy$, could be made after first writing the equation in the form $\log z = \log x + \log y$, the three plotted scales then being logarithmic.

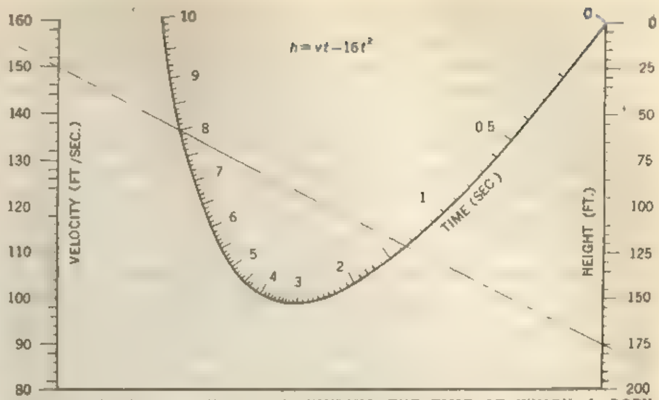

FIG. 3.—ALIGNMENT CHART FOR FINDING THE TIME AT WHICH A BODY THROWN UPWARD WITH A GIVEN VELOCITY ATTAINS A GIVEN HEIGHT (NEGLECTING FRICTION). THE LINE DRAWN SHOWS THAT FOR AN INITIAL VELOCITY OF 150 FT. PER SECOND THE BODY WILL BE 175 FT. HIGH IN 1.36 SEC. AND AGAIN (ON THE WAY DOWN) IN 8 SEC.

This type of chart has certain obvious advantages. Only three scales need be drawn, and they are more easily used than a complicated diagram. Interpolation can be accurately done since the line cuts cleanly across the scale. As a practical matter the line across the chart should not be actually drawn since a few lines in pencil would mar the chart. A fine thread may be stretched across the chart. An excellent line may be made on a transparent ruler with the point of a knife, a little graphite being worked in to give it visibility, and this can be laid across the chart.

The principle of the alignment chart was first described in 1884 by Maurice d'Ocagne (1862–1938) of the École Polytechnique in Paris. He developed the subject in many papers and books and particularly in his treatise of 1899, *Traité de nomographie*, in which were brought together both the general theories and a multitude of practical applications. D'Ocagne may properly be called the creator of nomography.

In its more general forms the alignment chart for the solution of an equation in three variables may employ straight scales arranged in various ways, or one or more of the scales may be curved as in fig. 3. A curved scale may be constructed from parametric equations $X = f(t)$, $Y = g(t)$. A value of t gives a point (X, Y) on the curve. Points for suitably spaced values of t are marked and the value of t is attached. Thus, $X = \cos t$, $Y = \sin t$ gives a circular scale, since $X^2 + Y^2 = 1$. Whether the resulting scale is curved or straight depends upon the parametric equations.

Take two functions of a variable x, two functions of y and two functions of z. Let these form three scales: an x scale $X_1 = F(x)$, $Y_1 = f(x)$; a y scale $X_2 = G(y)$, $Y_2 = g(y)$; and a z scale $X_3 = H(z)$, $Y_3 = h(z)$. Three points (X_1, Y_1), (X_2, Y_2) and (X_3, Y_3), corresponding to readings x, y and z, respectively, on the three scales lie on a line if the slope of the line joining the first two points is equal to the slope of the line joining the last two points; that is,

$$\frac{Y_2 - Y_1}{X_2 - X_1} = \frac{Y_3 - Y_2}{X_3 - X_2}$$

This condition may be put in the form

$$F(x)\,[g(y) - h(z)] + G(y)\,[h(z) - f(x)] + H(z)\,[f(x) - g(y)] = 0$$

or as a determinant

$$\begin{vmatrix} F(x) & f(x) & 1 \\ H(z) & h(z) & 1 \\ G(y) & g(y) & 1 \end{vmatrix} = 0$$

The chart will solve this equation for one of the variables when the other two are known. Conversely, an alignment chart can be made for any equation which can be written in this form.

If an equation can be solved by an alignment chart it can be solved by an infinitude of alignment charts. By applying a projective transformation

$$X' = \frac{a_1X + b_1Y + c_1}{a_3X + b_3Y + c_3} \qquad Y' = \frac{a_2X + b_2Y + c_2}{a_3X + b_3Y + c_3}$$

where a, b, c values are constants, to the plane of the chart we get another chart. The degree of a curve remains invariant, whence collinear points remain collinear and we still have an alignment chart for the equation. Because of the large number of constants at our disposal the chart can be thrown into a multitude of forms. Projective transformations are used to bring distant portions of a chart back on the page, to change the positions of scales so as to make the best use of the space on the page and to get convenient arrangements generally. The scales of fig. 3 consist of two parallel lines and a hyperbola. We could, for example, carry the linear scales into intersecting lines, or make the curved scale parabolic or circular, or greatly magnify some portion which we wish particularly to use. A useful result is that a convex quadrilateral covering any part of a chart can be carried into a rectangle of desired dimensions so that it fits on the page. *See* GRAPH; CHART.

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NONCONFORMISTS, English Protestants who do not conform to the doctrines or practices of the established Church of England. The word Nonconformist was first used in the penal acts following the Restoration (1660) and the Act of Uniformity (1662), to describe the "conventicles" (places of worship) of the Separatist congregations. Nonconformists are also called "dissenters" (a word first used of the five "Dissenting Brethren" at the Westminster Assembly of Divines in 1644–47). As a result of the movement begun in the late 19th century by which Nonconformists of different denominations combined together, leading to formation of the Free Church Federal council (*q.v.*), they are also called "Free Churchmen." The term is loosely applied in England and Wales to all Protestants dissenting from Anglicanism: Baptists, Congregationalists, Methodists, Unitarians and even such independent groups as the Society of Friends (Quakers), the Plymouth Brethren, the English Moravians, the Churches of Christ and the Salvation Army. (In Scotland, where the established church is Presbyterian, members of other churches, including Episcopalians, are Nonconformists.)

The first English Nonconformists were influenced by the continental Reformation and, like the Puritan party in the Church of England, wished only for a more radical reform of doctrine and ritual within the established church. The first Separatist congregation in London, under their pastor, Richard Fitz, met in secret at the Plumber's hall, where they were arrested in 1567 for treasonable opposition to the Elizabethan Acts of Uniformity and Supremacy. Such religious separatism was regarded as dangerous for both religious and political reasons, and Independents (also called Brownists, after their founder, Robert Browne, and, later, Congregationalists) and Baptists were subjected to organized persecution. Those who carried on Browne's work, as leaders of a Separatist congregation in London, Henry Barrow, John Greenwood and John Penry, were executed in 1593; Barrow and Greenwood for their treasonable assertion that "Christ is the only Head of his Church and His laws may no man alter," Penry ostensibly for complicity in the Marprelate controversy. As a result, many Independents and Baptists went into exile in Holland.

After the failure of the Church of England Puritan party to win over James I at the Hampton court conference (1604), the king threatened all Puritans, including the Presbyterians (who wished to reorganize the Church of England as a disestablished Presbyterian church), that they must either "conform themselves" or be harried out of the land. Among those who chose exile were the group known as the Pilgrim Fathers, who spread the ideas of English dissent to the new world, ultimately influencing the development of the U.S. constitution and respect for civil liberties.

Under Cromwell and the Protectorate, Presbyterianism predominated, although the Independents and Baptists also gained ground, and several left-wing radical groups (the Diggers, Levellers, Fifth Monarchy Men) developed the Lollard strain in dissent; while others—Shakers, Ranters and Quakers—wished to restore the spiritual enthusiasm of the early church, the Quakers especially reasserting need for dependence on the guidance of the "inner Light."

The rigorous laws of the Puritans produced reaction, further justified by the association in the public mind of dissenters with regicide, fanaticism and republicanism. After the Restoration, fear led to penal laws against Nonconformists—the so-called Clarendon code. The Act of Uniformity reauthorized the Prayer Book (*see* COMMON PRAYER, BOOK OF) and redefined the doctrines and rites of the Church of England, requiring that all clergy appointed under the Commonwealth should receive episcopal reordination and accept the Thirty-Nine Articles of 1571. Those who refused (numbering 2,000, including, as well as Presbyterians, some Independents and Baptists) were ejected from their livings (the "Great Ejectment," or "Ejection." Other restrictive acts included the Conventicle acts (1664 and 1670), which made meetings for worship illegal, even in private houses, where more than four outsiders were present; the Five-Mile act (1665) forbidding Nonconformist ministers to live, or visit, within five miles of a town, or any place where they had ministered; the Corporation act (1661) which forbade municipal office to those not taking the sacraments at a parish church; and the Test act (1673), which insisted that all officials of the crown should receive Anglican communion.

In 1689, however, a Toleration act was passed which demonstrated that the idea of a "comprehensive" Church of England had been abandoned, and that hope lay only in toleration of division. Toleration was limited, allowing Nonconformists to have their own places of worship (provided that these were unlocked and their locality notified), and to appoint their own preachers and teachers, subject to acceptance of certain oaths of loyalty, and of most of the Thirty-Nine Articles. Social and political disabilities remained, however, and Nonconformists were still denied office (as were, also, Roman Catholics). This led to the practice of "occasional conformity," but in 1711 an Occasional Conformity act imposed fines on any who, after receiving Anglican communion, were found worshiping at Nonconformist meetinghouses. A bill introduced by Viscount Bolingbroke to prevent the growth of schism by forcing all those who taught or kept schools to take an oath of allegiance to the Church of England was frustrated by Queen Anne's death, on Aug. 1, 1714, the day when it was to take effect. Had it become law, it would have destroyed the intellectual and educational power of dissent, which had made an important contribution to education by the foundation of "dissenting academies." Between 1663 and 1688, more than 20 academies had been founded and more than 30 more were started during 1690–1750. These, begun for the training of Nonconformist ministers to whom the universities were closed, became centres of learning, offering a wider, more liberal education than the universities then provided, including business training, science and sociology as well as theology and the classics.

The Toleration act did not apply to Unitarians, whose numbers grew in the 18th century. Their strength was allied to the growth of Rational Dissent, Deism (*q.v.*) and belief in human perfectibility. Side by side with this intellectual development went a spiritual decline in both Nonconformity and the Church of England. It was partly against this that the leaders of the evangelical revival in Anglicanism and the founders of the Methodist movement reacted. Methodists were only gradually forced into a position of Nonconformity and until the mid-19th century were not generally regarded as Nonconformists.

Quakers, however, were so regarded, and with other dissenters and evangelical Anglicans played a leading part in such movements for social reform as the abolition movement, the temperance movement, reform of prisons, and the founding of Sunday school movement, charity schools, orphanages and asylums. Methodists took the lead in the evangelization of the growing slum population in the late 18th and early 19th centuries and popularized dissent by building chapels; by open-air evangelism; by writing hymns; by organizing all members of Methodist societies into "classes"; and by starting circuits for ministers and lay preachers.

The gain in Nonconformist wealth and standing during the 18th century led to increased restiveness at civil and political disabilities. The Board of Dissenting Deputies—comprising laymen from the Baptist, Congregational and Presbyterian denominations which in 1727 had formed the Board of Dissenting Ministers in London—was founded in 1732 to fight for equality, redress of injustices and relief of distress caused by the discrimination under which the Nonconformists suffered. Among the abuses they attacked were unjust rates, illegal impressment, discrimination in collection of tithes, eviction for voting against Tory landlords (for the Nonconformist alliance with the Whigs, begun by their support for the Revolution of 1686, had continued), and the election by municipalities of Nonconformists to offices denied them under the Test and Corporation acts (this last for the purpose of acquiring their fines for refusing to serve). The deputies appealed unsuccessfully for repeal of the Test and Corporation acts in 1735 and 1739, but a grant was made for relief of distress. In 1811 they achieved repeal of the Five-Mile act and, in 1828, of the Test and Corporation acts. Other disabilities were removed in 1868, when abolition of church rates relieved Nonconformists of the necessity to pay for the upkeep of parish (Church of England) churches; and in 1880, when the Burials act made churchyard burial of dissenters legal. They also played a part in the founding (1828) of London university (*q.v.*), the first nonsectarian university; in the opening to all of Oxford and Cambridge (1871); in the fight for inclusion in the 1870 Education act of a clause prohibiting specifically denominational teaching in national schools; and in the demand for disestablishment of the Church of England. Although to some extent superseded by the Free Church council (which successfully protested against the levying of rates from Nonconformists for church schools in 1902), the Dissenting Deputies still exist.

In England as a whole during the 19th century, the "dissenting interest" formed a separate group, advocating freedom of conscience and developing its own educational and social institutions. Nonconformists greeted the 1832 Reform bill with enthusiasm: the towns enfranchised by it were centres of dissent, and training in lay preaching and in the church meeting had fitted dissenters to express their opinions democratically. From the Methodist chapel and the Congregational and Baptist church meeting came the leaders of Chartism, the Labour party and the trades unions, while the link between the Nonconformist wealthy middle classes and the Whigs was continued in support for the Liberal party. The Liberal government of 1906–10 has been called the most complete expression of the "Nonconformist conscience" (a phrase first used after the O'Shea divorce case, which drove Charles Stewart Parnell from political life).

The political and social influence of Nonconformity was at its height in the mid-19th century, backed by solid middle-class Victorian power. Because the professions had been closed to them, many dissenters, especially those educated in the "dissenting academies," had become scientists or had gone into business or trade. Nonconformist manufacturers and shipping owners became wealthy and powerful, and through their support the churches to which they belonged gained influence.

In the 20th century the general decline in church attendance and religious observance, growing concern at disunity in the face of the need for worldwide mission, and the consequent growth of the ecumenical movement (*q.v.*) somewhat replaced the rancour or arrogant separatism of the preceding centuries. There is still a place in English life for the Nonconformist witness, however, and for assertion of all that is best in the Puritan tradition and the Nonconformist conscience."

See CONFESSIONS OF FAITH, PROTESTANT; PURITANISM; articles on the various denominations (BAPTISTS; CONGREGATIONALISM; METHODISM, etc.); on such independent groups as SALVATION ARMY, THE; FRIENDS, SOCIETY OF, etc.; on the leaders and on relevant monarchs and statesmen. *See* also ENGLISH HISTORY; ENGLAND, CHURCH OF; REFORMATION; CHARTISM.

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NONDESTRUCTIVE TESTING. Nondestructive tests employ indirect measurements that do not damage test objects to detect flaws and measure performance properties of engineering materials, parts, assemblies and structures. Test indications must be correlated with strength or serviceability determined by past experience or by destructive mechanical tests of similar items.

Human senses often serve as nondestructive tests. Visual inspection reveals size, shape, surface discontinuities and finish. Dimensions are gauged and surface irregularities detected by touch. Cracked metallic parts are detected by striking with a hammer and listening to their vibrations. For centuries, skilled craftsmen have controlled the quality of their work through frequent inspections. They personally rejected defective materials or parts. Modern, high-speed production methods, however, offer little opportunity for such direct sensory inspection. In many operations parts move at high speeds behind shields and the workmen watch the performance of machines, rather than the product being fabricated. To ensure reliability, scientific nondestructive tests must be used to detect discontinuities and to measure performance properties of these products.

Nondestructive tests also are used to discover minute defects or hidden internal conditions that can cause premature service failures under severe operating conditions such as extreme temperatures, high stresses or damaging environments. Nondestructive tests are essential in prevention of disastrous failures of complex engineering systems such as those required for nuclear power systems, jet aircraft, missiles, space vehicles and military equipment, and process industries such as chemical and petroleum refining. They can also detect service damage prior to failure, and are cheaper and faster than dismantling complex equipment for direct inspection. Economic benefits result from their use to eliminate waste of materials, loss of machine and labour time, and user dissatisfaction.

Probing Media and Detection Systems.—Each nondestructive test method requires some form of probing medium to explore the test object, and a detection system to reveal its reactions to discontinuities or material properties. Probing media include electromagnetic waves, mechanical vibrations, electric and magnetic fields, liquid penetrants, heat, movements of electrons or ions, and other forms of energy or motions of matter. Detector signals must be amplified to useful levels, and converted to forms suitable for human interpretation or for actuation of display, recording or control devices. Many different physical effects are used in probing media and in detectors and amplifiers for test indications. For basic information on the physical phenomena and relationships involved in the applications illustrated in the following examples *see* X RAYS; ULTRASONICS; MAGNETISM, etc.

Penetrating Radiation Tests.—Electromagnetic waves, similar to light waves but of much shorter wavelengths (0.001 to 2Å; one $Å = 1 \times 10^{-10}$ metre), are used as probing media in penetrating radiation tests. Radiation sources include electronic X-ray generators and radioisotopes that emit gamma rays. Their high-energy photons have wavelengths small compared with inter-atomic

spacings, and penetrate through solid materials opaque to light. Radiation is partially absorbed and scattered within materials, depending upon wavelength, material thickness and density, and the types of atoms present. The transmitted radiation beam forms shadow images of voids and discontinuities, changes of material thickness and segregations of differing densities.

In film radiography, the shadow image is recorded by photographic films. In direct fluoroscopy, a phosphor screen fluoresces with a brightness proportional to radiation intensities. Electrostatic image tubes can be employed to enhance the brightness of fluoroscopic images. In xeroradiography, a photoconductive coating on a metal plate is electrically charged, and discharges locally when exposed to the radiation image. The resultant latent electrostatic image is developed by spraying the exposed plate with oppositely-charged, pigmented particles. Special X-ray-sensing television camera tubes can be used in closed-circuit television systems that reproduce images at a distance from the radiation source. Human observers interpret the X-ray images to detect internal discontinuities such as gas holes, porosity, slag inclusions, shrinkage defects, cracks, cold shuts (discontinuities in cast metal), misruns and other flaws in castings and weldments, and voids in brazed bonds. Positions and dimensions of internal components in complex assemblies are also measured from X-ray images, as are evidences of corrosion wall-thinning, fatigue cracking and other forms of deterioration of products in service.

Geiger counters, scintillation counters, ionization gauges, semiconductor crystals such as cadmium sulfide, and other point detectors provide signals proportional to radiation intensity. They can be used in thickness or mass-per-unit-area gauges to measure sheet materials in rolling mills, or coatings applied to sheet materials, often with feed-back controls to reduce process variations. X-ray diffraction and fluorescence analysis techniques are used to identify constituents, measure strain and follow structural changes during processing. Many other industrial applications exist where opaque materials are inspected by penetrating radiation tests.

Radiation hazards must be controlled in all industrial applications of penetrating radiations because of the biological damage these radiations can induce in human operators. Recommended practices are specified by the National Committee on Radiation Protection (N.C.R.P.) and in state and municipal safety codes.

Ultrasonic Tests.—Sound waves (or mechanical vibrations) at high frequencies (200,000 to 25,000,000 cycles per second) are used as the probing media for ultrasonic nondestructive tests. They are created in piezoelectric transducers and transmitted into solid test materials through films or layers of liquid couplants such as oil or water. Ultrasonic beams can be directed or focused like beams of light. They are partially reflected at interfaces where there are changes in material density or elasticity, and are refracted at interfaces between materials in which sound travels at different velocities. Within solid materials, vibrational modes that can be established include longitudinal (rarefaction and compression) waves, shear or transverse vibration waves, surface waves (like those on the ocean), and special modes related to dimensions of the sound conductor. Ultrasonic waves propagate well in fine-grained wrought materials, but tend to scatter and be attenuated in coarse-grained structures such as large castings. The echoes which return from material boundaries or discontinuities can be used to measure material thickness, to detect discontinuities, and to indicate some material properties. Under ideal test conditions, echoes from flaws of very small dimensions can be detected through considerable thicknesses of materials.

Many variations exist in ultrasonic test methods. In ultrasonic resonance testing, longitudinal waves at varying frequencies establish resonance in parallel-surfaced parts when the round-trip transit time equals the time between successive waves from the transducer. This permits measurement of material thickness, detection of laminar flaws in sheet or plate, and detection of corrosion wall-thinning or wear during service. In pulse-reflection testing, a brief burst of sound waves travels from transducer through the test object, reflecting from the opposite surfaces or from intervening discontinuities. The initial pulse and return echoes are displayed on a cathode-ray oscilloscope (*q.v.*) as a function of time, so that flaw depth or part thickness can be measured. Echo magnitude can be used to estimate flaw areas, in comparison with standard test blocks containing drilled holes. The method provides extreme sensitivity to cracks and laminar flaws (difficult to detect with X-ray tests), voids, inclusions, segregations and many other discontinuities.

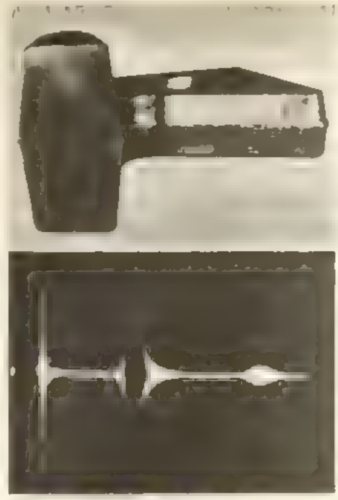

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FIG. 1.—(TOP) DEFECT IN AN ALUMINUM ALLOY DIE FORGING; (BOTTOM) OSCILLOGRAM SHOWING DEFECT

In contact ultrasonic tests, the transducer is held manually in contact with test-object surfaces, with an oil-film couplant. In immersion tests, the test object is immersed in water, and the transducer supported at a distance from the surface being scanned. Large-scale automatic systems have been developed to display cross-sectional or map-like facsimile images of test objects and internal discontinuities. Such systems are used to inspect sheet and plate, tubes, forgings and complex assemblies such as bonded laminates or brazed honeycomb structures with remarkable resolution of detail.

Electromagnetic Induction Tests.—An alternating magnetic field is used as the probing medium in electromagnetic induction tests. The test object is placed within the influence of a magnetizing coil carrying alternating current of suitable frequency. Eddy currents and varying states of magnetization are induced within the test object by transformer action. The magnetic fields of the test object are superimposed upon the exciting field, and can be detected either through their reaction on the exciting coils or by means of an additional pick-up coil system. The amplitude and phase relations of the output signals are analyzed by suitable electric circuitry, to separate insofar as feasible the effects of test material

BY COURTESY OF MAGNAFLUX CORP

FIG. 2.—PART SECTIONED BY SAWING TO SHOW DEPTH OF CRACK, AFTER SOME SURFACE GRINDING. CRACKS ARE SHOWN WITH MAGNETIC PARTICLES

conductivity, permeability, dimensions, shape and flaws. Rod, bar, tubes and symmetric test objects can be passed through test coils at high speeds to measure dimensions, alloy composition, hardness, strength properties and other characteristics, or to detect discontinuities such as cracks, seams, laps, wall thinning and others. Small probe coils can also be scanned over test parts to measure local discontinuities or variations in properties. Such methods have found wide application in European industries. Eddy current tests are particularly well-suited to high-speed automatic production processes since measurements often take only a few thousandths of a second. They produce electrical signals that can be analyzed statistically by electronic circuits and used directly to control processes or produce records.

Magnetic-Field Tests.—Ferromagnetic materials such as iron or steel can be tested by using magnetic fields as the probing medium. In magnetic-particle tests, the parts are suitably magnetized and a suspension of finely-divided magnetic particles is applied to the surface. Where surface or near-surface discontinuities transverse to the direction of magnetization introduce gaps in the magnetic flux path, some of the flux lines tend to "leak out" at the surface, attracting accumulations of magnetic particles which delineate the discontinuities. Visible or fluorescent dyes upon the particles permit them to be seen readily even when the discontinuities themselves would be invisible because of their minute size or subsurface locations. The test finds wide industrial application in detection of cracks, seams, laps, inclusions or segregations in ferrous materials.

In magnetic probe tests, a sensitive magnetometer or Hall effect detector is used to measure magnetic fields at the surfaces of ferromagnetic materials. Measurements of the residual field or its coercive force permit evaluation of material hardness, tensile strength or results of heat treatment. Ferromagnetic material thickness can be measured in terms of saturation flux linkages. Anisotropic conditions in rolled sheet materials can also be detected.

Liquid-Penetrant Tests.—The probing medium used in liquid-penetrant tests consists of a light petroleum distillate containing visible or fluorescent dyes. Test parts, after cleaning, are immersed or sprayed with liquid penetrant, which enters surface-connected discontinuities. After penetration, excess surface fluid is washed off, and a porous developer coating which serves as a blotter is applied. Penetrant trapped in discontinuities then seeps back into the developer coating, tending to spread laterally so as to amplify indications. An alternative system involves application of an emulsifying agent to aid in removal of the surface penetrant, providing increased sensitivity over penetrants which contain emulsifiers when applied. Surface-connected cracks, seams, laps and other linear discontinuities are shown by streaks, and porosity by dots or areas of indications, when processed parts are examined under suitable illumination. Test sensitivity is adequate to reveal discontinuities too fine to be seen with a light microscope (since wavelengths of visible light are too great to permit light to enter the fine defects).

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FIG. 3.—DYE PENETRANT INDICATION OF CRACK IN HEAT RESISTANT ALLOY DIESEL VALVE

Filtered-Particle Tests.—With porous materials such as some ceramics, solid particles are suspended in a liquid penetrant. When the liquid penetrant soaks into the porous material, the particles are filtered upon its surface. At cracks and other surface-connected discontinuities, much more penetrant enters, and numerous particles are filtered out at the entrance. Accumulations of particles coated with visible or fluorescent dyes are readily visible and greatly amplify test indications. Wet clay materials are inspected in this manner prior to kiln firing since defects present at this stage can be corrected at low cost.

BY COURTESY OF MAGNAFLUX CORP.

FIG. 4.—FILTERED PARTICLE TEST WITH BLACK LIGHT GIVING FLUORESCENT SURFACE INDICATION OF A DRYING CHECK IN UNFIRED SANITARY WARE. TEST IS MADE BEFORE GLAZE IS APPLIED

Thermal Tests.—Heat is used as the probing medium in thermal tests of metallic materials and bonded assemblies, with the resultant temperature distributions being indicated by temperature-sensitive coatings or remote infrared detectors. Temperature-sensitive paint coatings change colours at specific temperatures, and temperature-sensitive phosphors vary in fluorescent brilliance under ultraviolet excitation in response to gradients in temperatures. Heat-repelled fluid coatings are applied by spraying, and test parts pass under infrared heat lamps which create temperature gradients and evaporate the coating solvent. The test objects emerge with a varnish-like coating in which pigments reveal the temperature distributions attained during the heating transient.

Other Methods.—Many other nondestructive tests have been developed. Electric current tests are used to detect transverse fractures in railroad rails, in rail detector car systems. Electrified particles provide probing electric fields and detectors for discontinuities in insulating materials and coatings. Brittle lacquers and birefringent plastics are used in coatings to detect strain distributions. Pressure and leak tests are performed with liquid penetrants and gases such as helium or halogen vapours (which can be detected by sensitive instruments). Chemical reagents which react with specific constituents of test materials are employed in chemical spot tests. Many other nondestructive test methods and applications are described in the literature.

Test Limitations and Operator Requirements.—All nondestructive tests are specific, and have limited capabilities and applications. Complete inspection and quality assurance usually require the use of two or more tests, to cover all possibilities of material conditions and discontinuities that could lead to premature failure in service. All nondestructive test measurements are indirect, and their indications must be correlated with serviceability by other means—such as destructive tests of similar specimens under simulated service conditions, or by extensive service experience with similar objects or materials.

In most test methods that involve human interpretation, the training and judgment of the inspector are vital to test reliability. The inspector must have adequate knowledge of the nature of materials and their processing, of the design requirements and conditions of service, and of the influence of discontinuities upon performance. This extensive knowledge is rarely available in industrial personnel, and continued indoctrination and training are essential in maintaining inspector qualifications with rapidly-developing fields in modern industry.

See also ELECTRICITY, CONDUCTION OF; ISOTOPE; NUCLEAR INSTRUMENTS; PHOTOGRAPHY: *Scientific and Applied Photography.* For general mechanical (destructive) testing *see* HARDNESS TESTING; MATERIALS, STRENGTH OF: *Testing of Materials.*

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See also publications of the Society for Nondestructive Testing (journal *Materials Evaluation* and conference proceedings in book form); of Committee E-7 on Nondestructive Testing of the American Society for Testing Materials; of Commission V of the International Institute of Welding; and of other technical societies. (R. C. McM.)

NONE, the last of the "little hours," appointed to be recited at the ninth hour—*i.e.*, 3 P.M. *See* further BREVIARY and HOURS, CANONICAL.

NONIUS MARCELLUS (date unknown), African Latin grammarian and lexicographer, author of the *De compendiosa doctrina* (a sort of lexicon, in which are preserved extracts from the works of many earlier writers), was born at Thubursicum

Numidarum (in Algeria) between the end of the 2nd and the 5th century A.D. The *De compendiosa doctrina* consists of 20 chapters—the 16th is lost. The first 12 deal with language and grammar and in the brief remaining chapters words are grouped according to the nature of what they refer to. Except in the last chapter examples are given from ancient authors. There are editions by L. Mueller (1888) and W. M. Lindsay (1903). Nonius was a man of little understanding or accuracy but posterity is indebted to him for preserving fragments of Latin tragedies and the satires of Lucilius and Varro.

See Pauly-Wissowa, *Real-Encyclopädie der classischen Altertumswissenschaft*, xvii (1936); W. M. Lindsay, *Nonius Marcellus' Dictionary of Republican Latin* (1901). (G. B. A. F.)

NONJURORS, the name given to those beneficed clergy of the Church of England and of the Episcopal Church in Scotland who refused to take the oaths of allegiance to William III and Mary II in 1689 because they had previously taken the oath to James II. They included many men of devotion and learning and their secession was a serious loss to the church. There were about 400 in England, including William Sancroft, archbishop of Canterbury, and four others of the seven bishops who had refused to read in their churches James II's second Declaration of Indulgence in 1688—Thomas Ken of Bath and Wells, John Lake of Chichester, Thomas White of Peterborough and Francis Turner of Ely, together with the bishops of Chester, Gloucester, Norwich and Worcester. Other distinguished nonjurors were William Sherlock, master of the Temple; Jeremy Collier, ecclesiastical historian; George Hickes, dean of Worcester; Henry Dodwell, Camden professor of history at Oxford; and Henry Hyde, 2nd earl of Clarendon.

Believing in the doctrine of nonresistance to established authority, the nonjurors argued that James II was still the rightful king and likened the position of William III to that of Oliver Cromwell. They were ordered to take the oath of allegiance by Aug. 1, 1689, but were allowed six months' grace before deprivation. With the king's approval, Gilbert Burnet, bishop of Salisbury, attempted to reconcile them to the new order, but they refused the generous terms offered and were deprived of their sees and other benefices in Feb. 1690. Although they had only a small following among the mass of the people, who did not have to take the oath, Sancroft and his colleagues claimed to represent the true Church of England, and in 1693 requested James II, in exile in France, to nominate two new bishops to continue the episcopal succession. James chose Hickes and Thomas Wagstaffe, who were consecrated in 1694 as bishops of Thetford and of Ipswich respectively. In 1713 Collier, Nathaniel Spinckes and Samuel Hawes were consecrated as "bishops at large," without territorial titles. Ken, the most eminent of the nonjurors, disapproved of the succession of bishops and held that the schism should be ended, but the number of nonjurors was augmented in 1714 by those who refused to swear allegiance to George I.

The introduction by the nonjurors of a new communion office in 1718 including four "usages" taken partly from primitive liturgies and partly from the first Book of Common Prayer of Edward VI caused a schism among them, dividing them into "usagers" and "nonusagers." The four usages were the mixed chalice; prayers for the faithful departed; the Oblatory prayer, offering the elements to the Father as symbols of his Son's Body and Blood; and a prayer for the descent of the Holy Ghost on the consecrated elements. In 1731 both groups accepted the usages and united, but other internal dissensions followed. Their numbers were now very small, but the episcopal succession was maintained until 1805, when the last congregation came to an end. The nonjurors' public worship was conducted in chapels or oratories and in private houses.

In Scotland the nonjurors included the greater part of the clergy of the Episcopal Church, which ceased to be the state church in 1690. The Scottish episcopal clergy maintained their opposition to the government until the death of Charles Edward, the Young Pretender, in 1788, when the bishops agreed to recognize George III. A large number of Presbyterians in Scotland, principally among the Cameronians (*q.v.*), also refused to take the oaths of allegiance to William and Mary, but as their refusal was on different grounds they are not usually referred to as nonjurors.

See J. H. Overton, *The Nonjurors* (1902); H. Broxap, *The Later Non-Jurors* (1924).

NONNUS (fl. *c.* 425–*c.* 450), the most notable Greek epic poet of the Roman period, was born at Panopolis (Akhmim) in Egypt. His chief work is the *Dionysiaca*, a hexameter poem in 48 books whose main subject, submerged in a chaos of by-episodes, is the god Dionysus' expedition to India. Nonnus' fertile inventiveness, felicitous descriptive fantasy well served by a unique command of the language, appropriateness of word-coinage, unrivaled fluency of versification and vast literary knowledge made of him the much-imitated leader of the last Greek epic school. By uniting an essentially Homeric diction to stylistic elements found, in isolation, in his various epic antecedents or drawn from other genres, he achieved a kind of literary syncretism parallel to the religious one which is evident in the *Dionysiaca*, an erudite and valuable mythological storehouse. Nonnus' style, cumbersome with its ever-recurring, often daring metaphors, its constant, repetitive abundance, its exorbitant adjectival ornamentation and its unremittingly bombastic, frenzied tone, appealed to the taste of the time. His excessive indulgence in formulas and the restricted metrical limits set by him (some as a sign of virtuosity, some influenced by the prevalence of stress over pitch in contemporary pronunciation) to the structure of the hexameter add to the monotony of his verse. Later in life he was converted to Christianity and composed a hexameter paraphrase of St. John's Gospel (*Metabole*), which shows all his earlier stylistic faults, particularly inflation, whereas his colourful imagination and descriptive ability had now dried up.

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NONPARTISAN LEAGUE, common name for the Farmers' Nonpartisan Political league (often abbreviated N.P.L.) founded in North Dakota in 1915 and known after 1917 as the National Nonpartisan league. It was dedicated to rescuing the farmer from alleged economic abuses by local bankers and by grain speculators and railroad and elevator officials of Minneapolis and St. Paul, Minn. Another of its goals was the recovery of political control of North Dakota from these same interests and their agent, Alexander McKenzie, an expert in the manipulation of "invisible government." Founder of the league was Arthur Charles Townley (1880–1959), but much credit for awakening the people should be given to John H. Worst and Edwin F. Ladd of North Dakota Agricultural college.

The American Society of Equity and various other farm groups had secured adoption, in 1910–12, of a constitutional amendment permitting the state of North Dakota to build, own and operate grain elevators in Minnesota or Wisconsin, or both. But the state legislature refused (Feb. 1915) to implement the amendment and one member reportedly advised the concurrent convention of the Equity members "to go home and slop the hogs." The frustrated farmers were now ripe for any form of militant leadership. This was immediately supplied by Townley, a bankrupt flax grower who had recently been a Socialist organizer without benefit of Karl Marx. He and Fred B. Wood, a farmer near Deering, N.D., wrote the first constitution for the Nonpartisan league and immediately began the drive for members. The strategy was to support candidates from either major party who would pledge themselves to vote for state-owned elevators, mills, banks and hail-insurance companies. The dynamic Townley excoriated the "enemy" and rosily pictured the better days to come if his listeners would buy league memberships at $2.50 and support its program. (The cost of memberships later rose to $6, then $9 then $16.) Well over 20,000 farmers hopefully joined up, many giving postdated checks for the fee. The league's slate for 19

headed by Lynn J. Frazier (1874–1947) for governor and William Langer (1886–1959) for attorney general, won a smashing victory. In 1919 its creature legislature delivered as promised a state-owned Bank of North Dakota, a mill and elevator association, a hail-insurance company and a home building association. After weathering great difficulties these enterprises finally prospered under new management, though the home building association was later discontinued.

Townley's control over the league lasted only four years. Efforts to extend the organization into other states enjoyed some brief success in Minnesota, where it spawned the Farmer-Labor party, and in Idaho and South Dakota. Frazier and Langer, later in and out of the league, drove Townley into the political wilderness. The league suffered a defeat in 1921 when its man, Governor Frazier, was recalled by the voters. The defeat was tempered, however, by the failure of six antileague measures initiated by the Independent Voters association (I.V.A.), the league's sworn enemy. One year later Frazier won personal vindication for himself and for the league by victory in a contest for the U.S. senate.

The league virtually disappeared after 1924, though Langer revived it in 1932. The league tended to become a tight political machine under Langer's control; later it again declined in power. In 1956 the league affiliated with the Democratic party; in 1958 Senator Langer defied it and won re-election without a campaign. See also NORTH DAKOTA.

See Robert L. Morlan, *Political Prairie Fire: the Nonpartisan League, 1915–1922* (1955), the latest and best book on the league. Fred A. Shannon, *American Farmers' Movements* (1957), puts the topic into historical perspective and includes reprints of pertinent documents. (L. L. S.)

NOOT, HENRI VAN DER (1731–1827), Belgian leader during the revolution of Brabant in 1789, was born in Brussels on Jan. 7, 1731, the son of a landowner. An advocate at the sovereign council of Brabant, he began in 1787, in protest against the Holy Roman emperor Joseph II's reforms, to threaten the Austrian government with appeal to article 59 of the *Joyeuse Entrée* (*q.v.*), which released the Brabançons from allegiance to a prince who violated the constitution. This won him the support of the common people and of the clergy and influenced the guilds to raise a militia. The government insisted on the disbanding of the militia, but the estates of Brabant recognized Van der Noot as their defender. When his arrest was ordered, he fled to Breda in Dutch territory (Aug. 8, 1788). Nominated "plenipotentiary of the Brabançon people" by a group of guildsmen, he visited London and The Hague, offering Belgium to the house of Orange; and he also obtained verbal assurances of support from Prussia. As it turned out, however, the revolution was launched by his rival, the democrat J. F. Vonck, who thought that the Belgians should rely on their own efforts; and it was Vonck's general, J. A. van der Meersch, who won the battles against the Austrians. Even so, Van der Noot entered Brussels in triumph on Dec. 18, 1789. Appointed minister of the United Belgic States, he set himself out to eliminate Vonck and Van der Meersch, whose desire for a more representative form of government he denounced as an attack on religion and on the constitution. Vonck was driven out and Van der Meersch was arrested; but the Prussian general N. H. von Schoenfeldt, replacing the latter, was defeated by the Austrians, who recovered Brussels in Dec. 1790 (*see* BELGIUM: *History*). His incompetence having served to wreck the revolution, Van der Noot went into exile till the French had conquered Belgium. He was imprisoned for a time under the Directory (1796) and then remained in obscurity till 1814, when he emerged to plead for the return of Belgium to Austrian rule. He died at Strombeek on Jan. 12, 1827. (C. VE.)

NOOT, JONKER JAN VAN DER (*c.* 1539–*c.* 1595), Dutch poet, an ambitious opportunist and the pioneer of the Renaissance in the Netherlands, was born in Brecht *c.* 1539. The new metres and interest in classical learning are seen in his first poems (Ronsardian odes and sonnets) in *Het Bosken* (1568) and in his last major work *Lofsang van Braband* (1580) written in the (vain) hope of gaining nomination as the poet laureate of his province. His *Het Theatre oft Toon-neel* (1568), written and published in London while he was in exile, was translated into English with Edmund Spenser's assistance. His chief work, the epic *Olympias*, is complete only in his German translation, *Das Buch Extasis* (1576), though there are French and Dutch versions of the first half. Van der Noot died in Antwerp *c.* 1595.

See C. A. Zaalberg (ed.), *The Olympia Epics of Jan van der Noot* (1956). (P. K. K.)

NOOTKA (AHT), an Indian linguistic group of the southwest coast of Vancouver Island, B.C., whose territory extended from Cape Cook to San Simon point (near Victoria) and inland to the watershed. The Nootka, together with the Makah of northwesternmost Washington, constituted one of the two main divisions of the Wakashan linguistic stock. The second was the highly divergent Kwakiutl of northern Vancouver Island and the adjacent mainland. Salishan was spoken by all other natives of the island. The Nootka were located near the middle of the Northwest Coast culture area and their ways of life perhaps represent best the older and more basic aspects of that culture. Nootkans were oriented to the sea and their villages were located on bays or inlets. They made a specialized type of cedar dugout canoe, a remarkably seaworthy craft. These canoes and an intimate knowledge of coastal waters enabled the Nootka and Makah to travel considerable distances for sea-mammal hunting, visiting and trading. Both hunted the whale, a dangerous economic activity in which only two other coastal tribes engaged. Both also exploited the dense forests at their backs for game, roots and berries. Art was highly developed in the Northwest Coast manner. Totem poles and other elaborate stylized carvings were characteristic. Ceremonial feasts and property exchanges, called potlatches, were frequent. Northern Nootkan groups formed a social and political confederacy but the southern groups retained local autonomy. Numerous group names ended in *-aht* (*e.g.*, Nitinat, Clayoquot, Kyuquot, Mooachaht); hence some early writers used Aht as a collective designation. Capt. James Cook entered Nootka sound in 1778, at which time the population of the Nootka was perhaps 6,000, the Makah 1,500. Henceforth the fur trade flourished and the Indians rapidly acquired iron tools and many other appurtenances of western culture.

See Philip Drucker, *Indians of the Northwest Coast* (1955); James G. Swan, "Indians of Cape Flattery," *Smithsonian Contributions to Knowledge*, vol. 16, (1870). (V. F. R.)

NORA, an ancient site about 22 mi. S.W. of Cagliari (Carales) on the southern coast of Sardinia. Although according to tradition it was founded by Iberians from Tartessus, it occupies a characteristically Phoenician site, a triangular promontory ending in a steep cliff (Capo di Pula). The name Nora is related to the proto-Sard *norake* (tower, castle). Remains of a Sardinian *nuraghe* or towerlike monument were found nearby, and blocks from another were incorporated in a building identified as the Punic temple of Tanit. Apart from these, the earliest antiquities discovered at Nora are Phoenician, dating from the 7th century B.C. (*See* SARDINIA: *History*.)

In the Republican period, after the Roman annexation of Sardinia, Nora was its capital; under the Empire, it became a *municipium*. The latest Roman inscription records repairs of its aqueduct by Theodosius II and Valentinian III, A.D. 425–450; the last ancient writer to mention Nora, the *Anonimo Ravennate* (*c.* A.D. 700), describes it as a *præsidium* (fortified outpost).

Excavations in 1952–54 brought to light a wealthy imperial city overlying a typical Punic port. The Punic town, unfortified except for a watchtower at the tip of the promontory, had narrow irregular streets and buildings of characteristic Carthaginian construction. A *tophet*, where the bodies of cremated children were buried in great jars under steles carved with a temple façade and an image of the goddess Tanit, whose identity is confirmed by a graffito (*q.v.*) on a vase of the 3rd century B.C., is evidence for the violence of the period of the First Punic War. The imperial city dates from the Flavian period; a fine theatre, an aqueduct, a temple of Juno (probably the Carthaginian Tanit in Roman form), a handsome nympheum, baths and private villas were uncovered. The ruins of a paleo-Christian church, dedicated to the local saint, Efisio, and rebuilt in 1089, stand nearby.

See G. Pesce, *Nora, Guida agli Scavi* (1957). (E. H. RI.)

NORADRENALINE (Norepinephrine or Levarterenol), one of the hormones produced by the medulla of the adrenal gland. It has an effect on the body similar to that of stimulation of the sympathetic nervous system, producing rise in blood pressure, increase in concentration of blood sugar, etc. *See* Adrenaline and Noradrenaline; Adrenal Glands; Hormones.

NORBANUS, GAIUS (d. 82 B.C.), turbulent Roman popular leader at the turn of the 2nd and 1st centuries B.C. When tribune of the people (*c.* 103 B.C.) he accused Q. Servilius Caepio of having in 105 brought about the defeat of his army by the Cimbri through rashness; Caepio was condemned and went into exile. About ten years later Norbanus himself was accused of treason because of the disturbances that had taken place at the trial of Caepio, but the eloquence of M. Antonius, grandfather of the triumvir Mark Antony, procured his acquittal. During the social war (the war of the Italian *socii* or allies) Norbanus, as praetor in 88, successfully defended Sicily against the Italian allies. During the civil war between Marius and Sulla he sided with Marius; as consul in 83 he was defeated by Sulla at Monte Tifata, 3 mi. E. of modern Capua (Casilinum), and again in 82 by Q. Metellus Pius at Faenza (Faventia in Cisalpine Gaul). He fled to Rhodes, where he committed suicide while the Rhodians were debating whether to hand him over to Sulla.

See E. Badian, "Caepio and Norbanus," *Historia*, vi, pp. 318 ff. (1957).

NORBERT, SAINT (*c.* 1080–1134), archbishop of Magdeburg, reformer and founder of the canons regular of Prémontré (variously known as Premonstratensians [*q.v.*], Norbertines, White canons). Born between 1080 and 1085 in Xanten, Ger., Norbert became a canon of the collegiate church of Xanten, but he lived a worldly life at the court of the emperor Henry V. He was converted during a thunderstorm in 1115 and ordained a priest in the same year. Failing to reform his fellow canons at Xanten, he became an itinerant preacher who urged reform of morals for clergy and laymen alike. Unsuccessful in an attempt to reform the chapter of St. Martin at Laon, France, he was prevailed upon to found a religious institute at Prémontré near Laon (1120), of which the characteristic feature was the combination of an extensive, priestly apostolate with monastic discipline. St. Augustine's rule was adopted and the constitutions were modeled on those of the Cistercians. At Antwerp in 1124 Norbert preached successfully against the heresy of Tanchelin or Tanchelm. He was chosen archbishop of Magdeburg in 1126. Like his friend St. Bernard of Clairvaux he supported Innocent II against the antipope and won over the emperor Lothair II. He died on June 6, 1134, and was canonized in 1582. His feast day is June 6 (but July 11 in the order).

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NORD, the most northerly *département* of France, lies southwest of the Belgian frontier in French Flanders and French Hainaut and extends inland from a 20-mi. frontage on the Straits of Dover to the western flanks of the Ardennes uplands beyond the Sambre valley. It is bounded to the west by Pas-de-Calais and to the south by Aisne. Area 2,215 sq.mi. Pop. (1962) 2,293,-112. After Seine, Nord is the most populous *département* of France and contains in the continuous built-up area of Lille-Roubaix-Tourcoing one of France's largest urban agglomerations, with about 750,000 inhabitants, as well as numerous smaller mining and industrial towns on the coalfield nearby. This frontier district did not become part of France until the 17th century, and Flemish remains the language of the inhabitants of its northeastern corner between Dunkerque and the frontier. (For historical aspects *see* Flanders, County of.)

Behind the straight dune coast the reclaimed marshlands of the maritime plain are intersected by a dense network of drainage canals. Farther inland there follows a sandy plain with a few salient residual hills that played a great role in World War I. The chalk floor of the Flanders basin emerges at Lille and extends to the Sambre valley. France's major coalfield, buried benea[th] the chalk, crosses the *département* as a narrow strip from the Be[l]gian frontier east of Valenciennes to its western border beyon[d] Douai.

Except where it has been sterilized by towns and industry, the country is intensively farmed and produces large quantities of grain (wheat, oats, barley), sugar beet, potatoes and other vegetables, and fodder crops. Flax, tobacco, chicory and hops are also grown, and market gardening is important. An exceptiona[lly] heavy density of livestock is maintained, and farming is especia[lly] concerned with fattening young cattle, milk production for the sale and butter making, and pig rearing. Sugar refining, alcoho[l] distilling, flour milling, and brewing are widespread, impor[tant] industries. The major industrial development, however is associated with the old-established cloth-manufacturing towns and the modern exploitation of the coalfield. From the earliest pit near Valenciennes at the beginning of the 19th century, mining spread westward, transforming the agricultural countryside. Alongside the mines great quantities of patent fuels are prepare[d] and there are coking and distillation plants. Iron and steel works are especially concentrated along the canalized Escaut (Schelde) river in the vicinity of Valenciennes. Engineering, glass, chemicals, and other heavy industries are also carried on. Valenciennes and Douai are the chief towns on the coalfield.

Off the coalfield, to the southeast, are other steel and engineering works, with Maubeuge and Fourmies as outlying centres. North of the coalfield, textile industries are especially important but there is much engineering and Lille especially manufactures textile and agricultural machinery, besides having large boiler and locomotive works. Roubaix-Tourcoing is the chief seat [of] woolen textile manufacture and accounts for most of the French production of worsted. Linen is still an important product [of] Armentières and Lille. Cotton mills are more widespread and now synthetic and mixed fabrics are very much used. Manufacture of synthetic fibres has been introduced into the mining towns and, farther south, Cambrai, long famous for its linen ha[s] modern hosiery factories. Raw cotton is largely imported throu[gh] Le Havre, but in most other respects Dunkerque (*q.v.*) serves [the] industrial area with the imported raw materials it needs as well with large quantities of imported food. An artificial port grea[tly] improved since 1880, it is now the third port of France in vo[lume] of trade and has shipbuilding and oil-refining industries. A re[-]markable system of navigable waterways, interconnecting the canalized eastward-flowing rivers of Flanders, augments the ra[il]ways and roads that bind together the industrial complex and provide it with its external contacts.

Lille (*q.v.*), a former capital of French Flanders, is the pr[é]fecture and regional capital as well as the chief business and shop[-]ping centre of the immediately surrounding urban area. It is [the] centre of a modern bishopric, established in 1913, that compr[ises] the northern part of the *département*, the bishopric of Cambr[ai] corresponding with the southern part. The court of appea[l] still located at the old ecclesiastical and university city of Dou[ai] but Lille, with a modern university established in 1887, is now [the] centre of educational administration. The *département* cons[ists] of six *arrondissements*, centred upon Dunkerque, Lille, Dou[ai], Valenciennes, Cambrai and Avesnes.

Although modern warfare has taken its toll of old buildings some fine *hôtels de ville* and belfries have miraculously surviv[ed]. Elaborate, outdated fortifications and defensive moats are [fea]tures of several of the old towns of French Flanders and Li[lle] still shows Vauban's great citadel outside the old town.

(Ar. E. S.)

NORDAU (originally Südfeld), **MAX SIMON** (18[49]–1923), Jewish-Hungarian writer, a prominent Zionist and the au[-]thor of rationalist attacks on society which had a vogue at [the] time. Nordau (he changed his name in 1873) was born in Bu[da]pest on July 29, 1849. After qualifying as a doctor in 187[5] [he] moved to Paris in 1880 where he practised medicine. Two boo[ks], *Die konventionellen Lügen der Kulturmenschheit* (1883; Eng. trans. *The Conventional Lies of Our Civilisation*, 1884) and *Ent[ar]tung* (1892–93; *Degeneration*, 1895), made his name. In 18[..]

Nordau met Herzl and became an enthusiast for his plans for a Jewish state. He was vice-president of the first six Zionist congresses, where he shone as a speaker. After disputes over policy he resigned in 1921, dying in Paris on Jan. 22, 1923.

His works include *Gefühlskomödie* (1892) and *Die Drohnenschlacht* (1897) (fiction); *Doktor Kohn* (1898) (play); *Paris unter der 3. Republik* (1881); and *Die Krankheit des Jahrhunderts* (1889).

See A. and M. Nordau, *Max Nordau* (1943).

NORDENFLYCHT, HEDVIG CHARLOTTA (1718–1763), Swedish poet, remembered for her sensitive love poems, was born Nov. 28, 1718, at Stockholm. She fought all her life to keep her faith although disturbed by the ideas of the Enlightenment, and this conflict is expressed in her reflective poetry. The deaths of her fiancé in 1737 and of her husband soon after their marriage in 1741 inspired her finest poems, some of them published in *Den sörgande turtur-dufvan* (1743). During the 1750s she enjoyed a literary collaboration with Gustav Philip Creutz (*q.v.*) and Gustaf Fredrik Gyllenborg (*q.v.*). In 1761 she fell tragically in love with a man much younger than herself, and her poems about him mark the height of her achievement. She died at her home near Stockholm, June 29, 1763. Her *Samlade skrifter* were edited by H. Borelius and T. Hjelmqvist, 4 vol. (1924–38).

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NORDENSKIÖLD, (NILS) ADOLF ERIK, BARON (1832–1901), Finnish-Swedish scientist and arctic explorer, was born in Helsinki on Nov. 18, 1832. During his studies at Helsinki university he incurred the displeasure of the authorities for his Swedish and western sympathies, and in 1858 he settled in Stockholm. During this year he made his first arctic expedition, to Spitsbergen under Otto Torell, and was appointed professor and curator of the mineralogical department of the Swedish State museum. He now undertook a series of further expeditions to Spitsbergen—in 1861 with Torell again, and in 1864, 1868 and 1872–73 as leader—and made fundamental contributions to the knowledge of the geology of the area, while in 1870 he led an expedition to west Greenland to study the inland ice. During the 1868 expedition, partly financed by the Göteborg businessman Oscar Dickson, the patron who was to provide such decisive support for all his subsequent expeditions, Nordenskiöld reached 81° 42′ N. in the mail boat "Sofia." In 1873, after a winter had been spent in difficult conditions in north Spitsbergen, he crossed the ice sheet of North East Land. Nordenskiöld's thoughts now turned to what was to be his greatest achievement—the accomplishment of the northeast passage. In two preliminary voyages in 1875 and 1876 he penetrated the Kara sea to the mouth of the Yenisei. On July 21, 1878, Nordenskiöld sailed from Tromsö on board the steam vessel "Vega"; he reached Cape Chelyuskin on Aug. 19, and after being frozen in at the end of September near Bering strait, completed the voyage in the following summer.

The "Vega" made a triumphal voyage home via the Mediterranean and when Nordenskiöld reentered Stockholm on April 24, 1880, he was made a baron by King Oscar. In 1883, on his return from west Greenland, where he penetrated far onto the inland ice, he became the first to break through the southeast coast's great sea ice barrier. In 1893 he was elected to the Swedish Academy. He died at Dalbyö on Aug. 12, 1901.

Nordenskiöld's bibliography lists 178 works. Geologist, mineralogist and geographer, he also broke new ground in his contributions to the early history of cartography. His two great works in this field are *Facsimile-atlas* (1889), and the indispensable collection of hand-drawn maps and charts entitled *Periplus* (Eng. trans. by F. A. Bather, 1897). (P. A. B. G.)

NORDENSKJÖLD, (NILS) OTTO (GUSTAF) (1869–1928), Swedish geographer and explorer, was born at Hässleby, Småland, on Dec. 6, 1869; he was the nephew of Baron A. E. Nordenskiöld (*q.v.*). At Uppsala university he first specialized in geology, and in 1894 he became lecturer in mineralogy and geology there. An expedition which he led to Patagonia and Tierra del Fuego (1895–97) made important contributions to the understanding of the glacial geology of the world as a whole. In 1898 he visited Klondike in the Yukon, and in 1900 he accompanied G. K. Amdrup to east Greenland. Nordenskjöld's long-planned project for a scientific expedition to the south polar regions was embarrassed by serious financial difficulties, but on Oct. 16, 1901, the "Antarctic" sailed from Göteborg. In Feb. 1902 a station was established on Snow Hill Island off Graham Coast, and there Nordenskjöld wintered with five companions. The "Antarctic," which wintered at South Georgia, was crushed in the pack ice of Erebus and Terror gulf (Feb. 12, 1903) when trying to relieve them the following summer. The crew wintered in 1903 on Paulet Island. But in November of that year the Argentine vessel "Uruguay" under Capt. J. Irizar rescued all parties of the expedition (*Antarctica*, 1905). Important geographical discoveries had been made in the course of long sledge and boat journeys, and probably few polar expeditions have achieved greater scientific results; these were subsequently published in a model manner in *Wissenschaftliche Ergebnisse der schwedischen Südpolar-Expedition 1901–1903*, six volumes (1905–20).

Nordenskjöld made minor expeditions to west Greenland in 1909 and to Peru and western Patagonia in 1920–21. He became the first natural scientist at the University of Göteborg when he was appointed to the new chair of geography there in 1905, and in 1923 became the first rector of the Göteborg school of advanced commercial studies. Nordenskjöld was concerned to popularize and synthesize his science and achieved this successfully in a number of works. Religion was important for him, and in later years he made active contribution to the ecumenical movement. He died in Göteborg on June 2, 1928. (P. A. B. G.)

NORDERNEY, a long, narrow, low-lying island and the largest of the East Frisian group, Germany, which after the partition of the nation following World War II became part of the *Land* (state) of Lower Saxony, Federal Republic of Germany. It is 8 mi. long and up to 1½ mi. broad and its dunes rise to about 68 ft. The northern coast is exposed to storm waves, but more sheltered water lies to the south in the Wattenmeer between the island and the mainland. Most of the population (7,331 in 1961) lives in Nordseebad Norderney, a leading coastal resort and small fishing port with shipping service to Norddeich (5 mi.) on the mainland. (HA. T.)

NORDHAUSEN, a town of Germany in Erfurt *Bezirk* (district) of Thuringia which after partition of the nation following World War II became part of the German Democratic Republic. It is situated on the Zorge river on the southern slopes of the Harz mountains, at the west end of the Goldene Aue, a fruitful plain watered by the Helme, 40 mi. (64 km.) N.W. of Erfurt city. Pop. (1964) 42,018. Historic buildings that survived the heavy air attacks of World War II include the 17th-century *Rathaus* with the oaken Roland monument (1717), an ancient symbol of civic liberty, the late Gothic Roman Catholic cathedral (with a Romanesque crypt) and the Protestant church of St. Blasius (13th century). Remnants of medieval town walls are extant. The public "Gehege" park dates from the 18th century. There are a museum, a theatre, a teachers' training college, an institute of agricultural technology and a sports school. To the former main industries, the distillation of rye-whisky and tobacco manufacture, have been added shaft-sinking processes and the manufacture of tractors and excavators. The town developed around a castle and market founded by the Saxon king, Henry I (the "Fowler"), in the early 10th century near the older Frankish settlement of Northusen. It was made a free imperial town in 1220, accepted the Reformation in 1522 and lost its independence in 1802 after annexation by Prussia. This association ceased when, in 1945, Nordhausen fell within the limits of Thuringia. The city's limits were extended in 1950 with the incorporation of the neighbouring villages of Salza and Krimderode. (WA. M.)

NORDHORN, a town of Germany, *Land* (state) of Lower Saxony, which after partition of the nation following World War II became part of the Federal Republic of Germany. It lies on the Vechte river 4 mi. from the Dutch border and about 44 mi. (70 km.) N.W. of Münster. Pop. (1961) 39,449. Part of the Augus-

tinian monastery (founded 1394) and the Protestant church (1489) are extant. The town is on a branch railway, the main road from Bremen, and the Ems-Vechte and Süd-Nord canals. Textiles form the main industry and there are petroleum wells nearby. First mentioned in 890 and chartered in 1379, it suffered heavily from plague, fire and war in the 15th and 16th centuries. Its area was expanded in the 1920s by the addition of neighbouring communities.

NORDLAND, a *fylke* (county) of northern Norway, extends from about latitude 65° N. to the northernmost point of the Vesterålen archipelago, about two-thirds of its area being north of the arctic circle. Area 14,798 sq.mi.; pop. (1960) 237,193. Fjords penetrate into the mainland, which is sheltered by numerous islands. Lying within the zone of the Caledonian folding, Nordland has an alpine landscape with several peaks higher than 4,900 ft. (Oksskolten 6,283 ft.). Habitation is mostly confined to the coastal lowlands and to fluvial deposits around the heads of the fjords, though farmland exists up to 900 ft. in the inland valleys. Mosjøen, Mo, Bodø, the administrative centre, and Narvik (*q.v.*) are towns of 5,000–14,000 inhabitants. About one-eighth of the fish catch of Norway is landed in Nordland. Cod fisheries from February to mid-April on the eastern side of the Lofoten Islands are of special importance. Animal husbandry, formerly a subsidiary occupation, is now to a great extent the main occupation even in some coastal areas. Pyrites are mined in the Sulitjelma and Mo areas. New mines are being developed in the iron ore deposits in the Dunderlandsdal (*q.v.*). Water power has given rise to electrometallurgical and chemical industrial plants. Railways run from Bodø to Oslo and from Narvik to Sweden; fast coastal lines sail to Bergen. (L. H. Hg.)

NÖRDLINGEN, BATTLES OF, two battles of the Thirty Years' War (*q.v.*), fought near Nördlingen in Swabia.

In the first battle, on Sept. 5 and 6, 1634, the Holy Roman emperor Ferdinand II's army, under the nominal command of his son Ferdinand III (then king of Hungary) and the actual direction of Matthias Gallas, together with a Spanish force led by the cardinal-infante Ferdinand, decisively defeated the Swedish army under the dual command of Gustav Karlsson Horn and Bernhard of Saxe-Weimar. The resumption of hostilities by the Poles after the end of the Polish-Russian "War of Smolensk" had forced the Swedes to dispatch large contingents against them; Gallas therefore disposed of vastly superior forces; and the incompatibility of the bold Bernhard and the irresolute Horn threw away the success that the Swedes had on the first day of battle. Horn was taken prisoner and remained in captivity until 1642. The complete rout of the Swedish army, mainly effected by Gen. Jan de Weert, led to the dissolution of the Heilbronn alliance of 1633 and the end of Swedish preponderance in southern Germany and forced the cardinal de Richelieu into bringing France into active participation in the war.

In the second battle, on Aug. 3, 1645, the French under Turenne and the duc d'Enghien (later prince de Condé) fought an imperial and Bavarian army under Franz von Mercy and Jan de Weert at Alerheim, 5 mi. E. of Nördlingen. The battle is memorable for Mercy's death and for Turenne's brilliant generalship, which turned De Weert's almost completed victory into defeat.

Bibliography.—For the battle of 1634 *see* E. Leo, *Die Schlacht bei Nördlingen* (1900); J. Fuentes, *La Batalla de Nördlingen* (1906). For the battle of 1645 *see* S. Riezler, *Die Schlacht bei Alerheim*, in *Sitzungsberichte* of the Munich academy (1901). (S. H. S.)

NORDRHEIN-WESTFALEN: *see* North Rhine-Westphalia.

NORDSTRÖM, LUDVIG ANSELM (1882–1942), Swedish writer whose best work describes life in his native province, was born at Härnösand (the "Öbacka" of his novels), Norrland, on Feb. 25, 1882. He studied at Uppsala and became a journalist, traveling widely at home and abroad. A follower of Strindberg, in his early works (the collections of short stories *Fiskare*, 1907; *Borgare*, 1909; and *Herrar*, 1910; and the novel *De tolv söndagarna*, 1910), he treated themes from his birthplace with imaginative power, ironic realism and humour. Keenly interested in economics and industrialism, and influenced by Herbert Spencer, Émile Durkheim and H. G. Wells, he developed a higher individual view of society, and in his numerous later writings—theoretical treatises, travel books and journalistic works, short stories and novels—preached a utopian world society based on a universal economic solidarity which he called "totalism." He died at Stockholm, April 15, 1942. Selections from his diary were published in *Ur Ludvig Nordströms dagböcker* (1955).

See M. Stiernstedt, *Kring ett äktenskap* (1953); G. Qvarnström, *Från Öbacka till Urbs* (1954). (H. Es.)

NORD-TRØNDELAG, a *fylke* (county) of central Norway. Area 8,673 sq.mi.; pop. (1960) 116,635. It includes undulating lowland around Trondheimsfjord, forested uplands and valleys to the east and north (the northern is Namdal) and the rather rugged and humid coastal district west of Namdal. The Trondheimsfjord area was comparatively densely populated even in early historic times. Frosta was one of the judicial centres of the country in the middle ages. At Stiklestad, Olaf Haraldssøn (St. Olaf) fell in battle (1030). Nord-Trøndelag is one of the best agricultural regions of Norway. Manufactures of wood and pulp are of importance in most districts. Pyrite is mined in Namdal and iron ore west of the Trondheimsfjord. Considerable water power potential is developed in the Namsen river system and further developments were scheduled for the 1960s. Steinkjer, the administrative centre, Namsos and Levanger are the chief towns. The *fylke* is traversed by the railway to Nordland with a branch line to Namsos. (L. H. Hg.)

NORE, THE, a sandbank in the Thames estuary marked by a lightship, the first to be established in English waters (1732). The name is used also of the area of the estuary roughly coinciding with the naval port of Sheerness. The Nore anchorage was much used by the fleet in the wars of the 17th and 18th centuries. In 1797 sailors at the Nore mutinied against conditions, and their leader Richard Parker, was hanged from the yardarm of his ship. The commander in chief, the Nore, is the naval commander of the eastern area of England.

See G. E. Manwaring and B. Dobrée, *The Floating Republic* (1935).

NORFOLK, EARLS AND DUKES OF. Norfolk is the premier English dukedom and earldom. Ralph the Staller (1011–c. 1069), 1st earl, an obscure figure, was probably a Breton and obtained the earldom *c.* 1067. His son, Ralph de Guader (*c.* 1040–?1096), 2nd earl, a follower of William the Conqueror, forfeited the title when he revolted against the king in 1075. The earldom lapsed until it was granted by King Stephen to Hugh Bigod (*c.* 1095–1177) in 1141. The Bigod earls of Norfolk were prominent in the reform movements of the 13th century; Roger (d. 1221), 2nd earl of this line, was one of the council of 25 set up by Magna Carta in 1215 and Roger (*c.* 1212–1270), 4th earl, played an important role in the movement against Henry III between 1258 and 1265. On the death of Roger, 5th earl, in 1306 the title lapsed until Edward II granted it to his younger half brother, Thomas of Brotherton (1300–1338), in 1312. He supported Queen Isabella in 1326 and helped bring about the deposition of Edward in 1327.

On Thomas' death the title passed in the female line and his daughter Margaret (*c.* 1320–1400) was created duchess of Norfolk for life in 1397 at the time her grandson, Thomas Mowbray (*c.* 1366–1399), was created duke (*see* Norfolk, Thomas Mowbray, 1st duke of). The dukedom lapsed on the death of John (1444–1476), 4th duke of this creation, but the earldom passed to his daughter Anne, wife of the young Richard, duke of York who was murdered in the Tower of London. On her death the earldom became extinct.

The dukedom was given in 1483 to John Howard (*c.* 1430–1485), whose mother, Margaret, was a daughter of Thomas, the 1st Mowbray duke of Norfolk. He served Edward IV assiduously, was created baron in 1470 and was treasurer of the royal household from 1467 to 1474. He subsequently supported Richard III who created him duke of Norfolk in 1483 and made him earl marshal of England. Norfolk was killed fighting for Richard at Bosworth (Aug. 22, 1485), and the title was later under attainder (*see* Howard). Thomas (1443–1524), the 1st duke's son, was created earl of Surrey in 1483 but was an attainted captive after Bos-

worth until 1489 when he was released by Henry VII and restored to his earldom but not to the dukedom of Norfolk. He then served the king in Yorkshire and the north. Henry VIII used him on public business despite Surrey's dislike of Thomas Cardinal Wolsey. He commanded the army that defeated the Scots at Flodden field (Sept. 1513), and was created duke of Norfolk in Feb. 1514. He was guardian of England during the king's absence in France (1520) and acted as lord high steward at the trial of his friend Edward Stafford, duke of Buckingham. Among Norfolk's sons were THOMAS HOWARD (1473–1554), 3rd duke of Norfolk (*q.v.*), WILLIAM (*c.* 1510–1573), 1st Lord Howard of Effingham, and the admiral SIR EDWARD HOWARD (*c.* 1477–1513). The 3rd Howard duke of Norfolk was succeeded in 1554 by his grandson THOMAS (1538–1572; *see* NORFOLK, THOMAS HOWARD, 4th duke of) since his own son was executed in 1547 for treason (*see* SURREY, HENRY HOWARD, earl of). The 4th earl was executed in 1572 and the dukedom was not restored to the Howard family until 1660 when THOMAS HOWARD (1627–1677) became 8th duke. Both CHARLES (1746–1815), 11th duke, and HENRY (1791–1856), 13th duke, held prominent Whig sympathies. By act of parliament (1824) the dukes of Norfolk were empowered to act as hereditary earl marshal (*q.v.*) despite their adherence to Roman Catholicism. HENRY (1815–1860), 14th duke, added the surname of Fitzalan. BERNARD (1908–), 16th duke, succeeded to the title in 1917.

NORFOLK, THOMAS HOWARD, 3RD DUKE OF (1473–1554), uncle of Anne Boleyn and Catherine Howard, and who held important political offices under Henry VIII, was the eldest son of the 2nd duke. He married Anne, daughter of Edward IV, in 1495, thus becoming a brother-in-law of Henry VII, who had married Anne's sister Elizabeth. He became lord high admiral in 1513, led the van of the English army at Flodden in September, and was created earl of Surrey in Feb. 1514. In 1513 he married Elizabeth, daughter of Edward Stafford, duke of Buckingham. Surrey went to Ireland as lord deputy in 1520 but soon vacated his post to command the fleet which sacked Morlaix and ravaged the neighbourhood of Boulogne in 1522; in 1523 he raided and devastated southern Scotland. He succeeded his father as lord treasurer in 1522 and as duke of Norfolk in May 1524, and as the most powerful nobleman in England he headed the party hostile to Thomas Cardinal Wolsey. He favoured the divorce of Henry VIII from Catherine of Aragon and the king's marriage with Anne Boleyn.

Norfolk became president of the council in 1529 but his position was shaken in 1536 by the fall of Anne Boleyn, at whose trial and execution he presided as lord high steward. But his military abilities rendered him almost indispensable to the king, and in 1536, just after the rising known as the Pilgrimage of Grace had broken out, he was dispatched into the north of England; he temporized with the rebels until the danger was past, and then, as president of the council of the north, punished them with great severity. Sharing in the general hatred against Thomas Cromwell, Norfolk arrested the minister in June 1540. A conservative in religion, he and Bishop Stephen Gardiner were thereafter the chief opponents of Archbishop Thomas Cranmer, the earl of Hertford, Lord Lisle and the "advanced" group in Henry's council. He led the English army into Scotland in 1542 and into France in 1544; but the execution of Catherine Howard, another of his nieces who had become the wife of the king, had weakened his position.

In Dec. 1546 his son Henry Howard, earl of Surrey (*q.v.*), was arrested on a charge of treason; Norfolk himself suffered the same fate as accessory to the crime. Surrey was executed in Jan. 1547; his father was condemned to death by a bill of attainder, but before the sentence was carried out, Henry VIII died. Norfolk remained in prison during Edward VI's reign, but in Aug. 1553 he was released and restored to his dukedom and later in the month he acted as lord high steward at the trial of John Dudley, duke of Northumberland. In Jan. 1554 he was sent to suppress the rebellion which had broken out under Sir Thomas Wyat, but his men fled before the enemy. He died on Aug. 25, 1554, at Kenninghall in Norfolk. (R. B. WM.)

NORFOLK, THOMAS HOWARD, 4TH DUKE OF (1538–1572), executed for his intrigues with Mary Stuart, was the son of Henry Howard, earl of Surrey (*q.v.*), and was born on March 10, 1538. After his father's execution, the council removed him from his mother's charge and he was given as tutor John Foxe, the Protestant martyrologist. Restored to his father's title on Mary I's accession, he succeeded his grandfather as duke of Norfolk in Aug. 1554. Although too young to take much part in affairs in Mary's reign, he was in favour both with her and with Elizabeth I. After some hesitation he took command of the English forces in the north during the intervention in Scotland in 1559–60 and presided over the commission of enquiry in 1568 into the quarrel between the Scots and Mary Stuart, who had just fled to England. Jealous of the earl of Leicester's favour and William Cecil's influence with Elizabeth, and having recently lost his third wife, he listened readily to suggestions from William Maitland of Lethington and others that he should marry Mary. He was not, however, bold enough to ask Elizabeth's consent or disloyal enough to agree to a rising against her; and while he hesitated, Elizabeth in Oct. 1569 had him arrested. He was released in Aug. 1570, after the suppression of the rising of the northern earls, but soon allowed himself to be drawn into Roberto Ridolfi's plot for a Spanish invasion to put Mary on the English throne. Its discovery led to his execution on Tower hill on June 2, 1572, despite Elizabeth's reluctance to order his execution. He died protesting his innocence and that "he was never a papist."

By his first marriage to Mary, daughter of the earl of Arundel, the duke of Norfolk left a son, Philip, who became earl of Arundel (1580) in right of his mother; by his second marriage he left two sons, Thomas Howard, 1st earl of Suffolk (1603), and Lord William Howard. (R. B. WM.)

NORFOLK, THOMAS MOWBRAY, 1ST DUKE OF (*c.* 1366–1399), one of the lords appellant in 1388 and perhaps best remembered for his quarrel with Henry, duke of Hereford (afterward Henry IV). The son of John, 4th Lord Mowbray, he was a youthful companion of Richard II and was made earl of Nottingham in 1383. Jealousy of Robert de Vere, earl of Oxford, the king's favourite, probably led Nottingham to join the nobles, led by the earl of Arundel and the duke of Gloucester, who sought to limit the king's power. Richard was at their mercy after De Vere's defeat at Radcot bridge (Dec. 1387) and Nottingham's moderation helped to dissuade the lords appellant against the king's deposition, in favour of "appealing" (arraigning) the royal favourites in the Merciless parliament (1388). For nearly two years power lay in the hands of the lords appellant. But as soon as the king regained his authority, in 1389, he showed Nottingham marked favour and detached him from his former colleagues. Later he became captain of Calais and the royal lieutenant in northeastern France. Richard took him to Ireland in 1394 and soon afterward sent him to arrange a peace with France and his marriage with Isabella, daughter of Charles VI. But the earl's supreme service to the king was in 1397 when Richard took a tardy but severe vengeance upon three of the appellants. In their turn these lords were appealed of treason before parliament and, as on the former occasion, Nottingham was one of the accusers. Gloucester was entrusted to his keeping at Calais and in Sept. 1397 he reported that his prisoner was dead. The duke had been murdered and Nottingham was perhaps responsible, although the evidence against him is not conclusive.

Nottingham was created duke of Norfolk in 1397. He then began to fear for his own safety and took the duke of Hereford into his confidence. Hereford informed the king, who summoned Norfolk to his presence, and at Oswestry, Norfolk accused Hereford of speaking falsely. A court of chivalry decided that the dispute should be settled by single combat at Coventry; but when everything was ready for the fight, Richard interposed and ordered both combatants into banishment (Sept. 16, 1398). Norfolk was exiled for life and deprived of his offices, although not of his titles. This quarrel forms act I of Shakespeare's *Richard II*. Norfolk died in Italy, at Venice, on Sept. 22, 1399.

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(T. B. P.; X.)

NORFOLK, an eastern county of England, bounded north and east by the North sea, northwest by the Wash, south by Suffolk and west by Cambridgeshire and Lincolnshire. The geographical area, excluding tidal water, is 2,054.3 sq.mi., the county being the fourth in size in England.

Physical Features.—Norfolk is low-lying, the highest areas being a little more than 300 ft. above sea level, while in parts of the Fenland the surface is below ordnance datum (mean sea level as defined for ordnance survey). The solid geology of the area is relatively simple, the superficial geology complex, giving rise to well-defined natural subregions. The most important rock of the county is the Chalk outcropping in west Norfolk as a long broad ridge mostly more than 200 ft. above ordnance datum and dipping sharply eastward until at Great Yarmouth its surface is 450 ft. below ordnance datum. Beneath the Chalk on its western edge lie the older beds of Kimeridge Clay, Lower Greensand and Gault and from the Norwich area to the coast the Chalk is chiefly overlain by the marine Crag deposits. Successive glacial advances have moulded the surface topography by the deposition of large areas of boulder clays, sands and gravels that have later been eroded. Postglacial changes of land and sea level have led to the formation of peats and clays in low-lying regions.

Parts of the 90-mi. long coastline are diversified by dunes of blown sand, and spits and islands of shingle and sand. Generally the west and northwest coasts are subject to accretion but from Sheringham southeast to Caister-on-Sea there has been marked erosion.

Nine subregions characterized by distinctive combinations of soil, vegetation and land utilization may be recognized in Norfolk: (1) About one-eighth of the English Fenland lies within the county. In the north silt predominates, in the south peat. Its intensive cultivation is only possible through the maintenance of an elaborate system of drainage. (2) The North Alluvial plain extends along the north coast from Hunstanton to Cley and consists entirely of marshland, much of it salt marsh. (3) The Greensand belt runs southward for about 25 mi. from near Hunstanton and is characterized by undulating heathland and magnificent woodland and by the use of carstone as a building material. (4) The Breckland in southwest Norfolk is a thinly populated area with an unusually sandy soil. Agriculturally the area is marginal and its former extensive heaths have been largely replaced by modern coniferous forests. (5) The "Good Sands" region comprises the upland area of northwest Norfolk and for centuries has been the principal area for barley cultivation and sheep-rearing. (6) High Norfolk occupies the centre of the county almost from the north coast to the southern boundary with Suffolk and is characterized by its heavy loam soils and is still well wooded. (7) The Cromer-Holt ridge consists of coarse gravels with the thinnest of soils, ending seaward in lofty cliffs where landslides are common. (8) The Loam region of northeast Norfolk possesses good soils, largely arable, is well wooded and thickly populated. (9) The Broadland (*see* below) consists of marshland, often below high-tide level, in the lower courses of the Bure, Yare and Waveney rivers and their tributaries.

Archaeology and History.—Norfolk is rich in archaeological evidence of past human cultures though many prehistoric structures have largely been destroyed by the extensive arable farming of recent centuries. Paleolithic flint implements mainly of the Acheulean-Clactonian cultures occur commonly in gravel beds and indicate human occupation in interglacial periods. Flint tools left by Mesolithic hunters are found on the lighter soils. Kelling is the best-known site. In all subsequent periods, as well as in the Roman and early Anglo-Saxon periods, population was mainly concentrated on the relatively easily worked soils of the Breckland and west Norfolk. The Cromer-Holt ridge and the Norwich area also attracted settlers. The heavier afforested soils of High Norfolk and the Loam region were not fully exploited until late Saxon times. Seaborne invaders chiefly entered the area by the rivers draining into the Wash or along those which flow out at Yarmouth. By land, the Chalk ridge linked west Norfolk with southern England and was traversed by the important Icknield way.

The chief monuments of the Neolithic Age in Norfolk are [illegible] extensive group of flint mines (Grimes Graves) in the Brec[illegible] and elsewhere in the Chalk area, in addition to two long barr[illegible] and the henge monument at Arminghall. There are exten[illegible] traces of the Beaker invaders from the Rhineland and to th[illegible] and their Middle Bronze Age successors may be attributed [illegible] of the numerous round barrows. It was only in the Late Bron[illegible] Age that this metal was freely available in Norfolk and [illegible] metalsmiths' hoards attest this. The beginning of the Iron Age (about 500 B.C.) saw the arrival of fresh invaders from the con[illegible] tinent, well represented by a farmstead excavated at West Har[illegible] In the 3rd century B.C. a new ruling class came from the Seine Marne area of France and provided the dynasty which ruled those living in Norfolk and northwest Suffolk known later as the Ice[illegible] To the last phase of the Iron Age belong a group of remarka[illegible] hoards of gold and bronze ornaments and gold, silver and [illegible] coins. The remains of the Roman era in Norfolk are not [illegible] pressive, possibly due to the perishable nature of much of the building material employed and to the comparatively late romani[illegible] zation resulting from the severe repression which followed the revolt of Queen Boadicea in A.D. 61. The administrative [illegible] was the walled town at Caistor-by-Norwich (Caistor St. Edmun[illegible] and there was a fortified port at Caister-by-Yarmouth.

Villa estates were most common in west Norfolk and the Fen[illegible] land was thickly settled by peasant cultivators. In the 3rd [illegible] 4th centuries there was a coastal fort at Brancaster to repel Sax[illegible] pirates. The road system is still imperfectly known.

From about A.D. 400 Norfolk received fresh immigrants—Angles, Frisians and Saxons—from northwest Germany and the Low Countries but the detailed geography and chronolog[illegible] these intrusive groups are uncertain. By about 550 the sma[illegible] units had been brought under the control of an East Angl[illegible] monarchy which for a brief period, under Redwald in the ear[illegible] 7th century achieved a temporary dominance but later fell under the sway of its neighbours. Norfolk became officially Christian [illegible] 631 and formed part of the diocese of East Anglia until this [illegible] divided in 673 and the bishop's see for Norfolk established [illegible] North Elmham, where substantial remains of the 10th-centur[illegible] cathedral may be seen. To the 8th century belongs the develo[illegible] ment of town life at Thetford and at Norwich where a mint [illegible] in operation by about 920. From mid-9th century Norfolk [illegible] subject to Danish invasion. In 869 the Danes wintered at The[illegible] ford and King Edmund was killed, East Anglia becoming part [illegible] the Danelaw and receiving large numbers of Danish settlers, espe[illegible] cially in Flegg north of Yarmouth. In the renewed Danish [illegible] vasions of the early 11th century both Norwich and The[illegible] were burned. Despite these setbacks, late Saxon times in [illegible] folk saw a great growth of population and a corresponding expa[illegible] sion of cultivated land through the deforestation of much of [illegible] tral Norfolk. By the time of the Domesday survey of [illegible] Norfolk was one of the most thickly populated and wea[illegible] regions of England and remained so throughout the medieva[illegible] riod. The opening up of central Norfolk led to the developm[illegible] of Norwich while Thetford remained static, the bishop's see be[illegible] transferred from there to Norwich in 1094. Yarmouth and [illegible] were also important towns as early as the Norman conquest [illegible] medieval prosperity of Norfolk rested on its successful agricu[illegible] and on its worsted production. This medieval wealth is refle[illegible] in its magnificent buildings both secular and ecclesiastical. [illegible] viving castles include such imposing structures as Norwich, Ca[illegible] Rising, Caister, Baconsthorpe and Oxborough ranging from [illegible] 12th to the 15th centuries.

The numerous monasteries suffered severely at the Reformat[illegible] but Norwich cathedral survives from a rich Benedictine mona[illegible] and there are substantial traces of other religious houses [illegible] the Dominicans (Black Friars) at Norwich, and monasteries [illegible] Castle Acre, Binham, Thetford and Wymondham. Little re[illegible] of the Augustinian house at Little Walsingham, one of the [illegible] famous shrines of the middle ages. Many parish churches [illegible] rebuilt in the 14th or 15th centuries and are conspicuous for [illegible] size and rich embellishments.

The peace of medieval Norfolk was ruffled from time to time by baronial warfare, the rising of 1381, the private strife of the 15th century revealed vividly in the Paston letters (*q.v.*) and the formidable rebellion of Robert Ket (Kett) in 1549. During the Civil War Norfolk was largely on the parliamentary side but some magnates supported the king and Lynn was held on his behalf.

Many great country houses from the 16th century onward survive to attest the wealth of the county based on successful sheep farming and later agricultural developments. Outstanding among these great buildings are East Barsham manor house (early 16th century), Blickling and Raynham halls (early 17th century), Holkham and Houghton halls and Wolterton park (18th century) and many 19th-century mansions, among which Sandringham (*q.v.*) has special interest as the Norfolk home of the royal family.

Broadland.—The Norfolk broads (lakes) are situated in close relationship to the three confluent rivers of east Norfolk—the Waveney, Yare and Bure with its tributaries, the Ant and the Thurne. A few broads lie just over the border in Suffolk but belong to the same system. Physically the broads are of two types—side-valley, such as South Walsham and the Ormesby-Rollesby-Filby series, and bypassed, such as those at Wroxham and Hoveton where they were originally separated from the river channel which passes close to them. Investigations based on thousands of borings and supplemented by documentary evidence show conclusively that the broads originated as peat cuttings in late Saxon and early medieval times and were abandoned due to a rise in sea level. During the 19th century many were steadily reduced in size by the encroachment of vegetation on former open water, and some have disappeared completely.

The Norfolk broads, and the river system which links them, form an important recreation area, with pleasure boats, both sail and power-propelled, centred chiefly on Wroxham, Potter Heigham, Stalham and Yarmouth. There are more than 150 mi. of navigable waterway. Only the Yare is used by seagoing trading vessels, bringing mainly coal and timber to Norwich. The unique physical and vegetational characteristics of the region are reflected in its rich and varied natural history. Many rare birds, insects and plants in this area are likely to survive if physical conditions remain constant as a result of the establishment of nature reserves at such places as the following broads—Alderfen, Barton, Hickling, Ranworth, Cockshoot and Surlingham (all under the care of the Norfolk Naturalists' trust); Horsey mere (National Trust), Calthorpe broad, Bure marshes and Martham broad with Winterton dunes (Nature Conservancy). Besides the Broadland nature reserves there are other important reserves in the county. Scolt Head Island (Norfolk Naturalists' trust, National Trust and Nature Conservancy) is extremely important for its physical structure, bird and insect life. Blakeney point (National Trust) is well known for its geographical features, bird life and botany. In Breckland, typical heathland is preserved at Weeting and East Wretham (Norfolk Naturalists' trust).

Population and Administration.—The area of the administrative county is 2,035.8 sq.mi. with a population in 1961 of 389,316. The municipal boroughs are King's Lynn (pop. [1961] 27,554); Norwich, a city and county borough, a cathedral town and the county town (119,904); Thetford (5,398); and Yarmouth, formerly Great Yarmouth (52,860), a county borough. There are 10 urban districts. The county is in the southeastern circuit, and assizes are held at Norwich. The county quarter sessions meet at Norwich and King's Lynn. Norwich, Yarmouth and King's Lynn have separate courts of quarter sessions. Norfolk is in the diocese of Norwich except for three rural deaneries in west Norfolk which are in that of Ely. These are six county parliamentary divisions—South-West, North, Central, and South Norfolk, King's Lynn, and Yarmouth (which includes the county borough of Yarmouth)—as well as the parliamentary borough of Norwich which returns two members.

Agriculture, Industries and Communications.—The county is largely agricultural, the chief crops being barley, wheat, sugar beet, oats, vegetables and root crops. Large areas are devoted to peas for canning or freezing. Most kinds of livestock are raised, and the county produces a greater number of turkeys than any other in Britain. Catering for visitors and holidaymakers, especially to the Broads area and the coastal towns of Sheringham, Cromer and Great Yarmouth, is a big summer industry. Norwich (*q.v.*), the county town, is the main industrial and marketing centre. Agricultural machinery is made in many towns and the old silk industry survives in Norwich.

Of three large, well-known boys' schools in the county, two are in Norwich, namely, King Edward VI's school and the City of Norwich school. The third, Gresham's school, was founded at Holt, near Sheringham, in 1555, by Sir John Gresham.

In 1953, after serious floods had done much damage along the coast, seawalls were rebuilt and stronger defenses put up against the sea's encroachment. Fishing is carried on from Great Yarmouth and several smaller ports. The other principal trading port is King's Lynn (Lynn).

The railways of the Eastern region of British railways serve the main towns. The eastern rivers afford water communication with Great Yarmouth, while the Great and Little Ouse and some of the drainage cuts communicate with Lynn.

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NORFOLK, an independent city and seaport in the tidewater region of eastern Virginia, U.S., about 18 mi. W. of the Atlantic ocean near the mouth of Chesapeake bay. Its harbour of Hampton Roads (*q.v.*), formed by the junction of the James river and two tidal estuaries, the Nansemond and Elizabeth rivers, is one of the world's most magnificent harbours. About the harbour are also located the port cities of Portsmouth, Chesapeake, Hampton and Newport News (*qq.v.*). In 1960 Norfolk, the largest city in Virginia, had a population of 304,869. The Norfolk-Portsmouth standard metropolitan statistical area, consisting in 1960 of the cities of Norfolk, Portsmouth, South Norfolk, Virginia Beach and the counties of Norfolk and Princess Anne, had a population of 577,504. In 1963 South Norfolk and Norfolk county merged to form the city of Chesapeake, and Princess Anne county became part of Virginia Beach (*q.v.*). (For comparative population figures *see* table in VIRGINIA: *Population.*)

History.—The history of Norfolk began with an act of the Virginia general assembly of June 1680, on instructions from the King, which required each county to purchase 50 ac. and lay out a town and warehouses in order to encourage "trade and manufacture." Land for the town in lower Norfolk county was to be located "on the Easterne Branch on Elizabeth river at the entrance of the branch." The required land was purchased from Nicholas Wise, a carpenter, for 10,000 lb. of tobacco, and the town was laid out in 1682. In 1705 the house of burgesses made it a port of entry and landing, retaining the name Norfolk, and it was incorporated as a borough in 1736 with Samuel Boush as mayor and Sir John Randolph as recorder.

The commerce of Norfolk for many years depended chiefly on trade with the people of eastern North Carolina, who brought such raw materials as tar, pitch, juniper shingles, plank, hides and tobacco over treacherous waterways or crude roads. As business increased, artisans set up their crafts and shipbuilding and ship repairing became important industries.

Later a brisk trade developed with Barbados and the West Indies; and, as merchant ships became too large to load and unload conveniently at the quays along the rivers and bays, Norfolk became a busy warehouse centre. In recognition of its importance and the loyalty of its citizens, Gov. Robert Dinwiddie in 1753 presented Norfolk with a silver mace still cherished by the city.

The American Revolution brought complete destruction to Norfolk. At first the Norfolk citizens were outspoken against the

Stamp act and Great Britain's "most tyrannick exercise of unlawful power," as one of their protests stated it. But when the royal governor, Lord Dunmore, started open warfare against Virginia and protests ended in bloodshed, much of the population, especially the Scottish merchants, who had close ties with their mother country, made the town a rallying point for Tories.

In Dec. 1775 Governor Dunmore took over Norfolk as his headquarters, declared martial law and defeated a group of Virginia militiamen at Kempsville, southeast of the city. Later in the month Col. William Woodford and his Virginia riflemen completely routed the British at Great Bridge and occupied Norfolk.

On New Year's day of 1776 Dunmore's fleet anchored in the Elizabeth river, bombarded the town and set fire to some of the warehouses. The British burned 19 houses in all. The Virginians under Woodford burned more of the town after the bombardment, and the following month the rest of the town, except for St. Paul's church (which still has one of Lord Dunmore's cannon balls imbedded in its walls), was destroyed to prevent its use by the British.

Although the restoration of Norfolk was surprisingly rapid, the stifling of the West India trade by Great Britain, restrictions on trade and privateering by the French, British and Spanish during the Napoleonic Wars, a disastrous fire in 1799, rivalry of the fall-line cities such as Richmond and lack of an adequate commercial program by the state prevented even more substantial progress.

During the War of 1812 Norfolk was twice saved from invasion by the British. The first time, local militia, reinforced by U.S. marines, beat off a land attack on Portsmouth. An able defense of Craney Island (near the mouth of the Elizabeth) by Gen. Robert B. Taylor prevented the second invasion by barge.

After that war canals and railroads brought improved communications and increased trade with North Carolina and the whole Roanoke river valley. Norfolk continued to grow and in 1845 was incorporated as a city, but yellow fever struck in 1855, killing about 10% of the population, and in 1861 came the Civil War. Shortly after the outbreak of hostilities the navy yard at Portsmouth was burned and the port abandoned by Federal forces. During the next year the Confederates repaired and made good use of the shipyard facilities in the area, among other things, building the "Virginia," first ironclad warship to be tested in battle, from the remains of the Union ship "Merrimack" (*see* "MONITOR" AND "MERRIMACK," BATTLE OF). In May 1862, however, Norfolk fell to Union forces under Gen. John E. Wool and remained an occupied city, part of the time under Gen. Benjamin Franklin Butler (*q.v.*), throughout the remainder of the war.

The progress of Norfolk was accelerated after 1870 because of the completion of railroads converging on the port with its superior facilities. The extension of the Norfolk and Western railroad to the coal fields of Virginia and West Virginia in 1883 started a trade which made Hampton Roads one of the world's greatest coal exporting ports.

During World Wars I and II Norfolk experienced accelerated prosperity, at first caused by heavy shipments to the Allies, and in the later phases of both wars by the activities at the military posts in the area. Correspondingly severe was the postwar deflation following World War I when many of these posts were closed or reduced to skeleton installations. After World War II Norfolk experienced a building boom during which many of the outlying sections of the city were transformed from woods, fields and swamps into urban communities.

Government.—The city of Norfolk, which in 1906 annexed the town of Berkley on the south side of the Elizabeth river, adopted a council-manager form of government in 1918 which controls the city's municipal affairs. The port of Hampton Roads is under the jurisdiction of a state port authority created in 1926. Holdings of the federal government are also extensive in and around Norfolk. The more than 20 major military installations and commands include the naval operating base (Sewell Point), the naval air station (Breezy Point) and the amphibious training base (Little Creek) on the northern edge of the city; the Norfolk naval shipyard and the naval hospital in Portsmouth; and the headquarters of the U.S. Atlantic fleet and the supreme allied command, Atlantic (SACLANT) of the North Atlantic Treaty organization (NATO

Commerce, Industry and Transportation.—Trade in Nor-folk consists mostly of exporting bulk cargoes such as coal, to-bacco, cotton, timber, truck crops and grain. Although it is the Atlantic coast leader in export tonnage and stands high in the value of exports, import tonnage is relatively low. This was ini-tially because of the mountains that stand between Norfolk and the major consumer markets of the eastern and midwestern U.S. thus making inland transportation of goods expensive and causing Norfolk to lose this import trade to ports such as New York and Baltimore, and later to the lack of a thickly settled manufacturing hinterland.

Shipbuilding is perhaps the most important of Norfolk's indus-tries, but the city also produces chemicals, fertilizers, insecticides peanut and cottonseed oil, sea foods, textiles, automobiles, agri-cultural machinery and electric motors.

Norfolk is connected to every port city in Hampton Roads by bridge, tunnel, ferry or, in the case of Hampton, by a combination bridge-tunnel completed in 1957. In 1964 another bridge-tunnel was completed across the entrance of Chesapeake bay to Cape Charles, previously connected to Norfolk only by ferry. The Dis-mal Swamp canal (1828) and the Albemarle and Chesapeake canal (1860), both parts of the Atlantic Intracoastal waterway (q.v. connect Norfolk with Currituck and Albemarle sounds in North Carolina.

Education and Culture.—In addition to excellent public- and parochial-school systems, Norfolk contains Old Dominion college (1930), until 1962 Norfolk college of the College of William and Mary and a division of Virginia State college (1935). Also im-portant in the cultural life of the city are the Norfolk Symphony orchestra and the Norfolk Museum of Arts and Sciences. Places of historical interest include the Myers house (1791), St. Pau church (1739), the Adam Thoroughgood house (*c.* 1636–40) an Ft. Norfolk (1794). The city hall (1850) is now a memorial to Gen. Douglas MacArthur who was interred there in 1964.

Parks and Recreation.—Besides being a busy commercial and industrial city, Norfolk also offers much in the way of recreation: Ocean View, a beach resort area on Chesapeake bay, lies within the city limits and Virginia Beach is only about 18 mi. E. on the Atlantic. The Norfolk Municipal gardens in the northeastern sec-tion of the city contain beautiful displays of azaleas and came-lias. Near the city are also fishing grounds and additional bathing beaches. (R. L. Mo.

NORICUM was in Roman times a district south of the Dan-ube comprising central Austria and parts of Bavaria. As a Roman province its western boundary, against Raetia (*q.v.*), was approxi-mately the Inn river; in the south it met Italy at the summit of the Carnic Alps; and in the east, at least by Tiberius' time the frontier with Pannonia (*q.v.*) was a line running south from a point west of Vindobona (Vienna). But the earlier Celtic king-dom had been larger: on the east it included Carnuntum (q.v. Savaria (Szombathely, Hung.), Poetovio (Ptuj, Yugos.) and Emona (Ljubljana), together with the portion of the tribe of the Taurisci which lived near the source of the Save or Sava river. This kingdom was a Celtic confederacy dominating an earlier Illyrian population. It received Roman protection in the late 2nd century B.C., and had developed a fine culture in the late La Tène period, while Latin legends on coinage and other Latin inscrip-tions attest a marked measure of romanization. Its wealth came from minerals, iron and also gold; Strabo (iv, 208) tells of a Tauriscan gold mine discovered about 140 B.C. which led to an inrush of Romans and a drop in the price of Italian gold by one third.

The kingdom was annexed, apparently as a bloodless conquest by Rome *c.* 15 B.C., and the new province was placed under an equestrian governor, first called a *praefectus* but from Claudius' time a *procurator*. Roman traders and settlers now came in ever greater numbers, and romanization was rapid. Claudius made five of the Norican communities, including the capital, Virunum (near modern Maria Saal in Carinthia), into Roman *municipia*; many Noricans entered the legions; and the province was exceptional in providing soldiers for the praetorian guard, even in the early

century A.D. Crude iron was exported to Italy, especially to Aquileia, but there were also steel manufactures in the province, and Norican swords were familiar to Horace.

After the barbarian invasion of 167 (*see* MARCOMANNI) the frontier was reorganized, and *legio II Italica* was stationed in Noricum, its commander becoming the governor of the province. Its camp, by the end of the 2nd century at any rate, was at Launacum (Lorch, part of modern Enns) Under the later empire Noricum suffered severely from raids by Alamanni and other tribes, and was settled by Franks and Goths before the end of the 5th century.

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(G. E. F. C.)

NORILSK, a town in Krasnoyarsk *krai* (territory) of the Russian Soviet Federated Socialist Republic and the most northerly town of the U.S.S.R., lies at the foot of Mt. Shmidtikhi in the Putoran mountains (Gory Putorana), in the valley of the Rybnaya river, between Lakes Melkoye and Pyasino. Pop. (1959) 109,442. Norilsk was founded in 1935 as a mining centre for the rich variety of minerals in the area. Copper, nickel, cobalt, platinum and a little coal are exploited. There are enriching and copper-smelting plants in the town and a thermal power station. A railway links Norilsk to the port of Dudinka on the Yenisei, 72 km. (45 mi.) to the west. (R. A. F.)

NORMAL SCHOOL, an institution for the training of teachers. The first school so named, the École Normale Supérieure (1794), was intended to serve as a model for other teacher-training schools; it later became the College of Pedagogy of the University of Paris. The first public normal school in the United States was established at Lexington, Mass., in 1839 Normal schools were founded chiefly to train elementary-school teachers. They were commonly state supported and offered a two-year course beyond high school. In the 20th century the tendency has been to extend teacher-training requirements to at least four years and, especially after World War II, for the schools to broaden their programs, so that by the 1960s most former normal schools had become colleges or universities.

See TEACHER TRAINING.

NORMAN, MONTAGU COLLET NORMAN, 1ST BARON OF ST. CLERE (1871–1950), British banker, came from a family of merchant bankers with important connections in the United States. He left the family firm and in 1916 joined the Bank of England as assistant to the deputy governor. Norman was himself appointed deputy governor in 1918, and governor in 1920, a post he held for 24 years, longer than any previous governor of the bank. This period was notable for the many grave problems that arose after World War I, when Great Britain's financial ascendancy was first undermined, for the multiplication of the central bank functions in the modern state and for the development of closer relations between the central banks of all countries and in particular between those of Great Britain and the United States. On his retirement in 1944 he was raised to the peerage, taking the title Baron Norman of St. Clere in the county of Kent. He died on Feb. 4, 1950.

See Sir Henry Clay, *Lord Norman* (1957). (GA. S.)

NORMAN, a city in central Oklahoma, U.S., 18 mi. S. of Oklahoma City, is located on a plateau overlooking the valley of the South Canadian river; the seat of Cleveland county. Norman is the marketing and distribution centre of an extensive agricultural area which produces livestock and dairy products. There are also oil wells in the vicinity and some light industry.

Beginning as a tent city in April 1889, when Oklahoma was opened to white settlement, Norman was named in honour of an engineer who, in the 1870s, had aided in constructing the Santa Fe railroad through the territory. Before the settlement the railroad called the site Norman Switch. Incorporated in 1902, Norman adopted a commission-manager form of government in 1919.

The University of Oklahoma (*see* OKLAHOMA: *Education*), with 12 schools and colleges, was established there in 1892 on land donated by the people of Norman. The city is also the site of a state mental hospital and a cerebral palsy institute. For comparative population figures *see* table in OKLAHOMA: *Population*. (GE. H. S.)

NORMANDY, an ancient province of northern France. Its boundaries were approximately as follows: west and north, the English channel; northeast, the Bresle river, separating Normandy from Picardy; east, the Epte river, separating the Vexin Normand from the Vexin Français; southeast, a border between the Seine-Epte confluence and the Eure-Avre confluence, separating Normandy from the westernmost appendage of the government of the Île-de-France and from Orléanais; south, the Avre and upper Sarthe rivers as far as Alençon, separating Normandy from eastern Maine; and southwest, the Collines de Normandie and the lower Couesnon river, separating Normandy from western Maine and from Brittany. It thus corresponds, in terms of modern *départements*, to Manche, Calvados, Seine-Maritime and Eure (*qq.v.*), with Orne (*q.v.*) apart from Mortagne and Domfront. The provincial capital was Rouen (*q.v.*).

Ancient History.—The Seine and Eure valleys were inhabited in paleolithic times. The Cotentin peninsula and its hinterland have megalithic monuments like those of Brittany. Prehistoric metallurgy was affected by contact with the British Isles. Conquered by the Romans in 56 B.C. the future Normandy was organized in the 4th century A.D. as the province of Gallia Lugdunensis II.

Some Germanic settlement on the coast was begun before the collapse of the western Roman empire. On the overthrow of the kingdom of Syagrius in 486 the country passed under Merovingian Frankish rule. The Franks did little to modify the administrative structure, but promoted the foundation of great abbeys (St. Wandrille, Jumièges, Fécamp, Mont-St.-Michel). In the Merovingian partitions of France, the country was included in Neustria (*q.v.*), a name later taken sometimes to mean Normandy in particular.

The Norman Dynasty.—The Vikings (*q.v.*), Northmen or Normans were raiding the coast in Charlemagne's time; and as the Carolingian kings became weaker the invaders penetrated farther inland. Finally the French king Charles III the Simple (*q.v.*) came to terms with Rollo, the chief or duke of the largest band of Normans, accepting him as his vassal for part of the territory. This transaction (autumn 911?), known as the treaty of St. Clair-sur-Epte, is recorded only by the strongly pro-Norman Dudo (*q.v.*), writing nearly 100 years later. It seems that Rollo was originally enfiefed with lands in the dioceses of Rouen, Lisieux and Evreux. Subsequently, however, Rollo obtained rights over the Bessin (the country round Bayeux, where there had been a settlement of Normans independent of him) on transferring his allegiance to the Robertian king Rudolph (Raoul) in 923.

Rollo was baptized in 912, but is said to have died a pagan (927, 932 or 933?). His son William I Longsword was steadfastly Christian. William did homage to King Rudolph in 933 for the Cotentin and Avranches, where the local Normans had been regarded as more or less dependent on Brittany; and after Rudolph's death he came to terms with King Louis IV, of the restored Carolingian dynasty. In 942 he was assassinated.

William's young son and successor Richard I was taken into protective custody by Louis IV. Campaigning to bring the Normans under control and perhaps to reunite the fief to the crown's domains, Louis was in 945 taken prisoner by the Normans (who had been reinforced from Scandinavia or Denmark) and was handed over by them to the Robertian Hugh the Great, whom he had tried to entangle in his enterprise. Returned to his people, Richard withstood the last Carolingian attempts to subdue the duchy and, in 987, was instrumental in securing the French crown for the Robertian Hugh Capet, his brother-in-law.

Richard II, who succeeded his father Richard I in 996, held his own against a peasant insurrection, helped Robert II of France against the duchy of Burgundy, repelled an English attack on the Cotentin and conducted a war against Eudes, count of Chartres, against whom he asked for Danish help. On his death (1026 or 1027), his sons Richard III and Robert I (*see* ROBERT, dukes of Normandy) disputed the succession till the former's opportune death a year or two later. Robert I, known to legend as Robert

the Devil, obtained the Vexin Français from Henry I of France, whose side he took in the troubles following his accession. He died on his way home from a pilgrimage to Jerusalem in 1035.

Robert was succeeded by his bastard child William II (*see* WILLIAM I, king of England). Henry I of France took advantage of the situation to recover the Vexin Français, but supported William when the barons of the Bessin and the Cotentin rebelled, so that the rising was defeated in the battle of Val-aux-Dunes, near Caen, in 1047. In the 1050s, however, when William formed his alliance by marriage with Flanders, Henry turned against him. A French invasion from Picardy was defeated by the Normans at Mortemer in 1054 and a joint French and Angevin invasion at Varaville in 1058.

While the dukes had been consolidating their power for the past 150 years, the growth of the Norman population had outstripped the expansion of their territory. This explains the major role taken by sons of the Norman baronial houses in enterprises abroad: especially in the expeditions which led to the foundation of the Norman kingdom of Sicily. Comparable to the last-named achievement, but of far greater importance to Normandy itself, was Duke William's own conquest of England, from 1066.

During William the Conqueror's absences in England, Normandy was under the regency of his consort, Matilda of Flanders, with whom their eldest son Robert Curthose or Courteheuse (*see* again ROBERT) was associated from 1067 except when he was in rebellion against his father. Philip I of France, alarmed at his Norman vassal's excess of power, did what he could to weaken the duchy by favouring rebellion and invasion; and William died on an expedition for the recovery of the Vexin Français (1087). The personal union of Normandy and England was then broken: Curthose became duke as Robert II, but England passed to his next surviving brother, king as William II. The brothers, however, were not long at peace: Robert, as the more convenient vassal, had Philip's support; and William II was finally helped by his other brother Henry. On William II's death (1100) Robert's designs on England were frustrated by this other brother who became king as Henry I (*q.v.*). Fraternal quarrels continued, despite negotiation; and in 1106 Henry defeated Robert in the battle of Tinchebrai and became duke of Normandy himself. Louis VI of France took up the cause of Robert's son William the Clito against the revived Anglo-Norman power. Henry I, however, had his own only son William the Aetheling recognized as heir to Normandy and, in 1119, decisively defeated Louis VI and William the Clito at Brémule, in the Vexin Normand. When the Aetheling was drowned (1120), the Clito made further trouble in Normandy, but he died in 1128.

The Angevins and the French Conquest.—With Henry I's death (1135) the male line of the house of Rollo came to an end, and the Norman succession was long disputed. In 1144, however, Geoffrey Plantagenet, count of Anjou, second husband of Henry I's daughter Matilda (*q.v.*), finally won Normandy from the rival house of Blois. He and Matilda ceded the duchy to their son Henry in 1150. Having inherited Anjou and Maine from his father (1151) and acquired Aquitaine by marriage (1152), the duke became king of England as Henry II (*q.v.*) in 1154.

Efficiently divided for administrative purposes into viscounties under men who were originally the duke's vassals for their office but not for the territory that they administered (*baillis* were later appointed to supervise groups of viscounties), Normandy became a model state. It was also the geographic centre of the so-called Angevin empire. It was thus a primary objective for the Capetian kings of France in their struggle against the Plantagenet Angevins of England.

Louis VII of France, who had obtained the Vexin Normand as his price for recognizing the Angevin accession to Normandy, went to war with Henry on the latter's Aquitanian marriage, but later, by the treaty of Gisors (1158), agreed that Gisors and the Vexin Normand should be the dowry of his infant daughter Margaret, who was to marry Henry's eldest son Henry, later known as the Young King. Later intermittent warfare between Louis VII and Henry ended with the treaty of Montlouis (1174); but Philip II Augustus (*q.v.*) resumed the struggle. In 1187 he began by demanding the surrender of the Vexin, on the ground that Henry the Young King had died in 1183 and that the newly projected marriage of the latter's brother Richard (*see* RICHARD I, king of England) to the French princess Alice, who would have had the same dowry as Margaret, had not taken place. Philip supported Richard in the rebellion that hastened Henry II's death, and Richard was crowned duke of Normandy at Rouen in July 1189, before his English coronation.

The treaty of Messina (1191), which Philip and Richard concluded in Sicily on their way to the crusade, did not terminate the question of Gisors and the Vexin, which Philip consequently tried to annex, with the connivance of Richard's brother John (*see* JOHN, king of England), during Richard's captivity in Germany. On his return Richard won a great victory over Philip at Fréteval near Vendôme, in July 1194; but at the end of 1195 he concluded the treaty of Louviers, renouncing the Vexin Normand. He then began the rapid construction of the great stronghold of Château-Gaillard (*q.v.*), enclaved within the Vexin. When Philip had renewed hostilities in 1198, Richard won another victory at Courcelles in September; and by the treaty of Jan. 1199 the only Norman place left to Philip was Gisors. Three months later Richard was dead.

Though John secured the Norman and the English crowns (April–May 1199), his nephew Arthur of Brittany was put forward for the succession by a strong party in the other Angevin territories. Philip favoured Arthur till, by the treaty of Le Goulet (May 1200), he obtained from John not only the Vexin Normand but also the countship of Evreux, as well as concessions not affecting Normandy. Less than two years later, however, John was declared to have forfeited all his French fiefs; and in summer 1203 Philip invaded Normandy. Château-Gaillard, which John had retained, fell after a long siege; and when Rouen capitulated in June 1204 all Normandy was Philip's. Yet it was only with the treaty of Paris (1259) that the English crown specifically acknowledged the loss of Normandy to France.

Normandy and the Capetians.—Already under the Angevins there were communes in Normandy (*see* COMMUNE [MEDIEVAL]) and in 1204, when he entered Rouen, Philip Augustus had to guarantee the town's charter, the so-called *Établissements* (dating from *c.* 1170). Throughout the 13th century the arbitrary levying of services and taxes by the French kings was resented. To conciliate opinion Philip IV and Louis X issued the two ordinances together known as the *Charte aux Normands* (1314–15), guaranteeing a number of privileges to the duchy: there was to be no extraordinary taxation "save in absolute necessity"; vassals were not to be forced to do military service beyond the normal term due; freemen were not to be put to the torture save in grave presumption of a capital crime; and the Norman exchequer (a court of justice as well as a financial bureau) was to have cognizance of all cases arising within the duchy, without any evocation to the Paris parlement.

The Hundred Years' War.—In the first phase of the Hundred Years' War (*q.v.*) one of the Norman barons, Godefroy d'Harcourt, was already conspiring in 1343 against Philip VI of France and his son John (the future John II of France, on whom the duchy had been bestowed) before Edward III of England landed in the Cotentin in 1346. Subsequently the French position in Normandy was weakened by the fact that the malevolent Charles II (*q.v.*) of Navarre held lands there; but though the draft treaty of London (1359) stipulated cession to England, the treaty of Brétigny (1360) left Normandy to France.

Charles V, whom John had made duke of Normandy in 1355, began his reign as king of France by sending Bertrand du Guesclin to defeat the Navarrese at Cocherel on the Eure (1364); but in the Cotentin the English and the Navarrese long held their ground. French taxation led to the revolt of the Harelle in Rouen (1381–82).

The English king Henry V's victorious campaigns began with his capture of Harfleur in Sept. 1415; and by 1420 all Normandy except Mont-St.-Michel was in English hands. Though the English established a council for Normandy and emphasized the duchy's separateness from France (*cf.* the foundation of the University of Caen by Henry VI in 1432), there was always some resistance

to their regime; and after the death of the capable governor, John, duke of Bedford, this resistance gathered strength: the Pays-de-Caux rose in 1435, the Val-de-Vire in 1436. The French reconquest, however, was postponed till 1449. After the battle of Formigny (*q.v.*), in 1450, the last English strongholds surrendered.

The French Province.—Louis XI of France gave the duchy of Normandy to his brother Charles in 1465 but soon took it back and finally persuaded the French estates-general at Tours in 1468 to declare Normandy inalienable from the French crown. Thereafter Normandy was governed as a province, though for some time the *Charte aux Normands* was theoretically maintained. The exchequer became a *parlement*, with its seat permanently at Rouen. Norman participation in overseas exploration and trade from the start of the 16th century revived the maritime tradition.

Protestantism made great headway in Normandy, especially at the University of Caen. There was bitter fighting between Catholics and Huguenots in the periods 1561–63 and 1574–76 before the final contest between King Henry IV and the Holy League. Despite Henry's victories at Arques (1589) and at Ivry (1590), Rouen, with occasional relief from the Spanish Netherlands, held out for the League till March 1594.

Oppressive taxation during the Thirty Years' War provoked the rising of the *Va-nu-pieds* ("Barefeet") in 1639, which was ruthlessly put down. The attempt of the governor, Henry duc de Longueville, to rally Normandy to the Fronde in 1649 was a fiasco.

Louis XIV's intendants worked to assimilate Normandy's institutions to those of France and to promote still further its commerce and its maritime activity. The revocation of the Edict of Nantes (1685) led to a mass emigration of Huguenots, who had contributed greatly both to the economy and to the navy; but even so Normandy soon recovered its prosperity in the 18th century. The *départements* into which Normandy was dissolved in 1790 generally took a "federalist" attitude during the French Revolution, and the western areas were favourable to the Chouans (*q.v.*).

For the Normandy landings and the campaign of the Allies in 1944 *see* World War II. *See* also references under "Normandy" in the Index.

NORMANS, originally *Nortmanni* (Northmen), the term used generally in western Europe to denote the barbarian heathen pirates from Scandinavian lands, especially Denmark, Norway and, later, Iceland, who began to make destructive plundering raids on the west in the 8th century (*see* Viking). In the form "Normans" the term refers particularly to those Vikings who settled in northern *Francia* (the Frankish kingdom) and to their descendants, who together founded what became the duchy of Normandy and sent out fresh expeditions of conquest and colonization to southern Italy and Sicily, to England, Wales, Scotland and Ireland. The Normans did not themselves mark out the boundary of the territory they won in France: it was approximately the ancient ecclesiastical province of Rouen, itself in turn based on the Gallo-Roman province of Lugdunensis Secunda. But from an early period this territory acquired the name *Nortmannia* (Normandy) and this fact, together with the settlers' adoption of Christianity and the speech and culture of the Franks, shows that the people of Normandy must be regarded as historically distinct from, though clearly related to, the other pirate colonists of Scandinavian stock, whether in Britain, Ireland, the Loire valley or elsewhere.

Origins and Character.—During the second half of the 9th century, Viking raids on the northern and western coast lands of France had been growing in scale and frequency. In the last decades of the century a number of Scandinavians, of whom the majority were probably Danes, had secured a permanent foothold on Frankish soil in the valley of the lower Seine. In an unknown year during the first decade of the 10th century, a Viking named Hrólfr (Rollo), nicknamed the Ganger ("walker"), who had already gained a reputation as a great leader of Norse raiders in Scotland and Ireland, came to the Seine and soon emerged as the outstanding personality among the heathen settlers. Rollo was probably a Norwegian, the son of Rögnvald, earl of Möre (the district of Romsdal in western Norway). He had certainly achieved a leading position among the Seine Vikings by 911 when, as a result of the battle of Chartres, the Frankish king Charles III the Simple made the so-called Treaty of St. Clair-sur-Epte with the Vikings, allowing them to occupy the land between the Epte and the sea stretching from the Dives river on the west to the Bresle river on the east. It may be assumed that this Frankish concession was conditional on the Vikings' accepting Christianity and performing military service for the Carolingian monarchy. Within a generation (933) the Norsemen, still largely heathen in religion and piratical in behaviour, had extended their rule westward to Mont-St.-Michel, wresting from the Bretons the districts of Lower Normandy—the Bessin, Avranchin, Cotentin and Coutances. From 933 to the victory of William the Bastard at Val-ès-Dunes in 1047, the history of the Normans in Normandy (*q.v.*) was dominated by the struggle of a line of ruthless and forceful rulers, calling themselves variously counts of Rouen or Normandy and counts or dukes of the Normans, to establish political hegemony over the Frankish population of Upper and Lower Normandy and over their Scandinavian ruling class. In this struggle the two halves of Normandy were, not without difficulty, welded together, and the racial personality of the Normans was evolved.

Despite their permanent settlement in Gaul, their conversion to Christianity, their adoption of the French language, and their abandonment of sea-roving for Frankish cavalry warfare, the Normans retained many traits of their Viking ancestors. They displayed an extreme restlessness and recklessness, an unquenchable greed for wealth and power, a love of fighting accompanied by courage that was often foolhardy, and a craftiness and cunning which frequently went hand in hand with outrageous treachery. A reader of the sagas who turns to the chronicles that narrate the deeds of the Normans in Normandy, Britain or southern Italy cannot fail to be struck at many points by the close similarities between the Norsemen proper and their half-gallicized kinsmen: the astonishing daring of exploits by which, time and again, a mere handful of men would vanquish an enemy many times as numerous, the unequaled capacity for rapid movement across land and sea, the brutal, sacrilegious violence, the fondness for vivid and often unflattering nicknames, the precocious sense of the use and value of money—all these things were equally true of Norsemen and Normans. The conquest of Ulster by John de Courci (*q.v.*) might easily, for instance, in almost every detail, form the theme of a saga telling of some heroic Viking enterprise. In the same way, the part played by Bohemund I (*q.v.*) in the first crusade at once recalls the irresponsible bravery and cunning of a Viking freebooter.

Among the Norman traits regarded by contemporaries as specially characteristic, perhaps the most significant for history were their utterly unbridled character (*effrenatissima gens*, in the phrase of Geoffrey Malaterra, the 11th-century author of the *Historia Sicula*, [*The Sicilian History*]) and the capacity for quick and fruitful imitation and adaptation. The former was historically important because it meant that wherever a Norman state survived at all, as in Normandy itself, England or Sicily, it threw up, by a process akin to natural selection, a line of outstandingly able and ruthless rulers. William Longsword (d. 942), Richard II (d. 1027), Robert (*q.v.*) the Devil and William the Bastard, counts or dukes of Normandy; the last named (*see* William I) and his two sons, William II Rufus and Henry I, kings of England; Robert (*q.v.*) Guiscard (from Hauteville in Lower Normandy), his brother Roger I and nephew Roger II (*qq.v.*), rulers of Apulia and Sicily, were all among the most powerful and successful secular potentates of their age in western Europe. Provided that men of this calibre had good material to work upon, as they undoubtedly had in England and Sicily, they were able to create political institutions which proved stable and enduring (*see* English History: *The Normans*; Sicily: *History*).

The Norman Role in European History.—The Normans began as pagan destroyers, bent upon almost senseless plundering and slaughter. Forced to come to terms with the Carolingian and Capetian dynasties, to adopt French as their own language and Christianity as their religion, they quickly became missionaries and proselytizers of the civilization which they had attacked and which had ultimately absorbed them. They early grasped the principles

of Carolingian feudalism (*q.v.*), and Normandy became in the 11th century one of the most highly feudalized states in western Europe. Although the duke's own *servitium debitum* performed to the king of France was a mere ten knights, he himself could count on the service of hundreds of mailed knights, many of whom fought under the banner of the great Norman feudatories.

The art of castle-building was not a Norman invention, but the Normans became masters in the use of the simple yet enormously effective motte-and-bailey castle—a mound (motte) topped by a timber palisade and tower, surrounded by a ditched and palisaded enclosure (bailey). These little fortifications, which were complementary to the warfare conducted in open country by small units of cavalry, became the hallmark of Norman penetration and conquest. Again, although the Normans were at first learners and imitators in the practice of fighting on horseback, they took to cavalry warfare as to the manner born. Mounted on much the same breed of *destrier* or war horse as his Frankish, Angevin or Breton opponent, wearing the heavy mail *hauberk* or *byrnie* that was general among the warriors of northwestern Europe, protected by a conical helmet with long nasal, and by the familiar kite-shaped shield, armed with a long, broad-bladed sword and a slender lance, the Norman horse soldier of the 11th and 12th centuries proved on countless occasions that he could outfight and overwhelm the most powerful forces brought against him. To some extent, no doubt, this was due to the great importance which the Norman knightly class attached to the training of young warriors. They eagerly adopted the carefully fostered cult of knighthood, to some extent Christian in inspiration and based upon the belief that there should be in society an order of warriors dedicated to the art of cavalry warfare, which had grown up in the northwestern portion of the old Carolingian empire in the 10th and 11th centuries. But in the 11th century, when the Normans won their reputation, the Christian qualities in knighthood were almost negligible. The Norman knights were fierce and brutal mounted soldiers who had received an arduous training that left little room for the feelings of humanity and mercy with which Christian teaching was later to endow the concept of chivalry. To find a parallel it would be necessary to cite their terrible kinsmen, the Jomsborg Vikings, or even, still farther afield, the Seljuk Turks, barbaric mounted warriors whose role in Islam was curiously similar to that of the Normans in Christendom.

Just as the Normans became the typical exponents of Carolingian feudalism and of cavalry and castle warfare, so they also, though in a narrower sense, became the exponents and champions of religious orthodoxy. The conversion of the Scandinavians of Normandy was a slow and gradual process. Even by the end of the 11th century the Norman episcopate had barely accomplished the task of restoring one of the most desolated provinces of the western church. But under the patronage of the ducal house religious life flourished and a number of Norman monasteries, notably Bec, Fécamp, St. Evroul and St. Stephen's, Caen, became renowned centres of Benedictine life and learning. This was chiefly due to the encouragement given to non-Norman scholars and reformers, such as the Italians William of Dijon, Lanfranc of Pavia and St. Anselm of Aosta, to make their home in Normandy.

The great religious and ecclesiastical revival which marks 11th-century Normandy found another expression in the enormous popularity among the Normans of pilgrimages to Rome and the Holy land. This yearning for pilgrimages was one of the factors responsible for the Norman conquest of southern Italy (*c.* 1030–71) and of Sicily (1060–91). The other main factor was the emergence in the first half of the 11th century of what was virtually a new aristocracy in Normandy. In the struggles that accompanied this profoundly important social movement, and especially during the long minority (1035–47) of William the Bastard, many Norman nobles, and some younger sons with few prospects of inheritance at home, journeyed to the Mediterranean, inspired by a naïve mixture of religious devotion, love of adventure and desire for fresh conquests. In the south, once they had transformed themselves from casual bands of mercenaries and freebooters into the ruling class of a mixed Lombard, Byzantine and Saracenic state, the Normans stood for championship of the reformed and reforming papacy. In this situation there was an irony highly characteristic of the Normans, for their role as protectors of the Holy See and of orthodoxy was founded on the battle of Civitate, 1053, in which they inflicted a crushing defeat on a papal army under Leo IX, and on the terrible sack of Rome which they carried out ostensibly on behalf of Pope Gregory VII, in 1084. Surprisingly the part played by the Normans in the early crusades was relatively slight, consisting chiefly of the typically selfish and aggressive erection of the short-lived principality of Antioch by Robert Guiscard's eldest son Bohemund and his nephew Tancred. The role of the Normans in Europe in the 11th and 12th centuries may be summed up by saying that by their fierce energy and enterprise they extended the practice of centralized authoritarian rule, feudalism and cavalry warfare, and that through their simple devotion to the papacy they helped to spread the ideas of the reform movement in the western church.

Adaptation of Institutions in Sicily and the British Isles. —Geoffrey Malaterra said that the Normans were quick to imitate whatever they saw, and this faculty of imitation is evident in all the different countries where the Normans settled. But Norman imitation was never slavish, and is certainly not the whole story of Norman achievement. A truer explanation of Norman success would be that they combined a boundless self-confidence with a wonderful capacity for adapting to their own purposes the institutions they found in newly won territories. Thus, in Apulia and Sicily their control was based on faith in their own military superiority, in their strategic use of castles and harbours, and in their importation of feudalism to govern the relations of the count or king with his greater subjects. But in government they adopted the highly advanced and largely literate techniques already developed by the Greeks and Saracens. Though champions of the papacy, they preserved the existing tradition of religious toleration, which was accompanied by complete racial toleration. Without this toleration the Norman kingdom of Sicily would not have been possible. It was inevitable that the distinctively Norman character of Sicily should vanish during the 12th century, as the stream of Norman migration dried up, yet under the two Rogers and the two Williams it was, undeniably, a Norman vigour and attention to detail and a Norman concern for the strength of the royal financial system which made Sicily one of the richest and most powerful states of the Mediterranean.

North of the English channel, the Normans similarly brought their own brand of feudalism and their own ideas of strong personal government and fiscal institutions. But as in Sicily they adopted many existing native institutions and customs. In England even at the end (1135) of Henry I's reign the whole structure of royal government remained fundamentally Anglo-Saxon—monarchy, king's council, royal seal and writing office, the shire system and the sheriffs, the twofold revenue system consisting of the produce of royal estates compounded into annual cash payments, and a direct tax or geld levied on the landowning class, all originated from before the Conquest. But under Norman direction, and with a number of Norman innovations such as the exchequer, the itinerant justices and the sworn inquest (*see* ENGLISH LAW: *The Norman Age*), this system worked much more efficiently after 1066 than before, and, a fact of equal importance, England was made safe from foreign invasion. Norman influence on the church in England also worked powerfully in the direction of better organization and discipline.

In Scotland, after the accession of David I (*q.v.*) in 1124, the Normans penetrated in significant though never large numbers. They were encouraged by the ruling house and in consequence, though one can hardly speak of a Norman conquest of Scotland in the accepted sense, the Scottish kingdom by the late 12th century was thoroughly normanized in many features, notably military feudalism and methods of royal government. Here adaptation was of Celtic rather than Anglo-Saxon institutions, and the contrast between Scottish earldoms, to many of which men of Norman descent succeeded, and the English earldoms, which William I restricted and his successors turned into virtually honorific titles, remained striking as late as the 13th century. An earldom in Scotland remained an integral element in the administrative and

tary structure of the feudal kingdom. In Wales and Ireland, where the Normans settled at first in very small numbers, the degree of adaptation to native conditions was perhaps more marked than anywhere else. In Wales Norman lords acquired Welsh principalities and lordships intact and adopted many Welsh customs, including even the right of private war and a fixed share of booty captured from enemies. At the same time, they introduced towns and castles. The Normans in Ireland behaved in much the same way, though at first they were subject to a more stringent control by the English crown, which for a century maintained an efficient government at Dublin. Many Norman families in Ireland, however, as in Scotland, became thoroughly merged with the native population.

Summary.—The Normans had many shortcomings. Few intellectuals of eminence in the 11th or 12th centuries, still fewer spiritual leaders, were of pure Norman stock. Norman literature is negligible beside English or French. In the graphic arts little identifiably Norman work is outstanding. Norman architecture, impressively massive and enduring as it can be at its best, was a not specially original variant of the Romanesque of northern Europe. Nevertheless, they produced numerous leaders who worked for order and respect for the law in an age when barbarity and anarchy were still prevalent, and, in Sir Frank Stenton's phrase, "politically, they were masters of their world." *See* also references under "Normans" in the Index.

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NORMAN STYLE, in architecture, the Romanesque style developed in Normandy and England during the 11th and 12th centuries, up to the time of the general adoption of Gothic architecture in both countries. Since it was only shortly before the Norman conquest of England that Normandy became settled and civilized enough to produce an architecture, the origin in both countries is the same, and early types are extremely similar. This common early Norman differed from Romanesque in its love of geometric ornament such as zigzags, general crudeness in the scant figure and leaf carving, and a daring originality in construction ideas, possibly owing much to the fact that Lanfranc of Pavia (d. 1089) had introduced Lombard ideas into many Norman abbeys.

Although the English and French phases of the style were thus identical at the start, they soon became different. The French was characterized by careful structural articulation (Abbaye-aux-Dames and Abbaye-aux-Hommes, Caen, both founded in 1062 but altered later) and elaboration of tower and spire (St. Michel de Vaucelles, Caen, 12th century).

In England the chief characteristics are enormous length of church plan, the frequent use of great round columns for the nave arcade (Gloucester cathedral, 1089–1100; Tewkesbury abbey, 1123; and Durham cathedral, alternate piers, 1099–1128) and great decorative richness (Prior's door, Ely cathedral, late 12th century; St. Mary's chapel, Glastonbury abbey, 1186; the front of Iffley church, 12th century; and the Galilee porch at Durham, c. 1175). The general Norman structural genius is most markedly shown in the buttressing system and in the ribbed vault of Durham cathedral, whose date is much debated, being placed as early as 1133 and as late as the 13th century. *See* ROMANESQUE ARCHITECTURE; GOTHIC ARCHITECTURE; *see* also references under "Norman Style" in the Index.

NORNS correspond in Germanic belief to the *Moirai* (*see* FATE, in Greek; the name is found only in Scandinavian sources. They are usually represented as three and as spinning or weaving the fate of men. Some sources name them Urðr, Verðandi and Skuld, perhaps meaning roughly Past, Present and Future. In consequence of their presence at births, midwifery is sometimes associated with them. They are represented as dwelling by the "world tree," Yggdrasil's ash; and thus may also have been regarded as dispensers of blessing and fertility. (K. C. K.)

NORRBOTTEN, the northernmost and largest *län* (county) of Sweden, lies between the Gulf of Bothnia, Finland and Norway. Pop. (1960) 261,672; area 40,879 sq.mi. It extends for about 135 mi. from east to west, and for about the same distance from south to north, projecting into Lapland and the Arctic circle. From the coast, the land rises to the barren mountainous frontier with Norway, and there ancient rocks are exposed. In this district is the highest land in Sweden (Kebnekaise, 6,965 ft.), unexplored until 1880. The upland is crossed by depressions and that of Torneträsk allows a route to ice-free Narvik (*q.v.*), permitting winter export from the five iron-mining centres around Kiruna. A number of large, long lakes in these depressions help to regulate the river flow. Railways extend in the coastal zone through Boden to the frontier town of Haparanda (connecting with the different gauge of Finland) and inland through the Lapp centre of Jokkmokk. The region was occupied late by Swedish settlers but now has considerable significance through its mineral wealth. Few crops can mature in the short summer and timber is slow growing. The Lule river (Lilla Luleäv) has been harnessed at Porjus for power, which supplies the Narvik railway and industrial centres in the south. At Porjus and Luleå (*q.v.;* the county town) there is electrical smelting of iron. (A. C. O'D.)

NORRIS, FRANK (BENJAMIN FRANKLIN NORRIS) (1870–1902), U.S. novelist of the naturalistic school, was born in Chicago, Ill., March 5, 1870. He studied art in Paris and attended the University of California, Berkeley, and Harvard. He was news correspondent in south Africa, 1895; editorial assistant on the *San Francisco Wave*, 1896–97; and war correspondent in Cuba for *McClure's Magazine*, 1898.

Norris' *McTeague* (1899) is a tragedy of mean streets in San Francisco. *The Octopus* (1901), first of a projected trilogy, *The Epic of the Wheat*, pictures with bold symbolism the growth of the wheat in California and the struggle of the ranchers with the railway corporation. *The Pit* (1903) deals with wheat speculation on the Chicago board of trade, and *The Wolf*, unwritten at his death, would have shown the wheat relieving an old-world famine. *Vandover and the Brute* (1914) is a memorable study of degeneration.

After the example of Zola and the naturalists, Norris emphasized the determinism of heredity and environment in human life. Early influenced by Kipling and by popular notions of evolution, he exalted primitivism, but he finally adopted a more humanitarian ideal and began to view the novel as a proper agent for social betterment. He thus gave an impulse to the "muckraking" movement which followed, though he disavowed overt propaganda in the novel (*see* MUCKRAKERS). He strove to return American fiction, then dominated by historical romance, to more serious themes. Despite philosophic inconsistencies and romantic intrusions in his work, Norris was a writer of great original force. He died in San Francisco, Oct. 25, 1902.

Among his other works are: *Moran of the Lady Letty* (1898), *Blix* (1899), *A Man's Woman* (1900) and *The Responsibilities of the Novelist* (1903). His writings were collected (10 vol.) in 1928, and *The Letters of Frank Norris* edited by F. Walker in 1956.

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NORRIS, GEORGE WILLIAM (1861–1944), U.S. senator from Nebraska noted for his advocacy of many political reforms and of public ownership of hydroelectric power plants, was born on a farm in Sandusky county, O., on July 11, 1861. The death of his father and of his only brother left the family in straitened circumstances. At an early age Norris became the chief support of the farm household and was able to attend school only in the winter. Largely self-educated, he taught school and studied law at Northern Indiana Normal school (now Valparaiso university). He was admitted to the bar in 1883 and two years later moved to

Nebraska to begin practice. He was soon elected prosecuting attorney of Furnas county and in 1895 became district judge of the 14th judicial district, serving until 1902 when he successfully ran for congress as a Republican. He was re-elected for five successive terms, becoming leader of an insurgent group which in 1910 forced reforms in the house rules to reduce the autocratic control of the speaker.

In 1912 Norris was elected to the senate, where he served until 1943. As a senator he became known as an independent who, in his own words, "would rather be right than regular." His strong antiwar convictions led him to vote against the entry of the United States into World War I, and he denounced the Versailles treaty that followed it. He fought for many political reforms, such as presidential primaries and the direct election of U.S. senators. Norris was the author of the 20th amendment to the constitution which abolished the so-called "lame duck" sessions of congress. He introduced bills for the retention of Muscle Shoals as a government power-development project and for establishing the Tennessee Valley authority. The first TVA dam, completed in 1936, was named in his honour. He was also a leader in the demand for farm relief legislation and coauthor of the Norris-LaGuardia act, which restricted the use of injunctions in labour disputes and opened the way for a changed legal concept of labour-management relations.

Though always a Republican, Norris felt his party ties lightly; he endorsed Theodore Roosevelt in 1912, La Follette in 1924, Smith in 1928 and Franklin D. Roosevelt in 1932, 1936, 1940 and 1944. Norris spent a half century in public life, 40 years of it in congress. His last fight was an unsuccessful attempt to pass legislation outlawing the poll tax. He died Sept. 2, 1944, in McCook, Neb. In 1945 his book *Fighting Liberal* was published.

See Richard Lowitt, *George W. Norris: the Making of a Progressive, 1861–1912* (1963); Norman L. Zucker, *George W. Norris: Gentle Knight of American Democracy* (1966). (R. B. N.)

NORRIS, JOHN (1657–1711), English philosopher, notable both as a continuator of Cambridge Platonism and as an exponent of the theories of Nicolas Malebranche, was born at Collingbourne-Kingston in Wiltshire. Educated at Winchester and at Exeter college, Oxford, he became a fellow of All Soul's college in 1680. In 1689 he was appointed to the living of Newton St. Loe in Somerset. Thence in 1691 he was transferred to the rectory of Bemerton in Wiltshire, where he spent the remainder of his life. His numerous publications include poems and translations; moral and mystical writings; and theological and philosophical works, as well as a political tract, *A Murnival of Knaves, or Whiggism Planely Displayed and Laughed out of Countenance* (1683).

The poems (chiefly represented in his *Collection of Miscellanies*, 1687; *cf.* A. B. Grosart (ed.), *The Poems of John Norris*, 1871) and the translations must be ranked as minor works. The mystical and moral writings are those in which Norris shows most clearly the influence of the Cambridge Platonists, in particular that of Henry More and of Ralph Cudworth. In *An Idea of Happiness* (1683), following Plato, he places the soul's highest happiness in the contemplative love of God. *The Theory and Regulation of Love* appeared in 1688, with Norris' correspondence with More as an appendix. Other publications of this group were *Reflections upon the Conduct of Human Life* (1690), in the form of a letter to Lady Masham; *Christian Blessedness, or Discourses upon the Beatitudes* (1690); *Practical Discourses on Several Divine Subjects*, 3 vol. (1691–93); and *Letters Concerning the Love of God* (1695), being his correspondence with Mary Astell.

Norris' first considerable philosophical work was *Reflections upon a Late Essay Concerning the Human Understanding*, appended to the first edition of *Christian Blessedness;* in this he anticipated many later criticisms of Locke's theory, though he agreed with Locke in dismissing the doctrine of innate ideas. His adoption of Malebranche's theory of divine illumination involved him in controversy with the Quakers, against whose notion of "the Light within" he published *Two Treatises Concerning the Divine Light* (1692). His *Account of Reason and Faith* (1697) is one of the best of the many answers to John Toland's *Christianity Not Mysterious:* reason, according to Norris, is nothing but the exact measure of truth, that is to say, divine reason, which differs from human reason only in degree, not in nature. His most important work, *An Essay Towards the Theory of the Ideal or Intelligible World*, appeared in two parts (1701–04): the first treats the intelligible world absolutely; the second considers it in relation to human understanding. This work is a complete exposition of the system of Malebranche, in which Norris refutes the assertions of Locke and the sensualists. In *A Philosophical Discourse Concerning the Natural Immortality of the Soul* (1708) Norris defends that doctrine against Henry Dodwell.

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NORRISTOWN, a borough of southeastern Pennsylvania, U.S., is located on the north bank of the Schuylkill river, about 18 mi. N.W. of Philadelphia, the seat of Montgomery county. The present site was purchased by Isaac Norris and William Trent from William Penn, Jr., in 1704, and was originally known as Norriton plantation. When Montgomery county was created in 1784 the Pennsylvania legislature instructed that its courthouse be erected in Norriton township along the Schuylkill, and the community which grew around the courthouse was named Norristown and incorporated in 1812. The river and then a canal encouraged its growth, and in 1834 it obtained a railroad connection with Philadelphia. The city rises on gradual slopes northward from the river, with factories on the river shore giving way to increasingly better residential districts as the ground rises. Manufactures include metal and fibre products, machinery, drugs and tires. For comparative population figures *see* table in PENNSYLVANIA, *Population.* (R. F. WE.)

NORRKÖPING, a major port and industrial town of Sweden in the *län* (county) of Östergötland, stands on the Motala river 3½ mi. above its outflow into the Baltic trough through an inlet known as Bråviken, 113 mi. S.W. of Stockholm. Pop. (1965) 102,043. In the neighbourhood are some remarkable *hällristningar* (rock carvings) of the Late Bronze Age. The town was founded about 1350 and received its charter in 1384. Frequent fires (notably in 1719 when the Russians burned the town during the Northern War) have caused rebuilding on modern lines. The more important buildings include St. Olai church (1767; restored 1949); the town hall (1910); Hedvig's church (1673); two medieval churches, at Östra Eneby and Tingstad (with unique mural paintings); Holmen tower (1751); the grammar school (1862) and technical school (1959); and the museum and art gallery (1946). Louis de Geer (1587–1652), a Dutchman, is credited as being the first to introduce industry successfully there. The basis for development was the falls in the river, which afford motive power for the textile industry (which dominated Norrköping from the 1660s to the 1950s) and for factories producing food products, paper, lithography, radio and television sets, farm equipment, rubber and chemicals. The completion in 1961 of the fairway, the Lind canal, permits the harbour, now one of the most important in Sweden, to take vessels up to 30 ft. draft. Norrköping is a focus for both rail and road transport between Stockholm and the south and west of Sweden; there is an airport at Kungsängen on the eastern outskirts. (AR. J.; K. V. S.; B. H. HE.)

NORSE LANGUAGE: *see* NORWEGIAN LANGUAGE and SCANDINAVIAN LANGUAGES.

NORSE MYTHOLOGY: *see* GERMANIC MYTHOLOGY AND HEROIC LEGENDS.

NORTE DE SANTANDER, a department of the republic of Colombia, located in the eastern Cordillera adjacent to Venezuela. It was created in 1910 from the provinces of Cúcuta, Ocaña and Pamplona, which formed the northern part of the department of Santander. Area 8,037 sq.mi.; pop. (1964) 534,486. The eastern Cordillera bifurcates in Norte de Santander, one arm continuing northward as the Sierra de Ocaña and Sierra de Motilones while the other bends eastward to form the Venezuelan Andes. The largest rivers in the department drain into Lake Maracaibo. The Catatumbo region, near the Venezuela border, is an important oil-producing area. Agricultural products are grown largely for local use. In the cooler uplands wheat, potatoes, barley, maize and

horse beans are the principal crops. Coffee and sugar cane are grown on the middle slopes and lower valleys, as in the vicinity of the capital city of Cúcuta, pop. (1961 est.) 142,230. (Js. J. P.)

NORTH, BARONS. The English title of Lord North of Kirtling was created in 1554 for EDWARD NORTH (*c.* 1496–1564), a successful lawyer, clerk of the parliament (1531–40) and chancellor of the court of augmentations (1544–48). He was succeeded by his eldest son ROGER (1531–1600), 2nd baron, a courtier and soldier who married the daughter of Lord Chancellor Rich. Edward's second son was Sir Thomas North (*q.v.*), the translator of Plutarch. The 2nd baron's grandson DUDLEY (1582–1666), 3rd baron, son of Sir John North and of Dorothy, daughter and heiress of Dr. Valentine Dale, was educated at Cambridge and in 1600 married Frances, daughter of Sir John Brocket of Brocket hall, Hertfordshire. He was a prominent figure at the court of King James I and was a close friend of Prince Henry. In 1606 he discovered the springs of Tunbridge Wells, which cured North himself of a complaint and quickly became famous. He supported and subscribed to the expedition to Guiana made by his brother Roger North (*c.* 1585–*c.* 1652) in 1619, and when Roger departed without leave Dudley was imprisoned for two days in the Fleet prison. In 1626 he attached himself to the party of Lord Saye and Sele who was in sympathy with the aims of the house of commons, but when the Civil War broke out North took no part in it. In 1645 he was placed on the admiralty commission and acted as lord lieutenant for Cambridgeshire. He died at Kirtling on Jan. 16, 1666.

His elder son DUDLEY (*c.* 1602–1677), 4th baron, increased the family fortune by marrying Anne, the daughter of Sir Charles Montagu, brother of the 1st earl of Manchester. He was an accomplished and studious man. His numerous children included Francis (1704–1790), who became lord chancellor as Lord Guilford; Sir Dudley North (*q.v.*; 1641–1691), the economist; John (1645–1683), who became master of Trinity college, Cambridge, and professor of Greek in the university; and Roger North (1653–1734), the lawyer and historian. The eldest son CHARLES (1635–1691), 5th baron, was created Lord Grey of Rolleston (1673) during his father's life. Charles's son WILLIAM, 6th baron, died without issue in 1734, and the barony passed to a cousin FRANCIS NORTH, 3rd Baron Guilford and afterward 1st earl of Guilford (*see* GUILFORD, BARONS AND EARLS OF).

His son FREDERICK (1732–1792), 2nd earl of Guilford, is historically famous as Lord North, prime minister from 1770 to 1782 (*see* NORTH, FREDERICK NORTH, Lord). Frederick's son GEORGE AUGUSTUS (1757–1802), 3rd earl, left no male issue and the barony of North fell into abeyance till 1841 when it vested in one of his daughters SUSAN (1797–1884), wife of John Sidney Doyle, who took the name of North. Her son WILLIAM (1836–1932) succeeded as 11th baron, the title now being separate from that of Guilford. His great-grandson JOHN DUDLEY (1917–1941), 13th baron, succeeded to the title in 1938 but the title again fell into abeyance when he was killed on active service in 1941.

NORTH, SIR DUDLEY (1641–1691), English merchant, civil servant and economist, was born in Westminster on May 16, 1641, 4th son of Dudley, 4th Lord North (*see* NORTH, BARONS). He entered the Levant trade at an early age and spent many years residing in Smyrna and Constantinople and traveling, finally returning to England, a wealthy man, in 1680. He then served under Charles II as one of the sheriffs of the City of London and received a knighthood; under James II he was appointed a commissioner of customs; a confirmed Tory, he retired from public affairs shortly after the revolution of 1688. He died on Dec. 31, 1691.

His fame rests on the contribution to political economy made in his *Discourses Upon Trade: Principally Directed to the Case of the Interest, Coynage, Clipping, Increase of Money*, published anonymously in 1691 or possibly 1692. This work attracted little attention until rediscovered and reprinted in 1822, after James Mill had hailed the importance of Sir Dudley's ideas as summarized in the biography by his brother, Roger North, published in 1744. Research suggests that the preface of the *Discourses* and perhaps some concluding paragraphs advocating freedom of trade and enterprise were contributed by Roger.

The *Discourses*, though brief and aphoristic, are probably the most thoroughgoing statement of free-trade theory made in the 17th century. Though the older view is taken of trade as the exchange of superfluities, it is insisted "that the whole world as to trade, is but as one nation or people, and therein nations are as persons." Sumptuary laws and legal restrictions on interest rates are denounced as harmful and ineffective. Subsequent monetary doctrines are anticipated in the insistence that the supply of money can be left to free market forces "without any aid of politicians." The *Discourses* conclude: "It is peace, industry, and freedom that brings trade and wealth, and nothing else."

See J. R. McCulloch (ed.), ***Early English Tracts on Commerce*** (1856; reprinted 1954); W. Letwin, "The Authorship of Sir Dudley North's *Discourses on Trade*," *Economica*, vol. xviii, no. 69 (Feb. 1951). (T. W. H.)

NORTH, FREDERICK NORTH, LORD, afterward 2ND EARL OF GUILFORD (1732–1792), prime minister of Great Britain during the American Revolutionary War, for the conduct of which he was widely attacked. He was born in London on April 13, 1732, and was educated at Eton and Trinity college, Oxford. Elected member of parliament for Banbury at the age of 22, he represented the town (of which his father was high steward) for nearly 40 years. The duke of Newcastle made him a lord of the treasury in 1759 and he held this office under Lord Bute and George Grenville until 1765. On the fall of Lord Rockingham's first ministry in 1766 he was sworn a member of the privy council and made paymaster general by the duke of Grafton. On the death of Charles Townshend in Sept. 1767 he became chancellor of the exchequer.

North succeeded Grafton as prime minister in Feb. 1770 and continued in office for 12 of the most eventful years in English history (*see* ENGLISH HISTORY). George III had at last clinched the defeat of the Newcastle-Rockingham connection and found in North a congenial chief minister. The path of the minister in parliament was a hard one; he was popular and an able debater but at times he had to defend measures which he had not designed and of which he had not approved, and this too in the house of commons in which the oratorical ability of Edmund Burke and Charles James Fox was ranged against him. During peacetime North's financial administration was sound but he lacked the initiative to introduce radical fiscal reforms. The most important events of his ministry were those concerned with the American Revolution (*q.v.*). He cannot be accused of causing it, but one of the first acts of his ministry was the retention of the tea duty, and it responded to the Boston Tea Party with the Coercive acts of 1774. Underestimating the colonists' powers of resistance, he attempted to combine severity and conciliation. He faced war halfheartedly and was easily depressed by reverses; after 1777 it was only the king's repeated entreaties not to abandon his sovereign to the mercy of the Rockingham Whigs that induced him to defend a war which at times he felt to be both hopeless and impolitic. In March 1782 he insisted on resigning, after the news of Lord Cornwallis' surrender at Yorktown made defeat in the house of commons imminent. He had been rewarded for his assistance to the king by honours for himself and sinecures for his relatives, but in April 1783 North formed a famous coalition, much to George III's disgust, with Fox and became secretary of state with him under the nominal premiership of the duke of Portland. The coalition went out of office on Fox's India bill in Dec. 1783. For about three years North continued to act with Fox in opposition, but failing eyesight then caused his retirement from politics. He succeeded to the earldom of Guilford on his father's death in 1790 and died in London on Aug. 5, 1792.

See Sir Lewis Namier and J. Brooke, ***History of Parliament: the House of Commons, 1754–1790***, vol. iii (1964). (I. R. C.)

NORTH, SIR THOMAS (1535–1603?), English translator whose version of Plutarch's *Lives* was the source for many of Shakespeare's plays, was born in London on May 28, 1535. Possibly a student at Peterhouse, Cambridge, he was entered at Lincoln's Inn, London, in 1557, where he joined a group of young lawyers interested in translating. In 1574 North accompanied his brother Roger, 2nd Baron North, on an embassage to France. Thomas North had an extensive military career: he fought twice

in Ireland as captain (1582 and 1596–97), served in the Low Countries (1585–87?) and trained militia against the threatened invasion of England in 1588. He was knighted about 1596–97. He was justice of the peace for Cambridge in 1592 and 1597, and pensioned by the queen in 1601. He died in 1603 or soon afterward.

In 1557 North translated (from the French) Antonio de Guevara's *Libro del emperador Marco Aurelio con reloj de principes* under the title *Diall of Princes* (K. N. Colvile, ed., 1919). Guevara's elaborate prose influenced many early English translators, but North did not originate the mannered style which culminated in Lyly's *Euphues.* His translation (from the Italian) of oriental beast fables, *The Moral Philosophie of Doni* (1570; J. Jacobs, ed., 1888), was rapid and colloquial narrative. Plutarch's *Lives of Noble Grecians and Romans,* translated in 1579 from the French of Jacques Amyot, has been described as "after Malory's *Morte D'Arthur* and the *Book of Common Prayer* the earliest great masterpiece of English prose" (F. O. Matthiessen, *Translation: an Elizabethan Art,* Harvard University Press, Cambridge, 1931). There is an edition by C. F. T. Brooke, 5 vol. (1929–30). Shakespeare actually paid North the compliment of putting his prose directly into blank verse. (H. H. Ds.)

NORTH, THE, as a section of the United States, has always had rather indefinite boundaries, and its boundaries have varied from one period to another. In colonial times a distinction was sometimes drawn between the northern and southern mainland settlements of British America, with the Potomac river as the dividing line. Thus, in *The Administration of the Colonies* (1764), Thomas Pownall, who had become royal governor of Massachusetts in 1757, referred to the "Northern British Colonies" as distinct from the "Carolinas and other southern Colonies." More commonly, however, a threefold division was made: New England, the middle colonies and the south.

After the American Revolution the same kind of sectional classification was continued and, with the growth of the nation, was expanded. The pioneer American geographer Jedidiah Morse, in *The American Geography* (1789), wrote of "the *Northern,* or more properly *Eastern, Middle,* and *Southern* States." Later, as population spread beyond the Allegheny mountains, Morse and other geographers added the West as a separate section. In retrospect, the historian Frederick Jackson Turner (in *The United States, 1830–1850: the Nation and Its Sections,* 1935) defined and described a total of six sections as existing in the 1830s and 1840s. These sections consisted of (1) New England, (2) the middle Atlantic states, (3) the south Atlantic states, (4) the south central states, (5) the north central states and (6) Texas and the far west.

As early as 1796, in his farewell address, George Washington used the expressions "the North" and "the South" (as well as "the East" and "the West"). He warned that the federal union would be in danger if a time ever came when political differences were based upon geographical lines. By 1860 that time was at hand. Americans then commonly talked as if there were but two sections, the North and the South, and as if there were a fundamental conflict of interests between them.

The North, as it developed during the period between the Revolution and the Civil War, consisted of the free states. At the time of the Revolution, or soon afterward, 7 of the original 13 states abolished slavery. By the Northwest ordinance of 1787 slavery was prohibited in the Northwest Territory, and as new states were formed from that territory they made slavery illegal within their boundaries. By the Missouri Compromise of 1820 slavery was banned in the Louisiana Purchase north of latitude 36° 30′ except for Missouri, which was admitted to the Union as a slave state. California became a free state by its own choice and in accordance with the Compromise of 1850. By the Kansas-Nebraska act of 1854 the slavery prohibition of the Missouri Compromise was repealed; slavery was to be permitted in Kansas and Nebraska if the settlers in those territories desired it, but in 1861 Kansas was admitted with a constitution forbidding slavery. As of 1861 there were 19 free and 15 slave states, and the boundary between them followed the Mason and Dixon line (which separated Pennsylvania and Maryland), the Ohio river, and (except for Missouri) the latitude 36° 30′.

The question of slavery in the territories was the most prominent of the political issues that tended to unite the North and bring it into conflict with the South during the 1850s. Outright abolition was not a serious issue. Though a majority of northerners had come to feel that slavery was in some degree morally wrong, comparatively few of them joined or supported antislavery societies and still fewer believed that the federal government possessed the constitutional power to abolish slavery in the states where it was already established. In addition to the territorial question, however, there were matters of economic policy on which the North and the South differed. Generally the North favoured and the South opposed federal aid to industry and transportation through such measures as protective tariffs and direct expenditures for roads and canals.

The political differences between the North and the South reflected the differential economic and social development of the two parts of the country. In the North of the 1850s industrialization and urbanization had proceeded and were proceeding much further and faster than in the South. The ethnic composition of the people was more varied, with a considerably larger number of German, Irish and other immigrants settling in the North (though the proportion of Negroes remained smaller than in the South). The northern population was growing faster, the free states gaining by 41% and the slave states by only 27% between 1850 and 1860. There was more social and intellectual ferment in the "Yankee world," with its numerous and productive authors and its reform movements of all kinds. There was also a higher rate of both school attendance and literacy.

By the 1850s distinctions between the East and the West were obscured by those between the North and the South. At one time the West—both northwest and southwest—had formed something of an economic unit, with ties of trade that followed the Ohio-Mississippi river route. Then these ties were weakened and largely replaced by new ones joining the northwest with the northeast rather than the southwest. Among the new ties were the commerce of the Great Lakes and the Erie canal (opened in 1825) and the traffic of the railroads connecting the northwest with northeastern seaports. Chicago, for example, had a rail connection with New York by 1852.

The North attained its highest self-consciousness as a section during the Civil War. At that time "the North" was synonymous with "the Union." It included not only the free states but also the border slave states of Delaware, Maryland, Kentucky and Missouri (though there was considerable pro-southern sentiment in the border area, and Kentucky and Missouri were represented in the congress of the Confederate States as well as that of the United States). The North gained two states with the admission of West Virginia in 1863 and Nevada in 1864. Except for a brief period at the beginning of the war, the North maintained control of all the western territories except the Indian Territory (Oklahoma).

The 23 states of the Union (not counting West Virginia or Nevada) had a population of approximately 22,000,000, as compared with approximately 9,000,000 (including more than 3,500,000 slaves) for the 11 states of the Confederacy. The 23 states contained a disproportionate share of the economic resources of the entire country. The North possessed, for example, 81% of the factories and produced 75% of the nation's wealth.

But regional differences within the North reappeared even during the Civil War, when sectional unity was at its greatest. These wartime differences could be seen in such political controversies as that between Illinoisans demanding internal improvements (roads and canals) at federal expense and Pennsylvanians opposing them. The differences could be seen also in the agitation of the midwestern Peace Democrats, the so-called "Copperheads," who were motivated more by antagonism to the northeast and especially to New England than by attraction to the South.

During the postwar reconstruction (1865–77) sectional self-consciousness persisted in the North, and even after that time it was kept alive by Republican politicians who resorted to "waving the bloody shirt" (*i.e.*, recalling wartime hatreds) for electioneering purposes. But in the last two decades of the 19th century

East-West division in national politics often predominated over the North-South division. In the reform movements culminating in the Populist revolt, western and southern farmers aligned themselves against the "interests" of the East. Thus "the North" lost some of its validity as a sectional concept.

Meanwhile, in the later as in the earlier 19th century, geographers recognized no single North but divided the northern part of the United States into several regions. Thus William Swinton, in his *Elementary Course in Geography* (1875), listed New England, the middle states, the western or central states and the Rocky Mountain or Pacific states, in addition to the southern states. The federal census, in 1910 and after, included the northern states in the following classifications: New England, middle Atlantic, east north central, west north central, mountain and Pacific. The remaining census classifications (south Atlantic, east south central, west south central) included certain states that were at least partly northern in background and spirit—such as Delaware, Maryland, West Virginia, Kentucky, Oklahoma and Texas, not to mention the District of Columbia.

In the 20th century, geographers, sociologists, historians, business organizations and governmental agencies adopted various regional concepts to suit their own special purposes. It became less feasible than ever to treat the North as a single, clear-cut entity. Yet "the North" continued to be mentioned frequently in ordinary discourse. The term was used chiefly to indicate what was opposite from the South. Sectional self-consciousness both in the North and South increased with the rise of civil rights for Negroes as a major issue of national politics, especially after the supreme court's decision against school segregation in 1954. While, with respect to formal equality for Negroes, northern folkways were being resisted in the South, the northern pattern of life in many other respects was being readily accepted. Industrialization and urbanization, now proceeding even more rapidly in the South than in the North, tended to make the former more and more like the latter.

(R. N. Ct.)

NORTH ADAMS, a city of Berkshire county in northwestern Massachusetts, U.S., on the Hoosic river, is located in the northern Berkshires, 4 mi. S. of the Vermont border and 19 mi. N.E. of Pittsfield.

Within the city limits is a natural bridge 50 to 60 ft. high across Hudson brook. Among the city's educational facilities is State College at North Adams (1897). Manufactures include boots and shoes, machinery, electronic components, wire, paper, textiles and chemicals. Limestone is also quarried in the vicinity. In the western part of the city are the ruins of Ft. Massachusetts, built in 1745 by the Massachusetts Bay colony as a frontier defense and burned in 1746 by the French and Indians. Initially settled about 1737, North Adams had several false starts before being permanently settled in the 1770s by Quakers from Rhode Island. Incorporated as Adams in 1778, North Adams was set off and incorporated as a separate town in 1878; it was chartered as a city in 1895. For comparative population figures *see* table in MASSACHUSETTS: *Population.*

(R. C. L. S.)

NORTH AFRICA is that part of the African continent between the Mediterranean coast and the Sahara desert. The area in which the vast majority of its 50,000,000 inhabitants live is restricted to a fairly narrow coastal belt and to the lower Nile valley. Geologically, climatically and historically it belongs to the Mediterranean and to "White Africa," in contradistinction to "Black" or Negro Africa, the subcontinent lying south of the Sahara. The peoples of north Africa are relatively advanced and usually Muslim in religion. At various times they have been subject to European political control, and the economic links and cultural influences across the Mediterranean from southern Europe have usually been strong.

Most of north Africa has a marked dry season with low rainfall, and cultivation depends frequently upon irrigation. Egypt is an outstanding example of a country that can support more than 25,000,000 people, admittedly at a low standard of living, through intensive production based on the skilful application of irrigation. Elsewhere European settlers have been established, notably in Morocco, Algeria, Tunisia and in parts of Libya, and were formerly responsible for much agricultural production. Mineral deposits include iron ore, phosphates and petroleum, and manufacturing industries are well developed in many of the rapidly expanding towns.

There have been important political changes throughout north Africa since World War II. Reference should be made to the separate articles on the countries making up the region: ALGERIA; EGYPT; LIBYA; MOROCCO; TUNISIA; all these are independent sovereign states. *See* also AFRICA; ARAB; ATLAS MOUNTAINS; BARBARY; BERBER; LIBYAN DESERT; MOORS; NILE; SAHARA.

(R. W. SL.)

NORTHALLERTON, an urban district, market town and the administrative capital of the North Riding of Yorkshire, Eng., in the Richmond parliamentary division, 32 mi. N.W. of York by road. Area, 5.7 sq.mi. Pop. (1961) 6,726. It is on a slight eminence at the foot of the Cleveland and Hambleton hills, 3 mi. from the bank of the river Swale, where the western scarp of the Wolds causes the Vale of York to narrow to a width of 10 mi. forming the Northallerton Gate. Thus situated, midway between the coast and the manufacturing areas in the west of the county, it forms the gateway to the dales. The Romans are thought to have had a signal station there, on the terraced mounds of Castle hills, and the Conqueror chose it as a camping place for his army in 1068. According to the Domesday survey the Normans ravaged the area to such an extent that it was still waste in 1086. Northallerton suffered much from warfare with the Scots. In 1138 they were defeated by the English in the battle of the Standard, and their bodies were thrown into pits at a site still known as Scots Pits lane. In 1174 the castle was destroyed and in 1317 the town was burned by the Scots under Robert Bruce. Northallerton had been given by William Rufus to the bishop of Durham, whose successors continued to hold it until it was taken over by the ecclesiastical commissioners in 1865. According to an inquisition taken in 1333, the town, markets and fairs were held by the burgesses governed by two reeves and the bishop's bailiff. This form of government continued until 1851, when a local board was formed, and this was superseded by an urban district council in 1894. As a borough by prescription, Northallerton returned two members to the parliament of 1298, but was not represented again until 1640 when its earlier privileges were restored. From 1832 to 1885 it returned one member.

The church of All Saints, a cruciform building dating from 1120, is mainly Early English with a Perpendicular tower. Near it is the ancient Porch house, where Charles I was imprisoned, and the site of the Carmelite friary founded in 1356 by Edward III. Mount Grace priory, founded in 1397, was destroyed at the dissolution of the monasteries. Its ruins, 5½ mi. N.E. of the town, display one of the most complete ground plans in England of a pre-Reformation Carthusian monastery. The North Riding county library building was opened in 1938 in Northallerton. The town hall was built in 1874 with a market hall on the ground floor. The county hall was opened in 1906 and the county courthouse in 1936. The town has a considerable trade in dairy farming and has held a weekly fair since 1205. There are flour mills, metalworks, tanning and leather finishing, spring manufacturing, agricultural engineering, dried milk making, timberyards and laundering.

NORTH AMERICA, the northern part of the land mass comprising the Americas of the western hemisphere, which includes continental United States and Canada (sometimes referred to as Anglo-America), and Mexico and the countries and islands of the Caribbean area (generally called Middle America; *q.v.*). As thus defined, it is the third largest continent, occupying more than 9,000,000 sq.mi., slightly above 16% of the earth's land area, with a population of about 266,000,000.

North America is bounded on the north by the Arctic ocean, on the west by the North Pacific ocean and the Bering sea, on the east by the North Atlantic, with the Gulf of Mexico and the Caribbean sea to the southeast. It is separated in the northeast from Greenland (which is situated on the North American continental shelf and is sometimes considered part of North America) by Baffin bay. To the south, it is connected with South America by the Isthmus of Panama at lat. 7°–9° N., and extends for more than 5,000 mi. to 83° 7′ N. on the north coast of Ellesmere Island. Its

greatest width is about 4,000 mi., roughly bisected by the meridian of 100° W.

Tremendous cultural differences exist between the two major components of the continent. Canada and the United States have both experienced the colonizing effects of Great Britain, and many evidences of their common British heritage are evident, including a common language, common political and legal institutions, and many everyday customs. Middle America, on the other hand, received its cultural imprint more from Spain and Portugal, and like the countries of South America is primarily Latin in its culture.

Economic differences are as marked as social and political contrasts. Canada and the United States are outstandingly rich in natural resources and possess highly industrialized economies. In Middle America, farming, often at a subsistence level, is still the dominant activity; industrial production is very small when compared with that of the two large nations to the north, and the level of prosperity is decidedly lower.

This article is divided into the following sections and subsections:

It is not intended to present here the story of nations or of tribal peoples, but to summarize the continent's main natural, economic, anthropologic, historic and demographic aspects. These features receive further treatment in separate articles on the individual countries and regions, the major natural features, tribes and other specific subjects discussed. (C. F. Ko.)

I. PHYSICAL GEOGRAPHY

1. Geological History and Physiography.—North America may be divided into five areas which are roughly homogeneous with respect to the types of rock present and their structural relationships, the geologic history of the region and its present appearance.

Canadian Shield.—The Canadian shield includes some of the oldest rocks on the face of the earth. The region, as a whole, is composed of ancient crystalline rocks whose complex structure attests to a long history of uplift and depression, mountain building and erosion. Some of the ancient mountain ranges may still be recognized as a ridge or belt of hills, but the present appearance of the physical landscape of the Canadian shield is not so much a result of the folding and faulting and compression of the rocks millions of years ago as it is the work of ice in relatively recent geologic time. During the Pleistocene, the vast continental glaciers which covered northern North America had this region as a centre. The ice, in moving to the south, scraped the land bare of its over-

FIG. 1—PHYSIOGRAPHIC REGIONS OF NORTH AMERICA

lying mantle of weathered rock. Some of this material was deposited on the shield when the ice melted, but the bulk of it was carried south to be deposited in the Central lowland.

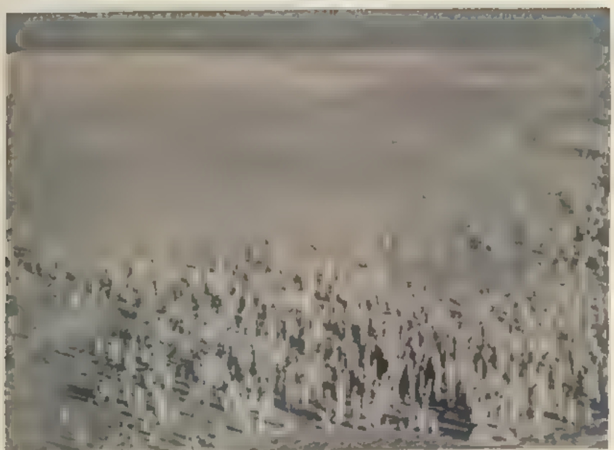
The resulting surface consists of rocky, ice-smoothed hills with an average relief of 100 ft., and irregular basins, which are mostly filled by lakes or swamps. In places, the old mountain ranges may be recognized by hills several hundreds of feet in height.

Central Lowland.—South and west of the Canadian shield the ancient basement of crystalline rocks was covered by sediments derived from mountains to the west and east, and from the shield itself. This broad region was little affected by the forces that warped the earth's crust. Domes and arches, basins and troughs can be detected in the structure of the old Paleozoic sediments of the central lowland, but within any local scene the rocks appear to be almost flat lying. The western portion of the lowland was veneered by more recent Mesozoic and Tertiary sediments derived from the Rocky mountains. These were eroded by the relatively few streams of the dry Great Plains into steep-sided river valleys and canyons separated by broad flat uplands.

The debris carried by the glaciers of the Pleistocene was dumped east of the Missouri river and north of the Ohio river. The tongue-like glacial lobes formed ridges and rows of hills 100 to 200 ft. high about their margins (end moraines) although most of the area within the lobes has a more even surface with hills ranging from 20 to 100 ft. in height. The disorder with which the drift was deposited resulted in many undrained pockets or depressions which filled with water to form lakes or swamps. South of the glacial border the old sediments form a hilly transition to the Appalachian highlands and their western extension—the Ozark-Ouachita upland. In this zone, the relief ranges up to several hundred feet, and is usually roughest along the many stream valleys which drain the area.

Plains of western Canada. Fields of ripening grain and farmsteads near Calgary, Alberta

...ridges and mountain glacial features, characteristic of the Cordilleran region, form a setting for Peyto lake, Banff National Park, Alberta



Arctic plains. Aerial view showing patchy coniferous forest, fading into tundra, north of the Arctic circle near Great Bear lake

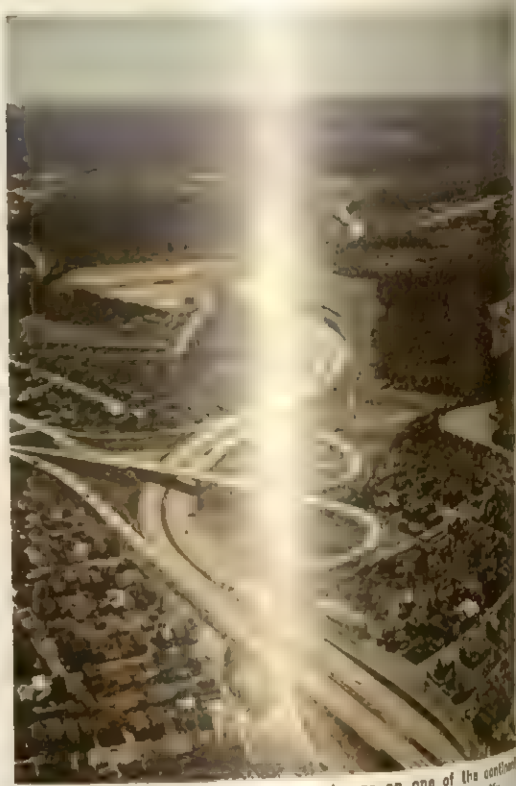
SCENES OF CANADA

PHOTOGRAPHS (TOP) GEORGE HUNTER FROM PUBLIX, (BOTTOM LEFT) AUVERT FROM PHOTO RESEARCHERS, INC., (BOTTOM RIGHT) JOHN P. KELSALL

New England littoral: a natural rocky harbour in Penobscot bay, Stonington, Me.

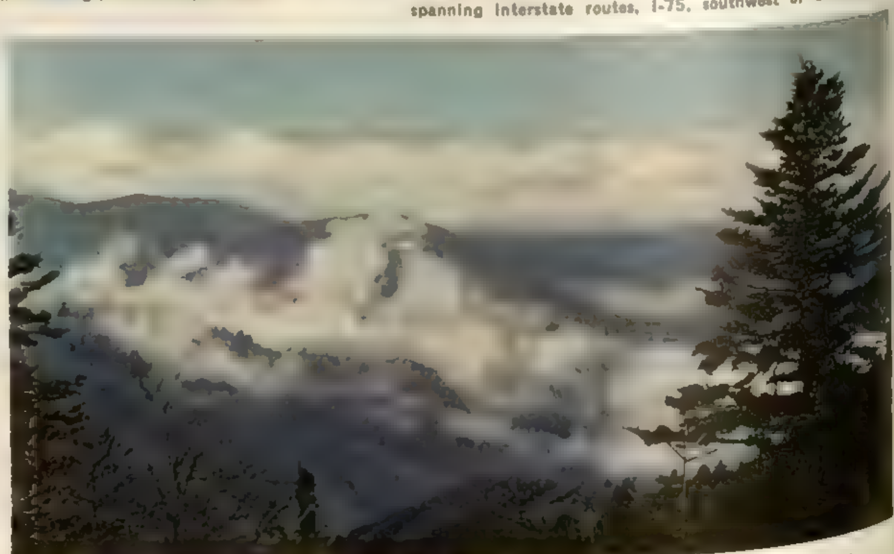
Northern Appalachian high[illegible] Green mountains, Peacham, Vt.

Coastal plains: pelicans lumber into the air from a nesting place at Cape Romain National Wildlife refuge, South Carolina



Interior lowlands: a cloverleaf interchange on one of the continent spanning interstate routes, I-75, southwest of Covington, Ky.

SCENES OF THE UNITED STATES

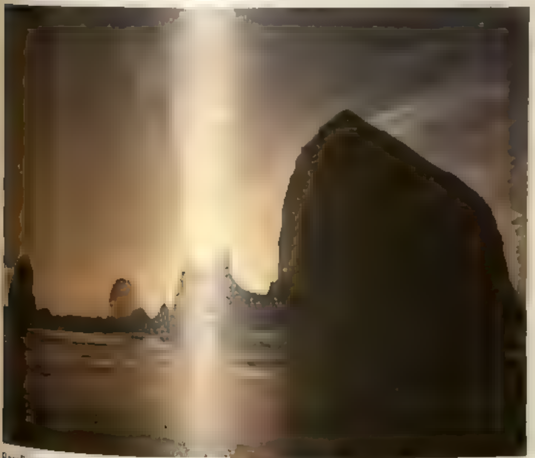


Southern Appalachian region: haze tints the peaks in the Great Smoky Mountain National park

PHOTOGRAPHS, (TOP LEFT, BOTTOM) BERNIE DONAHUE FROM PUBLIX, (TOP RIGHT) FPG, (CENTRE LEFT) "LIFE" © 1961, TIME INC., (CENTRE RIGHT) CHARLES E. ROTKIN—PFI

Central lowlands: islands [illegible] oughs of the Mississippi river near Lansing, Iowa. The Mississ[illegible] and its branches drain large areas of the interior and Gulf coastal [illegible]ns

Rocky Mountain system: fertile valley in Wasatch mountains, north of Provo, Utah. Rich mineral deposits have led to the industrial development of the area



Pacific coast: headland erosion has caused bizarre rock formations such as the Needles and Haystack at Cannon beach, Ore.

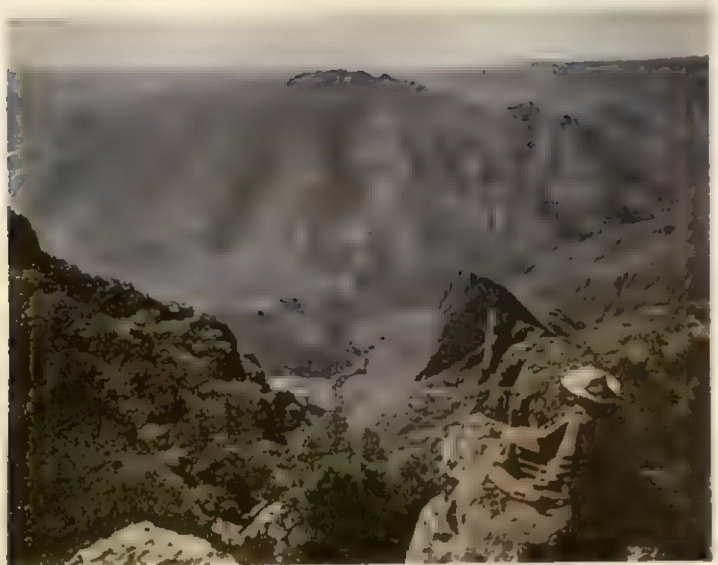
Pacific Mountain system: wilderness of the Sierra Nevada range. Deer watering at the Merced river in Yosmite National park

SCENES OF THE UNITED STATES

Basin and range region: gypsum sands of the White Sands National monument area near Alamogordo, N.M.

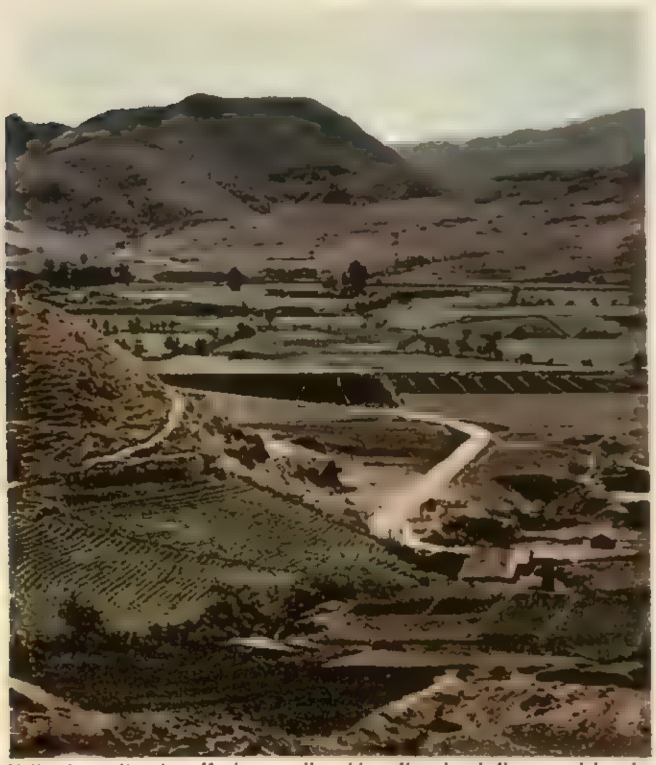
PHOTOGRAPHS, (TOP LEFT) LAURENCE LOWRY FROM RAPHO-GUILLUMETTE, (TOP RIGHT) HAL RUMEL FROM PUBLIX, (CENTRE LEFT) RAY ATKESON FROM PUBLIX, (CENTRE RIGHT) "LIFE" © 1961, TIME INC., (BOTTOM) A. C. SHELTON FROM PUBLIX

NORTH AMERICA



Sierra Madre Occidental: view from the western rim of the Barranca de Cobre in northwestern Mexico

Southwestern coast of [illegible] pulco has rugged coast, crescent beaches and tropical flora



Valley in southeastern Mexico: small arable valleys break the rugged terrain and provide most of the agricultural production in this region

Sierra Madre Oriental: Mt. Orizaba, snowcapped volcanic peak on the [illegible] of the states of Veracruz and Puebla

SCENES OF MEXICO

Appalachian Highlands.—Paleozoic sediments deposited at roughly the same geologic time as those of the central lowland were subjected to considerably greater uplift and folding and faulting in the area to the east. The area of most intensive mountain building is represented by the crystallized sediments of the Piedmont and the Blue Ridge mountains in the southern portion of the highlands and by the mountains of New England and eastern Canada to the north.

Directly to the west of the crystallized zone are ridges and valleys, their northeast-southwest lineament attesting to the compression from the east. Successive periods of uplift and erosion, accompanied by folding and faulting, created the complex structures that permitted the present topography to develop on the alternating hard and soft rocks of the area. The compressional forces died out to the west, and the land, although uplifted further and hence with greater relief, has much the same structural characteristics of the eastern portion of the central lowland. Throughout this hill region and the ridge and valley area, the relief ranges from 300 to 1,500 ft., with the steepest slopes and highest hills to be found along the valleys of the many streams which carve the area. (*See* APPALACHIAN MOUNTAINS.)

Coastal Plain.—The simplest structure of North America is to be found in the coastal plain. This is an area of relatively soft, young (Mesozoic and Tertiary) sediments overlapping the crystalline rock of the Piedmont in the east, the central lowland in the west, and extending as far south as the Yucatan peninsula. The rocks dip uniformly toward the sea, and the margin of the plain gives evidence of its youth in its extensive marshes and swamps, any of which could be converted to ocean floor by a rise in sea level of only a dozen feet.

The dip of the plain toward the sea has exposed successive bands of rock of varying resistance to erosion, creating belts of hills 100 to 200 ft. high alternating with flattish vales of very low relief.

Western Cordillera.—Somewhat younger than the ancient mountains of the Canadian shield and those of the Appalachian area, the high rugged mountains of the western Cordillera exhibit the greatest relief of the continent. The structural picture is so diverse as to include almost every conceivable type. The general north-south lineament of the ridges of varying rock type defines also the direction of the valleys and structural depressions which are filled with debris eroded from the mountain slopes. In the north and on the highest peaks in the south, glaciation has sharpened the ridge crests and provided still more debris with which to choke the valleys. Volcanoes, both active and dead, form some of the highest peaks and are often even the more impressive because of their relative isolation from other high mountains. Extensive outpourings of lava and the exclusion of some areas from intensive folding and faulting while they were being uplifted thousands of feet produced vast tablelands and plateaus. The rocks in this region range from the youngest sediments to the oldest crystallines, depending on the geologic history of the particular local unit.

Drainage.—The successive crustal movements by which North America was developed have determined the growth of several great river systems. The broad upheavals which developed the medial plains had the effect of engrafting many rivers from the eastern and western highlands upon trunks of unusual dimensions. Thus the Mississippi system, some of whose eastern tributaries probably date from early Mesozoic times, received great reinforcement by the addition of many long western branches in late Tertiary time, roughly contemporaneous with the uplift of the southern coastal plain, by which the lower trunk of the river was extended from its mid-length into the gulf. The present headwaters of that river trunk to which the name Mississippi has been rather arbitrarily applied are of very modern date, as they are consequent upon the abundant glacial deposits of northern Minnesota; and relatively modern courses appear to have been taken by the earlier-born Ohio and Missouri rivers around the margin of invading Canadian ice sheets, which displaced them from earlier courses.

The evolution of the Mackenzie resembles that of the Mississippi in a general way, but it presumably was much affected by glacial erosion and deposition, in consequence of which it, like the St. Lawrence, has many large lakes in its course. The regime of this great north-flowing river is strikingly unlike that of its south-flowing analogue on account of its course being from a warmer to a colder climate; hence while Mississippi floods have a free southward discharge, the floods of the Mackenzie have an obstructed northward discharge due to ice dams. Indeed, but for the complications that appear to be related to the outspread of Laurentian ice sheets, the areas drained by the Nelson and the St. Lawrence, now flowing to Hudson bay and St. Lawrence gulf, would be discharged by the Mackenzie and Mississippi. For a time, during the presence of the ice sheets, that simpler system was realized for the Mississippi, when it carried to the Gulf of Mexico much drainage now received by the St. Lawrence and Nelson; the flood plain of its lower trunk was probably given its wide breadth at that time.

Lake Superior is peculiar in apparently attributing its great depth to a somewhat pronounced displacement of its basin floor, in addition to whatever deepening it gained by glacial erosion.

The chief rivers that discharge to the Pacific rank below those that discharge to the Atlantic; but the Yukon, flowing from farther Canada and inner Alaska, is one of the great rivers of the world. The Columbia, of hardly inferior rank, drains a large area of the Cordilleran system in Canada and the United States; it is peculiar in having one of its head branches rise at the eastern base of the Rocky mountains in Montana, so that its waters flow westward through all the Cordilleran ranges of its latitude. The Colorado discharges a muddy current into the Gulf of California. (*See* also separate articles on the rivers.)

2. Climate.—The climatic character of an area derives from the operation of weather mechanisms over a long period of time. The weather of North America is of two main types: mid-latitude, the result of conflict between polar and tropical air; and tropical, in which cold polar air plays no part, and hence, in which frost is uncommon or nonexistent.

Mid-latitude Weather and Climate.—The vagaries of the weather of most of the United States and Canada are because of the location of the North American land mass in a zone of interaction between polar and tropical air masses. Air generally assumes the character of the surface over which it lies for periods of several days or weeks. As a result of the general circulation of the atmosphere, air masses are drawn together over North America from such unlike source areas as the Canadian arctic and the expanses of the Atlantic ocean in the tropics. The differences in the heat and moisture characteristics of these air masses result in the development of storms, known as cyclones. The zones of conflict between unlike air masses are known as storm tracks, the cyclones moving generally from west to east. As the northern hemisphere warms with the increasingly vertical attitude of the sun's rays in summer, the storm tracks shift northward. These shifts in the position of the storm tracks largely determine the nature of the climate of various portions of North America.

The Canadian arctic lies generally to the north of these storms, and is characterized by cold winters and cool summers with little precipitation in either season.

Winter is the time of greatest storminess. Many cyclones enter the continent from the North Pacific ocean, having originated over eastern Asia or the waters immediately off the Asiatic coast. These cyclones deliver little moisture in the lowlands, but the mountains of the western Cordillera cause lifting and chilling of the air, thus ensuring heavy rain and snowfall on the western slopes. Most of the storms enter the continent north of San Francisco bay, but an occasional storm delivers heavy rain to southern California.

As the cyclones from the North Pacific ocean move over the western Cordillera, they lose most of their moisture. Often these cyclones are rejuvenated as they descend the leeward slopes of the mountains into the central lowland. The more northerly of these are centred on the Alberta storm track, delivering small quantities of snow, but with a high frequency of occurrence, to the northern

central lowland and the Canadian shield, especially in the vicinity of the Great Lakes and the St. Lawrence valley. The more southerly storm tracks, called the Colorado and Texas cyclones, are able to draw in air from the Gulf of Mexico. This warm, moist tropical air enables much heavier snowfall to be delivered to the central lowland and the St. Lawrence valley, but with less frequency than is the case with the Alberta-type storm. This air, in crossing the southeastern United States, usually delivers heavy rain showers as well, so much so that some portions of the lower Mississippi valley actually receive more moisture under these conditions than in the summer season.

During the summer half year, the cyclone belts shift northward. The northwest Pacific coast receives storms from the Asiatic source area, but they are somewhat less frequent during this season and result in less rainfall than in winter. The shift of the storm tracks away from the southwestern United States creates desert conditions in the lowlands. The highlands receive thunderstorm rainfall from an occasional errant air mass of Atlantic ocean origin.

East of the Rockies a somewhat different picture prevails. The northward shift of the cyclone belts results in a lowered frequency of rainfall in much of the area, but this is more than offset by the torrential nature of the rainstorms that do occur. This is due to the tropical characteristics of the air which is drawn into the North American land mass from the Gulf of Mexico and the tropical areas of the Atlantic ocean. Most of the eastern United States and Canada receive the bulk of their moisture from summer thunderstorms and the cyclones which draw the tropical air northward.

Tropical Weather and Climate.—Tropical North America (Central America and the islands of the Caribbean and the Gulf of Mexico) is little affected by the mid-latitude cyclones. Instead, the weather and hence the climate of these areas is characterized by relatively monotonous heat, unaffected by frost except in the high mountains. The seasons are recognized by their wetness or dryness, rather than by cold or warmth.

Just as the bulk of mid-latitude North America receives most of its moisture during the northern hemisphere summer, so does this tropical regime. The mechanisms causing moisture to fall are more complex in the tropics, but seem also to be associated with the vertical attitude of the sun's rays. The same air that delivers moisture to the eastern United States and Canada in the summer drops rain from thunderstorms as it surges through this area. Hurricanes are common in late summer, and are also responsible for heavy precipitation.

The northern hemisphere winter is characterized by less frequent rain showers in this area, and by a predominance of clear, sunny skies.

3. Vegetation and Animal Life.—Patterns of vegetation and animal life generally conform to the broad controls of climate. On a more local scale, topography and soils have altered and modified these broad zones. Man has also made his impress, changing the pattern and character of the flora and fauna with the use of fire, the clearing of forests, plowing of grasslands, and grazing of domesticated animals. Thus the North American landscape of the 20th century shows the influence of all these factors. Temperature and moisture availability differences set the stage for consideration of the major variations in distribution.

Arctic.—The long cold winters and short cool summers of the far north create an environment that is too harsh for tree growth. Mosses in the extensive bogs, and lichens and short herbaceous plants on the better-drained uplands compose the bulk of the tundra vegetation. Relatively few animal species can exist there. Caribou, musk ox, polar bear and arctic fox are the larger varieties. Lemmings and the arctic hare are characteristic. Hordes of mosquitoes plague summer visitors. Few birds stay the winter, although many species migrate to nest there in the summer.

Subarctic.—Longer and milder summers to the south enable the forest to appear in the form of dwarf birches, willows, alders and spruce. As temperatures become less severe, the taiga or northern coniferous forest covers the landscape. Relatively pure stands of spruce, fir and several species of pine are intermingled with birch, willow, larch and poplar. There is little undergrowth except near

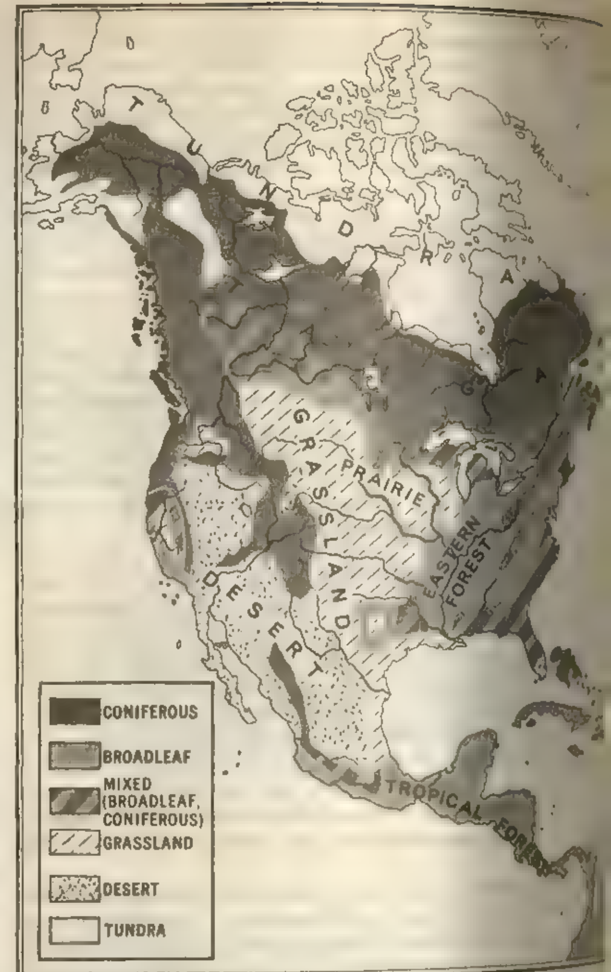


FIG. 2.—VEGETATION SOURCES OF NORTH AMERICA

streams. Carnivores, such as the black bear, lynx, fox an are present, as are deer, moose, elk and caribou. Rodents among them squirrels, porcupines, rabbits and beavers peckers and jays are common birds. Both arctic and sub forms trend far equatorward along the east and west coast where high elevations modify the warmer conditions lower latitudes. The western Cordillera blocks moisture winds and creates rain shadows that set lower timber-line based on aridity. There the conifers give way to desert an land forms.

The windward slopes of the mountains receive heavy pr tion, and near the Pacific ocean dense growth results giant forest trees 200 ft. or more in height. Cold te at high elevations result in an upper timber line vegetation is found above this level, which gradually de one proceeds north until, in central Alaska, trees are fou the valleys.

Eastern Forest and Coastal Plain.—In the central low clones bring warm tropical air as far north as the Gre Deciduous tree forms assume dominance in the landsc natural conditions, and the conifers die out. Birch, bee and oak are predominant in the north, and walnut oak and the tulip tree in the south. Much of the forest ha over, especially on the flatter uplands and in fertile The stream valleys remain wooded and provide shelter smaller mammals and birds that have withstood the pre civilization. Deer and fox may be found where there cover, and skunks, raccoons and muskrats join the squ rabbits as significant forms. Hawks and thrushes are birds. Numerous varieties of insects are present, as are reptiles.

The sandy belts of the coastal plain are generally co

er longleaf pine forests which may be relicts from glacial periods. The stream valleys of the coastal plain are likely to be very poorly drained, with swamp trees such as cypress and gum as dominant forms. The outermost margins of the coastal plain are occupied by marshes in which the characteristic vegetation consists of grass forms.

Grasslands.—Moisture variability from year to year and fire probably combined to slow the extension of forest vegetation into the dry west, after a climatic change had produced desert conditions in the heart of the interior. As a result, the first explorers found a broad belt of grassland between the forested humid east and the deserts of the west. The eastern portion has long been cultivated, but on the drier, western grasses, grazing is still the most significant land use and some semblance of the natural cover remains. The grasslands of the east consist of dense growth of tall varieties, often six feet or more in height. Glades occur in the forests, often on droughty limestone or sand plains.

In the prairie triangle of Illinois and Iowa, or on the margins of the Great Plains in Oklahoma and Texas, the grasses become dominant on the uplands. Only the stream valleys remain in forest or woods, for the break in topography of the belts of bluffs and the dampness of the bottom lands protect the trees from prairie fires and from drought.

The grasses and herbaceous vegetation of the prairies become less dense, and less tall bunch grass forms in the western steppe lands. These in turn form the transition to desert vegetation types in the driest parts of the west. Only along the moist valleys of perennial streams are cottonwoods and other deciduous trees to be found. Shrub forms, such as mesquite, are present in the warmer margins where high evaporation increases dryness, but they did not become dominant until man controlled fire.

Although lack of moisture in summer and occasional blizzards in winter constitute formidable hazards, large numbers of animals are found in the grasslands. Noteworthy were the tremendous herds of bison, which have been practically exterminated. Antelope, coyote, jackrabbits, prairie dogs and ground squirrels are common forms that remain in great numbers. Insects such as grasshoppers and locusts and ants are characteristic. Turtles, lizards and various snakes (some of them poisonous) have adapted to the environment.

Deserts.—In the desert even less moisture is available for plant growth than in the grasslands. The only perennial streams are those which flow from exotic, humid sources. Plants and animals have had to adjust to long periods with little or no moisture. Shrub forms become dominant over grasses; these include sagebrush, greasewood and creosote bush. High evaporation rates and topographic depressions combine to produce high saline concentrations in many of the soils. Thus, salt tolerance is another attribute necessary for plant growth. Around depressions or desert valleys there is often a zonation of plants, with the most salt-tolerant found nearest the centres, and the least on the better-drained uplands. In the driest places numerous forms of cacti are found. Some of these may attain heights of 20 to 30 ft. Much of this landscape is not suited to intensive grazing, and so only in the irrigated valleys was the natural vegetation materially disturbed.

The larger animals have difficulties surviving where water is so scarce. Fox are present and feed on rabbits. Owls, lizards and snakes may be found. But the total numbers and the varieties of wildlife are less than in more well-watered areas.

Tropical Forests.—The dry deserts and grasslands extend well southward into Central America. The better-watered portions of the tropics are covered by a dense growth of broadleaf evergreen trees. Several "stories" of tree and shrub growth are likely, with vines and lianas common. Seasonally well-watered areas are characterized by savanna, a tall grass landscape with scattered trees which are particularly dense near the water courses. Monkeys and squirrels, ants and termites, snakes and a wide variety of colourful birds constitute the animal life. In both vegetation and animal life, the number of species and the density of individuals increase in these frost-free, well-watered climates. *See* also the *Physical Geography* sections of UNITED STATES (OF AMERICA), CANADA, MEXICO, WEST INDIES, CENTRAL AMERICA; and ARCTIC, THE. (N. E. S.)

II. NATURAL RESOURCES

When the pioneers of Anglo-America took possession of the land there was a superabundance of natural resources. Subsequently, wasteful exploitation was not only condoned but frequently encouraged. Vast tracts of virgin timber were destroyed, wild game was killed and soils became eroded. This situation was further aggravated by the severe droughts of the 1930s and the consequent wind erosion in the dust bowl of the high plains. By mid-20th century, the U.S. and Canadian governments, alarmed at the wasteful practices and ignorance, undertook conservation measures and established agencies to study the problem. Genuine attempts are being made to gear the economic system to nature. (*See* WILDLIFE CONSERVATION; NATIONAL PARKS AND NATURE RESERVES; SOIL: *Soil Erosion and Conservation;* NATURAL RESOURCES.)

1. Water Resources.—In North America, as in other parts of the world, water has six major uses: domestic, irrigation, industry, transportation, power and waste disposal. Nearly all of these uses have expanded rapidly, partly because of expanding populations and industries, but also because per capita needs have been increasing rapidly. As a consequence, actual or impending shortages of water have occurred in many parts of the continent, not only in areas of small precipitation but also in many of the more densely populated portions of the humid sections. The availability of water has thus become a major concern for the people of North America.

Man has come to identify three principal sources of water: (1) precipitation, usually as rain or snow; (2) surface supplies, in the rivers, lakes and oceans; and (3) subsurface sources, usually brought to the surface by wells or springs. In North America, few attempts have been made to control precipitation, or to use that source of water directly, but there have been tremendous efforts to conserve waters by constructing reservoirs and other storage facilities in order to provide larger supplies at places not adequately served by lakes, rivers and other natural reservoirs. These reservoirs, both natural and artificial, have become the major source of water for the North American people. Underground supplies, including well water and spring water, were proved adequate only in a few areas with particularly favourable climate and geological conditions.

Water resources must always be viewed in the light of both quantity and quality. In populous industrial areas such as the northeast United States, southeast Canada and the central plateau of Mexico, so much water is utilized for sewage and industrial wastes that adequate domestic supplies are frequently difficult to obtain, in spite of the relatively heavy rainfall and large surface storage facilities of those areas. The natural mineral content of underground waters also varies a great deal, being very high in most areas underlain by limestone rocks and low in areas having acid rocks. In North America nearly all of the plains and plateau areas have limestone rocks and are consequently supplied with hard (mineralized) water from underground sources.

In the arid sections of northern Mexico, the western United States and portions of western Canada, water for irrigation is of prime importance. Giant storage reservoirs are used to hold winter precipitation until the water is needed for summer crops. Many streams in these areas have their sources in high mountains and, since many of the reservoirs are located at relatively high elevations, water power is cheaply and abundantly produced.

The most serious deficiencies of water appear in dry areas that have experienced marked urban development, notably in the Los Angeles (*q.v.*) metropolitan area of southern California where the new demands of a rapidly expanding population have been added to those of irrigation agriculture. An extensive system of aqueducts brings water to the area from the Colorado river; the Feather river project to make available water from the humid northern part of the state was begun in 1960 and a program of securing additional supplies by purification of sea water was projected. Long-distance transportation of water is not confined to

low-rainfall areas, however, since extensive supply systems were constructed to bring water to New York and other urban-industrial centres, usually from highland areas that lie considerable distances inland. In this manner, surpluses of water in many of the less populous areas were created to satisfy needs in metropolitan centres, where local supplies were inadequate.

Water for supplemental irrigation is being used increasingly by farmers in the upper Mississippi valley, where, in summer, short periods of drought may occur. Supplies usually are obtained either from wells or streams, and the severe competition for water prompted several states in that area to enact irrigation laws. Problems of water scarcity have appeared in all parts of the continent where there are considerable numbers of people.

Power, recreation and navigation uses of water differ from the others as they do not materially affect either the quantity or quality of available supplies. Hydroelectric power is most cheaply generated where there is heavy precipitation on high land. The best resources are therefore in the states and provinces that border the north Pacific coast of the United States and Canada, although eastern areas, which have splendid natural storage facilities in the Great Lakes and the lakes of the Canadian shield, also possess important power resources. Water for recreation is available in all sections of the continent, either in natural lakes and streams, or in man-made reservoirs and canals. Water transportation generally demands a relatively smooth terrain and a productive tributary area. In North America, the major navigation resources lie in the Great Lakes-St. Lawrence system, the Mississippi river and its branches, and the river systems of northwest Canada.

2. Soils.—Soils are classified in many ways, according to their colour, texture, origin and development, etc., but most significantly, according to the uses that can be made of them in agricultural production. A soil is valuable to man only in the light of its usefulness in producing a valuable commodity. This kind of perspective is necessary if we are to understand why, in North America, the best soils are those that can be made to successfully produce specific annual crops, especially the grain crops and cotton, which are of great importance in man's existence. Soils that produce only trees, grass or weeds, on the other hand, are usually considered less desirable, regardless of the lushness and vigour of their vegetation. Therefore, the quality of a soil is judged by its food-producing capacity, and if, in the course of human progress, this need changed, so would soil evaluations.

The geography of North American soils is most easily approached through the location of native vegetation, the dominant feature of which is a large, centrally located grassland region that is roughly triangular in shape, with apexes lying near the cities of Chicago on the east, San Antonio (Texas) on the south, and Edmonton (Alberta) on the north, and which has the richest soils of the continent. To the west and southwest lie the less fertile dry-land soils of the western United States and northern Mexico, which were formed under a vegetation cover of shrubs and related plants. To the north, northwest and east lie the less-productive soils of the areas that were originally in forest; and beyond them in the north are the generally infertile soils of the tundra. Only in the great central grassland did nature provide the physical environment necessary to form soils best suited for modern crop production.

The relative infertility of soils in both the dry regions and the humid forested regions is attributed to both climatic conditions and the characteristics of the parent material (rock) from which soils are formed. Limestone and its associated sedimentary rocks generally provide soils with minerals needed by grains and other annual crops. Soil-building materials in the central grassland region of North America generally contain those minerals, which were brought to the area mainly by (1) continental glaciers, in the area generally north of the Missouri and Ohio rivers; (2) streams of running water, in a broad belt lying immediately east of the Rocky mountains; or (3) wind, in scattered areas generally near the southern margins of the glacial deposits. In the southern portions of the central grassland area, much of the native surface rock has a high calcium content and is disintegrated into soils having these same general characteristics.

Outside the grassland region, where climates are either colder, drier or more humid, poorer soils usually occur. In the humid areas, deterioration is attributed to the removal of soluble minerals (especially nitrates, potash and phosphate) by heavy rainfall and the percolation effect of ground water, so that those minerals are available only to deep-rooted plants such as trees and vines. In the cold and dry regions poor fertility is due to lack of humus, the sparseness of the vegetation and consequent lack of annual contribution of vegetable matter such as roots, leaves and branches to the soil. Soils deficient in humus generally are unable to store moisture near the surface and thus cannot support shallow-rooted vegetation such as the grain crops and cotton. Mineral deficiencies of humid-climate soils may be offset considerably by the application of fertilizers; and water deficiencies in dry soils may be overcome by irrigation. Both these procedures provide good examples of the ways in which man can adapt his natural environment to his better advantage.

The foregoing describes only the very general features of soils geography in North America. Locally, there are many small areas where a combination of good parent materials and a favourable climate have produced soils of marked fertility. In the humid areas of the southeastern United States, as well as in Mexico and Central America, favourable materials often appear in the alluvial flood plains of major streams, the deposits of basaltic lava from nearby volcanoes and other fissures, and local occurrences of limestone. Soils derived from lava occupy many of the most fertile valleys of southern Mexico, and limestone soils are prominent in Cuba.

In the humid tropics, the river valleys, deltas and basins that can accumulate new (and unleached) minerals brought as alluvium from lime-rich upstream sources nearly always have the richest soils. In dry areas, the best soils usually occur in catch basins where water storage is sufficient to support considerable amounts of humus-giving vegetation. (*See* also SOIL.)

3. Minerals.—Most of the world's mineral wealth is taken from rocks that appear at or near the earth's surface. A few are derived from the waters of the sea, or from the atmosphere, but their quantities and economic importance are small. Among the great families of rocks, sedimentary types are the main sources for the production of the mineral fuels (coal, petroleum and natural gas), as well as most of the building stone, many kinds of rare earths and a few of the metals. It is from the other great families, the igneous and metamorphic types, however that most of the ores, the metal-bearing rocks of modern industrial civilization, are taken. The general distribution of the three kinds of rocks may therefore be used to identify areas in which these three great classes of minerals, the fuels, the metals and the other nonmetallic types, may be found.

Large areas of North America were occupied by ancient seas during geological periods when the mineral fuels were being formed with sedimentary rocks. The sedimentary regions include nearly all of conterminous United States, except for relatively small sections adjacent to the Atlantic and Pacific coasts as well as most of western Canada, Alaska and northern Mexico and large areas in the West Indies and beneath the Gulf of Mexico and Caribbean sea. Changes in the earth's crust, associated particularly with the appearance of the Rocky mountain system in the western portions of the continent, caused much of the sedimentary surface to be folded, broken, uplifted and in large part removed by erosion in areas affected by that major geological disturbance. Volcanic fires probably destroyed large amounts of fuels that were contained in sedimentary rocks, but at the same time, aided by the tremendous pressures present in the disturbance seem to have created favourable conditions for the concentration of metallic minerals into beds, veins and other deposits to form rich mineral-bearing rock. This process was frequently aided by the percolation of water through newly exposed rocks. These are believed to be the general circumstances under which the mountainous sections of western North America became the continent's leading source of ores, with the notable exception of iron.

Iron is mostly obtained from rocks that lie in the Canadian shield region near the margin of a much older mountain mass, whose interior rocks were long since exposed when the surface was removed by continental glaciation. These igneous and metamorphic rocks, which occupy most of eastern Canada and portions of the adjacent United States, are also important sources of nonferrous ores. Mines in the area of the Canadian shield, together with those in the Canadian Rocky mountains, provide a major element in the Canadian national economy. In Mexico the most important nonferrous metal is silver and in the western United States it is copper. Large reserves of iron ore occur in both areas, and there are many lesser metals, such as gold, silver, lead and zinc, much of which occurs in complex ores which yield several nonferrous metals. Metamorphosed and folded rocks in northern Arkansas yield bauxite for aluminum, and similar formations in Alabama yield iron ore for the Birmingham steel industry. Southeast Cuba also produces iron ore.

Outside the ore-producing areas lie the great sedimentary basins that extend from the Arctic ocean, on the north, southward through the middle of the continent, to the highlands of northern South America. There are produced most of North America's mineral fuels. It is of considerable significance that most of the continent's coal and a very considerable fraction of its petroleum and natural gas are produced near the margins of these sedimentary basins, where much folding and faulting was experienced in the formation of mountains. These crustal changes often had the effect of compressing coals into harder and more valuable fuels, and forming "traps" for the underground accumulation of petroleum and natural gas. Drilling of wells to great depths has shown that these crustal deformations often occur at considerable distances from present or former mountains, but the tendency for coal, petroleum and natural-gas production to transpire most prominently near the margins of the sedimentary basins is nevertheless a readily observed geographic fact.

Other minerals occur in almost endless variety. Some, such as sand, gravel and the stone that is crushed for use in concrete work, are found almost everywhere, but are of limited value, expensive to ship, and are mined only if a market exists. Others, such as gold and uranium, are extremely rare, and so valuable that they are likely to be mined wherever they are found. Thus, many communities in North America are connected with some sort of mining or related activity, but centres, where mining is the dominant element in the local economy, occur only where favourable conditions of geological occurrence and location in relation to markets are present.

4. **Land Use.**—Economic development of North America has been held within relatively narrow geographic limits by the character and spatial distribution of the resources described above. All such developments must be considered, however, not only in the light of available resources; but also as a consequence of the aspirations and productive capacities of the people who inhabit the continent.

The broad facts of land utilization include agriculture, manufacturing and trade, but the simple facts of economic development in North America indicate that less than one-fifth of the productive activity is concerned directly with the resources of nature and the raw materials that are extracted from the land, such as crops, minerals, fish and timber. The remaining four-fifths of the productive effort is devoted either to further refinement of natural materials that have already been transformed into manufactured goods, or to the rendering of services that satisfy human wants directly. In North America, the latter type of production is generally more important than the former, which is concerned with goods.

An understanding of the relative importance of the two kinds of production is vital to an understanding of patterns of land utilization in North America. In general, these considerations seem to indicate that conditions surrounding resource utilization and the production of raw materials may be expected to account for the location of only a minor fraction of the total productive activity and that the location of the remainder must be accounted for in some other way. In other words, there is no reason to expect the spatial distribution of production to bear any specific resemblance to the distribution of that continent's resources.

Nearly one-half of all the goods and services are produced in a relatively small area that lies generally south of a line drawn westward from Quebec in Canada, to Minneapolis in Minnesota and thence south to St. Louis, Mo., and eastward to Baltimore, Md. Other areas of major importance appear in southern California and in the southern portions of the central plateau of Mexico. These regions, which together constitute less than one-tenth of the land area of the continent, but which account for more than one-half its total production of goods and services, do not appear prominently on any map of raw-materials production. Their resources apparently are not ordinarily considered in surveys of the type undertaken here.

The most basic preliminary observation may well be that most of the working hours of the people of North America are spent in rendering services rather than in changing the form of goods. Fundamentally nearly all services must be rendered while in close proximity to the customer, as in the case of barbers, physicians, teachers, salesmen and many others. Thus it appears that the most important factor in the location of services is the presence of considerable numbers of people who have an appropriate volume of money and a desire for those services. But what brings these people to an area? The problem is further complicated, as frequent research shows that many types of manufacturing are attracted by potential customers; this provides a basis for understanding why the location of only a minor fraction of these productive activities can be accounted for in terms of the location of natural resources. What apparently happens is that in the early stages of production, the location of activity is rather closely adjusted to the existence of local resources. Raw materials leaving the farms, forests and mines, whose locations are adjusted to the presence of those resources, may be subjected locally to a small amount of elemental processing, such as canning, sawing or milling; but most of the work of increasing their usefulness is likely to be carried on in some distant location nearer markets for the finished products. These manufacturers, together with others in the region, attract additional service employees, and the ultimate outcome of this concentration appears in the great industrial cities and metropolitan regions.

The locations of markets for the continent's products must be considered in any explanation of the distribution of land uses. Historically, the greatest concentrations of population and productive activities first appeared at the western termini of the North Atlantic trade route to Europe, over which exports from Canada and the United States reached their most important world markets. Seaport cities with good harbours grew and prospered as this export trade expanded, and, in the process, developed large import, financial, industrial and other related economic interests. With the westward movement of population and production, these same types of activities were attracted to cities nearer those markets, and they sought sites mainly along major transportation routes, notably the Great Lakes-St. Lawrence waterway and the major trunk-line railroads. Climate and raw materials were also important in the rise of other metropolitan centres such as Los Angeles and the Federal District of Mexico. Many analysts believe that, in the long-run future, favourable concentrations of resources will come to outweigh historical factors in determining the location of economic activities.

By mid-20th century, regional planning (*q.v.*) in North America, demonstrated by the TVA, for large areas of like characteristics, grew out of a series of initiatives. Politically directed, it is based mainly upon the social and natural-resource structure, and economically seeks the fullest development of local resources and skills. Natural resources are also discussed in *The Economy* sections of articles on the various countries. (H. H. McC.)

III. ANTHROPOLOGY

1. **Ethnology.**—The American Indians had their origins in Asia, and are basically Mongoloid in physical type. The new world may be dismissed as the home of fossil human development

because no fossil progenitors have been found and the evolution of the primates clearly occurred in the old world. The date of arrival in North America as yet has not been accurately established but occurred sometime during the last glacial period. (*See* ARCHAEOLOGY: *Prehistory: The New World Prior to Urban Civilization.*)

Culture.—The earliest incomers to the new world possessed a series of traits that were relatively ancient and were shared with most cultural groups in the old world. These included the use of fire and the fire drill; the domesticated dog; stone implements of many kinds; the spear thrower, harpoon and simple bow; cordage, netting and basketry; crisis rites and shamanistic beliefs and practices. Important traits lacking in the new world but known in the old world included various significant domesticated animals, plants and artifacts—including cattle, sheep, the goat, pig, horse, camel and reindeer; wheat, barley and rice; the wheel and the plow; iron; and stringed instruments. The higher cultures of the new world, all possessing enough advanced traits to warrant calling them civilizations, were spread from the valley of Mexico south to Peru. The economic base of the American high cultures was horticulture with maize, beans and squash the staple crops. These crops were cultivated from the St. Lawrence river in the north to the Rio de la Plata in South America. The plants were tended by hand, using only the simple digging stick or a hoe.

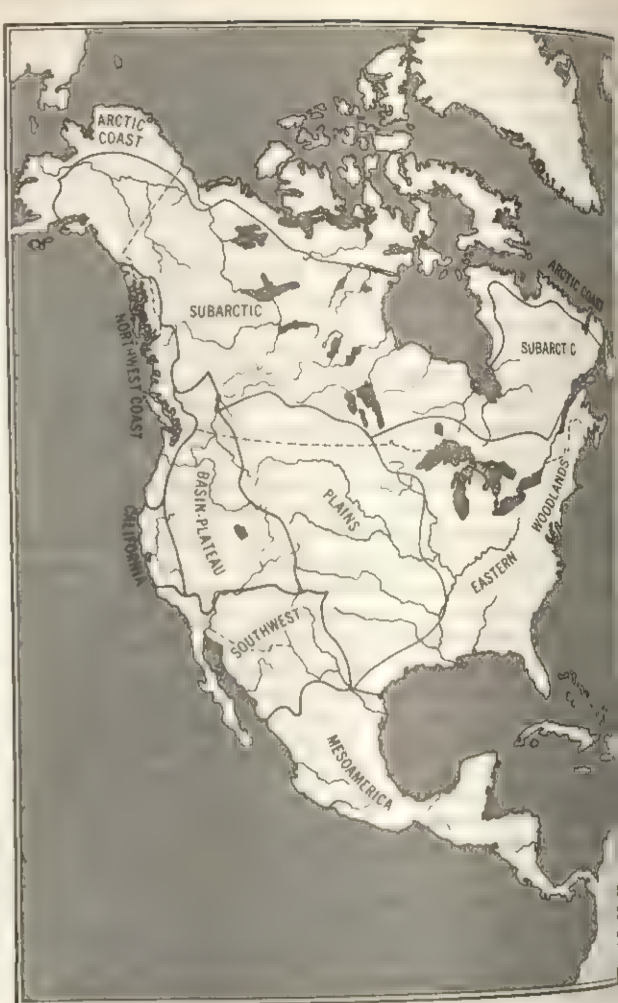
Middle America was a region of towns, therefore, of higher political organization, and in Mexico and Peru of considerable empires. The intellectual achievements, dependent upon the existence of a priesthood, culminated in the mathematical and calendrical systems and in an incipient system of writing employed by the Maya and Aztec. (*See* ARCHAEOLOGY: *Mesoamerica;* AZTEC; MAYA INDIANS; MIDDLE AMERICA.)

The question of whether or not the advanced techniques used by the higher cultures of America were independent inventions or the result of contact and borrowing from the old world is still debated. No evidence is presently available to document the possibility of old world contact, and until such evidence is forthcoming the most probable conclusion is that of independent invention. Analysis of the known intellectual achievements shows them to be unique. The Maya devised position numerals and a sign for zero, but their system of numeration was vigesimal and they were using the system several hundred years before the sign for zero was invented in the old world.

Culture Areas.—According to Harold E. Driver and William C. Massey there were at the time of European contact about 240 different tribal entities in North America; these were divided into a number of groups or culture areas. (*See* fig. 3.)

Classification of groups of tribes into culture areas is an attempt by anthropologists to reduce the complexity of cultural types to fewer, meaningful units. Ideally, a culture area is a geographic region inhabited by tribes that resemble each other in the totality of culture traits more than they resemble other tribes. Because of the variable diffusion of traits, however, there are often considerable differences among tribes within a culture area. In the Plains culture area of *c.* A.D. 1800 there were fully nomadic bison hunters, semisedentary hunters who practised some agriculture, and sedentary village farmers. The following classification is somewhat arbitrary but necessarily so in a brief summary. Nine culture areas are listed and indicated in fig. 3. The more important or better-known areas are described in separate articles and in *Prehistory and Archaeology* below. The main areas are: (1) arctic coast (*see* ESKIMO); (2) subarctic, which includes both Athapaskan and Algonkian forest hunters (*see* CANADA: *Native Peoples;* ATHAPASKAN; ALGONKIAN TRIBES); (3) northwest coast; (4) basin-plateau, the area of somewhat marginal cultures in the intermontane west; (5) California; (6) southwest, including northern Mexico (*see* PUEBLO INDIANS); (7) plains (*see* PLAINS INDIANS; SIOUAN INDIANS); (8) eastern woodlands (*see* MUSKOGEAN INDIANS; IROQUOIS); (9) Mesoamerica (*see* AZTEC; TOLTEC; ARCHAEOLOGY: *Mesoamerica*).

Indian Population.—The number of Indians in North America at the time of Columbus was estimated by A. L. Kroeber at about 1,000,000 north of Mexico and about 5,000,000 in Mexico and Central America. Numbers fell significantly after contact with the



FROM A. L. KROEBER IN "AMERICAN ARCHAEOLOGY AND ETHNOLOGY"

FIG. 3.—CULTURE AREAS OF ABORIGINAL NORTH AMERICA

Europeans, mainly because of increased warfare and some diseases such as measles and smallpox which were fatal to Some tribes became extinct; others merged and lost their Since about 1910 the Indian population has steadily increased, some, like the Navaho (*q.v.*), were more numerous in the than in aboriginal times.

2. Languages.—The outstanding characteristic of American Indian languages is their diversity. There are more than 60 guage families in North America, comprising over 500 languages but these have been reduced to a smaller number of superstocks Edward Sapir and others. No genetic relationship to any language group in the old world has been fully demonstrated as yet may conclude from this that the ancestors of the Indians left old world so long ago that any relationship was lost through guistic change. (*See* AMERICAN ABORIGINAL LANGUAGES, TRAL AND NORTH AMERICAN LANGUAGES.)

3. Physical Anthropology.—American Indians are not form in physical type but are basically Mongoloid. They some distinctive traits, including reddish-tan skin colour nounced cheekbones, prominent noses, thin lips, well-developed chins and heavy faces. Hair and eye colour is uniformly dark cept in cases where admixture with Europeans has occurred. of the classic Asiatic Mongoloid physical traits, such as epicanthic eye fold and fatty cheeks, are generally absent in the new world populations, excepting the Eskimo.

See also INDIAN, NORTH AMERICAN; INDIAN, LATIN-AMERICAN FOLKLORE (AMERICAN INDIAN); and *The People* sections of cles on the various countries in the Americas. (R. J. R

IV. PREHISTORY AND ARCHAEOLOGY

North American prehistory is a complex and variable record man's adaptation to the various continental environments and

his developing culture over more than 25,000 years. The earliest records of the peopling of North America are scanty and it is difficult to characterize their culture beyond calling it a hunting and gathering economy with simple stone and bone tools. The earliest remains were found in the western United States, Mexico and South America. First settlers seem to have crossed the Bering straits region from Asia during the expansion of the last major Pleistocene ice sheets. As the great ice sheets developed and expanded they not only covered major land areas in the northern hemisphere but they also brought considerable areas of the continental shelves above sea level. In the arctic this provided a tundra coastal plain across which man could move from Asia to North America. The amount of the earth's moisture incorporated into the ice probably lowered the sea level hundreds of feet. Asia and America were thus not separated by the gradual rise of the sea until about 9,000 years ago; likely sites of the earliest migrants are now below sea level.

Some authorities believe that the culture of the earliest inhabitants is represented by crude scrapers shaped by percussion, choppers, knives and a few bone perforators. Such tools are equated with an eastern Asiatic mid-Pleistocene complex which lasted well up into the Late Paleolithic when more advanced and varied industries were developed in western Asia and Europe and spread east and northeast.

The Americas were the last major land mass, with the possible exception of Australia, to be occupied by prehistoric man, who first had to develop the cultural equipment to exist in the arctic area. Once this adjustment was made, during the Würm-Wisconsin glaciation he was able to move, by way of the nonglaciated areas, into the Mackenzie basin and into continental United States. The time of the initial dispersal into North America is estimated to be between 25,000 to 35,000 years ago. Some period of time should be allowed for the gradual spread of the first Americans throughout the varied environments during the retreating phase of the Wisconsin ice. There were significant displacements of vegetational and climatic zones to the south during this period.

1. Early American Hunters.—In contrast to the sparse knowledge of the period from 25,000 to 10,000 years B.C. is the considerable body of data on the cultural pattern of primarily hunting people whose remains were found from the Pacific to the Atlantic and from the Gulf of Mexico to the borders of the last major stand of the Pleistocene ice sheets in the north central United States between 10,000 and 8,000 years B.C. (*See* fig. 4.) In spite of regional differences in detail there was a remarkable similarity in the industrial complex of these people. They lived in a variety of environments, from mountain passes and valleys in the west to the then better-watered grasslands of the plains, and the varied forest and park-land environment of the eastern woodlands. Their projectile points (a variety of fluted forms), scrapers, perforators, knives and a variety of bone tools indicated that one of their major food supplies came from animals, whose hides provided clothing. In the western plains and the southwest they hunted such extinct North American animals as the camel, ground sloth, tapir, mammoth and horse.

FIG. 4.—APPROXIMATE BOUNDARIES OF EARLY AMERICAN FLUTED BLADE HUNTERS AND AREA OF DESERT CULTURE IN NORTH AMERICA AT 8000 B.C. (IMPORTANT SITES AND CULTURE GROUPS OF PERIOD SHOWN)

In the Great Lakes area of the eastern woodlands they may have hunted mastodon, but other commoner animals such as the elk and deer presumably formed the bulk of their meat diet. Some of their bone and wooden tools were probably used for working and ornamentation. These early hunters had temporary shelters and moved about as small bands in search of game. Their presence was known primarily from "kill" sites and a few areas indicated temporary occupation along streams or lakes. Their physical type is not clearly known but it was related to that of the eastern Asian Late Paleolithic population and is less Mongoloid than many groups of American Indians of the historic period.

2. The Desert Culture.—In the western United States from Oregon to northern Mexico and from the Pacific coast to the eastern foothills of the Rocky mountains there was a distinctive cultural adaptation to the dry, upland environment. From before 8000 B.C., to the historic period in some areas, there existed a desert culture type (*see* fig. 4–6) that may be viewed in a general way as an equivalent to the Archaic level in the eastern United States.

The Desert culture people lived as small bands of wandering seasonal food gatherers, collectors and hunters. They ate a wide variety of animal and plant foods and developed techniques for small seed harvesting and processing. Their best-known habitations were caves and rock shelters. Found preserved because of the dry environment were twined basketry, nets, mats, cordage, fur cloaks, sandals, wooden clubs, digging sticks and in some instances even desiccated bodies. They had the spear thrower, with darts of pointed hardwood or with points of flint and later of obsidian. Their rough stone implements were shaped by percussion and consequently many of their choppers and scrapers had a Paleolithic appearance. When these were discovered on open sites where organic materials were not preserved they gave a false impression of great antiquity. Their projectile points however showed excellent craftmanship and followed continent-wide styles. Milling stones and handstones were a prominent feature of Desert culture sites. The dog, another migrant from Asia, was known by about 4000 B.C., and was also found at this time in eastern Archaic sites.

3. California.—On the far west coast in California, the marked variety of geographical situations developed a number of regional complexes dependent upon intensive exploitation of the local resources. None of these were agricultural, although population density in some of the more favoured areas appears to have approached that of the early farming cultures of the southwest and east. In the southern desert area the people subsisted upon plant seeds and small game with utilization of crude flint tools, grinding stones and (later) arrowheads, the main implement forms recovered. In the mountainous area of the state and in the better-watered central areas, larger game animals such as the elk and deer, supplemented by acorns, fish and birds, were the major food supply. By at least 2000 B.C., in this central area, the utilization of the local resources plus cultural intrusions from the north resulted in the adaptation that only changed in minor details up to the historic period. The coastal groups from north to south depended upon the sea for their food supply, some subsisting mainly on shellfish, some on sea mammals, others on fish and still others a mixture of all three. All of these may be said to be on an Archaic level of development, but they are probably better viewed as developed regional variants of the Desert culture. The intensive regional adaptations probably account for the linguistic variability and many small tribal groups found in California at the historic period.

4. Northwest Coast.—In the north Pacific part of the United States and in western British Columbia, some of the early sites of the hunters had fluted blades, crude choppers and cutting tools. Between 9000 and 7000 B.C. there were varied economic activities but with an emphasis on hunting. By about 8000 B.C. some sites showed a strong orientation toward salmon fishing, particularly during the salmon runs, and tended to emphasize the use of bone and antler tools. The burin, a chisellike bone working tool, was found in these levels along with prepared cores and blades. During the postglacial warming period which culminated between 3000 and 2000 B.C. the inhabitants of the dryer areas without permanent streams took on more of the traits of the Desert culture to the south, while others turned toward riverine fishing and marsh resources or to food from the sea. In the first millennium B.C. the Marpole complex, a distinctive ground slate complex, was known in the Fraser river area with basic resemblances to the northwest coast historic culture in maritime emphasis, woodworking, large houses and substantial villages. The emphasis on ground slate and woodworking tools is like that in the eastern boreal forest Archaic, and recalls similar emphasis in northwestern Siberian early Neolithic cultures. Another culture trait of ultimate Siberian origin which came to the British Columbia area shortly after A.D. 1 was a second introduction of the polyhedral core and blade, regarded as a distinctive part of the Arctic Small Tool tradition. In most of the areas of the northwest coast clear indications of the beginnings of the historic cultures were not known until about A.D. 1300.

5. The Eastern Archaic.—In the eastern woodland area, partly as a result of the variety of forest environments, climatic differences and physiographic features, there developed a series of regional adaptations to local food supplies. The change from the primarily hunting economy of the early American hunters was gradual and is clearly seen in slowly evolving projectile point and other implement changes. The pattern of life became one of mixed hunting and collecting, with some groups by 6000 B.C. developing a taste for riverine and coastal living with abundant fish and mollusk resources to supplement the vegetational products such as acorns, seeds, berries and tubers.

During the long eastern Archaic from 8000 to 1500 B.C. regional diversification was developed and strong continuities or traditions may have been seen in local areas, some of which are named in fig. 5. These reflected both the greater exploitation of regional environments through generations of experimentation and greater familiarity with the resources, and the resultant resistance of the environmentally conditioned culture to group mobility. It was during the Archaic that significant early linguistic diversification probably occurred, and during which varieties of physical types developed.

The typical Archaic house was a small circular structure with wooden posts for the wall and roof supports. The covering was probably bark. Cooking was done in the open by boiling in containers of wood, bark or hides or by baking in pits or by roasting and grilling. Identification lists of mammal, fish and bird bones from Archaic sites read like a listing of the early historic fauna. Various game-gathering devices, including nets, traps and pitfalls, were used besides the spear and dart thrower. Fishhooks, gorges and net-sinkers were known, and in some areas fish weirs were built. River, lake and ocean mollusks were consumed and their discarded shells formed large shell middens near the favourable collecting areas. The deep shell middens have preserved a record of stylistic change and the introduction of new industries to the Archaic economy. While relatively little of the vegetal foods were preserved, nut hulls are known and the grinding and pounding stones attest to this type of food supply. Probably a great many native roots, berries, fruits and tubers known as used in the early historic period were incorporated into the diet during the Archaic. Also the extensive list of plant medicines recorded by the early colonists were probably a part of the primitive Archaic pharmacopoeia.

The large variety of chipped-flint projectiles, knives, scrapers, perforators, drills and adzes reflect regional styles and changes during the long Archaic period. The Late Archaic was distinguished by the gradual development of ground and polished, grooved stone axes, celts, pestles, gouges, adzes, plummets and forms attached to the spear thrower. This was a reflection of a growing versatility in the technology and economy. Trade and exchange are also known from the distribution of native copper implements from the Michigan-Wisconsin area to as far south as Louisiana and Florida, and the finds of southeastern marine shells as far north as the upper Mississippi-Great Lakes area. An extensive system of trails and water routes was probably in existence during the Late Archaic.

The great boreal forest zone of spruce, fir and pine which now runs from New England and the maritime provinces of Canada

FIG. 5.—HUNTING AND GATHERING CULTURES IN NORTH AMERICA, ABOUT 3000 B.C.

westward to the Canadian plains and the Mackenzie valley gradually acquired its present distribution following the retreat and melting of the Canadian ice cap. Its present distribution was reached by about 2500 B.C. This forest zone is not well known archaeologically because of its inaccessibility and the absence of modern settlements. The forest cover and the climate had a limiting effect on the cultural development and on the general pattern of hunting and fishing. These efforts were supplemented by some use of plant material. The early historic Algonkian tribes of the area from the Naskapi on the east to the various Cree (*q.v.*) and Ojibwa (*q.v.*) bands to the south and southwest of Hudson bay were the cultural descendants of the cultural adaptation which took place in this forest zone.

In the upper Great Lakes area the Old Copper culture has a special interest because copper implements and weapons were made from the native copper of the Lake Superior basin. This culture appeared about 3000 B.C. and lasted about 2,000 years. It was a northern expression of the Late Archaic. Its tools and weapons, particularly in the adzes, gouges and axes, clearly indicate an adaptation to the forest environment. In the area south of James bay to the upper St. Lawrence about 2000 B.C., there was a regional variant called the Laurentian Boreal Archaic and in the extreme east the Maritime Boreal Archaic. In this eastern area, slate was shaped into points and knives of similar form to the copper implements to the west. Trade between the eastern and western areas could be recognized and this evidence, along with general similarities of the culture, suggests that water transportation by canoe was known at this time.

Along the southern border of the central and eastern boreal forest zone between 1500 and 500 B.C. there developed a distinctive burial complex, reflecting an increased attention to burial ceremonialism. These burials, many including cremations, were often accompanied by red ochre, caches of triangular blanks, fire-making kits of iron pyrites and flint strikers, copper needles and awls, and polished stone forms. The triangular points of this complex may have represented the introduction of the bow and arrow from the pre-Dorset and Dorset cultures east of Hudson bay. The earliest Woodland pottery appeared in the Great Lakes area about 1000 B.C. It is another of the culture traits derived from northeastern Asia and across northern Alaska to northwestern Canada. The route by which it reached the Great Lakes is not known.

6. The Plains Archaic.—In the western plains from about 8000 to 3000 B.C. the fluted blade points were no longer made, and many styles or types were produced which were identified by such local names as Plainview, Angostura, Milnesand, Agate Basin, Scottsbluff and others. These minor varieties of dart and spear point and their primarily hunting culture may be included in the term Plano. The Plano complex or culture type was a direct descendant from the fluted blade early American hunters. Their primary game animal was the bison, for the larger animals of the preceding period had died out or were exterminated.

The stone complex associated with the Plano hunters was markedly similar from site to site over a considerable period of time during which the climate became increasingly warmer and until the major warm period was reached about 3000 to 2000 B.C. As the climate moderated, peoples of the Late Plano complex moved north into Saskatchewan and Alberta (*see* fig. 5) with the grazing game animals, and by 3000 B.C. had reached the arctic tundra zone in the Northwest Territories of Canada at Grant and Dismal lakes and Great Bear river. Important elements of this culture also moved east in the Mississippi valley and western Great Lakes area. Many of the sites of this culture type were kill sites with abundant bison bones which accounted for the number of implements and tools associated with hunting and leather working. In the tundra zone the major game animal was the caribou. However, some choppers, pounders and milling stones were known, and living sites indicate that the Plano economy was not as limited as it may seem.

7. The American Arctic.—There is little evidence of man in the American arctic in the period between 25,000 and 10,000 years ago, and only scattered finds and no excavated sites of culture which could have occupied the period between 8000 and 5000 B.C. There were some finds of fluted blades and of Plano forms which probably reached Alaska via the Mackenzie corridor, and also knives and graving tools of immediate Siberian origin which may have been of this same antiquity. In the Seward peninsula and in the Brooks range there were indications of a land hunting and to some degree sea-mammal hunting group which may have been related to some of the boreal forest cultures to the south. Their estimated time period would be from 5000 to 3000 B.C. Interior Alaska and western Canada are not well known archaeologically.

Between 3000 and 2000 B.C. the Arctic Small Tool tradition developed in northwestern Alaska. It was based on the hunting of caribou and other tundra animals along with some dependence on sea mammals. This culture included some elements from the northern spread of the Plano hunters to northwestern Canada but was primarily derived from northeastern Asia. It gradually spread eastward in the Canadian tundra to the northwest and northeast side of Hudson bay, into extreme northeastern Canada, and to western and northern Greenland. This eastern spread was accomplished by 1000 B.C.

In the dominant culture centre of the arctic, the Bering sea area, there developed from 500 B.C. to A.D. 500 a number of cultures identified as Paleo-Eskimo whose primary adaptation was that of sea-mammal hunting. These cultures blended elements of the earlier Arctic Small Tool tradition with pottery and other traits from the Lena valley, and with elements from cultures which developed along the northeastern Siberian coast. The sea-mammal hunting economy gradually moved eastward as the Thule culture and became the economic base for most of the Eskimo groups in the central and eastern coastal arctic by the time of European expansion into the area. Another branch of the sea hunting culture was found in southeastern Alaska where it came into the historic period with the Aleut and western Eskimo.

8. Early American Planters.—Primitive agricultural practices began in Mexico by 6000 to 4000 B.C., and by approximately 2000 B.C. were known on the northern fringe of the Mesoamerican culture area. Maize was not the only crop plant, for gourds, squash, peppers, cotton and varieties of beans were also domesticated. Maize was grown in the southwestern United States by 2000 to 1000 B.C. but most of the other domesticates did not arrive until just before and after A.D. 1. The early introduction of maize in the southwest had no marked effect on cultural development, and the existence of pottery, storage pits, domestic houses with semisubterranean floors and lateral entryways were not known until about A.D. 1. These houses had wood uprights for walls, central roof supports, radiating beams and wattle and daub plastered walls. Ceremonial houses were much larger than the domestic homes and they show no evidence of everyday occupational debris. Two important cultural traditions, Hohokam and Mogollon (*qq.v.*), developed in southern New Mexico and Arizona (*see* fig. 6). These two traditions, developed from similar late preceramic phases of the Desert culture, were influenced by similar traits from northwestern Mexico but evolved into different complexes as the result of differing environmental conditions and subsequent cultural accretions from Mexico (see *Southwestern Village Farmers* below). The early Anasazi (*q.v.*) culture expressions called Basket Maker of the Four Corners area (namely northwestern New Mexico, southwestern Colorado, southeastern Utah and northeastern Arizona) were primarily stimulated through contact with Mogollon populations to the south. These early small settlements were the first village agriculturalists in the southwest.

On about the same time level were the first village cultures of the east which, however, developed an elaborate burial ceremonialism. The cultural expressions of the east known as Early Woodland were in some part a development from Late Archaic complexes and in part stimulated by new techniques and concepts which came into the area from a number of directions. Woodland pottery was introduced from northeastern Asia about 1500 B.C. and burial mounds made their first appearance slightly later (*see* MOUND BUILDERS). It is believed early agricultural activities began about 1000 to 500 B.C. although clear evidence for this in the humid east is not yet available. It is not certain whether agriculture was introduced directly from northeastern Mexico or by way of the southwest. The best-known culture types were

Adena, which began in Early Woodland in the Ohio valley, and Hopewell (*q.v.*), which marked the beginning of Middle Woodland in the northern Mississippi and Ohio valley. Both these cultures were stimulated by the arrival of concepts and practices from Mexico that were recognized by the production of figurines, ear spools and certain ceramic innovations such as the negative painted pottery. Late Adena and Hopewell reached their peak of development and expansion during a relatively warm minor climatic phase between 200 B.C. and A.D. 200, which allowed a northern spread of this early agricultural economy into Wisconsin and the southern half of Michigan.

The village areas of Adena and Hopewell varied in size from ½ ac. to about 5 ac. Circular and oval houses for single family occupancy were built of wood and bark, and storage and refuse pits were excavated in the village area. The villages were usually located in major stream valleys adjacent to, or on, easily tilled alluvial flood plains. The earthwork patterns of Ohio valley Adena and Hopewell were placed in or near the village and are ceremonial expressions not clearly understood by archaeologists. The size and complexity of these geometric earthworks and the accompanying burial mounds compare favourably with those of northwestern Europe during the Bronze and Early Iron ages. Extensive trade and travel by these people was proved by raw materials brought into the Ohio-Illinois areas from the Rocky mountains, North Dakota, Lake Superior, the southern Appalachians, and the Gulf and South Atlantic seacoasts. Ohio, particularly, served as a distributing centre for ceremonial goods and special products over a wide area in the eastern United States. These cultures were the first indications of craft specialization and of social stratification.

FIG. 6.—DISTRIBUTION OF EARLY AMERICAN FARMERS AND CONTEMPORANEOUS GROUPS IN NORTH AMERICA ABOUT A.D. 1

There is a clear evidence of cultural regression between A.D. 200 and 700 in the north-central United States following the Hopewell expansion and florescence. This is attributed to a minor cold phase which did not allow a continuation of agriculture in this area under the techniques then current. While there was concurrent change in the south, this did not take the form of a lowering of the cultural level.

9. Eastern Village Farmers.—The last major cultural development in the eastern United States is called Mississippian because its primary centre was in the valley of the Mississippi river, and along its major tributaries, and in the southeast. This predominantly agricultural complex was a marked cultural advance over earlier stages in the east. Its initial growth and expansion was at approximately the same period (A.D. 700–1200) as that of the southwestern Anasazi complex. (*See* fig. 7.) The initial growth was along the Mississippi between modern St. Louis and Vicksburg. It was stimulated by the introduction of concepts, religious practices and improved agricultural procedures from northern Mexico, which resulted in a sedentary societal organization. By A.D. 1000 large villages were in existence with subsidiary villages and farming communities nearby. Regional specialized production in pottery, projectile points, house types and other utilitarian products reflected the tribal groupings of the period. The outstanding feature of this culture type was the earthen temple mound, which served as a raised platform on which the major community buildings were placed. These council houses and "temples" served as the political and ceremonial centres. The platform mounds were placed on the sides of a central plaza which served as a ceremonial centre for the tribal community during the important recurrent functions or during times of crisis. The more permanent buildings, both family and community, were of wattle and daub construction, usually rectangular in floor plan. In some areas large, circular charnel houses received the remains of the dead, but burial was normally made in large cemeteries, or under the floors of dwellings. The size of the ceremonial tribal centre varied from 10 ac. to 100 ac. Important household industries involved the production of mats, baskets, clothing and a variety of vessel forms for specialized uses. Food surplus was kept in ground storage pits and in storage cribs above the ground.

One of the more striking developments was the production of ceremonial costumes and ornaments, for use in the religious ceremonies that were conducted by an organized priesthood with a well-established ritual. The religious symbolism spread throughout the Mississippian complex and a number of centres of production of specialized ceremonial items are known. Other innovations were walled fortifications with timber palisades and bastions surrounding the village, which reflected an increase in intergroup aggression and a tendency, continuing into the historic period, toward the development of confederacies. The intergroup conflicts apparently were primarily quests for prestige and revenge instead of means of territorial expansion or economic control.

Many of the tribal groups of the early historic period parts

pated in the Mississippi culture. Among these were the Caddoan-speaking tribes of Arkansas, Oklahoma, Texas and Louisiana (*see* CADDO); the southern Siouan Osage and Quapaw (*see* SIOUAN INDIANS); the Natchez, Choctaw, Chickasaw and Creek (*qq.v.*), who were Muskogean-speaking (*see* MUSKOGEAN INDIANS); the Cherokee (*q.v.*) of the Iroquoian linguistic family (*see* IROQUOIS); and the Algonkian-speaking Illinois, Miami and Shawnee (*see* ALGONKIAN TRIBES).

Along the eastern and northern periphery, such tribes as the Siouan Catawba and Tutelo, the eastern Algonkian Powhatan and Micmac (*qq.v.*), the Iroquoian tribes of the eastern Great Lakes, and the Algonkian tribes of the forest zone south of Hudson bay and the western Great Lakes, all retained the older Woodland complex but with some indications of Mississippian influence. The extent of this influence seems to have depended on their nearness to the more advanced cultural complex, and on their ability to maintain an agricultural economy along with hunting and gathering.

There was a spread of Woodland culture during Middle Woodland into the eastern part of the plains from Oklahoma to North Dakota, with some sites, particularly in eastern Kansas, clearly forming a part of the Hopewellian complex (*see* fig. 6). Some of the Woodland traits went as far west as the high plains in Colorado. Most of the Woodland sites in this latter area were, however, Late Woodland in their relationships and probably began about A.D. 700–800. In the plains there was evidence of corn and bean cultivation during Middle Woodland, and in Late Woodland cultivation of gourds and squash. Between about A.D. 300–400 and A.D. 800 there was little occupation of the western part of the plains by agricultural people because of the relative aridity. After A.D. 800, however, Late Woodland populations had spread west to the eastern slopes of the Rockies and were in contact with eastward-moving Puebloan people. A favourable agricultural period was indicated by the marked increase in village size and in population density for the next 400 years, during which hospitable areas along major streams were occupied by various interrelated cultural groups collectively known as the plains Mississippi cultures. Part of this complex was connected to the developing Mississippi complexes to the east by diffusion, and to some degree by a migration of such groups as the Omaha (*q.v.*) and Ponca from the St. Louis area by about A.D. 1000. Some cultural characteristics such as the earth lodges with entranceways had connections into the southwest, but the major orientation was toward the Mississippi valley. Together with a northward expansion of agricultural people along the Missouri into North and South Dakota before A.D. 1200, segments of the Upper Republican adaptation were developing along stream and creek valleys west into the high plains (*see* fig. 7) but because of increasing aridity in the western area they subsequently withdrew to the east. Between A.D. 1500–1700 the high plains from New Mexico to Wyoming and in eastern Oklahoma, Kansas and Nebraska were preempted by horse-using, semiagricultural and plains Apache and Comanche (*qq.v.*). Prehistoric village agriculturalists of a plains Mississippi tradition came into the historic period as the Pawnee, Arikara, Mandan, Hidatsa, Crow (*qq.v.*) and Wichita.

10. Southwestern Village Farmers.—The southwestern village farmers were distributed from eastern Utah and southern Colorado through most of New Mexico and Arizona. The effective agricultural area varied with fluctuations in climate that profoundly affected the ability of the Indians to occupy marginal regions. While corn and some other agricultural plants were introduced from Mexico between 2000 B.C. and A.D. 1, the first village complexes, with 5 to 15 pit or surface houses, ceremonial buildings, refuse pits and pottery, did not appear until shortly before A.D. 1 in southern Arizona and New Mexico. Two of the major farming complexes began at this time: Mogollon was located in the mountainous belt of west central New Mexico and east central Arizona, while Hohokam was located in the desert area of the Gila basin of southern Arizona. The latter group depended upon irrigation for its crops while Mogollon depended upon rainfall and stream diversion over flood plains. Mogollon became the pattern of agriculture adopted by the Indian groups of the Four Corners area along with other traits from the south, and later developed into the Anasazi (*q.v.*) or Puebloan culture, the third major farming complex of the southwest.

The geographical expansion, population growth and striking development of permanent villages with multiroom and multilevel buildings came during the period from A.D. 700 to 1200, which coincided with a minor climatic period of favourable distribution of rainfall for plant growth over the entire southwest. For the same climatic reasons, there was an expansion of popu-

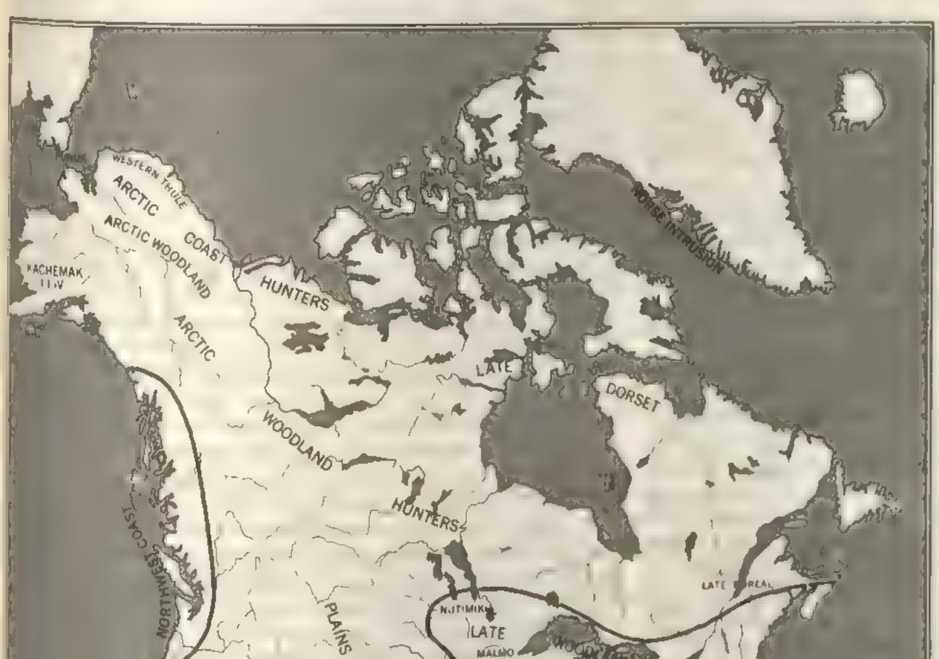


FIG. 7.—EXPANSION OF FARMING VILLAGES AND CONTEMPORANEOUS WESTERN AND NORTHERN HUNTING-GATHERING CULTURES IN NORTH AMERICA, ABOUT A.D. 1000

lation and cultural movement from central and western Mexico into northwestern Mexico. Trade and cultural stimuli then moved from northwestern Mexico into the American southwest at a time when the climate in both areas was most favourable for population and cultural growth. Indicating such cultural movement, cast copper bells, parrots, ball courts, shell trumpets, pottery vessel shapes and designs were found; they clearly reflect the transmission of religious beliefs and ceremonies. These southern influences were blended into local and regional complexes.

The Anasazi village agricultural complex had expanded by A.D. 900 to occupy northeastern Arizona, southwestern Colorado and northwestern New Mexico. By A.D. 1100 expansion had taken place into the Virgin river valley of southeastern Nevada, north as far as the Great Salt lake and northwestern Colorado, to the east into southeastern Colorado and to the Pecos and upper Canadian river valleys of New Mexico. Some of the important cultural characteristics, incorporated into the architectural plan, that identify Anasazi of this period are stone masonry, multiroom and multistory house structures and oriented kivas (ceremonial chambers). Textured and corrugated, gray cooking and utilitarian pottery and pottery with black painting on white slip are also found. During this period there was probably a development of priestly offices and of rituals and ceremonialism. The increasing population concentration in large pueblos was apparently organized into households according to lineage. Control of the agricultural activities was presumably in the hands of clan leaders who were also the priests who officiated in the rain-producing ceremonies. During this period some of the larger village populations ranged from 300 to more than 1,000 people.

Primarily because of increasing aridity there was a marked retraction of Anasazi culture between 1100 and 1300 from its northern, western and eastern limits of expansion. As a result, a concentration of the pueblos took place in northeastern Arizona, and along the Rio Grande and its immediate tributaries, and in the present Zuñi area of western New Mexico. In these favourable areas the Anasazi groups were able to maintain their societies by sand-dune farming with floodwater and some canal irrigation. The increased importance and elaboration of religious rain-producing ceremonies between 1300 and 1540 is deduced from paintings on kiva walls and from a more elaborate symbolism in pottery decoration. Polychrome painting on pottery was the major decorative technique. At this time the village houses were grouped around one or more plazas, as in the upper Rio Grande and Little Colorado areas.

The early historic and modern Pueblo Indians (*q.v.*), from the Zuñi and Hopi (*qq.v.*) on the west to the Rio Grande groups on the east, were the direct descendants of the Anasazi populations.

The Mogollon complex in its early phases from 200 B.C. to A.D. 700 consisted of relatively small villages of pit houses grouped near a large ceremonial structure. The pit houses had a round to quadrangular floor plan, sometimes with long, lateral entries. No organization of the village structures into a pattern is apparent and trash disposal was random. The dead were buried flexed, sometimes with brownish-textured, polished, red-filmed and red-painted pottery. While the initial impetus for sedentary village life appeared early in the Mogollon area there was an apparent period of cultural quiescence about A.D. 400 to 600. With the growth and spread of the Anasazi complex in the period after 700, the main flow of culture was from that area, and Mogollon villages from A.D. 900 to 1100 were a blend of local development strongly influenced from Anasazi. During the climatic deterioration after A.D. 1200 much of the Mogollon territory in southwestern New Mexico was abandoned. The western Puebloan groups of the late prehistoric period also seem to represent this blend.

The Hohokam culture of southeastern Arizona was primarily limited to main river valleys. Their agriculture was made possible by extensive irrigation canals which required intervillage co-operation. They lived in villages of scattered pit houses made of brush and mud, which were dispersed along the streams and canals. Their main settlements and major culture growth took place also during the period A.D. 700–1200. Following this for 200 years, there was a blend with Anasazi and Mexican elements and a tendency toward the construction of more compact settlements surrounded by compound walls with a few massive multiroom and two-story buildings. Some of the other distinct characteristics were etched shell ornaments, paddle and anvil shaping and finishing of pottery, red-on-buff pottery, excellent stone carvings, well-made projectile points and grooved stone axes, ball courts, small kivas, cremation, and relatively little evidence of trade and influences from northwestern Mexico. Such historic groups as the Pima and Papago (*qq.v.*) are regarded as descended from the Hohokam people.

North American prehistory presents a great variety of cultural adaptations—from the early hunting and gathering groups that initially occupied the U.S. territory and gradually moved into the Canadian area to the early historic agricultural societies and hunting, fishing peoples. The major climatic and ecological areas strongly influenced the culture types which arose from 12,000 to 3,000 years ago. Following the introduction of agriculture and associated concepts from the dominant Mesoamerican civilization there developed two important centres of farming societies, in the southwest and in the Mississippi valley. Their growth and development was arrested by the intrusion of European explorers and colonists, and North America rapidly became a part of western civilization. *See* also ARCHAEOLOGY; INDIAN, NORTH AMERICAN INDIAN, LATIN-AMERICAN; for *Prehistory and Archaeology* of Middle America *see* MIDDLE AMERICA. (J. B. GN.)

V. EXPLORATION AND SETTLEMENT

The first Europeans to discover North America were probably Northmen, part of the population movement which carried Scandinavians to Normandy, England, Scotland, Ireland and the islands to the north and west between A.D. 700 and 1100. They were pirates, plunderers, traders and settlers attracted by fair lands and seas teeming with fish, or driven by population pressures or by the wrath of rivals or rulers at home.

About 1070 Adam of Bremen wrote of Norse discoveries in North America and references to the continent appear in the Icelandic annals of the next several centuries. But the "Saga of Eric the Red" and the "Saga of the Greenlanders" are the major sources. Apparently Bjarni Herjolfsson discovered North America in 985 or 986, when driven off course while sailing from Iceland to the Greenland settlements. In 1002 or 1003 Leif Ericsson (Eiriksson) sailed west from Greenland and gave the names Helluland, Markland and Vinland to sections of the American coast as he moved southerly along it. Leif wintered in Vinland and on his return, his brother Thorvald voyaged there, and was killed by natives. (See ERIC the Red.) About 1020 Thorfinn Karlsefni (*q.v.*) sailed to Vinland with three ships, taking domestic animals and women with him. His expedition spent three winters in the new land. After Karlsefni's return, Leif's half sister, Freydis, led an expedition to Vinland that was marred by vicious murders.

Locating the routes, landfalls and camps of the Vikings has stirred controversy because the evidence is fragmentary and contradictory. Also the Norse era apparently coincided with centuries of milder climate in northern latitudes, thus the vegetational clues in the sagas are misleading. Writers have suggested many locations for the Viking camps in northeastern North America. The authenticity of artifacts of alleged Viking origin, such as the Kensington stone found in Minnesota and the Beardmore weapons found in western Ontario, is questionable. In 1961, however, Helge Ingstad found a settlement site of Norse style at L'Anse au Meadow, Newfoundland. By the use of carbon-14 it was determined that the site was from the Viking era and a Norse spindle whorl indicated the presence of women.

The Vinland map, published in 1965, has been described as "the only surviving graphic record" of the Norse voyages to contain any element of experience." (R. A. Skelton *et al.*, *The Vinland Map and the Tartar Relation*, p. 239, Yale University Press, 1965.) It dates probably from 1431–49 and the writing that appears on the map supports Bjarni Herjolfsson's role, which has hitherto sometimes been questioned. It also suggests the presence in medieval Iceland of more evidence concerning Vinland than has survived and it strengthens the possibility that re-

FIG. 8.—"THE VINLAND MAP"

This map, drawn probably in the 1430s or 1440s by a monk in Basel, Switz., who presumably copied it from older maps that were subsequently lost, is the earliest known map showing part of North America and suggests that the Northmen discovered America in the 11th century. In the upper left-hand corner of the map is a reasonably accurate map of Greenland (labeled "Gronelada") and a curiously shaped island called "Vinlanda" (the Latin version of "Vinland," the name said to have been given to North America by Eric the Red's son Leif Ericson). The two large river mouths may represent Hudson Strait and the Gulf of St. Lawrence. The Latin inscription at upper left, translated into English, reads: "By God's will, after a long voyage from the island of Greenland to the south toward the most distant remaining parts of the western ocean sea, sailing southward amidst the ice, the companions Bjarni and Leif Eiriksson discovered a new land, extremely fertile and even having vines, the which island they named Vinland. Eirik [Henricus], legate of the Apostolic See and Bishop of Greenland and the neighboring regions, arrived in this truly vast and very rich land, in the name of Almighty God, in the last year of our most blessed father [Pope] Paschal [II], remained a long time in both summer and winter, and later returned northeastward toward Greenland and then proceeded [*i.e.*, home to Europe?] in most humble obedience to the will of his superiors"

evant information may have passed through English sailors to Bristol or even reached Spain and Portugal before North America was rediscovered.

Europeans entered an age of geographical discovery during the 15th century, reflecting developments in economic, social and political life under way for some centuries. Merchant groups had developed in western Europe, eager to expand trade and able to finance increasingly ambitious ventures. Most valuable of trade goods were the spices, coming overland from the orient to the eastern end of the Mediterranean. Since Italian merchants controlled the spice trade, merchants to the northwest wished to find new routes to the east.

The intellectual climate was prepared for an age of discovery by Renaissance scholars who developed an interest in the natural world, reviewed the speculations of the Greeks about the earth, and hazarded their own. At the same time Europeans were advancing in ship construction and improving navigational aids. After the first discoveries the new printing press allowed wide distribution of explorers' accounts. The rise of national states, Portugal, Spain, France, England and the united Netherlands, contributed also to the age of discovery. Monarchs encouraged exploring ventures in hope of increasing trade and acquiring treasure or territory. In the tradition of militant Christianity, Europeans wished to convert the non-Christians of the world. With the coming of the Reformation in the early 16th century, moreover, religious differences sharpened national rivalries as Protestants sought to outstrip the Roman Catholic Spanish and Portuguese, whose kings had divided the newly discovered areas of the world between themselves with papal approval in the treaty of Tordesillas (*q.v.*) of 1494.

1. Early Spanish Explorations.—In 1492 Christopher Columbus reached the Bahama Islands with three ships, proceeding then to Cuba and La Española (Hispaniola). A native of Genoa, Columbus sailed under a commission from the Spanish crown. Encouraged by tales of lands beyond the Canary Islands and stories of oriental riches, Columbus accepted the theory that the earth was spherical and sought the east by sailing west. He was probably motivated by a sense of Christian mission and a desire to rule new lands as Spanish governor, to win riches and to be known as a great geographer. Returning to Spain, Columbus maintained that he had reached the eastern fringe of Asia. Although he traversed much of the Caribbean and traced the mainland coast from Honduras to the Isthmus of Panama in three subsequent voyages, Columbus found no passage to Cathay, the medieval name for China. As governor of the Indies he also failed, but his discoveries of gold and pearls drew others and the royal fifth of such treasure interested the Spanish rulers. (*See* COLUMBUS, CHRISTOPHER.)

Based on La Española, Spanish captains probed the Caribbean, the Gulf of Mexico and Central America, hoping to find a western passage, to establish principalities and to exploit local resources. Shortly after 1500, Ferdinand V gave rights of conquest and gov-

ernment on the Mosquito Coast and the adjacent South American coastline to two adventurers, Diego de Nicuesa and Alonso de Ojeda. From their ventures, initially plagued by disease, dissension and hostile Indians, emerged Vasco Núñez de Balboa who led a force across the isthmus to the Gulf of Panama in 1513. (*See* BALBOA, VASCO NÚÑEZ DE.) From the isthmus, captains worked north along the Pacific and Caribbean shores.

By 1516 Diego Velázquez de Cuéllar had subjugated Cuba and he directed the attention of his lieutenants to the mainland. In 1519 Hernán Cortés (*q.v.*) led the third of such expeditions. Retracing the routes of his predecessors along the Gulf of Campeche, Cortés burned his boats at Veracruz and penetrated the mountains with a small force to Tenochtitlán (Mexico City), the Aztec capital of Montezuma II (*q.v.*).

By astute diplomacy, brilliant soldiering and adept handling of Indian allies Cortés broke and plundered the rich Aztec empire. Ignoring Velázquez in Cuba, Cortés became governor of the new region, established himself at Mexico City, and subdued the surrounding territories. During the mid-1520s his men clashed in Honduras with forces from the isthmus. The general outlines and topography of Central America and southern Mexico were now becoming clear.

Some Spanish adventurers pushed north from La Española. In 1513 Juan Ponce de León threaded the Bahamas and skirted peninsular Florida. (*See* PONCE DE LEÓN, JUAN.) Alonso de Pineda (1519) traced the shore of the Gulf of Mexico from the Florida keys to the Pánuco river in Mexico. During 1524–25 the Portuguese Esteban Gomes coasted from the Grand Banks to Florida in Spanish service. Later expeditions probed the continental interior. Pánfilo de Narváez (*q.v.*) landed a large party in Florida in 1528. Eight years later, four survivors, two of whom were Alvar Núñez Cabeza de Vaca and the Negro slave Esteban, reached northern Mexico after walking from Galveston bay. Cabeza de Vaca's tale encouraged minds inflamed by stories of rich Inca treasure and Indian legends of the seven golden cities of Cibola.

Expeditions begun by Hernando (Fernando) De Soto and Marcos de Niza (Fray Marcos) in 1539 and by Francisco Vázquez de Coronado in 1540 followed routes which stretched, when combined, from the Grand canyon to the Savannah river, ascended the Mississippi valley beyond the Ohio and linked the upper waters of the Brazos to the Kansas river. (*See* DE SOTO, HERNANDO; NIZA, MARCOS DE; CORONADO, FRANCISCO VÁSQUEZ DE.) Early major Spanish explorations were completed in 1542–43 when Juan Rodriguez Cabrillo and Bartolomé Ferrelo surveyed the Pacific coast from lower California to a point beyond latitude 42° N., although minor figures explored in the eastern Appalachians and the southwest after 1550. (*See* also LATIN AMERICA.)

2. French, English and Dutch Explorations Before 1772.—While the Spanish exploited the lower latitudes, other European captains ranged the northern coasts. Such was the voyage of the Genoese John Cabot (*q.v.*) in 1497, backed by the British crown and Bristol merchants, and believed to be the second Bristol expedition to reach North America after 1480. Subsequent English, Portuguese and French expeditions found little of interest until the Frenchman, Jacques Cartier (*q.v.*), ascended the St. Lawrence river in a series of expeditions beginning in 1534. But he found no treasure, and interest in the interior waned. In 1578–79 Sir Francis Drake (*q.v.*) explored the Pacific coast of North America to 48° seeking a passage to the east. Increasingly, however, Frenchmen and Basques fished the Gulf of St. Lawrence and incidentally began a trade in furs with the natives. American furs, particularly beaver, were sufficiently popular in Europe by 1600 that the French king tried to nurture the trade by assigning it as a monopoly to favoured merchants.

French fur traders founded Port Royal in 1605 but in 1608 Quebec became the centre of the trade. From there the governor of French Canada, Samuel de Champlain, hoped also to discover a Pacific passage (*see* CHAMPLAIN, SAMUEL DE). The fur trade also drew the French into the interior since it was always profitable to forestall tribes seeking to act as middlemen. After 1615 the desire of the Recollet (Franciscan), Jesuit and Sulpician religious orders to Christianize the Indians contributed to exploration. But the hostile Five Nations of the Iroquois (*q.v.*), west of the Hudson and below the St. Lawrence and Lake Ontario, impeded the French. Allies of the Dutch at Fort Orange, these Iroquoians fought the northern tribes friendly with the French. Because of the Iroquois the French initially avoided the lower lakes and followed the Ottawa into the interior, traversing to Georgian bay. From the explorations of Champlain, of subordinates like Étienne Brulé, and of the missionaries, the French, in 1650, understood the St. Lawrence-Great Lakes system in a general way, although western Lake Superior and southern Lake Michigan were unexplored. They knew also of both the Hudson and Susquehanna river routes to the sea and had heard of a northern sea beyond the Laurentian divide.

During the 1660s, French activities impinged on those of the English. Annoyed by trading restrictions in New France and by the hampering Iroquois, Pierre Esprit, sieur de Radisson, and Médart Chouart, sieur de Groseilliers, sought British backing to establish a northern trade outlet, having perhaps been themselves to James bay. As a result Englishmen organized the Hudson's Bay company (*q.v.*). They were already familiar with the approaches to Hudson bay and its general character through the efforts of English explorers including Sir Martin Frobisher, John Davis and Henry Hudson (*qq.v.*), who had all sought a northwest passage to the orient around 1600.

The French now attempted to widen their sovereignty in North America. During 1671–72, Paul Denis, sieur de St. Simon, followed the Saguenay and Rupert rivers to James bay. Simon François Daumont, sieur de St. Lusson, proclaimed French rule of interior North America at Sault Ste. Marie in 1671. Daniel

ADAPTED FROM HAROLD E. DAVIS, "THE AMERICAS IN HISTORY," THE RONALD PRESS (1953)

FIG. 9.—PRINCIPAL EXPLORERS OF NORTH AMERICA: GENERAL LOCATION AND DATES OF THEIR MOST IMPORTANT DISCOVERIES

Greysolon, sieur Dulhut (Duluth), declared French sovereignty at Lake Mille Lacs (in present Minnesota) and descended the St. Croix and Mississippi rivers to the Wisconsin while rescuing Father Louis Hennepin from the Sioux Indians. The French also tried to push south to Spanish territory in order to confine the British settlements along the Atlantic coast. In 1673 Louis Jolliet and the Jesuit, Jacques Marquette (*qq.v.*), followed the Fox-Wisconsin traverse from Green bay and descended the Mississippi almost to the Arkansas, returning by the Illinois river to Lake Michigan. Nine years later René Robert Cavelier, sieur de La Salle, descended to the mouth of the Mississippi and claimed the whole region, which he named Louisiana, for France. (*See* La Salle, René Robert Cavelier, Sieur de.)

After reaching the lower Mississippi valley, the French sought trade connections with the Spanish settlements. Notable in this effort were the expeditions of Louis Juchereau de Saint Denis from Natchitoches, La., to San Juan Bautista (Villahermosa), Mex., in 1714; of Bernard de la Harpe along the Red, Arkansas and Canadian rivers between 1719 and 1722; and of Pierre and Paul Mallet. Beginning in the winter of 1738–39 the Mallet brothers followed the Missouri, the Platte and the South Platte into the high plains, angled southwest to Taos and Santa Fe and returned to the Mississippi along the Canadian and Arkansas rivers. In the northern plains Pierre Gaultier de Varennes, sieur de la Vérendrye, countered British competition by pushing trading posts beyond Lake Superior, baiting his request for a western trading monopoly by promising to seek the Western sea. Between 1731 and 1744, Vérendrye and his sons discovered and described lakes Winnipeg, Winnipegosis and Manitoba and their relation to the major rivers of the region. They reached the Black hills and mapped the upper Missouri but decided that the Saskatchewan river provided the best route to the Pacific.

While the French ranged from James bay to the Gulf of Mexico, the British and Dutch explored below the Great Lakes and east of the Mississippi. Englishmen established Jamestown in 1607 and the Dutch occupied the Hudson valley following its discovery by Henry Hudson in 1609. By 1650 fur traders were searching for passes through the Appalachian barrier. During 1671 Virginians discovered the upper Kanawha. Two years later James Needham reached a Cherokee village on the upper Tennessee river and accompanied braves to the Kanawha and the Ohio rivers and to the junction of the Chattahoochee and the Flint rivers. During 1692–94 Arnout Cornelius Viele from Albany descended the Ohio, perhaps to the Mississippi. During the late 1690s, Carolinians reached the junction of the Arkansas and Mississippi rivers and followed an expatriate French trader, Jean Couture, down the Tennessee to the Ohio. Carolinian competition with French and Spanish in the Gulf hinterland revealed the topography of this region.

Initially the Hudson's Bay company showed little interest in the interior, allowing superior trade goods to draw the Indians to Hudson bay. Henry Kelsey's expedition during 1690–92 was an exception to this policy. Kelsey ascended the Hayes river from York Factory, crossed the head of Lake Winnipeg and explored beyond Lake Winnipegosis. Spurred by French activity, the company sent Anthony Henday into the interior in 1754. He pushed beyond longitude 113° W. between the major branches of the Saskatchewan. Seeking in 1770–72 to locate the source of copper brought by Indians to company posts, Samuel Hearne reached the lower Coppermine river, crossing Great Slave lake to take the Slave river while returning. Hearne's discoveries long discouraged exploration in the barren lands northeast of his route.

3. Pacific Coast, Northwest and Arctic Explorations.—Russian interest in the relation of Asia to North America prompted exploration in the early 18th century. Vitus Jonassen Bering (*q.v.*), although his achievement was disparaged, traversed Bering strait in 1728. Both he and Alexei Chirikov reached southern Alaska in 1741 and Russian traders began the China trade in Aleutian sea otter and seal. Russian efforts provoked response from Spain, Great Britain, France and ultimately the United States.

By sea, Spanish expeditions of 1774 and 1775 coasted from California to latitude 57° N. Capt. James Cook (*q.v.*), cruised from Oregon to Bering strait in 1778, seeking the terminus of a northwest passage. After his death the expedition reached latitude 70° 44″. Official Russian, Spanish, British and French expeditions and numerous traders probed the northwestern coast after 1785. On land, the Spanish pushed their settlements to San Francisco bay during the 1760s and 1770s, exploring back from the coast in the process and seeking trails to link this frontier to Santa Fe and Taos. During 1776–77 Father Silvestre Vélez de Escalante led a notable expedition from Sante Fe northwest to Utah lake, southwest to Sevier lake and the upper Virgin river, and back to Santa Fe.

On the northern plains, the North West company of Montreal replaced the French fur traders after New France passed to Great Britain in 1763. Seeking to forestall the Hudson's Bay company, and to tap the fur fields of the Russians, Alexander (later Sir Alexander) Mackenzie (*q.v.*) descended the Mackenzie river from Great Slave lake to the Arctic ocean in 1789. In 1793 he followed the Peace river into the Rockies, traversed to the Fraser and then cut overland to the Pacific.

After the United States purchased Louisiana, the official Lewis and Clark expedition (*q.v.*) ascended the Missouri, crossed from the Jefferson fork to the Pacific slope and reached the mouth of the Columbia in 1805. Traders and trappers soon explored the American Rockies and Great Basin. To the north, British traders explored the Fraser and upper Columbia and entered the upper Yukon country. Meanwhile, representatives of the Russian-American company probed interior Alaska. After 1850 exploration in the American and British western possessions became increasingly scientific, culminating in the establishment of official geological surveys.

Prior to 1818 explorers by sea in the north had stopped short of Point Barrow and on land had reached the arctic coast only at the Mackenzie and the Coppermine rivers. In the next 40 years, the British admiralty, the Hudson's Bay company and private scientific ventures changed the situation. The land-based expeditions of Sir John Franklin, John Rae (*qq.v.*) and Thomas Simpson explored much coastline between Point Barrow and the Melville peninsula. On sea, Frederick W. Beechey filled the gap west of Point Barrow, Lt. William (later Sir William) Edward Parry (*q.v.*) sailed from Baffin bay to Melville Island and Sir John Ross (*q.v.*) explored the Boothia peninsula and, with his nephew James (later Sir James) Clark Ross (*q.v.*), located the north magnetic pole. When Sir John Franklin sought the northwest passage in 1845, ice trapped his ships south of Prince of Wales Island and the crews perished. During the next decade searching parties amassed information about the arctic. But not until 1903–06 did Roald Amundsen (*q.v.*) sail from the Atlantic to the Pacific north of the continent and only in 1915–16 did Vilhjalmur Stefansson discover the last major islands at the north of the Canadian archipelago.

4. European Settlement.—Although Swedish and Dutch traders established colonies on the Delaware and the Hudson during the 17th century and Russian traders were active on the west coast of North America for more than a century, their contributions in settling North America were minor in comparison to those of the Spanish, French and English.

Spanish Settlement.—During the 16th century individuals, willing to organize expeditions and transport colonists, obtained contracts from the Spanish crown, allowing them to exploit regions in North America. Although the contracts conveyed extensive rights of government and economic privileges, the authority of these impresarios was usually soon challenged by royal officials. After 1535 the viceroyalty of New Spain provided the major frame of government for Spanish holdings in the Caribbean and on the mainland, north of the Isthmus of Panama.

Dissatisfaction with prospects at home, and desire to find adventure and wealth, or to carry Christianity and European culture abroad, brought Spaniards to the new world. Impresarios, and sometimes the crown, encouraged such movement, although only Spanish citizens of undoubted orthodoxy could migrate. By 1570 the white population of New Spain numbered about 54,000, mainly

of Andalusian antecedents. The possibility of riches, the sophistication of many natives and the climate, encouraged the Spanish to use Indian labour widely. The crown soon forbade Indian slavery but it persisted, and other systems of forced labour also evolved. Spanish arms, European diseases and the new regimen almost extinguished the island natives, whom the Spanish replaced by African slaves. There were more than 93,500 Negroes and mestizos in New Spain by 1570. Although the mainland Indians also decreased in numbers they always dominated the population, numbering about 3,000,000 in 1570. Spanish settlement was characterized by considerable miscegenation.

The success of Cortés caused an exodus from the Caribbean islands. The Greater Antilles developed a prosperous sugar plantation economy, but smaller islands remained unoccupied. After the initial conquests, Spanish settlement on the mainland reflected mining and agricultural opportunities and strategic considerations. The preliminary conquest was complete in Central America by 1600 but portions of the region remained unconquered in 1700. By 1600 Spanish colonization, pushing north from the valley of Mexico, had reached points due west of the mouth of the Rio Grande. Although silver and gold mines like those of Zacatecas produced concentrations of population, much grain and livestock was produced in New Spain. Dominican, Franciscan and Jesuit missions helped pacify the Indians in frontier regions. At times, colonies of civilized Indians were moved to the frontier to assist soldier and missionary.

After Huguenot colonization on the Florida coast threatened Spanish shipping in the Bahama channel, the Spanish finally occupied Florida during the 1560s. Missionary efforts in Virginia failed but missions along the Carolina and Georgia coasts survived. At the end of the 16th century Juan de Oñate colonized New Mexico and Santa Fe was established in 1610. During the 18th century the Spanish pushed their Pacific frontier from the Sonora region to San Francisco bay.

Settlement of the British Colonies and the United States.—After the Virginia company of London founded Jamestown, the English established numerous colonies along the North American coast from Maine to Georgia and in the West Indies. Individuals and groups sought patents from the British crown conferring territorial and administrative privileges in the new world upon them. Economic opportunities attracted most colonial promoters, although experience in Virginia dispelled hope of matching Aztec treasure. But desire to modify Anglican church doctrines, or to alleviate the condition of nonconformists and indigents influenced promoters in a number of colonies. The crown never closed the colonies to religious dissenters. Although companies or proprietors originally controlled the colonies, they were ultimately in most cases brought directly under the crown.

The English colonists engaged in farming, fishing, shipbuilding and trade, with tobacco, rice and indigo important in the southern mainland colonies and sugar plantations characterizing the Indies. Although important, the mainland fur trade was never dominant. Mortality was high initially in Virginia and Plymouth but emigration attracted Englishmen because of enclosures on estates in Britain, high land prices, dissatisfaction with Stuart political and religious policies and the generous colonial systems of land disposal and government. Many emigrated as indentured servants. During the 1630s a large Puritan migration arrived in Massachusetts, soon itself supplying emigrants for Connecticut, Rhode Island and New Hampshire. A British Quaker migration began to develop Pennsylvania in 1682. Germans and Scotch-Irish came after 1700 to settle mainly in Pennsylvania and the colonies to the south. Scottish, Welsh and Huguenot settlers arrived also. After 1600 many African slaves were brought to the southern colonies. By 1760 the colonies in North America were supporting about 2,000,000 inhabitants of European and African origin.

Indian relations, land policy, topography, soil fertility and a number of minor factors modified settlement. The agricultural frontier was in the piedmont region until 1700 and was roughly marked by the Alleghenies until 1800. The Mississippi provided the frontier of the early 19th century in the United States. During the 1840s pioneers established the Oregon, Utah and California settlements. Subsequently miners flocked to the cordilleras as a succession of gold and silver strikes followed the California discoveries of 1848. Between 1860 and 1900 farmers occupied the high plains. Established settlements provided settlers for new lands, the pioneers migrating generally along isothermal lines. Immigration to the United States averaged about 10,000 annually between 1790 and 1830; by the 1850s the average inflow had risen to slightly more than 280,000 people yearly and during the 1890s it was almost 370,000. Many immigrants remained in the older regions, but Germans, Scandinavians and British particularly helped to settle the northern territories and states. The small farms and urban orientation of these regions apparently attracted the foreign-born more strongly than did the systems of slavery and plantation agriculture prevalent in the southern section of the United States before the Civil War. (*See also* AMERICAN FRONTIER.)

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FIG. 10.—AREAS CLAIMED BY BRITAIN, FRANCE AND SPAIN IN NORTH AMERICA IN 1750

Settlement of the French Colonies and Canada.—French settlements developed in New France (Canada) and Acadia (the coast of Nova Scotia) on the North American mainland. The fur traders, required to transport colonists under their trading monopolies, performed these obligations unsatisfactorily. There were only 1,800 French on the Bay of Fundy when Acadia passed to England in 1713. Ineffective administration by the merchant company holding the fur monopoly in New France led the crown to assume direct control in 1663 when the colony numbered about 2,500. Thereafter settlers were obtained by offering free passage and land on easy terms and by inducing French soldiers to remain in New France. The government conveyed girls from France as wives for settlers and seigneurs brought in colonists to work their land grants. For a time during the 18th century French criminals were transported to the colony. After 1680 the

population grew mainly from natural increase. Since royal policy barred dissenters and French agriculture experienced few disruptive changes, little interest in emigration developed in France. Settlement in New France spread out from Quebec, Trois Rivières and Montreal along the St. Lawrence, penetrating the back country along the Richelieu but little elsewhere. Although primarily a farming settlement by the 18th century, New France produced little surplus and the fur trade dominated its commerce.

Established in 1699, Louisiana (*q.v.*) developed under a merchant proprietor and later the Compagnie des Indes Occidentales. In 1731 it became a royal province and was enlarged to include the Illinois country. The fur trade, agriculture and lead mining in Missouri occupied the residents.

By 1760 the French mainland colonies of North America had a European population of about 80,000 while the Indies numbered an additional 45,000 plus about 300,000 slaves. Aside from the French nucleus, Great Britain, then including Ireland, and the American colonies provided most of the settlers for the British provinces which ultimately amalgamated as the dominion of Canada. During the 1760s New Englanders moved to Nova Scotia and merchants from New York and New England established communities in Quebec and Montreal. The American Revolution caused Loyalists to migrate to Upper Canada, Nova Scotia and New Brunswick. Between 1790 and 1815 many settlers from the United States entered Upper and Lower Canada. After 1815 immigration from the British Isles became important, including Irish famine refugees and Scottish crofters (tenant farmers). The Fraser river gold rush in 1856 drew a polyglot population to British Columbia but this province developed slowly. Although Lord Selkirk established a colony of Scottish settlers in the valley of the Red River of the North in 1812 (*see* RED RIVER SETTLEMENT), and the fur trade left some retired servants and métis, or half-breeds, few settlers entered the Canadian prairies before 1890. The government actively promoted the region and by 1930 settlers from the older provinces, from the United States, Great Britain, western and central Europe had occupied most of the arable land.

Major Territorial Adjustments in North America.—The European monarchs assumed that their sovereignty followed their nationals in the new world but colonial policies, European wars and American rivalries produced territorial adjustments in North America. When the Spanish concentrated on the mainland, English, French, Dutch and Danes seized unoccupied Caribbean islands, from the Bahamas to the Windward group during the 17th century. In 1655 the British occupied Spanish-held Jamaica and subsequently gained footholds on the Honduras and Mosquito coasts. The French gained the uninhabited portions of Haiti.

During 1664 England seized New Netherland and in 1713 acquired French claims to Acadia, Newfoundland and Rupert's Land, the region draining into Hudson bay. In 1763 France ceded all mainland territory east of the Mississippi to Great Britain and west of that river to Spain. Concurrently Spain surrendered Florida to the British. Following the American Revolution, the United States in 1783 obtained the territory south of Canada, and east of the Mississippi, while Spain regained Florida.

Napoleon wrested Louisiana from Spain in 1800 but revolt in Haiti jeopardized French plans in America and paved the way for the independence ultimately of Haiti and the Dominican Republic. The United States purchased Louisiana from France in 1803 (*see* LOUISIANA PURCHASE). The Spanish transferred Florida to the United States in the treaty of 1819, the United States accepting here also a western boundary for Louisiana which left Texas in Spanish hands.

Beginning in 1810 revolution shattered the Spanish empire in America. On the mainland Mexico, Guatemala, El Salvador, Honduras, Nicaragua and Costa Rica emerged, although the countries of Central America together formed the Central American Union between 1823 and 1839 (*see* CENTRAL AMERICA).

In 1835 settlers from the United States in Texas revolted, proclaiming a republic which gained admission to the United States in 1845. After a short war with the United States, Mexico in 1848 renounced claims to Texas and also ceded New Mexico and upper California. In 1853 the United States acquired the Gadsden Purchase lying south of the Gila river (*see* GADSDEN PURCHASE).

The boundary between the United States and the northern British provinces was extended along the forty-ninth parallel beyond Lake of the Woods to the crest of the Rockies in 1818 and to the Pacific in 1846. Meanwhile the disputed Maine-New Brunswick boundary was fixed in 1842. Russia and Great Britain set the interior boundary of Alaska by treaty in 1825 and Russia sold this region to the United States in 1867.

Important changes in territorial administration occurred in the British provinces after 1860. In 1867 Nova Scotia and New Brunswick joined Canada (modern Ontario and Quebec), in the dominion of Canada. Canada purchased Rupert's Land from the Hudson's Bay company in 1869, British Columbia joined the federation in 1871, Prince Edward Island in 1873 and Newfoundland, including Labrador, in 1949.

Following the Spanish-American War in 1898, Cuba gained independence from Spain, and Puerto Rico was ceded to the United States (as were Guam and the Philippines). Panama declared its independence from Colombia in 1903 and granted a Canal Zone in perpetuity to the United States. The United States purchased the Virgin Islands from Denmark in 1917, and in 1958 the West Indies federation was established within the Commonwealth of Nations. The federation broke up in 1962. *See* also AMERICAS, THE; LATIN AMERICA; CENTRAL AMERICA; and ARCTIC, THE; and the *History* sections of UNITED STATES (OF AMERICA); CANADA; MEXICO; GREENLAND; WEST INDIES; and of articles on the Central American and Caribbean republics. (A. G. Bo.)

VI. POPULATION

North America, with approximately 9% of the world's population, ranks as the third most populous continent in the world. Because it occupies about 16% of the world's land area, its population density is below that for the world as a whole.

1. Distribution.—People are quite unevenly distributed within the continent. The southeastern quarter of Canada and the eastern United States contains one of the world's great population concentrations. In this area live more than four-fifths of the U.S. population and nearly two-thirds of Canada's, comprising the densest urban concentrations and many of the largest cities of the two countries. The most densely settled area for its size is to be found about the mouth of the Hudson river in what is known as the New York-Northeastern New Jersey Standard Consolidated area or Greater New York. From this centre northeastward to Boston and southwestward to Baltimore is the largest aggregation of people on the whole continent.

Some of the islands of the West Indies are also very densely populated. Barbados contains an average of 1,400 persons per square mile. Since a majority of the population of this tiny island of the West Indian group is rural, its density is comparable to that of some of the more heavily populated rural areas elsewhere in the world. Other Caribbean islands which have high rural densities include Martinique, Puerto Rico, Jamaica, the Windward Islands, the Leeward Islands and the republic of Haiti.

The distribution of population within Mexico is representative of many other Middle and South American republics. Almost one-half of Mexico's inhabitants are found in the basins and valleys clustering about the capital city, in a district representing less than one-seventh of the country's entire area.

Two large, sparsely populated areas characterize the continent of North America. One of these is in Canada, which is a relatively unoccupied country except for a rather narrow fringe scarcely more than 100 mi. wide along a part of the northern border of the United States. The second area is the western half of the United States with the exception of portions of Washington and Oregon west of the Cascade ridge, central and southern California, and the irrigated lands along the major river valleys. Alaska is the United States' largest but least densely populated state.

2. Population Growth.—In the second half of the 20th century most political divisions in North America were experiencing

Area and Population of the Countries of North America, 1960–65 and 1880–82, with Density per Square Mile

Area	Population	Date	Area (sq.mi.)	Density per square mile	Population 1880–82
Continental United States*	178,690,403	1960 census	3,608,786†	49.5	50,189,209
U.S. possessions‡					
Panama Canal Zone	42,122	1960 census	558	75.7	
Puerto Rico	2,349,544	1960 census	3,435	684.0	752,000
Virgin Islands of the U.S.	32,099	1960 census	133	241.3	33,763
Canada	18,238,247	1961 census	3,851,809	4.7	4,504,319
United Kingdom possessions					
Antigua	54,304	1960 census	170	319.4	.
Bahama Islands	130,220	1963 census	4,406	29.5	43,521
Barbados	232,327	1960 census	166	1,400.0	171,860
Bermuda	42,640	1960 census	21	2,030.5	14,888
British Honduras	90,121	1960 census	8,867	10.2	27,452
British Virgin Islands	7,340	1960 census	59	124.4	...
Cayman Islands	7,622	1960 census	100	76.2	4,700
Dominica	59,916	1960 census	290	206.6	...
Grenada	88,677	1960 census	133	666.7	42,403
Montserrat	12,108	1960 census	32	378.4	..
Saint Christopher-Nevis-Anguilla	56,591	1960 census	138	410.1	..
Saint Lucia	86,108	1960 census	238	361.8	38,511
Saint Vincent	79,948	1960 census	150	533.0	40,548
Turks and Caicos Islands	5,716	1960 census	166	34.4	4,732
Danish Realm					
Greenland	33,140	1960 census	840,000§	0.04	10,000
French possessions					
Guadeloupe	283,223	1961 census	687	412.3	200,339
Martinique	292,062	1961 census	431	677.6	167,679
St. Pierre and Miquelon	5,025	1962 census	93	54.0	5,534
Netherlands Realm					
Netherlands Antilles	194,458	1960 census	394	493.5	...
Costa Rica	1,336,274	1963 census	19,652	68.0	..
Cuba	7,630,700	1965 estimate	44,218	172.5	1,521,684
Dominican Republic	3,047,070	1960 census	18,703	162.9	300,000
El Salvador	2,510,984	1961 census	8,056	311.6	613,273
Guatemala	4,278,241	1964 census	42,042	101.8	1,224,606
Haiti	4,660,000	1965 estimate	10,714	434.0	872,000
Honduras	1,884,765	1961 census	43,277	43.6	350,000
Jamaica	1,609,814	1960 census	4,232	380.3	580,804
Mexico	34,923,129	1960 census	761,600	45.9	10,447,974
Nicaragua	1,535,588	1963 census	50,193	30.5	275,815
Panama	1,075,541	1960 census	29,209	36.8	285,000
Trinidad and Tobago	827,957	1960 census	1,980	418.2	.
Total	266,434,024	—	9,355,118	28.4	.

*Excludes Hawaii. †Excludes 60,960 sq.mi. of U.S. portion of Great Lakes. ‡Excludes area and population of Navassa and Swan Islands §Includes 708,070 sq.mi. of ice cap

a rapid growth in population, exceeding the average annual rate of 1.8% for the world as a whole. Canada's annual growth was about 3.0%; that of the United States 1.6%. The growth of these two countries is due principally to increases in their birth rates following World War II, their extremely low death rates and to an excess of immigration over emigration.

The islands of the Caribbean and the republics of Middle America are also growing at annual rates far in excess of those of many other parts of the world. Among them are Costa Rica, 4.9%; Dominican Republic, 3.6%; and Nicaragua and Honduras, both with a percentage growth of about 3.4% annually. The growth throughout Middle America is the result of extremely high birth rates and declining death rates. They have an average crude birth rate of about 37 per 1,000 population as compared with a world average of 36. Death rates for the area as a whole average 10 per 1,000 population, compared with 18 for the world.

North America has been an area of considerable population growth for most of its recorded history. From about 1880 to mid-20th century the population of the continent increased almost threefold. In 1850 the United States had a population of 23,300,000, whereas that of Canada was 2,400,000. In 1960 the population of these countries had grown to a total of 196,900,000, or a total increment of 666%.

3. Racial Composition.—In Canada, about 44% of the total population are of British stock, 30% are French, and about 10% have been classified as having mostly German, Scandinavian and Ukrainian backgrounds. The native groups comprise Indians and Eskimos, but these make up only slightly more than 1% of the total population.

Of the total U.S. population in 1960, 88.6% were white, Negroes constituted 10.5% and the remaining fraction consisted of Orientals and others.

The population of Middle America includes Indians, descendants of Europeans, Negroes and mixed peoples. Indians constitute more than 50% of the population of most of the mainland republics, but great variations exist among countries. Costa Rica, for example, is almost entirely white; Guatemala is predominantly Indian; Mexico classifies about 30% as pure Indian, 15% white and 55% mestizo. The predominant stock of many of the West Indian islands is Negro. Jamaica has a population which is about 78% Negro and 14% mulatto. The population of Haiti is 90% Negro with the remainder being mulatto of French-Negro descent. Only a very small proportion of the population of Middle America is of purely white descent.

On the continent as a whole, more and more people are moving to urban centres. The 1960 census showed the United States as being 69.9% urban. In 1961 Canada had an urban population of 69.6%.

See CENTRAL AMERICA: *Population*, the *Population* sections of articles on the various countries and the article NEGRO, AMERICAN. Comparative statistics may be found in the annual *Demographic Yearbook* published by the United Nations statistical office. *See* also references under "North America" in the Index.

(C. F. Ko.)

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(A. G. Bo.; N. E. S.; H. H. McC.; R. J. R.; J. B. Gn.)

NORTHAMPTON, EARLS AND MARQUESSES OF. The earldom of Northampton was united with that of Huntingdon until 1136, again possibly from about 1146 to 1157 and for the last time between 1174 and 1184. Both titles were first bestowed in 1065 upon WALTHEOF (d. 1076), son of Siward, earl of Northumberland. Waltheof, himself earl of Northumberland from 1072, was involved in a conspiracy against William I in 1075, forfeited his titles and was executed on May 31, 1076. His daughter Matilda (d. 1130/31) married first SIMON DE ST. LIZ (d. *c.* 1111), who was styled earl of Northampton by 1091, and secondly DAVID I (*c.* 1082–1153), king of Scotland. David held the titles from 1113–14 until 1136. His stepson, the second SIMON DE ST. LIZ (d. 1153), was recognized as earl of Northampton, possibly by 1141, and may later in Stephen's reign also have held the Huntingdon title. His son, another SIMON (*c.* 1138–1184), was probably recognized as earl of Northampton from 1155 to 1157; he held both titles after 1174. On his death in 1184 without issue, the earldom of Huntingdon passed to David, a grandson of King David I; the title of earl of Northampton became extinct.

WILLIAM DE BOHUN (*c.* 1312–1360), youngest son of Humphrey de Bohun, earl of Hereford and Essex, was created earl of Northampton in March 1337. With his elder brother Humphrey, he helped the young Edward III rid himself of Roger Mortimer's tutelage in 1330. He served in the Scottish and French wars of Edward III and was at the battle of Crécy (1346) and the siege of Calais. He was succeeded at his death in Sept. 1360 by his son, HUMPHREY DE BOHUN (1342–1373), who also inherited the earldom of Hereford and Essex in 1361. Humphrey died in Jan. 1373, leaving only two daughters. The elder, Eleanor, married Thomas of Woodstock (d. 1397), afterward duke of Gloucester, the youngest son of Edward III; but although he received the 3rd penny of the county in 1374, he seems never to have been recognized as earl of Northampton. The 3rd penny of the county was transferred in Dec. 1384 to HENRY BOLINGBROKE (1366–1413), earl of Derby, afterward king Henry IV, the husband of Humphrey's younger daughter Mary. On his accession as king in Sept. 1399, all his honours became merged in the crown.

WILLIAM PARR (1513–1571), only son of Sir Thomas Parr and brother of Catherine, 6th wife of King Henry VIII, was created marquess of Northampton on Feb. 16, 1547, shortly after the accession of Edward VI. Widely influential, he was created lord great chamberlain for life in 1550. He was a leader of the Protestant party and was one of those who did homage to Lady Jane Grey after Edward VI's death. Attainted under Queen Mary in Aug. 1553, his title was restored by Elizabeth I. He died without issue on Oct. 28, 1571, and his title became extinct.

HENRY HOWARD (1540–1614), younger son of Henry Howard (d. 1547) earl of Surrey, was created earl of Northampton on March 13, 1604. Although restored in blood in 1559 (his father had been attainted and executed in Jan. 1547) he won little favour in Elizabeth's reign and was arrested in 1571 on a charge of aspiring to marry Mary Stuart. He died unmarried in London on June 16, 1614, and his title became extinct.

WILLIAM COMPTON (*c.* 1568–1630), 2nd Lord Compton, was created earl of Northampton on Aug. 2, 1618. His wife was Elizabeth, daughter of Sir John Spencer, lord mayor of London from 1594 to 1595. Compton died in London on June 24, 1630. His son SPENCER COMPTON (1601–1643) accompanied Prince Charles (afterward Charles I) to Spain in 1623 and in the Civil War was colonel general of royal forces in Northamptonshire and Warwickshire. He was killed commanding the victorious royalist forces at the battle of Hopton Heath on March 19, 1643. William's son JAMES (1622–1681), also a royalist, held household appointments under Charles II. James's 3rd son, Spencer Compton, earl of Wilmington was prime minister (first lord of the treasury) from Feb. 1741 until Aug. 1743.

On the death of JAMES COMPTON (1687–1754) on Oct. 3, 1754, without male issue, the barony of Compton descended through his daughter Charlotte, while the earldom of Northampton passed to James's brother GEORGE (1692–1758). George was succeeded in turn by his nephews CHARLES COMPTON (1737–1763) and SPENCER COMPTON (1738–1796). Spencer's son CHARLES (1760–1828) was created marquess of Northampton on Sept. 7, 1812. WILLIAM BINGHAM COMPTON (1885–) is 6th marquess and 14th earl of the Compton line.

NORTHAMPTON, a municipal, county and parliamentary borough and the county town of Northamptonshire, Eng., lies 66 mi. N.W. of London by road. Pop. (1961) 105,421.

The streets of the business centre of Northampton converge on All Saints' church which was rebuilt during the late 17th century in the classical style. Other noteworthy churches are St. Sepulchre's, which retains a rotunda (*c.* 1110); St. Peter's, a magnificent example of late Norman architecture; and St. Matthew's, masterpiece of the late 19th-century local architect Matthew Holding and now containing a "Madonna and Child" by Henry Moore and a painting of the crucifixion by Graham Sutherland. The nave of the Roman Catholic cathedral (bishopric founded 1850) was built in 1864; a new chancel and a central tower were completed in 1960. At nearby Hardingstone is one of the three surviving Eleanor crosses. The guildhall (1864 with later additions) is a sumptuous example of Victorian Gothic designed by Edward Godwin. The borough has a theatre, two museums and an art gallery, grammar schools, a school of art and a college of technology.

Northampton lies in the valley of the river Nene, and thus is bypassed by the Grand Junction canal, and the London Midland region main railway line. A branch canal was completed in 1815, and a branch railway in 1845; the present Castle station, on the site of the medieval castle, was opened in 1881 when a loop line via Northampton was constructed to relieve congestion on the main line. The London–Yorkshire motorway, opened in 1959, passes near the borough boundary (southern access at Collingtree, northern at Heyford, respectively 3 and 5 mi. from the town centre). A small private airfield exists at Sywell, 6 mi. N.E.

The principal industry in Northampton is shoe manufacturing, traditionally shoes for men, but since the end of World War II there has been considerable production of women's shoes as well. The number of shoe factories and of workers has fallen but output has remained steady. Leather is also produced in large quantities. Engineering is well established in Northampton and some of the surrounding villages; manufactures include tapered roller bearings, motor-vehicle components, earthmoving equipment, lifts (elevators) and electronic instruments. The town is an important retail centre, serving Northamptonshire and north Buckinghamshire.

The earliest reference to Northampton occurs in a chronicle under the year A.D. 914. Town walls and a castle were built by Simon de Senlis (*c.* 1100). Northampton was a place of importance during the early middle ages, and its first charter was granted in 1189, but about 1300 it began to decline. Several national councils, some of the early parliaments and the trial and condemnation of Thomas Becket (1164) were held in the castle. The Yorkists defeated the Lancastrians (1460) just outside the town

walls during the Wars of the Roses. Northampton was for parliament during the Civil War, and after the Restoration the castle and town walls were demolished. Much of the town was destroyed by fire in 1675. Shoe manufacturing began in the 17th century, but the industry on a large scale did not develop until after 1815.

During the late 19th century the inhabitants of Northampton acquired a national reputation for the expression of uncompromising radical opinions. Charles Bradlaugh, the social reformer, was elected member of parliament in 1880; parliament, however, refused to acknowledge him until 1886, although he had been re-elected by his constituents on four subsequent occasions. In 1923 Margaret Grace Bondfield, the first woman member of the cabinet, was elected member of parliament for the borough.

At Great Brington, 6 mi. N.W. of Northampton, the church contains the tombstones of the brothers Laurence and Robert Washington, the former (d. 1616) an ancestor of President George Washington. Both stones display the Washington arms. The family moved from Sulgrave, also in Northamptonshire, to Brington about 1600: according to borough records an earlier Laurence Washington, grandfather of Laurence and Robert, was mayor of Northampton in 1532 and 1545. (V. A. H.)

NORTHAMPTON, a city of west central Massachusetts, U.S., on the Connecticut river, is located about 16 mi. N. of Springfield; the seat of Hampshire county.

Since its founding in 1654, chiefly by settlers from Connecticut, Northampton's character has reflected much of the general development of New England. Throughout the 18th century it was a self-sufficient agricultural community; its pastor from 1729 to 1750 was Jonathan Edwards (*q.v.*). After the American Revolution it was the scene of several debtors' demonstrations during Shays's rebellion. (*See* MASSACHUSETTS: *History.*)

In the 19th century Northampton became a major stagecoach stop and the northern terminus of a canal from New Haven, Conn., completed in 1834. Railroad connections with the south and east came in 1845. The establishment of a woolen factory in 1809 ushered in a slow transition from agriculture to industry, which boomed after the American Civil War. Manufactures include brushes, cutlery, wire cable, caskets and optical equipment. The silk industry, once the leader, declined in the 1920s.

Smith college was founded under the will of Sophia Smith (1796–1870) of nearby Hatfield to provide young women with a college education equal to the best offered to men. Chartered in 1871 and opened at Northampton in 1875, Smith became the largest independent college for women in the U.S. The Smith college school for social work, which trains social caseworkers and prepares students for the degree of master of social sciences, was founded in 1918. From 1925 the college sent groups of students abroad to study during their junior year.

George Bancroft, the historian, founded his Round Hill school for boys in 1823 on the site occupied after 1867 by the Clarke School for the Deaf. The People's institute, now primarily a community centre, was founded by the novelist George Washington Cable in 1896 for adult education.

Northampton was also the home of Sylvester Graham (1794–1851), the advocate of coarse flour for whom the graham cracker was named. Calvin Coolidge, 30th president of the U.S., who began his law practice in Northampton, died there in 1933.

Incorporated as a town in 1656 and as a city in 1883, Northampton is part of the Springfield-Holyoke standard metropolitan statistical area. For comparative population figures *see* table in MASSACHUSETTS: *Population.* (D. H. S.)

NORTHAMPTON, ASSIZE OF, a number of ordinances agreed upon by the king of England and the magnates in council at Northampton in 1176. They were issued as instructions to six committees of three judges each, who were to visit the six circuits into which England was divided for the purpose. Parts of the assize repeated the substance of some provisions of the Assize of Clarendon (1166), but with several differences. Thus, arson and forgery now appeared among the crimes about which juries of presentment were to inquire, and those who failed at the ordeal were to lose a hand as well as a foot. An important section defined some of the rights of the heir, the lord (or lords) and the widow of a deceased free tenant; its protection of the heir's right to succeed to land established the possessory action of *mort d'ancestor.* The justices were also ordered to hear pleas of novel disseizin (recent ejectment from a free tenement) arising since May 1175 and to try proprietary actions commenced by the king's writ for the recovery of land held by the service of half a knight's fee or less. In their fiscal capacity they were to inquire into escheats, churches, lands and women in the king's gift. Monies accruing to the king from proceedings before the justices were among the receipts for which royal bailiffs were to account at the exchequer. As a result of the rebellion of 1173–74 it was provided that an oath of fealty should be taken by all; "to wit, barons, knights, freeholders, and even villeins (*rustici*)," and that anyone who refused should be arrested as the king's enemy; the justices were to see that castles whose demolition had been ordered were razed, to inquire into castle-guard and to prepare a register of fugitives.

See A. L. Poole, *From Domesday Book to Magna Carta* (1951). The text is printed in W. Stubbs, *Select Charters*, 9th ed. (1913), an English translation in *English Historical Documents*, vol. ii, ed. by D. C. Douglas and G. W. Greenaway (1953). (ER. S.)

NORTHAMPTONSHIRE (abbr. NORTHANTS), an east midland county of England, is bounded northwest by Rutland and Leicestershire, west by Warwickshire, southwest by Oxfordshire, and southeast by Buckinghamshire, Bedfordshire, and Huntingdon and Peterborough. The area of the geographical county is 915 sq.mi. (2,370 sq.km.) and that of the administrative is 905 sq.mi. (2,344 sq.km.); Northamptonshire is 58 mi. (93 km.) long and almost exactly half as broad at its widest point. Until 1889 it included the Soke (or Liberty) of Peterborough which then became a separate administrative county; after April 1965 the Soke was united to Huntingdonshire to form a new county.

Physical Features.—The underlying structure of the county is very simple. It forms part of the Jurassic escarpment, there known as the Northampton Uplands, which run up to 735 ft. (224 m.) at Arbury Hill near the Warwickshire border. All the rocks are of Jurassic age, the dip being in a general way to the southeast and the strike from southwest to northeast. The oldest and most westerly belt consists of Lias formations which cover a large surface in the southwest and centre, around Banbury (Oxfordshire), Daventry, and south of Market Harborough (Leicestershire), and they are also exposed along the rivers near Towcester, Northampton, Wellingborough, and Kettering. The hard ferruginous marlstones of the Middle Lias were in the past much used for building material, while the Upper Lias is worked for bricks at Raunds, Rothwell, and formerly in many other places. Next above the Lias lie the Northampton sands, important for their iron ore, the county containing one of the largest ironstone fields in Britain; it has been worked mainly in the district north of the Nene between Thrapston and Northampton as far north as Corby, which is now the centre of the principal mining area. Through the middle of the county from the southern border northeast to Northampton, Rockingham, and toward Peterborough, is a wide elevated tract of Oölitic rocks, containing the most famous building freestone of the county, a Lincolnshire Oölite, known as Weldon Stone. The lower beds near the borders of Rutland yield a limestone which splits easily into slabs, known as Collyweston "slates," still quarried for roofing though not so much as formerly. Along the southeastern border of the county a belt of Oxford Clay occupies the surface. Boulder Clay is widely distributed over the uplands and in the east of the county, and glacial and river gravels are also plentiful. At Kingscliffe glacial deposits of high quality silica clay have been worked for several years.

The southwestern portion of the county forms the principal watershed of the Midlands; the Ouse with its tributary the Tove, the Cherwell, the Avon, the Leam, the Welland, and the Nene have their sources in this region. The Nene flows slowly in a northeasterly direction draining to the Wash. In appearance the county is unspectacular; there are no moors or large commons. Apart from the opencast mines and the built-up areas, most of the land is farmed though there are substantial tracts of woodland, relics of Rockingham, Salcey, and Whittlewood forests. The largest of the reservoirs at Pitsford, over 3 mi. long and with a capacity

of 4,635,000,000 gal. (17,550,000,000 litres) was opened in 1956. Other stretches of water have been adapted for sailing and aquatic sports. The county Naturalists Trust controls a wildfowl refuge on Pitsford North Reservoir, as well as part of a disused canal near Passenham and Wicken and a nature reserve in Salcey Forest. The National Trust owns more than 30 ac. (12 ha.) in the county and protects more than 600 ac. (245 ha.).

History.—In primitive times the waters of the North Sea reached almost to the foot of the Northamptonshire Uplands, then covered with dense forest. Paleolithic flint implements have been found in the gravels of the Nene, and there have been a few Neolithic finds. Beaker and other Bronze Age pottery has been found on the uplands. Iron Age A, B, and C cultures are represented and a number of hill forts are known. Hunsbury, 1½ mi. SW of Northampton, is the most famous of these and has yielded a bronze decorated sword scabbard which is an important example of pre-Christian Celtic art, as is a fine bronze mirror from Desborough. The main Roman road, now known as Watling Street, crossed the west of the county and a network of other roads has been traced. Important Romano-British settlements were situated at Towcester, Whilton, Irchester, and probably Kings Sutton. In the 6th century the Middle Angles penetrated up the Nene Valley; in the 7th century Penda, king of Mercia, brought the whole area under his control, and his son Peada founded an abbey at Medeshamstede (now Peterborough) in 655. Foundations also existed at Oundle, Brixworth, and other places, but were destroyed when in 870 the district was overrun by the Danes; Peterborough (*q.v.*) alone was recolonized about 965. The shire is probably of Danish origin, being the area which owed allegiance to Northampton as a military and administrative centre in the 10th century. In 917, when Edward the Elder, after fortifying Towcester, recovered Northampton, this area extended to the Welland, and at the time of the Domesday survey the boundaries approximated to those of the modern county with the addition of the Soke of Peterborough. The Geld Roll (William I) and Domesday Book (1086) mention 28 hundreds in Northamptonshire, part of Rutland being assessed under this county, but by 1316 the hundreds had been reduced to 20, including the hundred of Nassaburgh (Peterborough). At the time of the Domesday survey the chief lay tenant in Northamptonshire was Robert, count of Mortain, whose fief escheated to the crown in 1106. The large estates of William Peverel, founder of the Augustinian abbey of St. James at Northampton, also escheated to the crown in the 12th century. In the 15th century the most famous family was the Wydvilles (Woodvilles), who owned Grafton Regis where Edward IV secretly met and married Elizabeth Woodville in 1464. Other famous families were the Treshams and the Catesbys. Archbishop Henry Chichele was born at Higham Ferrers, and Sir Richard Empson was born at Towcester.

Northampton (*q.v.*), because of its central position and the proximity of its forests in which there were royal hunting lodges, was a favourite meeting place of the councils and parliaments of the Norman and Plantagenet kings. Henry II and Thomas Becket met at Northampton in 1163. In 1215 the barons besieged the castle and in 1264 Henry III captured it from the younger Simon de Montfort. During the Wars of the Roses Henry VI was defeated at Northampton in 1460. In 1607 there was a serious revolt in the county against enclosures of arable land for sheep pastures which had already brought wealth to many county families such as the Spencers and Knightleys. In the Civil War the county declared largely for Parliament, Charles I being defeated at the Battle of Naseby in 1645 and imprisoned at Holdenby in 1647.

From the time of Robert Browne (d. 1633), the independent churchman (buried in St. Giles' churchyard, Northampton), the county has been noted as a centre of Nonconformity. William Carey, the Baptist missionary to India, was born at Paulerspury in 1761, and Dr. Philip Doddridge moved his academy to Northampton when he became independent pastor there in 1729. Thomas Fuller (1608–61) and John Dryden (1631–1700) were born at Aldwinkle and Thomas Percy (1729–1811) was rector at Easton Maudit. The Althorp or Pytchley Hunt (removed to Brixworth in the early 19th century) came into prominence in the second half of the 18th century, as did the Grafton Hunt later.

Northampton's first charter dates from 1189, Brackley's from about 1260, and Higham Ferrers' (*q.v.*) from 1251. From 1547 Brackley returned two members to Parliament, and from 1557 Higham returned one. Under the act of 1832 the county returned four members in two divisions. Under the 1948 act the division of the county and Soke of Peterborough were: Kettering, Peterborough, South Northants, and Wellingborough. The county borough of Northampton also returns one member.

As the archdeaconry of Northampton (mentioned in the 12th century), Northamptonshire was part of the diocese of Lincoln down to 1541 when with Rutland it was separated to become the new diocese of Peterborough. The archdeaconry of Oakham consisting of the northern half of the diocese (including Rutland) dates from 1875. Northampton also gives its name to the Roman Catholic diocese founded in 1850 and covering seven counties.

Architecture.—Of monastic foundations there are no remains of importance. At Geddington and also at Hardingstone, on the outskirts of Northampton, there are Eleanor crosses erected by Edward I. The county is famous for its churches, many with magnificent broached spires. To the Saxon period belong the towers of Earls Barton Church and Brigstock, but the oldest of them all is Brixworth Church built about 675 in the form of a basilica.

Of Norman work, the finest examples are St. Peter's and St. Sepulchre's, Northampton. St. Mary's (Early English and Decorated) in Higham Ferrers is one of the finest churches in the county; those at Irthlingborough and Lowick (with their lantern towers), Warmington (fine Early English work), Rushden, Finedon, Raunds, and Fotheringhay (*q.v.*) should be mentioned. The county is rich in family chapels full of monumental statuary such as those of the Spencers at Brington and the Montagus at Warkton.

Rockingham Castle is now mainly Elizabethan or Jacobean though it was originally built by William I and has a surviving gateway and hall rebuilt by Edward I. Fotheringhay and Northampton castles have disappeared. Barnwell Castle built in 1266 has four round towers and an imposing gateway. Kirby Hall, a beautiful Elizabethan building now a ruin taken over by the Ministry of Works, was once the residence of Sir Christopher Hatton (d. 1591), lord chancellor of England; he also rebuilt Holdenby, which later became a royal residence but was mostly demolished in 1655. Castle Ashby is Elizabethan with a front by Inigo Jones, and Althorp Park dates from the 16th century. Apethorpe Hall, also begun in the 16th century, was the home of Sir Walter Mildmay. The Triangular Lodge at Rushton built (1593–95) by Sir Thomas Tresham, a noted Catholic recusant, is a remarkable allegory of the Trinity. Lamport Hall (National Trust) has a central block designed by John Webb between 1654 and 1657. Boughton House near Kettering is notable for its north facade, the most French looking late-17th-century building in England. Easton Neston is a perfect example of a house by Nicholas Hawksmoor (built 1700–02). Of smaller houses Sulgrave Manor is the ancestral home of George Washington. Northamptonshire, traditionally known as the county of spires and squires, was dubbed the Heralds Garden (1610) by John Norden, the topographer, in reference to its numerous halls and manor houses.

Population and Administration.—The population of the administrative county (1961) was 292,584 (mid-1965 est. 301,640). In 1961 the population of the county borough and county town of Northampton was 105,421 and thus increased to more than 120,000 with the extension of the borough's boundary in April 1965. There are four municipal boroughs, namely Brackley (pop. [1961] 3,208), Daventry (5,860), Higham Ferrers (3,753), and Kettering (38,659). There are nine urban and eight rural districts. The population of Corby in 1961 was 35,938, of Wellingborough 30,583, and of Rushden, 17,377. Corby (*q.v.*), a village in 1931 (pop. 1,596), is a New Town covering 4 sq.mi. (10 sq.km.; not quite coincident with Corby Urban District) with a rapidly growing population estimated in mid-1965 to be 44,610. The court of quarter sessions sits at Northampton and there are nine petty sessional divisions. Northampton has a separate court of quarter sessions. There are 269 civil parishes.

The Economy.—About 84% of the geographical county is farmland. While towns have gradually encroached on farmland, the restoration of land left derelict after opencast ironstone mining has partly restored the balance. During World War II there began a tremendous increase in tillage, maintained and further increased after the war.; by the mid-1960s the figure exceeded 294,000 ac. (119,000 ha.). Cereal crops have increased nearly threefold since 1939 and potato acreage is eight times the 1939 figure. Sugar beet covers above 3,300 ac. (1,300 ha.). The county is best known, however, for livestock rearing, the area of permanent grass, mostly on the hilly uplands, covering about two-fifths of the total farmland. The number of sheep, so important a factor in the county's economy from the 15th to the 18th century, has increased considerably since 1939, and was about 390,000 in the mid-1960s. Important county agricultural shows are held annually at Overstone near Northampton and there is an agricultural institute at Moulton.

The industries of the county are mainly concentrated in a belt of towns along the London-Carlisle road, about Northampton, and in the steel town of Corby where more than 13,000 workers are employed in the huge iron and steel works. Smaller industrial centres are at Brackley, Towcester, and Daventry (radio installations). The chief industries of Northamptonshire include the historically ancient manufacture of boots and shoes and tanning; at Kettering there is a shoe research institute. Engineering is the next most important industry, mainly at Northampton where there are tapered roller bearing, electrical, electronic, and general engineering works. At Northampton and at Kettering the manufacture of clothing is well established; corsets are made at Desborough. Box making and printing, the manufacture of plastic dolls and foodstuffs are among the other industries of the county. At Northampton there is a large brewery. Among older trades now discontinued are lacemaking, of which Wellingborough was a centre, the making of whips formerly carried on at Daventry, of ropes, of clay tobacco pipes at Northampton, of paper in various mills, but especially the weaving of cloth (a staple industry of the county down to about 1800). Agricultural and earth-moving machinery are also made there, and there are firms of vinyl and plastic molders as well as three iron foundries and a large cosmetics factory.

Lying between London and the industrial north, Northamptonshire is traversed by three main railway routes, though, because the gradient down to the Nene was too steep, the main London to Birmingham line, built in 1838, runs a few miles to the west of Northampton. Electrification was completed in November 1965.

In the 18th century Towcester, which lies on Watling Street, and Northampton prospered on their inns. Near Towcester lies Silverstone, a popular centre for motor racing. The Great North Road also touches the county at the western end of the Soke of Peterborough, while the A6 runs through the central industrial belt. The M1 motorway enters the county near Hartwell passing through Watford Gap to Crick, a branch (M45) running west to Coventry and Birmingham. Other main roads run from the Oxfordshire border through Northampton to Stamford via Kettering and to Peterborough via Wellingborough. The former Grand Junction and Grand Union canals pass through this county. There is a small airport at Sywell outside Northampton.

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NORTH ATLANTIC TREATY ORGANIZATION

(NATO) was established by the treaty signed on April 4, 1949, in Washington, D.C., by representatives of 12 countries: Belgium, Canada, Denmark, France, Iceland, Italy, Luxembourg, the Netherlands, Norway, Portugal, the United Kingdom and the United States. This list was increased to 14 during the Korean War, when in Feb. 1952, in accordance with the provisions of art. 10, Greece and Turkey acceded to the treaty. Three years later, in May 1955, the Federal Republic of Germany entered the alliance.

Treaty Provisions.—The North Atlantic treaty consisted of 14 articles, the most important of which were art. 6, defining the area to be covered by the treaty; art. 5, the "trigger" clause, setting forth the obligations of the member states if an armed attack should occur within the defined area; and art. 2, providing the basis for political and economic co-operation within the alliance. As modified with the adherence of Greece and Turkey art. 6 explicitly included "the territory of any of the Parties in Europe or North America, . . . the Algerian departments of France . . . the territory of Turkey or . . . the islands under the jurisdiction of any of the Parties in the North Atlantic area north of the Tropic of Cancer." Within this vast expanse, far greater of course than the North Atlantic plus western Europe, the parties agreed (under art. 5) that "An armed attack against one or more of them . . . shall be considered an attack against them all; and consequently they agree that, if such an armed attack occurs, each of them, in exercise of the right of individual or collective self-defense recognized by Article 51 of the Charter of the United Nations, will assist the Party or Parties so attacked by taking forthwith, individually and in concert with the other Parties, such action as it deems necessary, including the use of armed force to restore and maintain the security of the North Atlantic area."

The hope of the members that the treaty would transcend the essentially defensive, military features of art. 5 was expressed in art. 2: "The Parties will contribute toward the further development of peaceful and friendly international relations by strengthening their free institutions, by bringing about a better understanding of the principles upon which these institutions are founded, and by promoting conditions of stability and well-being. They will seek to eliminate conflict in their international economic policies and will encourage economic collaboration between any or all of them."

The treaty formally and definitively recognized that a brief chapter of world history had ended, a chapter which had been marked by a European and American coalition with the Soviet Union to defeat the Axis powers in World War II and establish a new international order after that defeat. Soviet action inside the United Nations had forced the west to the conclusion that the international organization could not in and of itself maintain peace and security. The swiftness with which the Soviet Union converted eastern European countries from German satellites into Communist puppets indicated that Russia was bent on external expansion. Above all, the Communist *coup d'état* in Czechoslovakia in 1948 and the breakdown of the four-power control commission in Germany posed for western statesmen a threat to their national security and independence.

Preliminary Steps.—Preservation of free institutions in Europe after World War II required three types of action. First was the elimination of Communists from the ministries of certain European countries and the isolation if not the reduction to impotence of the various national Communist parties, avowedly instruments of Soviet design and tools of Soviet policy. In 1947 this step had been taken in France and Italy, the two countries with the largest Communist parties; in the rest of western Europe by that time Communist organizations could not undertake successful programs of subversion or insurrection. The second requisite was co-operation among European nations, since individually each was patently incapable of defending itself against the Communist colossus. A beginning in this direction was made with the establishment in 1948, as the European co-ordinating agency for the European Recovery program (E.R.P.), of the Organization for European Economic Cooperation (O.E.E.C.). More significant as forerunner of the North Atlantic treaty was the Brussels pact (a 50-year mutual defense alliance), signed in March 1948 by Belgium, the Netherlands and Luxembourg (the so-called Benelux countries), France and the United Kingdom just one month after the Communists seized control of Czechoslovakia.

In the third place, however, western European countries, even united and determined to remain outside the enlarging Soviet orbit, could attain their objective only if North America threw its weight into the balance. Under the Marshall (E.R.P.) plan, the United States in 1948 had undertaken a multibillion-dollar program of economic assistance, but military aid and political commitments were also needed if the Soviet Union was to be convinced of the folly of further European aggrandizement. For Canada as a member of the British Commonwealth such a commitment followed most logically upon the close involvement of the mother country in continental affairs after World War II, beginning with the Dunkerque treaty with France in 1946. Canada was therefore a leader in arguing for a broadening of the Brussels pact to include North America.

United States membership in a military alliance in peacetime represented a sharp break with the nation's former policies of neutrality and isolation. The United States had joined with the other American republics of the western hemisphere in the Inter-American Treaty of Reciprocal Assistance (Rio treaty), which became a prototype of the North Atlantic treaty in its self-defense aspects. (*See* PAN-AMERICAN CONFERENCES.) Bipartisan leadership proceeded to use the Rio treaty as the precedent for United States membership in "such regional and other collective arrangements as are based on continuous and effective self-help and mutual aid." These words from the Arthur S. Vandenburg resolution adopted by the U.S. senate in June 1948 clearly indicated the increasingly favourable disposition of the United States toward a North Atlantic treaty soon to be negotiated.

From Pact to Organization.—Some time passed after the signing of the 1949 treaty before the North Atlantic treaty became an organization. The transition was accelerated by North Korea's attack on South Korea in June 1950, which was interpreted to mean that international Communism would not shrink from overt military aggression anywhere in the world, including Europe, where weakness and indecision seemed to provide favourable opportunities.

The key to the organization that developed was the relationship between two complexes of committees, one civilian and one military. Periodic meetings of foreign and defense ministers of the signatory powers attracted the major share of public attention, but the cardinal element in the political control of the organization was the North Atlantic council, on which representatives of the member states sat in theoretically permanent session. Individual meetings of the council could be informal, with no agenda and no record of decisions, or could entail the presence of selected advisers to the delegates for the discussion of particular problems. The size of the organization and the increasing range of subjects considered by the council made the work of the secretary-general and his staff very important. To balance the prominent role played by U.S. representatives on the various military committees the secretary-general was chosen from among the other countries. Lord Ismay of the United Kingdom was succeeded by Paul Henri Spaak of Belgium, followed in turn by Dirk U. Stikker of the Netherlands. Working under the direction of the secretary-general was an international staff secretariat that gradually increased in size. A highly important factor in the long-term viability of the organization was the growing consciousness of the members of the secretariat that they were to function as international civil servants; they were to reflect the views of the organization. not primarily the views of their own governments. The North Atlantic council had several civilian committees, perhaps the most significant of which were those concerned with infrastructure (the network of installations supporting the military capability of the organization) and the annual review committee, whose function it was to survey the military programs of the member governments to determine the adequacy of their contributions to the organization and the forces which they might justly be called upon to maintain at the disposal of the NATO commanders.

Responsible within the organization to the North Atlantic council was the complex of military committees, at the head of which was the military committee itself. A noteworthy subsidiary was the standing group, meeting in Washington and composed of British, French and United States representatives whose task it was to provide advice co-ordinated among the three senior nations of the alliance.

Also beneath the military committee were the various regional commands into which the area covered by the treaty was divided. Of these commands the supreme allied commander in Europe (SACEUR) was so important, by reason of the central continental area for whose defense he was responsible, as to overshadow, at least in the popular view, the other commands which were administratively on the same level. It was to this critical zone that most of the U.S. ground and air forces were assigned. SACEUR began to emerge with the appointment late in 1950 of Gen. Dwight D. Eisenhower of the United States as its head; he was followed by three other U.S. generals, Alfred M. Gruenther, Lauris Norstad and Lyman L. Lemnitzer. As in the case of other commands, including most prominently the supreme allied commander Atlantic (SACLANT), with headquarters in Norfolk, Va., SACEUR was in turn divided regionally into subordinate forces for northern, central and southern Europe and for the Mediterranean. On the European continent another division was by the type of forces involved—land, sea and air.

Problems of Co-ordination.—Not without difficulty were arrangements for defense actually made. While recognizing the necessity for co-operation, nations were understandably reluctant to accept subordinate positions in areas which for centuries they had individually fought to defend—often against nations that were now their partners in NATO. Where overlapping interests threatened to conflict, as in the Mediterranean, compromise arrangements were hammered out in lengthy political sessions. Once established, distributions of command positions were difficult to change in recognition of shifting national responsibilities. In the Mediterranean, for example, both France and Italy felt that their developing requirements for national defense should be reflected in organizational arrangements. It was, furthermore, easier to advance the principle of national concentration on particular weapons and forces than it was in practice to induce nations to abandon portions of their military establishment. The limited standardization of matériel that developed resulted less from explicit decision on the part of the organization than from the burden of national defense expenditures and the co-operation among private manufacturers in western Europe and North America. Equality of sacrifice was another principle that was accepted by all members of the organization in theory but could not be reduced to concrete mathematical formulas for sharing defense costs. Increasing prosperity did not make most member states any less loath to increase the military proportion of their budgets, even to meet specific threats such as that posed by the crisis over West Berlin. Disruptive disputes on these questions could be avoided because the United States shouldered the largest burden of military responsibility. At the same time there was a rapid increase in West German military might, and there were recurrent actions of the Soviet Union that reminded all members that some compromise of national independence was necessary to meet the continuing threat.

Problems of Implementation.—Of even greater seriousness were three other political-military problems: (1) the number and type of forces that the allies could and should raise, (2) the nature and size of contribution that the Federal Republic of Germany should make and (3) the degree of involvement of U.S. forces and weapons in the organization.

1. After the outbreak of the Korean War military estimates placed at more than 90 the number of conventionally armed divisions needed in western Europe to deter and defeat a Soviet attack. It immediately became apparent that NATO nations could not and would not come close to this level. The large gap between what ought to be done and what would be done forced the acceptance of an increased element of risk; force goals were adopted that were only slightly more than half as large as originally established.

In 1954 a step of long-lasting significance was taken with the announcement that NATO forces would not hesitate to use nuclear weapons to defend western Europe even if the Soviet attack at

first employed only conventional arms. One purpose of NATO's conventional forces thus came to be the deterrence of attack by confronting the Soviet Union with the necessity of mobilizing considerable power for any advance. Another purpose would be to give the western allies time to reflect on whether the use of nuclear weapons, with all the dangers entailed, was indispensable to their self-protection. Although about 30 divisions was the stated minimum required for the concept of deterrence and defense, European nations displayed continued reluctance to raise their allotted number in strength and readiness. Still subject to debate was the feasibility of avoiding thermonuclear holocaust once even small-yield atomic weapons had been employed by either side.

2. Into this problem of the number and type of forces needed to defend western Europe the question of the German Federal Republic intruded. From the very outset the logic of defense dictated a "forward strategy" or concentration of forces in West Germany. Economic and political decisions made by western European nations, when measured against the units available to the Soviet Union for any attack, pointed increasingly to the necessity of a German military contribution. However, for some countries, particularly France, which had welcomed German cooperation in European political and economic institutions, the reconstruction of a German army symbolized in an obvious, grievous way the decline of their power and prestige before the historical European malefactor. Four years passed after Sept. 1950, when the United States first pressed for a German military contribution, before France, under the arrangement known as the Western European Union, accepted German membership in NATO and the right of Germany to a military establishment. In the interim, French opposition finally destroyed the formula for subordination of German units to a supranational military and political control as embodied in the European Defense and European Political Communities (E.D.C. and E.P.C.) respectively. Restraints on Germany still existed in the agreement within the Western European Union that Germany should produce some weapons, notably naval vessels and missiles only in limited size and quantity and should manufacture no atomic, biological or chemical weapons at all. The growing dependence of the organization on German forces for defense against Soviet threats, especially to West Berlin, added to NATO's decision to use weapons of mass destruction if necessary, and the inexorable, if slow, spread of nuclear technology loosened these unilateral restrictions to such an extent that the remaining ones seemed more illusory than irksome.

3. The United States was the key element in both these problems. It obviously was not disposed, even if it were able, to bridge the gap alone between available and needed western forces. Moreover, domestic legislation prevented the United States from transferring nuclear weapons to custody of another country or of providing information on their manufacture to allies who had not demonstrated their ability to produce such weapons without assistance. This position, in addition to making a German contribution more urgent, also profoundly influenced the operating principles of NATO. Nuclear weapons "assigned to NATO" would be guarded by United States forces and would pass into foreign hands only after a Soviet attack had taken place. Protracted French efforts to develop a limited form of independent nuclear power emphasized that the main deterrent to Soviet aggression remained in Anglo-American hands, with neither the British bomber command nor the United States strategic air command subject to orders from the organization in times of peace. When, after 1958, the Soviet Union was able to threaten the territory of the United States directly, European countries professed uneasiness over whether the leader of the alliance would, if worse came to worst, throw its forces into the defense of the continent at the almost certain cost of millions of casualties at home. Suggestions for increasing allied confidence in the binding nature of the treaty included creation of national nuclear forces or the pooling of substantial atomic power under direct control of the organization.

Significance.—NATO was designed primarily as an instrument of military defense in the immediate postwar era, which was characterized by a Soviet military threat to western Europe and by a U.S. preponderance of nuclear military power. With the passage of time the balance of east-west military power shifted and European economic dependence on the United States greatly declined. In the structure of western cooperation, which included such institutions as the Organization for Economic Cooperation and Development, the European Economic Community (better known as the Common Market) and the European Atomic Energy Community (Euratom), NATO continued to be important, but it no longer dominated the interallied scene. Affected by nonmilitary relations, NATO nonetheless did not venture far beyond the strict confines of European defense. Habits and machinery for political consultation were broadened and improved under the shock of the abortive invasion of the Suez area in 1956 by British and French troops. But in this function NATO was clearly assisting the ways of traditional diplomacy rather than adding organizational devices for formal conciliation or settlement. The enduring strength of the organizations also depended in large part on solutions to problems in which NATO countries were involved outside the geographical area formally covered by the treaty, as in the case of France in Africa, Portugal in Africa and Asia and perhaps the United States in relation to Communist China. Clearly the security of the alliance rested on more than the military forces it was able to mobilize in Europe, the Mediterranean and the Atlantic.

During the early 1960s, the French government, under the leadership of President De Gaulle, exhibited a growing disenchantment with NATO and a determination to develop its own independent military force. French leaders had for some time been expressing their dissatisfaction with the NATO military structure, which placed primary reliance upon U.S. troops and U.S. nuclear power. In 1960 France had become the fourth world power to produce and test a nuclear device; it also had under way a program to build up a bomber striking force. In March 1966 the French government, holding that the conditions that had brought about the formation of the alliance in 1949 no longer existed, notified the other NATO members that it would withdraw its troops from the NATO defense system by July 1, 1966; it also requested the removal, within a year, of the NATO military headquarters and of U.S. and Canadian troops and bases from French soil. France did not denounce the 1949 treaty, which provided that no member could withdraw for 20 years, but stated it would fight at the side of the allies in case of unprovoked attack during the following three years.

The physical shifting of NATO's military and political headquarters from Paris to Brussels, begun in 1966, coincided with profound changes in the nature of the alliance. In view of the growing *détente* with the U.S.S.R., apparent since 1963, NATO ministers' consultations increasingly emphasized strictly European issues—especially those bearing upon aspirations for economic unity—rather than military deterrence. On these new grounds and in the absence of France, Germany took the lead in broad policy-making in NATO; the U.S., occupied with Asia and a limited participant in Europe's affairs once the mutual-defense motive had been subordinated, no longer exercised the kind of influence that brought the alliance into being.

For a discussion of the opposing eastern European Communist military command, *see* WARSAW TREATY ORGANIZATION. *See* also ALLIANCE; PAN-EUROPEAN MOVEMENT. For other regional agreements for mutual defense and consultation, *see* SOUTHEAST ASIA TREATY ORGANIZATION; BAGHDAD PACT. *See* also references under "North Atlantic Treaty Organization" in the Index.

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NORTH BAY, a city of Ontario, Can., and the seat of Nipissing district, is on the northeast shore of Lake Nipissing. It serves as a dividing point between northern and southern Ontario, hence its popular description "gateway of the north." For many years it was best known as a railway centre and distributing point, and tourism is important. North Bay is the site of a large all-weather jet air base. Pop. (1966) 23,115; Greater North Bay, including the adjacent townships of Widdifield and West Ferris, about 45,000. (C. M. FE.)

NORTH BORNEO (SABAH): *see* MALAYSIA.

NORTHBROOK, THOMAS GEORGE BARING, 1ST EARL OF (1826–1904), English statesman and viceroy of India, was born in London on Jan. 22, 1826, the eldest son of Sir Francis Baring (afterward 1st Baron Northbrook). He was educated at Christ Church, Oxford, and was brought up in an atmosphere of Whig politics. After gaining extensive experience as private secretary to several statesmen and as a junior minister, he became undersecretary of state for war in 1861 and again in the Gladstone ministry of 1868, and was appointed viceroy and governor general of India in 1872. He followed a policy of financial economy, and in 1875 succeeded in lowering the general level of import duties from 7½% to 5%. But his relations with the home government deteriorated after the Liberal duke of Argyll was succeeded as secretary for India by the Conservative Lord Salisbury with the return of the Disraeli ministry to power in 1874. When Salisbury urged the remission of the import duty on Lancashire cotton piece goods, Northbrook declined for, although he believed in the principles of free trade, he thought that the duty was justified by the revenue it produced and that Indian opinion would be scandalized by any idea that India's interests were being sacrificed to Lancashire's. He also disagreed with Salisbury's proposal to station a British agent at Herat despite the opposition of the amir of Afghanistan. Finally, in 1876, Northbrook resigned on personal grounds, and was given an earldom. He served as first lord of the admiralty in the Gladstone ministry of 1880–85, and went to Egypt in 1884 as special commissioner to inquire into financial problems. He died at Stratton park, Hampshire, on Nov. 15, 1904.

See B. Mallet, *Thomas George, Earl of Northbrook* (1908).

(KE. A. B.)

NORTH CAROLINA, popularly known as the "Tar Heel state" and the "Old North state," one of the original 13 states, the 12th to ratify the constitution, is located in the southeastern part of the United States. It is bounded on the north by Virginia, on the east and southeast by the Atlantic ocean, on the south by South Carolina and Georgia and on the west and northwest by Tennessee. North Carolina has an extreme length from east to west of 503¾ mi., which is greater than that of any other state east of the Mississippi river. Its total area is 52,712 sq.mi., of which 3,615 sq.mi. are water surface; in size it ranks 28th among the states. The name Carolina ("land of Charles") was first used in 1629 in honour of Charles I of England. The capital of the state is Raleigh (*q.v.*), named in honour of Sir Walter Raleigh. The North Carolina state motto is *Esse quam videri* ("To Be Rather Than to Seem"). The flag has a blue union containing a white star and the letters "N" and "C," the star surmounted by a scroll bearing the inscription "May 20th, 1775" (the date of the Mecklenburg declaration of independence), and below the star another scroll inscribed "April 12th, 1776" (the date of the Halifax resolution); the fly consists of two equal bars of red and white. The state bird is the cardinal, the flower the dogwood and the song "The Old North State."

PHYSICAL GEOGRAPHY

Physical Features.—The state (between latitude 33° 52′ and 36° 34′ N., and between longitude 75° 27′ and 84° 20′ W.) lies wholly within the three leading topographical regions of the eastern portion of the United States: the Coastal plain, which occupies approximately the eastern half; the Piedmont plateau, which occupies about 20,000 sq.mi. in the middle; and the Appalachian mountain region, which occupies about 6,000 sq.mi. in the west.

Coastal Plain.—At the eastern extremity of the Coastal plain region an outer coast line is formed by a chain of narrow sandy islands, known as the Outer banks, from which project capes Hatteras, Lookout and Fear, whose outlying shoals are known for their difficulty of navigation. Between Hatteras and Lookout is Raleigh bay and between Lookout and Fear is Onslow bay; and between the chain of islands and the deeply indented mainland Currituck, Albemarle (*see* ALBEMARLE SOUND), Croatan, Pamlico, Core and Bogue sounds form an extensive area, especially to the northward of shallow, brackish and almost tideless water. Projecting into these sounds and between the estuaries of rivers flowing into them are extensive tracts of swampland, the best known of which is the Dismal Swamp (*q.v.*), which lies mostly in Virginia and is about 37 mi. long and 22 mi. wide. The Coastal plain contains many natural lakes, the largest of which are Mattamuskeet, Waccamaw, Black and Phelps. Through most of the region, which extends inland an average of 150 mi., the country continues very level or only slightly undulating, and rises to the westward at the rate of little more than one foot to the mile. The Fall line, the boundary between the Coastal plain and the Piedmont plateau, has a very irregular course across North Carolina, but lies in a general southwesterly direction from the Falls of the Roanoke between Halifax and Northampton counties to Anson county on the South Carolina border; it marks a rapid increase in elevation of about 200 ft.

Much of the land near the coast is low and swampy, but the western part of the Coastal plain has much fertile soil, chiefly sand silt loams. This is the largest and best farming area in the state, the place where much of the nation's bright-leaf tobacco is grown as well as a great variety of other crops. The Sandhills area in the vicinity of Pinehurst and Southern Pines, at the western edge of the Coastal plain, is famous as a winter resort and as a peach-producing area. The chief rivers in the Coastal plain are the Roanoke, Chowan, Tar-Pamlico, Neuse-Trent and Cape Fear. With the exception of the Cape Fear, which empties directly into the ocean, all of these rivers flow into the sounds, which are shallow and not very good for navigation and trade. Wilmington (*q.v.*), the state's leading deep-water port, is situated on the Cape Fear river.

Piedmont Plateau.—North Carolina has the largest Piedmont plateau area of any of the eastern states. This region extends from the Fall line westward to the Blue Ridge escarpment, toward which its mean elevation increases at the rate of about 3½ ft. to the mile. This gently rolling country ranges in elevation from about 400 ft. in the Durham area to 1,500 ft. in the Morganton vicinity. The chief rivers of the Piedmont are the Yadkin (Pee Dee-Yadkin), Catawba and Broad. The Piedmont rivers, being shallow and swift and having many waterfalls, are not good for navigation but are excellent for the development of power. Textiles, tobacco and furniture manufactures first developed in the Piedmont, and this region remains the centre of North Carolina manufacturing.

Appalachian Mountains.—The third physical division in the state is the mountain region, a part of the Appalachian system. There are two large chains of mountains, the Blue Ridge (*q.v.*) on the east and the Great Smoky mountains (*q.v.*) on the west. Connecting these two chains are several cross ridges. One of these, the Black mountains, contains Mt. Mitchell (6,684 ft.), the highest peak in the eastern part of the United States. The state has the largest mountain area in eastern America. In the "Land of the Sky," as this beautiful region is sometimes called, there are 43 peaks of over 6,000 ft. and 125 others of more than 5,000 ft. The mountain valleys are usually narrow and deep, though few descend to less than 2,000 ft. above sea level. The beautiful scenery, pleasant climate and good roads have made this region one of the great summer resorts of the nation.

From the Black mountains, the streams flow as from a ridge pole, some to the Atlantic, others to the Mississippi and finally to the Gulf of Mexico. West of the Blue Ridge the Hiwassee, the Little Tennessee and the French Broad rivers flow west or northwest into Tennessee. Farther north are the headwaters of the New river, which finds its way to the Ohio. On the southeastern slope of the Blue Ridge rise the Broad, the Catawba and the Yadkin, which first flow northeast, then, finding a passage across one of the ridges of the Piedmont plateau, turn to the southeast and across the boundary line into South Carolina, in which state their waters reach the Atlantic.

Climate.—The climate of North Carolina varies from that of the southeast corner, which approaches the subtropical, to that of the mountain region, which is like the medium continental type except that the summers are cooler and the rainfall greater. The mean annual temperature for the state (below an elevation of 4,000 ft.) is about 59° F. (about 15° C.); for the Piedmont plateau

region, 60° F.; for Southport, in the southeast corner of the state, 64° F.; and for Highlands, at an elevation of 3,817 ft. in the southwest corner, 50° F. Extremes have ranged from −19° F. (about −28° C.) at Highlands to 107° F. (about 41° C.) at Chapel Hill, Orange county. The average precipitation for the state is about 50 in. a year, nearly all of it in the form of rain. For the Coastal plain region it is 48 in.; for the Piedmont plateau region 47 in.; and for the mountain region 54 in. On the east slope of some of the mountains the rainfall is exceedingly heavy. The winds are variable and seldom violent, except along the coast during the subtropical storms of late summer and early autumn.

Soil.—In the Coastal plain the soil is generally sandy, but in all parts of this region more or less marl abounds; south of the Neuse river, the soil is mostly a loose sand, north of it there is more loam on the uplands, and in the lowlands the soil is usually compact with clay, silt or peat; toward the western border of the region the sand becomes coarse and some gravel is mixed with it. The entire Piedmont region is underlain by crystalline rocks, such as granite and schists. The soils are, for the most part, red sandy loams, gravelly and sandy in spots.

Vegetation.—The growing season, free from killing frost, ranges from 240 days along the coast to 200 in the mountains. Because of its great variety of climate and soils, North Carolina has the greatest variety of plant life of any state in eastern North America. Tree species range from subarctic spruce and balsam fir in the high mountains to subtropical palmetto in the Wilmington-Southport area. North Carolina is one of three states having the greatest variety of hardwoods. It is the second largest lumber producing state in the south and the fifth largest in the nation. Pines are found throughout the state, especially in the east. Near the coast grows the carnivorous Venus's-flytrap.

Animal Life.—Among the most prevalent wild animals are rabbits, squirrels, raccoon, opossum, deer, bear, muskrats, foxes and wildcats. The commonest birds are cardinal, wren, mockingbird, chickadee and also many varieties of woodpeckers and warblers. Quail, doves, robins, wild turkeys, geese and duck also are plentiful. Many migratory game birds winter in North Carolina and swans, geese and ducks nest near the coastal waters.

Inland-water fish such as bluegills, crappies, bass and sunfish are found in many ponds and lakes throughout the state. Brook and rainbow trout also thrive in the mountain streams. Shad, herring, croakers and many other varieties of fish are to be found in the sounds and other waters of eastern North Carolina. Oysters, clams, shrimp and scallops are abundant along the seaboard.

State and National Parks, Historic Sites, Forests and Game Refuges.—By the early 1960s the state had acquired and developed almost a score of parks and recreational areas, among which are Mount Mitchell, Fort Macon near Beaufort, Hanging Rock in Stokes county, Morrow Mountain in Stanly county, Cliffs of Neuse in Wayne county, William B. Umstead park in Wake county, Town Creek Indian mound in Montgomery county and Tryon's palace at New Bern.

The United States government contributed greatly to recreational development by the creation of four large national forests—Pisgah and Nantahala in the mountains, Uharie in the Piedmont and Croatan in the Coastal plain. It also established the Great Smoky Mountains National park (*q.v.*), containing about 500,000 ac. in North Carolina and Tennessee. National military parks and historic sites are Guilford Courthouse (near Greensboro), Moores Creek (near Wilmington), Fort Raleigh (at Roanoke Island) and Wright Brothers National memorial (at Kitty Hawk). The Cape Hatteras National Seashore recreational area, established in 1953 and comprising 28,500 ac. in public beach and dune lands, was the first such area in the national park system.

HISTORY

The history of North Carolina may be divided into four main periods of unequal length and significance: the period of discovery and early colonization (1524–1663); the period of proprietary rule (1663–1729); the period of royal rule (1729–76); and the period of statehood (from 1776).

Discovery and Early Colonization.—The first Europeans to explore the coast of North Carolina were the French led by Giovanni da Verrazano in 1524. Two years later, Lucas Vazquez de Ayllón led a Spanish expedition from Santo Domingo and planted a temporary colony of over 500 people near the mouth of the "Rio Jordan," probably the Cape Fear. In 1540 Hernando de Soto's expedition from Florida penetrated the mountains of North Carolina before turning west and discovering the Mississippi river. Neither the French nor Spaniards made further efforts to colonize this region.

It was the English who permanently colonized and held North Carolina. After receiving from Queen Elizabeth I a patent for colonization in the new world, Sir Walter Raleigh in April 1584 sent Philip Amadas (or Amidas) and Arthur Barlowe to discover a suitable site for a colony bordering on Florida, then in the possession of Spain. Amadas and Barlowe returned in September with a glowing account of the coast of North Carolina, and on April 19, 1585, a colony of 108 men under Ralph Lane sailed from Plymouth in a fleet of seven small vessels commanded by Sir Richard Grenville. The colony was established at the north end of Roanoke Island on Aug. 17 and about a week later Grenville returned to England for supplies. Threatened with famine and with destruction by hostile Indians, the entire colony left for England on June 19, 1586, on Sir Francis Drake's fleet. Only a few days after their departure Grenville arrived with supplies and more colonists, 15 of whom remained when he sailed away. Although greatly disappointed at the return of the first colony, Raleigh dispatched another company, consisting of 121 persons under John White, with instructions to move the plantation to the shores of Chesapeake bay. The new company arrived at Roanoke Island on July 22, 1587, and were forced to remain there by the refusal of the sailors to carry them farther. Of the 15 persons left by Grenville not one was found alive. White's granddaughter, Virginia Dare (b. Aug. 18, 1587), was the first English child born in America.

Governor White soon returned to England for supplies, and having been detained there until 1590 he found upon his return no trace of the colony except the word "Croatoan" carved on a tree hence the colony was thought to have gone to friendly Indians of that name. The fate of the "Lost Colony" has remained one of the mysteries of history (*see* ROANOKE ISLAND).

Geographical conditions determined that the first permanent settlement of North Carolina was from Virginia rather than from Europe directly. The first permanent English settlement in America was made at Jamestown, Va., in 1607. Within a relatively short time people from this settlement were beginning to explore what is now northeastern North Carolina, and the area was also beginning to attract attention in England. In 1629 King Charles I granted Carolana (Carolina) to Sir Robert Heath, who did not succeed in planting a colony. The region north of Albemarle sound was first settled in the 1650s, probably as early as 1653, by persons moving south from Virginia in quest of good farm land. This settlement attracted attention in England, where a group of courtiers applied to Charles II for a patent to the territory south of Virginia including the Albemarle settlements.

Proprietary Rule.—In 1663 Charles II granted the territory between the 31st and 36th parallel, and extending from sea to sea to the earl of Clarendon, the duke of Albemarle and six other favourites. These were the same boundaries as those in the Heath patent, which was now declared void because of failure to settle. By a second charter issued to the eight lords proprietors in 1665 the limits of Carolina were extended to 29° and 36° 30′. The proprietors established Albemarle county and divided it into precincts which chose representatives to an assembly which, with the court system, council and governor appointed by the proprietors, constituted the government. The first assembly met in 1665. In 1669 the proprietors adopted the Fundamental Constitutions of Carolina, written by John Locke, but this elaborate and feudalistic form of government failed to work and was eventually dropped. The proprietors failed to give Albemarle county competent officials or a stable, efficient government, and the colony grew slowly. The hardy, individualistic settlers drove several incompetent governors from office. Albemarle county ceased to exist by that name in 1689 when the proprietors appointed Philip Ludwell

governor of "that part of our Province of Carolina that lies north and east of Cape Fear." Two years later a reorganization of government provided for a governor of all Carolina, resident at Charleston, who should rule the northern settlement through a deputy. From 1712 until 1729 the proprietors appointed governors to rule "North Carolina" as a separate province, though the boundary between North Carolina and South Carolina was not agreed upon until 1735 nor fully surveyed until 1815. The North Carolina-Georgia boundary was not surveyed until 1819.

Settlers had troubles with the nonresident proprietors over quitrents and other matters relating to land tenure; with Virginia, which forbade shipment of Carolina tobacco through its ports and disputed over the boundary until its joint survey in 1728; and with England, whose trade regulations and taxation of tobacco led to Culpeper's rebellion in 1677. In 1708 the Cary rebellion broke out because of the taxation of Quakers and other dissenters for support of the established church. The colony suffered heavily from the Tuscarora War (1711–13) and was able to defeat Tuscarora (*q.v.*) only by timely military aid from South Carolina. The trade of the colony suffered from pirates who frequented the coast, and the governors made little effort to stamp out piracy. This handicap to commerce was practically removed in 1718 when an expedition from Charleston captured Stede Bonnet and when another expedition from Virginia killed Edward Teach, commonly known as Blackbeard.

Owing to all these troubles and to inadequate transportation facilities, North Carolina's growth was extremely slow. All the other English colonies began with the founding of towns, but North Carolina had no town until after 1700. Bath, the oldest town in the state, was settled by French Huguenots from Virginia and was incorporated in 1706. In 1710 New Bern (*q.v.*) was settled by Swiss and Germans. In 1722 a village on Queen Anne's creek was named Edenton in honour of Gov. Charles Eden. Beaufort was begun about the same time. About 1727 Brunswick was laid out on the lower Cape Fear by Maurice Moore of South Carolina, and the attractive and fertile valley of the Cape Fear with its superior navigation was settled quite rapidly. Newtown, incorporated as Wilmington in 1739, soon became the chief port. The estimated population of the colony at the close of the proprietary era was 35,000; they covered the area from Virginia southward beyond the Neuse river and in the Cape Fear valley.

Royal Rule.—In 1729 North Carolina became a royal colony when King George II purchased the shares of seven of the eight lords proprietors for £17,500, plus £5,000 for arrears in quitrents. Lord Carteret, later earl of Granville, refused to sell, and a strip of land in North Carolina lying between latitude 35° 34′ and the Virginia line (36° 30′), known as the Granville district, was laid off as his one-eighth share of Carolina. Granville held the land in this area and collected quitrents, but he had no governmental jurisdiction. His land policy in the Granville district was a source of serious friction with inhabitants, and his ownership of the land deprived the colonial government of badly needed revenue.

The passage of North Carolina to the crown caused no significant change in governmental structure or powers, though it brought the colony more closely into line with British imperial administration. Royal government was characterized by greater stability, stronger administration and better enforcement of law and order than had prevailed under the proprietary regime. The transfer of the province to the crown marked the beginning of a significant era in North Carolina—its first real period of progress. The history of the colony for the next 40 years was characterized by a steady and rapid growth in population; settlement of the whole Cape Fear valley and the Piedmont; expansion of agriculture, industry and trade; some improvements in transportation and the beginnings of a postal system; a higher standard of living, reflected in better homes, finer furniture, more and better tools and implements and more comfortable living conditions; rapid growth of dissenting sects, notably Presbyterians and Baptists; and founding of many churches, a few schools and some libraries.

As settlement expanded many new counties and towns were founded, among the latter being Halifax, Campbellton (present Fayetteville; *q.v.*), Hillsboro, Salem, Salisbury (*q.v.*) and Charlotte (*q.v.*). There was a great increase in the production and trade of tobacco, naval stores (tar, pitch, turpentine and rosin) and rice with England, New England and the West Indies. The first printing press was set up at New Bern in 1749, and two years later appeared the first book and the first newspaper, the *North Carolina Gazette*, edited by James Davis, the public printer.

During the royal period, Scotch-Irish, Germans, Highland Scots, English and a few other national stocks poured into North Carolina. Between the battle of Culloden (1746) and the American Revolution, perhaps 20,000 Highland Scots settled in the Cape Fear valley, comprising the earliest and largest settlement of Highlanders in America. About 65,000 Scotch-Irish, who came largely by way of Pennsylvania, and 25,000 Germans (Moravian, Lutheran and Reformed), also by way of Pennsylvania, settled throughout the Piedmont counties. Negro slaves increased from 6,000 to more than 40,000, being found mostly on eastern plantations engaged in the production of tobacco, rice and naval stores. The population of 35,000 in 1729, confined to the Coastal plain, increased to nearly 300,000 in 1775 and extended from the coast to the Blue Ridge mountains and to the Watauga-Holston valleys beyond. When North Carolina became an independent state in 1776, about one-third of its people were of English stock; nearly one-third were Scottish, either Highlander or Scotch-Irish; one-fifth were Negroes; and about one-tenth were Germans.

Geographic, ethnic, economic, social and religious differences produced a deep-seated east-west sectionalism. The colonial government was dominated by the east, and even county government was controlled by the royal governor through his power to appoint local officers. County officials were often corrupt, inefficient and oppressive. The back country people suffered from excessive taxes, dishonest officials and exorbitant fees. They also complained bitterly about multiple office holdings. An association called the Regulators sought vainly to obtain reforms. Then they refused to pay taxes and fees, punished public officials and interfered with the courts. The Regulation insurrection ensued, in which the insurgents were crushed by Gov. William Tryon, who later became colonial governor of New York, with the support of the eastern-dominated government at the battle of Alamance, May 16, 1771.

The political history during the royal period is, like that of other colonies, the story of a constant struggle between representatives of the people and representatives of the crown. There were bitter disputes over questions of government, trade, finance and religion. In 1765–66 armed patriots prevented the enforcement of the Stamp act in the colony. The people formed associations pledged not to purchase British goods in protest against the import duties levied under the Townshend act of 1767. In 1774 they sent aid to Boston after its port was closed by the British following the Boston Tea Party.

In Aug. 1774 the first provincial congress met at New Bern in defiance of Gov. Josiah Martin and elected delegates to the first Continental congress. A second provincial congress met in April 1775, and in the next month royal rule ended in North Carolina when Governor Martin fled from New Bern to a British ship in the Cape Fear river. A committee representing the militia companies of Mecklenburg county on May 31, 1775, adopted a series of resolutions which declared that the royal commissions in the several colonies were null and void, that the constitution of each colony was wholly suspended and that the legislative and executive powers of each colony were vested in its provincial congress subject to the direction of the Continental congress; and the resolutions requested the inhabitants of the county to form a military and civil organization independent of the crown of Great Britain which should operate until the provincial congress should otherwise provide or the British parliament should "resign its unjust and arbitrary pretensions with respect to America." The Mecklenburg declaration of independence, which it is alleged was passed on May 20 by the same committee, is of doubtful authenticity, though the date appears on the state flag by legislative act. The Whig (patriot) victory at Moores Creek bridge, Feb. 27, 1776, thwarted Governor Martin's efforts to re-establish royal authority.

Independence.—The first sanction of independence by any

colony was the Halifax resolution adopted by the fourth provincial congress on April 12, 1776, and the same body immediately proceeded to the consideration of a new and permanent form of government. Their labours ended, however, in another provincial government by a council of safety, and the drafting of North Carolina's first state constitution was left to a constitutional convention that assembled on Nov. 12, at Halifax.

In the American Revolution, North Carolina furnished ten regiments of Continental troops and many thousands of militia. It sent military aid to South Carolina and Virginia and to Washington's army in the north, while it also helped to defeat the Cherokees and suppress the numerous Tories who made the revolution a civil war in North Carolina. A British invasion was turned back on Oct. 7, 1780, by the destruction of Maj. Patrick Ferguson's army at King's mountain. Cornwallis' invasion of the state culminated in the battle of Guilford Courthouse on March 15, 1781. Though it was a technical British victory, Cornwallis retreated to Wilmington from where he marched north to his fate at Yorktown.

Statehood.—During the confederation, 1781–89, North Carolina, like other states, met its federal obligations to the central government only when it wished to do so. The state sent delegates to the Constitutional Convention of 1787 at Philadelphia, but the state convention, at Hillsboro, called to ratify the constitution for North Carolina, did not meet until July 21, 1788, when ten states had already ratified. The document was strongly opposed because it contained no bill of rights and on the ground that it would provide for such a strong central government that the state governments would ultimately be sacrificed. At the conclusion of the debate the convention declared itself unwilling to ratify the constitution until a bill of rights had been added and it had been amended in several other particulars so as to guarantee certain powers to the states. But a second convention met at Fayetteville in Nov. 1789 and the constitution was speedily ratified (Nov. 21).

In 1789 also the University of North Carolina was chartered by the state legislature (opened to students in 1795) and the state ceded its western lands (Tennessee) to the United States. In 1792 a permanent capital was located at Raleigh and a capitol building was completed in 1794. The first banks were established in 1804 at New Bern and Wilmington. Superior courts were provided for each county in 1806 and a supreme court was created about the same time, though district judges for it were not provided until 1818. In the second war with Great Britain (1812–15), North Carolina's quota of 7,000 soldiers served on the southern frontier and along the Canadian border.

East-West Struggle.—The period from 1789 to 1835 was marked by a contest between the dominant eastern and the western counties. The west urged that equal county representation in the legislature be replaced by representation based on population. This was stubbornly resisted, and the west assumed a threatening attitude as the east opposed its projects for internal improvements for which the west had greater need. Finally in Jan. 1835 the legislature passed a bill for submitting to popular vote the question of calling a constitutional convention. In the election that followed in April, every eastern county gave a majority against the convention, but the west voted strongly for it and carried the election. In the convention, the east made some concessions, such as the popular election of the governor, the disfranchisement of free Negroes, the abolition of borough representation in the legislature, the choosing of state senators from districts according to public taxes, and the apportioning of members of the lower house (commoners) to counties according to population based on the federal ratio. The electorate gave its approval to the revision, and with this the agitation over representation ceased.

Whigs and Democrats.—The period 1835–60 was an age of progress in the state. After the constitutional reforms of 1835 broke the political dominance of the east, the new progressive Whig party controlled the state government from 1836 to 1850 and adopted the program of public education and internal improvements that had been proposed by state senator Archibald D. Murphey, pioneer advocate of public education, 20 years earlier. The Democratic party, generally dominated by the planter class, grew weary of successive defeats because of its negative program of opposition to Whig policies. It captured control of the state in 1850 because of its able young leaders (notably W. W. Holden and David S. Reid), its advocacy of free suffrage (abolition of 50-ac. requirement to vote for state senators), and the weakening of the Whig party as a result of the slavery controversy and the failure of the Whigs to press forward with the progressive program they had launched.

The Democratic party controlled the state from 1850 to 1862. Once in power it gradually adopted and extended the progressive program inaugurated by the Whigs. In the generation before 1860 the state government completed a new capitol in 1840 (the first one had burned in 1831), gave millions of dollars of aid for building of plank roads and a 900-mi. network of railroads, established (1839–40) and provided the major financial support for a state system of free public elementary schools for white children, established institutions for the care of the blind, deaf and insane, expanded the state system of taxation and made some liberal changes in the criminal law and in the legal status of women. The state university grew rapidly; many private academies were founded as well as colleges for women; and the leading denominations established colleges for men. Newspapers increased in numbers and circulation, and there was a beginning of indigenous authorship. Bright-leaf tobacco was developed, and there were many improvements in farming methods and increases in crop production (particularly cotton and tobacco). There was also a significant beginning of manufactures, notably cotton textiles. This age of progress and prosperity was brought to an end by the Civil War.

Civil War and Reconstruction.—The fundamental points of difference between North Carolina and South Carolina were exemplified in the controversy over slavery. South Carolina led the extreme radical element in the south and was the first state to secede (Dec. 1860). North Carolina held back, worked for a compromise, sent delegates to the Washington peace convention in Feb. 1861 and did not secede until May 20, 1861, after President Lincoln's call for troops to preserve the union. Entering the war reluctantly, the state furnished troops in excess of its voting population and of its relative population in the Confederate states. While making its full contribution of men, money and supplies to the Confederacy, the state, under the political control of the Conservatives after 1862 with Zebulon B. Vance as governor, sharply criticized the policies of the Jefferson Davis administration, contending that the Confederacy was encroaching upon the prerogatives of the states. The northeastern part of the state was captured by Federal troops in 1862 and held throughout the war. The battles of Ft. Hatteras, Plymouth, Ft. Fisher (the "Gibraltar of America") and Bentonville, Sherman's invasion in March 1865 and Johnston's surrender to Sherman near Durham on April 26, 1865, were the most notable events of the war in North Carolina. Wilmington remained the most important blockade-running port in the Confederacy until the fall of Ft. Fisher in Jan. 1865. About 40,000 North Carolina soldiers died in battle and from disease. The war had bled North Carolina white and left it with a depressing heritage of defeat.

Reconstruction was a difficult experience in North Carolina as in other southern states. In 1865 Pres. Andrew Johnson appointed W. W. Holden provisional governor until an election could be held. The convention of 1865 repealed the ordinance of secession, declared slavery abolished, repudiated the state war debt and scheduled elections for the establishment of a constitutional state government. Jonathan Worth, who was elected governor, was an honest and capable official, but the government established shortly thereafter in accordance with the views of congress was corrupt, inefficient and tyrannical. Carpetbaggers, Negroes and native whites known as scalawags were in control of affairs, while many people of wealth, refinement and education were disfranchised. The Republican party, organized in the state in 1867, took the lead in writing and adopting the constitution of 1868—a very liberal document—and captured control of the state government. Gov. W. W. Holden (elected 1868) was so unpopular and tyrannical that he was impeached, convicted and removed from office by the legislature in 1871. Under his successor, Tod R.

BY COURTESY OF (CENTRE RIGHT) STANDARD OIL OF NEW JERSEY; PHOTOGRAPHS, (TOP) KAUFMANN AND FABRY PHOTO, (CENTRE LEFT, BOTTOM CENTRE, BOTTOM RIGHT) F P G., (BOTTOM LEFT) PHILIP GENDREAU

SCENES IN NORTH CAROLINA

Top: Pilot mountain, a curious rock formation (about 2,500 ft. high) near Mount Airy. In the foreground is a field of tobacco, the state's leading crop

Centre left: Asheville, resort city in the southern Appalachian highlands, western North Carolina

Centre right: Wild ponies of Ocracoke Island, Pamlico sound. According to local legend, the ponies are descendants of animals brought by early colonists

Bottom left: Greenfield lake, near Wilmington

Bottom centre: Birthplace of Andrew Johnson, Raleigh

Bottom right: View along Cape Fear river near Wilmington, part of the Intracoastal waterway

BY COURTESY OF (TOP LEFT) THE STATE OF NORTH CAROLINA DEPARTMENT OF CONSERVATION AND DEVELOPMENT, (TOP RIGHT, CENTRE, BOTTOM RIGHT) STATE OF NORTH CAROLINA PHOTOGRAPH, (BOTTOM LEFT) STANDARD OIL OF NEW JERSEY; PHOTOGRAPHS, (CENTRE, BOTTOM RIGHT) GUS MARTIN (CENTRE RIGHT) AUTHENTICATED NEWS

VIEWS OF NORTH CAROLINA

Top left: The Greek Revival state capitol building at Raleigh, completed in 1840

Top right: Wright memorial at Kitty Hawk, site of the first powered airplane flight, 1903, by Wilbur and Orville Wright

Centre: Home Moravian church at Winston-Salem, centre of the Moravian faith in the southern U.S., opened in 1800

Centre right: The conservatory in Biltmore house, the George Vanderbilt estate near Asheville, completed in 1895

Bottom left: The chapel of Duke university, Durham

Bottom right: State fair arena at Raleigh

Caldwell, there was some improvement in the condition of affairs, and in 1875 a constitutional convention at Raleigh, with the Democrats slightly in the majority, amended the constitution, their work being ratified by popular vote at the state election later in the year. The native white element completely regained possession of the state with the reelection of Zebulon B. Vance as governor in 1876.

Late 19th Century.—For the next 20 years the Democratic party gave the state respectable, cheap government and kept the Negro from office and political influence; but under control of the conservative element, sometimes known as Bourbon Democrats, it neglected the needs of the great mass of farmers, catered to railroads and other business interests and sought to perpetuate itself in power by appeals to party loyalty and race prejudice rather than by meeting the social, educational and political needs of the state. Cotton, tobacco and furniture manufactures grew rapidly after 1880. Business prospered but agriculture was in a sad plight, as it was throughout the nation generally. Finally, the organized farmers of the state formed the Populist (People's) party, which in 1894 fused with the Republicans and carried the state; two years later, Daniel Russell, a Republican, was elected governor. The race question dominated the elections of 1898 and 1900, when the Democrats came again into power; and in 1900 a constitutional amendment (the literacy test and the so-called "grandfather clause") virtually disfranchising the Negro was adopted.

20th Century.—In the midst of this period came World War I, in which the state contributed over 86.000 persons to the armed services and $160.000.000 in bond purchases. A decade of significant highway, educational and other economic and social developments followed, being succeeded in turn by the depression of the 1930s, which brought widespread hardship and severe curtailment of education and other public services. The state government extended relief to the counties by assuming substantially the full cost of highways in 1931 and of public schools in 1933. By 1940 the state was beginning to enjoy another period of progress. Meanwhile, state-wide prohibition, in effect since 1908, was superseded in 1933 by a system of state-supervised county liquor stores.

In the 1940s the national defense program and World War II had important effects on North Carolina. Some of the country's largest military installations were located in the state, among them Ft. Bragg and Camps Lejeune, Butner, Davis, Mackall, and Cherry Point. More than 362.000 North Carolinians served in the armed forces and more than 7,000 lost their lives. Residents of the state subscribed over $1.800.000.000 in various bond drives. Almost $2.000.000.000 was spent in the state by the armed forces for manufactured war supplies, not including subcontracted materials, and North Carolina delivered more textile goods to the army than did any other state.

The state established a pension and retirement system for teachers and other state employees in the 1940s, provided a nine months' term for public schools and launched a vast medical care program, providing for a four-year medical school and hospital at the state university and hospitals throughout the state. Legislative appropriations were made to the North Carolina Art society and to the North Carolina Symphony society, the first instances of state financial aid to art and music. In 1959 the State Art museum at Raleigh had the most outstanding art collection in the south. In 1949 the voters of the state approved a bond issue of $200.000.000 for secondary road construction. Bond issues to the extent of $75,000,000 for construction of public school buildings were approved by the voters in 1949 and 1953.

Rapid industrialization, accompanied by urbanization, made manufacturing the chief source of the state's wealth and gave it pre-eminence in the nation in tobacco, cotton textiles and wooden furniture. Industrial expansion and diversification after 1950 were almost phenomenal. In national politics the state went Republican for the first time since Reconstruction when it voted for Herbert Hoover in 1928, but in 1932 the state returned to the ranks of the Democratic "solid south."

Among the most significant later developments in the state were the creation in 1956 of the state board of higher education; the reorganization of the state government by the creation of a department of administration; the revision of the corporate tax structure; the creation of the Research Triangle (University of North Carolina at Chapel Hill, Duke university in Durham and North Carolina State college at Raleigh) and the development of the Research park; and the adoption of the Pearsall plan to cope with the problem of desegregation in the public schools.

GOVERNMENT

North Carolina has been governed under the charters of 1663 and 1665 (1663–1729), under commissions and instructions from the crown (1729–76) and under the constitutions of 1776 and 1868, with numerous amendments. The present constitution, as amended, prescribes that no convention of the people of the state may be called by the legislature unless by the concurrence of two-thirds of all the members of each house, followed by an affirmative vote of a majority of the electors voting on the question; and that an amendment to the constitution may be adopted also by a three-fifths vote of each house, followed by an affirmative vote of the majority of electors voting on the question. The suffrage provisions containing the famous "grandfather clause" (in art. vi, sec. 4) were adopted in the form of a constitutional amendment, ratified in 1900, and in effect July 1, 1902. This amendment required that any applicant for registration must be able to read and write any section of the constitution; the grandfather clause, however, provided that no person who was entitled to vote on or before Jan. 1, 1867, or his lineal descendant, should be denied registration by reason of his failure to possess the educational qualifications, provided that he registered prior to Dec. 1, 1908. In effect, the amendment disfranchised Negroes. In June 1959 the supreme court of the United States upheld this literacy test.

Executive.—The constitution provides for an executive department consisting of a governor (not eligible for immediate re-election), lieutenant governor, secretary of state, treasurer, auditor, superintendent of public instruction, attorney general, commissioner of agriculture, commissioner of labour and commissioner of insurance, all elected by popular vote for terms of four years. An ex officio council of state is adviser to the governor. A utilities commission of three members, a commissioner of revenue, a highway and public works commissioner, a board of education, a board of higher education and other boards and commissioners are appointed by the governor. From 1776 to the constitutional revision of 1835, the governor was elected by the legislature for a one-year term; from 1835 to 1868 he was chosen by the voters for a two-year term; after 1868 he was chosen for a four-year term. The North Carolina governor has no veto power, the only instance of this kind in the nation. Yet the governor exercises vast power by control of appointments and by virtual control of state expenditures, as head of the budget bureau.

Legislature.—The general assembly comprises a 50-member senate and a 120-member house of representatives. A constitutional amendment in 1962 required the speaker of the house to reapportion the house after each federal census if the legislature fails to do so. The legislature in special session reapportioned both houses in 1966: house members are elected from 49 districts; senate members from 33 districts. Sessions of the general assembly are held biennially, beginning on the first Wednesday in February of the odd-numbered years. It usually remains in session from 60 to 90 days.

Judiciary.—The voters approved a constitutional amendment in 1962 to reorganize the state's judiciary into a general court of justice with appellate, superior and district court divisions and with an administrative office of the courts. The amendment required some 1.400 recorder-type and justice-of-the-peace courts to be replaced by Jan. 1, 1971, with a system of district courts, at least one per county, and with magistrates appointed by judges of the superior court replacing justices of the peace.

Local Government.—The governing body in each of the state's 100 counties is the board of county commissioners—either three or five—elected by popular vote for two-year terms. Other important elective county officials are the sheriff, clerk of superior court, register of deeds, treasurer, coroner and board of education. There are many appointive offices, among the most important being

a superintendent of schools and a superintendent of public welfare. Most of the revenues for county government are derived from taxes on real and personal property.

The three forms of city government in the state are: (1) mayor and council, (2) commission, and (3) city manager. The latter system is the most prevalent among the larger towns and cities.

Finances.—North Carolina is one of the few states in the Union that has no state tax on real property; this source of revenue was turned over to local governments in the 1920s. State revenue is derived chiefly from a general 3% sales tax, individual income taxes, corporate income taxes, motor fuel taxes and licence taxes. Major state expenditures, in order, are for public schools and institutions of higher learning, roads and highways, and health, welfare and safety.

POPULATION

The population of North Carolina in 1790 was 393,761; in 1830 it was 737,987; in 1870, 1,071,361; in 1910, 2,206,287; in 1940, 3,571,623; in 1950, 4,061,929; and in 1960, 4,556,155. This last figure represented an increase of 27.6% over the population in 1940 and of 12.2% over 1950.

The population per square mile in 1960 was 86.4, as compared with 77.1 in 1950, and with 49.6 for the U.S. in 1960.

*North Carolina: Places of 5,000 or More Population (1960 census)**

Place	Population				
	1960	1950	1940	1930	1900
Total state	4,556,155	4,061,929	3,571,623	2,559,123	1,893,810
Albemarle	12,261	11,798	4,060	2,691	[illegible]
Asheboro	[illegible]	[illegible]	6,981	[illegible]	992
Asheville	[illegible]	[illegible]	[illegible]	[illegible]	14,694
Belmont	[illegible]	[illegible]	[illegible]	[illegible]	145
Burlington	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Canton	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Chapel Hill	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Charlotte	[illegible]	[illegible]	[illegible]	[illegible]	18,091
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]rd	[illegible]	[illegible]	[illegible]	9,903	7,910
[illegible]	[illegible]	[illegible]	[illegible]	2,805	1,072
[illegible]am	[illegible]	71,311	60,195	21,719	6,679
[illegible] Wilmington	[illegible]	[illegible]			
[illegible] City	[illegible]	[illegible]	[illegible]	8,925	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Forest City	6,556	4,971	5,035	2,312	1,090
Gastonia	37,276	23,069	21,313	12,871	4,610
Goldsboro	28,873	21,454	17,274	11,296	5,877
[illegible]	7,723	5,026	4,339	2,166	2,052
[illegible]	119,574	74,389	59,319	19,861	10,035
[illegible]	22,860	16,724	12,674	5,772	2,565
[illegible]	12,740	10,996	7,047	5,222	3,746
[illegible]ville	5,911	6,103	5,381	3,720	1,917
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Point	62,063	39,973	38,495	14,302	4,163
[illegible]ville	13,491	3,960	873	656	309
[illegible]	[illegible]	28,448	—	—	—
[illegible] Mountain	[illegible]	[illegible]	[illegible]	2,800	2,062
[illegible]	24,819	18,336	15,388	9,771	4,106
[illegible]	8,242	7,134	5,685	2,643	1,334
[illegible]	6,427	4,045	1,886	1,606	688
[illegible]	10,257	7,888	7,598	3,718	1,296
[illegible]	16,093	13,571	10,550	5,254	1,234
[illegible]	5,699	5,423	4,525	3,190	828
[illegible]	15,105	9,186	5,803	2,691	849
[illegible]	10,882	10,140	6,475	4,084	2,427
[illegible]	[illegible]	7,121	[illegible]	4,115	1,533
[illegible] City	5,583	5,144	3,695	2,958	1,379
Morganton	9,186	8,311	7,670	2,867	1,948
Mount Airy	7,055	7,192	6,286	4,752	2,680
New Bern	15,717	15,812	11,815	12,198	9,090
Newton	6,658	6,019	5,407	3,021	1,583
[illegible] Belmont	8,128	3,048	—		
[illegible]	[illegible]			—	—
[illegible]	6,978	6,085	3,991	3,606	2,059
[illegible]	93,931	65,679	46,897	24,418	13,643
[illegible]	14,267	[illegible]	[illegible]	5,313	3,262
Roanoke Rapids	13,120	8,156	8,545	3,369	1,009
[illegible]	5,512	[illegible]	[illegible]	2,509	1,507
[illegible] Mount	[illegible]	[illegible]	[illegible]	12,742	2,937
[illegible]	[illegible]	[illegible]	[illegible]	1,651	1,021
[illegible]	21,297	20,102	19,037	13,884	6,277
[illegible]	12,253	10,013	4,960	2,977	1,044
[illegible]	17,698	15,508	14,037	3,609	1,874
[illegible]	6,117	5,574	3,678	1,895	764
[illegible] Pines	5,198	4,272	3,225	743	517
[illegible]	19,844	16,901	11,440	7,895	3,141
[illegible]	8,411	8,120	7,148	4,568	2,499
[illegible]	15,190	11,154	11,041	5,676	751
[illegible]	9,939	9,698	8,369	6,314	4,842
[illegible]	6,159	5,295	2,940	1,942	1,307
[illegible]	5,510	—	—	—	—
[illegible]	6,928	4,975	3,966	1,800	912
[illegible]	44,013	45,043	33,407	33,372	20,976
[illegible]	28,753	23,010	19,234	10,612	3,525
[illegible]†	111,135	87,811	79,815	48,395	13,650

*Populations are reported as constituted at date of each census. †Winston city and Salem town were consolidated under the name of Winston-Salem in 1913.

Note: Dash indicates place did not exist during reported census, or data not available.

Of the 1960 population, 1,801,921, or 39.5%, lived in [illegible] rated places of 2,500 or more, as compared with 33.7% in [illegible]. The state has six standard metropolitan statistical areas. [illegible] are Asheville, Charlotte (enlarged in 1963), Durham, Gr[illegible] High Point, Raleigh and Winston-Salem. These areas [illegible] in 1963) had a total 1960 population of 1,163,880.

The number of occupied dwelling units (or households) in 1960 was 1,204,715. The average population per household had declined from 4.0 in 1950 to 3.7 in 1960.

The population of the state was distributed by colour and nativity in 1960 as follows: 74.2% native white; 0.4% foreign-born white; and 25.4% nonwhite, nearly all Negro. There were 98.2 males per 100 females in the white population, and 94 [illegible] the Negro population; 6.8% of the population was 65 years and over; and 56.3% of the population 14 years old and over was in the labour force. Of the total number of employed, 12.8% were engaged in agriculture, 6% in construction, 31.7% in manufacturing and 21.6% in transportation and trade.

Most of the foreign-born white population of North Carolina is of English, Greek or German stock. The population of the state contains less than 1% of foreign-born persons.

EDUCATION

Public Schools.—The public-school system of North Carolina made remarkable and well-rounded progress after 1900. The total school expenditures between 1901 and 1929 increased from $[illegible] per capita of enrollment to $42.53. As a result of the depression public school expenditures dropped, but they rose rapidly in the decades during and after World War II. School attendance is compulsory between the ages of 7 and 16 inclusive. The length of school term and salary scale for white and Negro teachers are identical; in fact, the average Negro teacher's salary is [illegible] cause a larger percentage of Negro teachers hold class A certificates. From 1917, with the aid of federal funds, the state supported vocational education, particularly agriculture and home economics, in the public schools.

In the years following the supreme court ruling concerning racial segregation in the public schools (1954), some desegregation occurred under the pupil assignment law of 1956. Under the Pearsall plan the state constitution was amended in 1956 to permit state and local funds to be spent for private school [illegible] grants for children whose parents object to their attending [illegible] grated schools, and to allow local school units to close [illegible] schools if conditions should become "intolerable." Local school boards in many cities and counties admitted Negro pupils to schools that formerly were all white.

Higher Education.—There are about 40 senior (four years or more) colleges and universities in North Carolina, one-third [illegible] supported, the other two-thirds private or church-related. [illegible] The state also has a number of junior colleges, some of which [illegible] community colleges receiving local and state support, the other private or church-related institutions.

University of North Carolina.—Chief among the state institutions of higher learning is the University of North Carolina at Chapel Hill, chartered in 1789 and opened in 1795, one of the oldest state universities in the country and the first [illegible] operation in the south. Other branches of the consolidated university are North Carolina State of the University of North Carolina at Raleigh (founded 1887) and the University of North Carolina at Greensboro (1891). By 1860 the University [illegible] Carolina had become the largest university in the south [illegible] the best. It remained open during the Civil War though [illegible] dent body was very small, but, unable to weather the Reconstruction period, it was closed from 1870 to 1875. It struggled [illegible] the latter part of the 19th century and had a vigorous growth [illegible] World War I. In 1931 the consolidated university, comprising the three institutions, came into being. The university's colleges and schools at Chapel Hill include arts and sciences [illegible] gional planning, library science, social work, law, medicine, dentistry, nursing, pharmacy and public health. Its library [illegible] more than 1,000,000 volumes. North Carolina State of the [illegible]

[illegible]y of North Carolina at Raleigh includes schools of agricul[illegible], design, education, engineering, forestry and textiles. The [illegible]sity of North Carolina at Greensboro (formerly Woman's [illegible]) has schools of liberal arts, education, home economics and [illegible], and commercial and nursing education departments.

[illegible] State Institutions.—Other state-supported colleges are [illegible] Carolina college (1907) at Greenville, Western Carolina col[illegible] (1889) at Cullowhee and the Appalachian State Teachers [illegible] (1903) at Boone. State-supported Negro institutions in[illegible] the Agricultural and Technical college of North Carolina [illegible]) at Greensboro, the Winston-Salem Teachers college [illegible]), the North Carolina College at Durham (1910) and state [illegible]chers' colleges at Fayetteville (1877) and Elizabeth City (1891). A school for the Lumbee Indians of Robeson county is [illegible]ed at Pembroke. In 1963 three public community junior [illegible] Asheville-Biltmore, Charlotte and Wilmington—were [illegible]sformed into senior colleges, and legal provision was made for the creation of several more community colleges.

Private Institutions.—Among the nonstate-supported institu[illegible]s of higher education Duke university, formerly Trinity col[illegible] (Methodist), at Durham, is the greatest. It received from [illegible]s B. Duke the sum of $6,000,000 for building and an endow[illegible] fund estimated to be from $80,000,000 to $100,000,000, one [illegible] the largest foundations for education and hospitalization in [illegible] world (*see* DURHAM). Well-known church-related colleges [illegible] Wake Forest college (Baptist; 1833) at Winston-Salem; Da[illegible]n college (Presbyterian; 1837) at Davidson; Greensboro col[illegible] (Methodist; 1838) at Greensboro; Lenoir Rhyne college [illegible]an, 1891) at Hickory; Catawba college (Reformed; 1851) [illegible]ry; Meredith college for women (Baptist; 1891) at Ra[illegible] Elon college (Christian; 1889) at Elon; High Point college [illegible]dist; 1924) at High Point; Salem college for women [illegible]an; 1772) at Winston-Salem; Belmont Abbey college [illegible] Catholic; 1878) at Belmont; Guilford college (Quaker; [illegible]) at Guilford College; Atlantic Christian college (Disciples [illegible]hrist; 1902) at Wilson; Methodist college (1960) at Fayette[illegible]; North Carolina Wesleyan college (Methodist, 1961) at [illegible]ky Mount; and St. Andrew's college (Presbyterian, 1961) at [illegible]burg. Institutions originally established for Negroes in[illegible] Shaw university (Baptist, 1865) at Raleigh, Johnson C. [illegible] university (United Presbyterian; 1867) at Charlotte; [illegible]stone college (Methodist; 1879) at Salisbury; St. Augus[illegible] college (Episcopal; 1867) at Raleigh; and Bennett college [illegible]men (Methodist; 1873) at Greensboro.

HEALTH AND WELFARE

The chief state-supported institutions in 1960 consisted of hos[illegible] the white insane at Raleigh, Morganton and Butner and [illegible]tal for Negro insane at Goldsboro; the Caswell Training [illegible] for delinquents at Kinston, the North Carolina Orthopedic [illegible] for crippled children at Gastonia, the North Carolina hos[illegible] the treatment of spastic children at Durham, sanatoriums [illegible] treatment of tuberculosis at Black Mountain, McCain and [illegible]; the Stonewall Jackson Training school for delinquent [illegible] boys at Concord; the Eastern Carolina Industrial Training [illegible] for delinquent white boys at Rocky Mount, the Morrison [illegible] school for delinquent Negro boys at Hoffman, the train[illegible] school for Negro girls at Rocky Mount; the North Carolina [illegible] Home and Industrial School for Girls and Women at [illegible]and; and the Central prison at Raleigh.

[illegible] state has a very effective public health program headed by [illegible] board of health, established in 1877. All of the state's [illegible]ties have local health departments. North Carolina was [illegible] state to pass a law (1959) making poliomyelitis vaccina[illegible]pulsory.

THE ECONOMY

Agriculture.—North Carolina is a state of small farms, the [illegible] size being about 80 ac.; Texas is the only state having a [illegible]ber of farms. The leading crops are tobacco, corn, cot[illegible], hay and potatoes; and a great variety of other crops, [illegible] and vegetables is grown. North Carolina produces about two-fifths of the U.S. tobacco crop [illegible] tobacco used [illegible] tobacco [illegible]. The annual [illegible] from tobacco [illegible] to more than $[illegible] [illegible] in descending order were tobacco, [illegible] cotton lint, dairy products, eggs, hogs and forest products. North Carolina agriculture is being diversified rapidly; by the early 1960s livestock accounted for [illegible] of farm income as compared with about 16% in 1939.

In 1900 North Carolina was seventh among the southern states in the value of all farm crops. After 1920 it usually ranked 2nd in the south and from 5th to 13th in the nation. Nearly all farms are electrified. The state leads the nation in the number of 4-H club members.

The percentage of farms operated by tenants dropped from 44% in 1940 to 30% by the 1960s. Nearly 60% of Negro farmers are tenants, as compared with about 20% of white farmers.

Lumbering.—Woods and forests cover more than one-half the area of North Carolina, the total amount of standing saw timber approximating 50,000,000,000 bd.ft. Of this timber, about 40% is pine and other softwoods; the remainder hardwood. On rich forest resources are based the state's major paper, furniture and pulp products industries, which collectively rank third, after textile and tobacco manufactures. The annual pulpwood cut is approximately 1,000,000 cords, while the lumber yield rose from 544,000,000 bd.ft. in 1889 to 1,994,000,000 bd.ft. by 1950, in the latter year representing about 5% of the national total. More than two-thirds of the state's counties co-operate with the state division of forestry, and in the 1960s more than 16,000,000 ac. were receiving protection.

Fisheries.—In the sounds along the coast, in the lower courses of the rivers that flow into them and along the outer shores fishing is an important industry. The total value of the North Carolina fisheries runs to about $12,000,000 a year, the most important items being food fish, shrimps, menhaden and oysters. Chief oyster and crab fisheries are located in Pamlico sound, creeks and inlets; shrimp fisheries are concentrated in Pamlico sound, rivers and creeks, and offshore in the Atlantic.

Minerals.—More than 300 different rocks and minerals are found in North Carolina, about 75 of them commercially valuable. From 1800 to 1848 North Carolina was the leading gold producing state, having mined approximately $60,000,000 worth of the precious metal. After 1900 the state normally ranked from 36th to 39th among the states in the total value of its annual mineral production. It is noted chiefly for its nonmetallic minerals. Mineral products (in descending order, according to value) include building stone (by far the most important), sand and gravel, feldspar, mica, clays, talc and pyrophyllite and tungsten. The state usually ranks first in the nation in the production of feldspar and mica, second or third in talc, and vermiculite and tungsten.

Manufactures.—The value of manufactures in North Carolina after World War II rose to exceed that of farm products. North Carolina is the leading industrial state of the south and one of the dozen foremost industrial states of the nation. In all such indexes as number of plants, labour force, total salaries and wages paid, value of raw materials used, total value of output and total value added by manufacture, North Carolina ranks from 10th to 14th among the states. Its leading manufactures (listed in descending order, by value of output) are textiles, tobacco, food products, furniture, chemicals, lumber, electrical machinery and pulp and paper. [illegible] North Carolina leads all other states.

The textile [illegible] employed in manufacturing. Gaston, Mecklenburg and Guilford counties have been the leaders in textile manufacture, Gaston county having more cotton mills than any other county in the United States. Hosiery mills have been concentrated in the Piedmont, with Winston-Salem, Asheboro, Burlington and Durham being [illegible] W[illegible] Greensboro. High Point has been the [illegible] centre [illegible]

manufacture, but other important centres are Thomasville, Lexington, Lenoir, Statesville, Newton-Conover, Hickory, Mount Airy, Sanford and a number of other towns.

Transportation and Communication.—Railway building was begun in North Carolina in the 1830s, and the state's first two railroads, the Wilmington and Weldon and the Raleigh and Gaston, were completed in 1840. By 1860 nearly 900 mi. had been built with state aid, the most important road being the North Carolina railroad, extending from Goldsboro to Charlotte; this road is still owned by the state, though leased to the Southern railway. Great expansion, accompanied by consolidation of many small lines into larger systems, occurred between 1880 and 1900. Railway mileage in the second half of the 20th century, however, was slowly declining.

After 1920 great progress was made in highway construction and in the development of a state system of highways. By the early 1960s the state was maintaining a system of more than 70,000 mi. and registered motor vehicles numbered almost 2,000,000 annually. There were several regularly scheduled airlines and more than 100 airports and airfields.

In 1911 the Inland or Intracoastal waterway, built with federal funds, was completed between the Neuse river and Morehead City; the whole project was completed in 1936. The state has two ports of entry for ocean-going vessels: Wilmington and Morehead City.

The state has about 180 radio stations and 12 television stations; nearly 50 daily newspapers and about 150 other newspapers.

See also references under "North Carolina" in the Index.

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NORTH CAROLINA, UNIVERSITY OF, one of the oldest state universities in the United States, was chartered in 1789 and began instruction in 1795 at Chapel Hill, N.C. *See* NORTH CAROLINA: *Education*.

NORTH-CENTRAL PROVINCE, CEYLON, the N.C.P." to those who know it well, covers 4,009 sq.mi. of undulating country lying for the most part between 50 and 500 ft. above sea level (the province has no coast). There rises from the lowland a series of ridges (like those running from the central highlands of Ceylon to Trincomalee), and of isolated hills, the highest of which is Ritigala (2,514 ft.). Pop. (1960 est.) 308,000, mainly Sinhalese. Almost the whole province is floored by ancient crystalline rocks, the ridges being made of quartzites. East of these ridges the land drains to the Mahaveli Ganga, which is followed by a belt of alluvium; to the west of them drainage is mainly to the northwest.

The province falls in Ceylon's lowland dry zone, with its marked alternation of heavy rains during the northeast monsoon and severe drought during the southwest (*see* CEYLON: *Physical Geography*). Except to the southwest the N.C.P. is almost completely ringed by sparsely inhabited country, much of it still covered with the mixed evergreen and deciduous forest appropriate to the local climatic regime. A rather degraded version of the same forest fills the wasteland between the villages of the rest of the province, while on the east there are patches of poor grassland (*damana*) like that of the Eastern province. Elephant and other wild animals are to be found in the forests and *damanas*. The Wilpattu National park lies across the boundary with the North-Western province.

The modern N.C.P. is almost coterminous with the Rajarata ("king's country") of the ancient Sinhalese and was, in fact, the heartland of their civilization. (*See* CEYLON: *History*.) There they built and adorned their two great capitals, Anuradhapura and Polonnaruwa (*qq.v.*), whose splendid ruins have been rescued from the jungle and carefully preserved. These cities and other settlements were supplied with water for their rice fields and for their other needs by great and skilfully constructed irrigation works (notably the tanks near Minneriya, Polonnaruwa and Anuradhapura), many of which have now been restored to working order. All over the province, too, are many scattered sites of great archaeological and aesthetic interest.

The chief towns are Anuradhapura, capital of the province and of a district (pop. [1953] 18,390), and Polonnaruwa, also a district capital, both growing rapidly. Since the breakdown of the ancient civilization the N.C.P. has been the scene of struggling villages whose inhabitants grow rice irrigated by small tanks and practise shifting cultivation in the surrounding forest. Many such villages remain, now freed from malaria, but they are losing their isolation and, with it, some of their distinctiveness and charm. It is the restoration of the great irrigation works that now attracts people to the N.C.P. and leads them to a new landscape, dominated by wide acres of rice. There is a fairly good road network and a main line of railway. (B. H. F.)

NORTHCLIFFE, ALFRED CHARLES WILLIAM HARMSWORTH, 1ST VISCOUNT (1865–1922), the most successful newspaper publisher in the history of the British press and the creator of popular modern journalism, was born at

Chapelizod, Dublin, July 15, 1865, the eldest of a family of 14. His father, Alfred Harmsworth (1837–1889), was an impecunious schoolmaster who after the birth of his second child was persuaded by his wife's social ambitions to give up a teaching post in Dublin and move to London to read for the bar, becoming in due course an unsuccessful barrister of convivial temperament whose large family was brought up in genteel but often acute poverty interrupted by bouts of Bohemian extravagance. His mother, who died in 1925 aged 87, was the guiding force in the family, exercising over her first-born (the description of himself with which he signed his daily letters to her) an emotional dominance which made other intimate personal relations difficult for him.

Of the seven sons, the three eldest all became members of the house of lords: Alfred, Harold, 1st Viscount Rothermere (*q.v.*), and Cecil Bisshopp (1869–1948), 1st Baron Harmsworth of Egham. The fourth, Robert Leicester (1870–1937), was made a baronet.

The Harmsworths moved to London in 1867, and after an unhappy interlude at Stamford grammar school, Alfred was educated until he was 16 at a struggling private school owned by the father of A. A. Milne, the writer. He showed considerable talent as founder and editor of the school magazine but no gift for sustained study. After several attempts to "get rich quick" by inventing and selling a silk hat reviver and an all-purpose pill, and after having a position with the amiable son of a peer as secretary-companion on a continental tour, he embarked on free-lance journalism as a contributor to popular papers such as *Comic Life*, *Scraps*, *Young Folk Tales* and *Youth*, of which last he became editor at a salary of £2 a week. In 1885, after a temporary breakdown in health, he went to Coventry as editor of *Bicycling News*, owned by the firm of Iliffe, at £2 10*s*. a week, and began to contribute to *Tit-Bits*, the phenomenally successful popular weekly of informative scraps for the new reading public created by the Education act of 1870. The success of *Tit-Bits*, which has some claim to be regarded as the initiator of the revolution in popular journalism in which Northcliffe himself played such a leading part, fired him with the ambition to start a similar paper of his own to be called *Answers to Correspondents*. He tried to interest Iliffe's in the scheme. They turned it down but promised to print it for him on credit for a few weeks if he could get someone to back him, and in 1887 he left to seek his fortune in London. There, with a few hundreds put up by the son of a Dublin friend of his mother's, he began to publish cheap booklets (most of them written by himself) on careers, a cure for biliousness and any other subject likely to attract popular interest. He had little financial success until an introduction to an ex-army officer with a rich wife enabled him to raise enough money to take advantage of Iliffe's offer in 1888. (This was soon after his marriage to Mary Elizabeth, daughter of Robert Milner, a West Indian merchant.)

Answers to Correspondents, soon shortened to *Answers*, was the foundation of Northcliffe's career. It was not, however, an immediate success and was only saved when a simple puzzle brought to the office by an American visitor proved a hit. A competition offer of £1 a week for life for guessing the amount of gold coin in the Bank of England on a certain date established it in public favour. By this time Alfred had been joined by his brother Harold (who had been ordered by his mother to resign a safe job as a civil service clerk to help her first-born through the financial tangle which threatened his enterprises). The combination of Alfred's genius for sensing the public taste and Harold's financial ability and capacity for attracting advertising by exploitation of the idea of the net sales certificate proved irresistible. *Answers* was followed by a host of other cheap popular periodicals, chief among them *Comic Cuts* ("Amusing Without Being Vulgar") and *Forget-Me-Not*, for the new reading public of women. These formed the basis for what became in Amalgamated press (from 1959 Fleetway press) the biggest periodical publishing empire in the world.

But although Alfred Harmsworth enjoyed wealth his primary passion was journalism. In Aug. 1894 he seized the chance presented to him by an ambitious young journalist, Kennedy Jones, who had, with a friend, acquired an option on the nearly bankrupt *London Evening News*, bought the paper for £25,000 and launched into newspaper publication. The flair that had brought such results with cheap weekly magazines proved equally effective with newspapers. The character of the *Evening News* was changed overnight. Long news reports and long leading articles were banished, a column for women was started and a daily short story introduced. About £300,000 had previously been sunk in the paper without success, mostly by the Conservative party. Within a year Harmsworth had a circulation of 160,000 copies and was making a substantial profit. For the first time in his life he found himself cultivated as a political influence by men who would have taken no notice of the owner of *Comic Cuts*. He enjoyed the experience. He next conceived the idea of a chain of halfpenny morning papers in the provinces and made a start by buying up two papers in Glasgow and merging them into the *Glasgow Daily Record*. His touch with a Scottish public proved, however, less sure, and he decided to embark instead on the experiment of a popular national daily published in London. The *Daily Mail*, first published on May 4, 1896, was the result. It was a sensational success. Announced as "The penny newspaper for one halfpenny" and "The busy man's daily journal," it struck a new note that was exactly suited to the new reading public. "Explain, simplify, clarify," Harmsworth told his staff. All news stories, leaders and feature articles were kept short, and articles of interest to women, political and social gossip and a serial story were made regular features. Although news headlines remained, at first, modest in size, far more were used than in any previous paper. With its first issue the *Mail* established a world record in daily newspaper circulation and this lead it never lost while Northcliffe lived. He moved on to new triumphs. He bought the *Weekly Dispatch* when it was nearly bankrupt and turned it (as the *Sunday Dispatch*) into the biggest selling Sunday paper in the country, founded the *Daily Mirror* (1903), which, after a false start as "a paper for gentlewomen," found success in exploiting a wholly new market as a picture paper with a circulation rivaling that of the *Mail*, saved the *Observer* from extinction (1905) and in 1908 reached what he believed to be the pinnacle of his career by securing control of *The Times*.

Northcliffe (he was created a baronet in 1903 and raised to the peerage as Baron Northcliffe in 1905) was the most successful popular journalist of his own or any other day because he knew instinctively what the new, semieducated public wanted. He was one of them himself: he thought as they did, although at a level infinitely more charged with energy and imagination. He lacked the power of sustained thought or abstract judgment but he had a passionate curiosity about practical things, an insatiable appetite for facts and was genuinely excited by everything new. Lord Robert Cecil called the *Daily Mail* "A newspaper for office boys written by office boys," but Northcliffe knew that his readers were office boys on the way up: "Remember," he told his staff, "you are writing for people with £1,000 a year—or at any rate people who hope and think they'll be £1,000-a-year men tomorrow." Success lay, he believed, in flattering readers by letting them see "their own opinions and prejudices echoed in a newspaper," and since most of these opinions and prejudices were his own he found this easy. He was a popularizer of genius. As the element of megalomania in his character swelled with success he came to believe that the genius that had brought him immense circulation also gave him the right to speak for the nation. He believed in his power to sway public opinion by, in his own words, "telegraphing a message to millions with damnable retention," and he undoubtedly had great influence on the social habits of the new middle class. But although he came to believe that he controlled immense political power through his newspapers (an opinion confirmed by many around him) there is little evidence that his direct impact on public events was large. Thus, although he performed a valuable service by his exposure of the shell shortage in the early days of World War I, his attacks on Lord Kitchener, which led to the *Daily Mail's* being publicly burned on the stock exchange, probably delayed changes on which the cabinet had already decided. He tended to be used as a megaphone by men more politically adroit than himself. Thus, although he claimed to have brought about

the downfall of Asquith, he was unable to exercise any influence over the composition of the new administration and his final break with Lloyd George at the end of the war, when Lloyd George contemptuously rejected his demand to be consulted on the membership of the cabinet in return for his newspapers' support, had no perceptible effect on the results of the postwar election. He did valuable wartime service as head of the British war mission in the United States (June–November, 1917), for which he received a viscountcy, and (from Feb. 1918 until the end of the war) as director of propaganda in enemy countries, but failed to secure for himself the official place at the Versailles peace conference on which he had set his heart.

He wanted power. What he got was big business, setting in motion forces that changed the direction of much of the press away from its traditional informative and interpretative role to that of the commercial exploiter and entertainer of mass publics who had always to be given what would excite and amuse them. The financial reward was enormous, not only from sales but from the advertising revenue the great new circulations were able to attract, and Northcliffe spread some of this wealth in higher wages and better conditions for all who worked on newspapers. But he failed to achieve the power he craved because he lacked the ultimate quality of the great journalist, the patience to persuade. For this reason, although he brought *The Times* financial support at a time when it was crippled by losses, by dissension among minority shareholders and by an out-of-date 18th-century constitution, and transformed it from a 19th-century relic into a modern newspaper, *The Times* was, in a deeper sense, one of his failures. He tried to turn it into an instrument of personal policy, not seeing that to do so would be to destroy the very foundation of its authority. He was destroyed by the nature of his own success. Always unpredictable, he became the victim of a megalomania that destroyed the balance of his judgment and led him into extravagances of autocratic decision that made it difficult even for those who most admired him to work with him. He was persuaded to go on a prolonged world tour as a rest cure but a complete breakdown followed and on Aug. 14, 1922, he died in London.

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(E. F.-Ws.)

NORTHCOTE, JAMES (1746–1831), English painter, known largely for his historical paintings, but also a portraitist of considerable skill, was born at Plymouth on Oct. 22, 1746. In 1773 he went to London and was admitted as a pupil into the studio and house of Reynolds, attending also the Academy schools. He was elected associate of the Academy in 1786 and full academician in the following spring. He died on July 13, 1831.

Northcote's output, especially of portraits, was prodigious; there are a number of examples in the National Portrait gallery, London. His sitters included many notable persons, among them Samuel Taylor Coleridge and John Ruskin. Northcote was one of the chief painters employed by John Boydell (*q.v.*) for his Shakespeare gallery, some of his works on this commission being "The Murder of the Young Princes in the Tower," "The Burial of the Young Princes" and "Prince Arthur and Hubert." Northcote wrote lives of Reynolds (1813) and of Titian (1830), whose lifelong admirer he was, and two series of *Fables*.

NORTH DAKOTA, the "Flickertail state," is one of the north central group of the United States lying in an area designated by the U.S. geological survey as the centre of the North American continent. It is bounded on the north by the Canadian provinces of Manitoba and Saskatchewan, on the east by Minnesota (from which it is separated by the Red river), on the south by South Dakota and on the west by Montana. Extending 341 mi. from east to west and 212 mi. from north to south, it has a total area of 70,665 sq.mi., of which 1,208 sq.mi. are water surface, and it ranks 17th among the states in size. The state capital is at Bismarck (*q.v.*). North Dakota entered the union in 1889, the 39th state in order of admission. The wild prairie rose is the state flower and the state tree is the American elm. The state bird is the western meadow lark. The name of the state is derived from *dakota*, a Sioux word meaning "allies." The nickname is that of the tiny Richardson's ground squirrel, or yellow gopher.

PHYSICAL GEOGRAPHY

Physical Features.—The land surface of North Dakota consists largely of rolling prairies and plains, slowly rising half a mile in altitude from east to west to form a series of three successive steps or plateaus. The eastern or lowest part is made up of the flat valley of the Red river, once the bed of Lake Agassiz, formed by a retreating glacier. The area varies in width from 40 mi. near the Canadian border to 10 mi. near the South Dakota line. On the western edge of the Red river valley the land rises sharply, marking the beginning of the central plateau, sometimes referred to as the drift plain or prairie. It varies in elevation from 1,650 ft. in the Pembina mountains to 1,350 ft. in the south where the hills rise again to become the Couteau des Prairies in Sargeant county in the southeast corner of the state. The drift prairie is a rolling fertile plain varying in width from 70 mi. in the south to more than 200 mi. along the Canadian border, broken by low ridges of hills, shallow coulees and numerous small lakes. Devils lake, the largest natural body of water in the state, and the Turtle mountains lie in the northern part.

Rising 300 to 400 ft. above the drift plain and cutting across the state diagonally in a northwest-southeast direction is the third area, the Missouri plateau. Between the escarpment and the Missouri river the plateau is known as the Couteau du Missouri and west of the river as the Missouri slope. The surface is irregular and rolling, dotted with old lake beds, some of which contain large deposits of sodium sulfate, valuable clays and large beds of lignite coal. The Missouri slope is the most unusual area of the state. In it are located the badlands of the Little Missouri river where a fantastic array of buttes and mesas characterize the landscape. Vividly exposed layers of bright coloured clay and scoria indicate that the various buttes were at one time connected. The highest point in the state is Black butte, 3,468 ft. above sea level. In the western part the Killdeer mountains rise about 700 ft. above the surrounding region.

Climate.—North Dakota has a continental climate with a wide range of temperature. The mercury often reaches 100° F. (about 38° C.) during the summer and falls at times to −30° F. (−34.4° C.) during the winter months. The average temperature for June, July and August is 65.7° F., and for December, January and February, 9.7° F. A relatively low humidity, averaging 68% makes the extremes less noticeable. The sections vary greatly in precipitation, ranging from 22 in. in the southeastern corner to about 14 in. in the southwestern portion. Most of the rainfall comes in the late spring and summer during the growing season. The state is subject to alternating wet and dry years, with crop yields ranging from very good to almost complete failures. Long severe winters are typical, with an average snowfall of 30 in. Blizzards are common on the drift plain and cyclonic action during the summer months produces much of the precipitation.

Soil.—The soils of the state may be roughly divided into three general types based on their origins: the lake-bottom soils in the east, the glacial soils in the central section and the residual soils of the western portion. Small areas of alluvial land are to be found along the Missouri, James and Sheyenne rivers. In the Red river valley the soils are of the rich black loam type, 20 to 30 ft. in depth, formed in lake beds from which the water long ago disappeared. The soil change from the lake-bed area to the glacial-drift types of the central region is abrupt. The drift left by the Wisconsin glacier plus a dense grass cover produced the soils of central North Dakota. The top layer is black or dark brown loam below which lies the glacial debris of sand, gravel and boulders that is exposed in places. Farther west the soil is thinner and lighter in colour. Boulders are common and often show through the earth surface; there also are outcroppings of sandstone and shale, indicating evidence of glaciation.

Vegetation.—Because of its semiarid climate North Dakota has only about 600 sq.mi. of wooded area. In the Red river valley, Turtle mountain and Devils lake regions, such trees as the [illegible] Juneberry, elder, green ash, poplar and cottonwood are common.

BY COURTESY OF (BOTTOM LEFT) GREATER NORTH DAKOTA ASSOCIATION; PHOTOGRAPHS, (TOP) W. P. SEBENS, (BOTTOM RIGHT) EWING GALLOWAY

SCENES IN NORTH DAKOTA

Top: Wheat harvesting in the Red River valley, the "black earth" agricultural belt in the eastern part of the state

Bottom left: Statue of Sakakawea on the grounds of the state capitol, Bismarck. Sakakawea, or Sacagawea, a Shoshone Indian known as the Bird Woman, accompanied the Lewis and Clark expedition to the Pacific, 1805–06

Bottom right: Scene in the badlands, an area of eroded sandstone and clay in the western sector of the state, part of the Theodore Roosevelt National Memorial park

NORTH DAKOTA

BY COURTESY OF (BOTTOM LEFT) GREATER NORTH DAKOTA ASSN.; PHOTOGRAPHS (TOP) W. P. SEBENS FROM OSBORN'S STUDIOS, (BOTTOM RIGHT) W. P. SEBENS

THE STATE CAPITOL AND OTHER SCENES IN NORTH DAKOTA

Top: The capitol building, Bismarck. The 19 story building was designed in 1932 by J. B. de Remer and W. F. Kurke, North Dakota architects

Bottom left: Blockhouse at Fort Abraham Lincoln State park. Gen. George Custer led his troops from this fort to the battle of Little Big Horn in 1876

Bottom right: Four Bears bridge, near the upper end of the Garrison reservoir, is known as the "bridge with 19 names." Because of jealousy between the Mandan and Hidatsa Indians, plaques were fixed at each end of the span bearing a list of names of rival tribal chieftains as associate titles of the bridge

chokecherry and wild plum trees, high-bush cranberries and wild grape bushes grow abundantly along the eastern streams. In the Missouri and Little Missouri regions are found the broadleaf cottonwood, willow, ash and elm, as well as bushes of the buffalo berry and the flowering currant. Of the Rocky mountain types of trees, some stunted yellow pine and red cedar are to be found in the badlands and on the buttes of the Little Missouri. The tall Indian and blue grasses of the east are replaced by grasses of medium height in the central area and by the shorter, grayish varieties of buffalo and grama grasses in the west. Wild flowers, the yellow violet, cornflower, blue and yellow flax, black-eyed Susan, yellow goldenrod, sunflower and wild prairie rose, grow in great profusion throughout the state.

Animal Life.—In early times large numbers of buffalo, elk, deer and antelope roamed the North Dakota area, providing a permanent source of food, clothing and shelter for the native Indian tribes. With the coming of the railroad and the final defeat of the Indians in the 1880s, large numbers of these animals were destroyed for their hides and for sport. Scattered remnants of the once great herds took refuge in the badlands where state laws saved them from annihilation. In the fur-trading period the most valuable animals were the beaver, mink, otter, fisher and marten and less-valuable pelts were obtained from the weasel, black-footed ferret, skunk, red fox and raccoon. Other animals sometimes killed for their skins included the black and grizzly bear, mountain lion or cougar and buffalo wolf. Trapping of fur-bearing animals is still an important activity in North Dakota and is often followed by farmers during the winter months. Small animals common in the state are the coyote, chipmunk, squirrel, ferret and the yellow gopher or flickertail.

Among the many songbirds in the state are the sparrow, oriole, blue jay, robin, black-billed cuckoo, blackbird and meadow lark. Many waterfowl nest in the state each year. The most important upland game bird is the pheasant and the town of Mott in Hettinger county, in the southwest corner of the state, is called the pheasant capital of the state. There are extensive migratory bird and animal refuges scattered throughout North Dakota. Perch, black and rock bass, pickerel, pike, sunfish and catfish are found in the larger lakes and rivers. Suckers and carp are also common.

State and National Parks.—The best-known park in North Dakota is the Theodore Roosevelt National Memorial park of 70,436 ac., lying in the scenic badlands of the Little Missouri river. The park is visited by more than 170,000 persons annually. The Fort Abraham Lincoln State park of 750 ac., located just west of Bismarck on the western bluffs of the Missouri river, contains the sites of two early military posts and a Mandan village. The Turtle River and Lake Metigoshe State parks and the International Peace garden, partly in the state and partly in Manitoba, are popular with tourists. The 15-room château of the French nobleman the marquis de Mores, built in 1883 at Medora where he attempted to set up a meat-packing establishment, was given to the state in 1936 with its original furnishings.

HISTORY

The first white men to visit North Dakota were members of an expedition from Ft. La Reine (Portage la Prairie, Man.) led by Pierre Gaultier de Varennes, sieur de la Vérendrye. They reached a Mandan earth-lodge village in 1738, possibly the Menoken site, 13 mi. E. of modern Bismarck.

Two sons of Vérendrye crossed the Missouri near Sanish in 1742 and explored the country to the southwest in an attempt to carry out their father's dream of establishing an overland trade route to the Pacific. After reaching the Bighorn mountains they abandoned their search and recrossed the Missouri at Old Crossing. After the English occupation of Canada in 1763 the Hudson's Bay company and the North West company, operating from Ft. Garry (Winnipeg), established trading posts on the Missouri at the mouth of the Knife river where they were found by the Lewis and Clark expedition that wintered at Ft. Mandan in 1804–05. The purchase of the Louisiana territory by the United States in 1803 and the success of the Lewis and Clark expedition made St. Louis a rendezvous for American fur traders who exploited the fur resources of the upper Missouri. The American Fur company built, among others, Ft. Clark in 1826 and Ft. Union in 1829. The War of 1812 put an end to British attempts to extend the Canadian frontiers southward. By the treaty of Paris of 1818 the international boundary was fixed at the 49th parallel as far west as the Rocky mountains.

The first white settlement in North Dakota was made by a band of settlers from Lord Selkirk's colony of Scottish Highlanders in Manitoba, who settled at Pembina in 1812. When Maj. Stephen H. Long explored the Red river valley in 1823, he reported the population as numbering 350. Ft. Snelling (St. Paul) was established in 1823, and a brisk trade between this fort and Ft. Garry soon developed along both sides of the Red river. Ft. Abercrombie was built in 1858 and Ft. Pembina in 1863, and these forts became the rendezvous for commercial and military operations in the northwest, as well as rallying points for settlers.

Between 1850 and 1870 there was considerable difficulty with the Dakota (*q.v.*) Indians, whose lands in Minnesota had been largely appropriated by the whites and whose buffalo herds on the Dakota prairies were fast being depleted. The Minnesota outbreak of 1862 was followed by campaigns which finally drove the hostile Dakotas to the badlands west of the Missouri (*see* MINNESOTA: *History*). All eastern North Dakota was then open for occupation, and the completion of the first railroad to the eastern border in 1871 inaugurated the settlement period in earnest. The following decade saw intensive development in the Red river valley, and by 1880 settlement was spreading into the drift plain, especially along the line of the Northern Pacific railway which in 1873 had reached the Missouri at Bismarck. West of the Missouri the country was made attractive by the extension of the Northern Pacific, while the completion of the Great Northern railway across the northern part of the state in 1887 opened that region to settlers.

The region forming North and South Dakota, which after 1861 had been known merely as Dakota territory, was divided in 1889 into a northern and southern half. A convention met in North Dakota in July and framed a constitution which was accepted by the people in an election held on Oct. 1. Pres. Benjamin Harrison declared the state's admission to the union simultaneously with South Dakota on Nov. 2, 1889. The population of North Dakota was then almost 175,000.

The period 1890–1915 was one of constant growth. Competing railway lines strove to forestall each other in tapping promising grain territory. Once there they did their best to bring settlers into the newly opened region by conducting land excursions. Nearly 18,000 immigrants annually made new homes in the state. Settlement of the drift plain was practically completed and homesteaders invaded the good land beyond the Missouri river. The inrush continued with little abatement until after World War I when, because of the general depression in agriculture, it practically ceased. The economic distress of North Dakota's farmers during the depression was greatly increased by severe drought and dust storms between 1929 and 1935. During World War II all agricultural production records were broken.

In politics North Dakota is normally Republican, but its farmers and other dissatisfied groups have shown a tendency to desert the party in times of agricultural distress and form separate factions that usually promised more direct and radical remedies. It was one of the states involved in the Populist movement of the 1890s. In 1915 a number of Republican party members who were dissatisfied with the method of marketing grain organized the Nonpartisan league with A. C. Townley, a Socialist, as the head of the organization. By 1918 the league had elected a governor and a majority in both houses of the legislature.

In 1920 the Nonpartisan league lost much of its prestige, and many people from all parties opposed its program. Forgetting party lines, leaders of this opposition group formed the Independent Voters association (I.V.A.), which was influential in government during the remainder of the decade. In 1932 the league again came into control with the election of William Langer (1886–1959) as governor. Removed from office in 1934 for allegedly seeking political contributions, Langer won an appeal from conviction and was re-elected governor in 1936.

To combat the league the Democratic party and conservative Republicans formed a coalition in 1938 and elected John Moses, a Democrat, governor. Langer, however, was elected to the U.S. senate as a Republican in 1940 and was re-elected three times, the last time as an independent. Conservative Republicans, attempting to develop a strong party in 1943, adopted the name Republican Organizing committee (R.O.C.) and elected Fred G. Aandahl governor for three terms. Aandahl was succeeded by Norman Brunsdale and John E. Davis, both Republicans. In 1960 the Democrats showed some signs of resurgence with the election of Quentin N. Burdick to the U.S. senate and of William L. Guy as governor.

In most presidential elections after 1900 the state voted for Republican candidates but it supported Democratic candidates Woodrow Wilson in 1912 and 1916, Franklin D. Roosevelt in 1932 and 1936, and Lyndon B. Johnson in 1964. The majority for Roosevelt in 1932, 71%, was matched only by that for Republican Dwight D. Eisenhower in 1952.

GOVERNMENT

The constitution of North Dakota provides for a government operating on the state, county, township and municipal levels. The voters of North Dakota in 1964 approved an amendment to the constitution increasing from two to four years the terms of the governor, lieutenant governor, secretary of state, auditor, treasurer, superintendent of public instruction, commissioner of agriculture and labour, commissioner of insurance and county superintendents of schools. The tax commissioner also serves four years; the three public service commissioners six years. The governor appoints other state officials and the members of numerous boards and commissions.

The legislative assembly consists of a house of representatives of 106 members elected for two-year terms and a senate of 53 members elected for staggered terms of four years.

The state judicial system consists of a supreme court of five members elected for ten years and six district courts with judges elected for six-year terms.

The county is an important administrative unit. Each of the 53 counties in the state elects county commissioners for four-year terms and a sheriff, auditor, register of deeds, treasurer and state's attorney for terms of two years.

The township acts as a local unit of government for the county. Municipal governments are of the commission and mayor-council types.

About 40% of state tax collections come from the retail sales tax, 20% from an income tax and the balance from taxes on cigarettes, beer, liquor, oleomargarine, motor vehicle registration, oil and gas production and from the use tax.

POPULATION

The population of the North Dakota area increased from 2,405 in 1870 to 577,056 in 1910 and to 680,845 in 1930. With the agricultural depression of the 1930s people began to leave the state in considerable numbers, and the population dropped to 641,935 in 1940 and to 619,636 in 1950. In 1960 the population of the state was 632,446. The population per square mile in 1960 was 8.9 as compared with 49.6 for the United States as a whole.

*North Dakota: Places of 5,000 or More Population (1960 census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	632,446	619,636	641,935	646,872	319,146
Bismarck	27,670	18,640	15,496	7,122	3,319
Devils Lake	6,299	6,427	6,204	5,140	1,729
Dickinson	9,971	7,469	5,839	4,122	2,076
Fargo	46,662	38,256	32,580	21,961	9,589
Grafton	5,885	4,901	4,070	2,512	2,378
Grand Forks	34,451	26,836	20,228	14,010	7,652
Jamestown	15,163	10,697	8,790	6,627	2,853
Mandan	10,525	7,298	6,685	4,336	1,658
Minot	30,604	22,032	16,577	10,476	1,277
Valley City	7,809	6,851	5,917	4,686	2,446
Wahpeton	5,876	5,125	3,747	3,069	2,228
Williston	11,866	7,378	5,790	4,178	763

*Populations are reported as constituted at date of each census.

While the population is largely rural, the percentage of peopl living in areas considered urban increased from 16.6% in 193 to 35.2% in 1960. The state had one standard metropolitan sta tistical area, which is Fargo-Moorhead. This area had a tota population of 106,027 in 1960, 66,947 in North Dakota. In 196 12.0% of the population was 65 years old and over; and 36.5% o the population 14 years old and over was in the labour force.

Large numbers of immigrants moving into the state prior t World War I resulted in a large representation of foreign group among the more important of which were Norwegians, Russians Canadians and Germans. In 1960, 93.3% of the population of th state was native white and 4.7% was foreign-born white. Ther were 11,736 Indians in the state in 1960, largely from the Hidats (*q.v.*), Mandan, Arikara (*q.v.*), Chippewa (*see* OJIBWA) and Siou (*see* SIOUAN INDIANS) tribes.

EDUCATION

The state department of public instruction under an electe superintendent supervises elementary and secondary schools Schools are supported largely by local taxes, although seven twelfths of the state sales tax is distributed to the various district through an equalization fund. A revolving fund of $5,000,000 wa provided by the state in 1923 to aid needy school districts in th construction of buildings. The money is loaned to the district and is repayable in 20 years with interest.

North Dakota has nine state institutions of higher learning under a seven-member board of higher education appointed by th governor. The system was established by constitutional amend ment in 1939. The University of North Dakota at Grand Forks founded in 1883 under the Territorial act, includes colleges of science, literature and arts, education, engineering, business and public administration, and nursing, schools of law and medicine a graduate school and the university college.

Also under the board of higher education are North Dak State university, formerly North Dakota Agricultural college (es tablished 1890), at Fargo, which includes six colleges, the state agricultural experiment station and eight branch stations located throughout the state; state teachers' colleges at Ellendale (1889 Mayville (1889), Valley City (1889), Minot (1913) and Dick son (1916); and two junior colleges, the North Dakota School Forestry at Bottineau (1906) and the North Dakota State Schoo of Science at Wahpeton (1903).

Jamestown college, a private coeducational institution affiliated with the Presbyterian Church, was founded in 1884 at Jamestown.

HEALTH AND WELFARE

The state correctional and charitable institutions include a state hospital for mental patients at Jamestown, a school for the dea at Devils Lake, an institution for the feeble-minded at Grafton a state training school at Mandan, a school for the blind at Gran Forks, a penitentiary near Bismarck and a tuberculosis sanator at San Haven near Dunseith. These institutions are under th general control of a state board of administration; the work o the state agencies for the care of children, the aged and the phys cally handicapped is co-ordinated through the state welfare board A home for soldiers at Lisbon is under a special board.

THE ECONOMY

Living Conditions.—A large percentage of the people o North Dakota live on farms or in small villages. The standard of living is relatively high as indicated by retail sales, home owne ship, wealth and property distribution. More than 45% of th farm homes have telephones and 88% have electricity. On family in four has its own power plant. More than 60% hav refrigerators or deep freezes. More than 90% of the farmers own tractors and 80% have automobiles.

The number of nonagricultural workers rose substantially afte World War II, the largest increases occurring in mining constru tion, manufacture of nondurable goods and in general trade an finance. Hourly wage increases in manufacturing were sligh below national levels. Because of the lack of industrialization th labour supply considerably exceeded the demand. In 1947 th

state legislature passed a "right to work law" that was amended in 1949.

Agriculture.—North Dakota has had an agricultural economy since statehood. The trend in the second half of the 20th century has been toward larger farms. In the 1960s it was estimated that there were about 50,000 farms in the state, with an average size of about 800 ac. Spring wheat accounts for about 50% of the cash value of North Dakota crops, other products in order of their importance being barley, flaxseed, durum wheat, oats, potatoes, soybeans, sugar beets, corn and hay. Income from livestock and livestock products rose steadily in importance, with cattle and calves accounting for more than half. Dairy products were second, followed by hogs and poultry. Pig production increased rapidly after the development and promotion of pelleted barley as a new hog food by the North Dakota agricultural experiment station. North Dakota farmers have pioneered in the organization and operation of co-operative marketing and purchasing associations. After World War II co-operative marketing increased and there was some expansion of consumer co-operative activities.

Water Development.—An extensive water-development program was undertaken in North Dakota under the Missouri River Basin Development program authorized by congress in 1944. Participated in by both federal and state governments, the program was designed to provide irrigation, power, water supply and recreational activities for the people of the state. Garrison dam on the Missouri is one of the largest earth-filled dams in the world. Other dams included in the program were Dickinson and Heart Butte dams on the Heart river, Jamestown on the James, Baldhill on the Sheyenne and Homme on the South branch of the Park.

Industry.—Handicapped by climate, distances from eastern markets and centres of population, high transportation costs, and with local raw materials limited largely to agricultural products, industry in North Dakota has grown slowly. Manufacturing establishments tend to be small and to produce low-cost items. Flour mills are scattered throughout the state. Various meat-packing activities are carried on in different parts of North Dakota. Grand Forks, located in the potato area, has several industries based on that crop; and Dickinson, in the coal-mining region, produces 35,000 tons of lignite briquettes annually. The processing of dairy products is increasing in importance.

Mining.—Lignite deposits in the western two-thirds of the state are estimated to cover 32,000 sq.mi.; almost 90% of them are workable. Coal-mining operations have been carried on in western North Dakota since the time of the earliest ranching. Most of the commercial lignite mines are of the strip type. The bringing in of an oil well in April 1951 in the northwestern part of the state opened a new area of activity, and by the late 1950s more than 1,175 wells were in operation in about 60 fields, most of them in the western and northwestern parts of the state. About 1,100 cu.ft. of wet gas are produced for each barrel of oil. There are extensive deposits of clay, sodium sulfate, salt and sulfur.

Transportation and Communication.—The state is served by four large railroad systems operating over more than 5,000 mi. of track. The Great Northern system serves the northern section of the state and the Northern Pacific covers the southern part. The Minneapolis, St. Paul and Sault St. Marie, more often called the Soo line, covers most of the northern and eastern sections, while the tracks of the Chicago, Milwaukee, St. Paul and Pacific are located in the southwest corner of the state. North Dakota has more than 6,000 mi. of primary state highways. Trunk airlines serve the state along with local service carriers.

The first newspaper in North Dakota, the *Bismarck Tribune*, was established in 1873. In 1874, the *Fargo Forum* was founded as the *Fargo Express* and five years later the *Grand Forks Herald* began publication. In the 1960s the state had about 120 newspapers, about 100 of which were weekly, and 18 periodicals. The first broadcasting station, WDAY, was established in Fargo in 1922 and in the 1960s there were 12 radio stations and 10 television stations in operation.

See also references under "North Dakota" in the Index.

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NORTH EAST FRONTIER AGENCY, a wild tangle of sparsely populated mountainous country in the extreme northeast of India, stretches broadly from the Brahmaputra river plain in Assam northward to the main crestline of the Assam Himalayas and eastward to an irregular line passing through a series of lofty peaks, known as the "hump" during the World War II airlift to China. Geographically and constitutionally, the agency is a part of Assam (*q.v.*). Pop. (1961) 336,558; area 31,438 sq.mi., but the frontiers have never been surveyed in detail and marked out on the ground. The agency (N.E.F.A.) comprises five frontier divisions. Kameng in the west adjoins Bhutan; eastward of this is Subansiri and then Siang frontier division (*q.v.*). At the blind eastern end of the Assam valley is Lohit, while Tirap lies to the south on the Burmese border. The area is intersected by rivers; its greater part has a heavy rainfall and is thickly forested. It is inhabited by tribes mostly of Mongoloid stock such as the Monba, Mishmi, Abor, Miri, Dafla and Aka, each occupying roughly defined tribal areas. They are mostly animists and practise shifting cultivation. The agency is administered by the governor of Assam as agent of the president of India, assisted by an adviser in Shillong (agency headquarters). Difficulty of communications is one of the agency's major problems. In 1957 several airstrips were commissioned and others were planned. The various administrative centres and outposts are linked by radio.

The northern boundary, about 550 mi. long, in dispute between India and China, is known as the McMahon line because Sir Henry McMahon was secretary in the Indian foreign department and represented Great Britain at the conference held in Simla (1913–14) to settle frontier and other matters relating to Tibet. The line was regarded by the British as the natural, ethnic and administrative boundary. Representatives of Britain, China and Tibet agreed that the frontier between Tibet and northeast India should follow the crest of the high Himalayas. Two days later the Chinese republican government disavowed its plenipotentiary and refused to sign a convention. Prior to that the British-Indian government had made agreements with the indigenous tribes and set up the Balipara frontier tract in the west and the Sadiya frontier tract in the east, together constituting the North East Frontier agency (1912–13) and including undoubted Assamese territory.

After the independence of India in 1947, China made claims to practically the whole area covered by Kameng, Subansiri, Siang and Lohit, arguing that the McMahon line had never been accepted by China and was the result of British "aggression." In letters to the Indian prime minister, Jawaharlal Nehru, the Chinese prime minister, Chou En-lai, quoted a map in the 1929 edition of *Encyclopædia Britannica* showing the disputed territory as Chinese, with the boundary following the alignment of Chinese maps. Some Chinese maps before 1935 have shown N.E.F.A. as part of India, and since then as part of Tibet. The *Survey of India* (1883) showed the disputed tribal areas as *de facto* administered by British India. British and Indian maps since 1914 have usually followed the McMahon line. If the Chinese claims were allowed, the Indo-Chinese border would follow roughly the margin of the Assam plain, a frontier almost impossible to defend. Following this dispute Chinese troops crossed the McMahon line on Aug. 26, 1959, and captured an Indian outpost at Longju, a few miles south of the line. They abandoned this in 1961 but in Oct. 1962 crossed the line, this time in force. After first striking toward the Tangla ridge and Towang near the Bhutan border the Chinese later extended their attack along the whole frontier. Deep inroads into agency territory were made at a number of points. Later the Chinese agreed to with-

draw approximately to the McMahon line and in 1963 returned Indian prisoners. *See* INDIA: *History*. (L. D. S.)

NORTHERN DESERT TERRITORY (AL BADIYAH ASH SHAMALIYAH), a region of Iraq, originally formed after 1947 as a *liwa'* (province), along with the Southern Desert territory and Al Jazirah, from what had previously been termed tribal areas and left undemarcated. Area 39,127 sq.mi. As late as 1941 the western margins of certain provinces in Iraq containing a significant proportion of nomads did not have precisely defined western boundaries, and the delimitation of the three desert provinces completed the administrative structure of the country. The Northern Desert territory includes the greater portion of lands lying west of the Nasiriyah and Karbala provinces, including the extension of Iraqi territory to meet the frontiers of Jordan and Syria. The inhabitants, mostly nomadic, are mainly Dulaim and Ruwalla tribesmen, and as there is much seasonal movement the population numbers fluctuate considerably. By 1960 the region had been administratively attached to the settled *liwa'*. (W. B. FR.)

NORTHERN IRELAND: *see* IRELAND, NORTHERN.

NORTHERN LIGHTS: *see* AURORA POLARIS.

NORTHERN NIGERIA, the largest of the federation's three regions, had a population of 29,808,659 at the 1963 census. Its area of 264,282 sq.mi. covers more than three-quarters of Nigeria. Most of the region lies north of the Niger and Benue rivers, with Ilorin province and parts of Kabba and Benue provinces to the south. From the low-lying valley country the ground rises to 1,000–2,000 ft. over large areas, to 4,000–5,000 ft. in the Jos plateau and to over 6,000 ft. in the Adamawa highlands. In the northeast the land slopes gradually down to the great inland drainage basin of Lake Chad (*q.v.*). Major river systems flow to the Niger (Sokoto and Kaduna rivers), to the Benue (Gongola and Katsina Ala) and to Chad (Komadugu Yobe), but only the largest rivers are perennial. During the continuous dry season of varying length (4–9 months) agricultural activities are reduced to a minimum and there are severe water supply problems; for part of this season the dry harmattan (*q.v.*) wind from the Sahara intensifies aridity. Rainfall varies from 20 to 60 in. and should suffice everywhere for cultivation, but is often variable and unreliable. Temperatures are generally high throughout the year rising to well over 38° C. (100° F.) during the hottest season. Vegetation ranges from savanna, with considerable tree growth (particularly in the river valleys) in the south, to acacia scrub on the northern borders, but there is no desert.

In the northernmost provinces peoples speaking Hausa and Fulani (*qq.v.*) form the majority of the population except for an important group of Kanuri (*q.v.*) people in Bornu province. Of the many smaller and varied groups farther south in the middle belt, the Nupe, Yoruba and Tiv (*qq.v.*) are the most important. About three-quarters of the total population are Muslims; most of these are in the north with pagan peoples in the middle belt. Only 3% profess Christianity.

In culture and administration the Hausa-Fulani-Kanuri areas are traditionally more advanced than the rest of the region. In the northern emirates Frederick John Dealtry Lugard (*q.v.*) introduced a system of indirect rule and even with modern political developments the emirs and the native administrations, particularly the larger emirates of Kano, Sokoto, Bornu and Katsina, remain powerful. Northern Nigeria became self-governing within the federation in 1959. Representatives are elected by adult male suffrage to a house of assembly from which the regional government is formed. There is also a house of chiefs. The regional capital is Kaduna (*q.v.*) where Lugard established the headquarters of the Protectorate of Northern Nigeria. Social services are limited though great advances have been made in medical and educational facilities, and important campaigns have been conducted against malaria and sleeping sickness. About 250,000 of the children in the region attend school. Ahmadu Bello university was opened at Zaria (*q.v.*) in 1962.

Agriculture is the basis of the economy both for subsistence and in production for export. There persists a sharp distinction between cultivators and pastoralists, most of the latter being nomadic Fulani who move their herds in search of pasture and water. But their migrations are restricted by tsetse-fly infestation affecting two-thirds of the region. Some progress has been made in developing mixed farming but fertility is generally maintained by leaving the land fallow for varying periods. In some areas the pressure of population has caused deterioration of the land, in others (notably Kano) numerous people are supported by intensive cultivation. Over much of the region cereal crops (sorghums and millets) are the staple foods, though in the south root crops (cassava and yams) are cultivated. Peanuts (groundnuts) and cotton are the main exports, though hides and skins are also important. These cash crops are also consumed within the region and are fully integrated into the indigenous agricultural systems. A sugar plantation and a refinery were established at Bacita in the Niger valley in the early 1960s. Tin and columbite are mined on the Jos plateau and adjacent areas. International restrictions on tin production, imposed in 1958, were removed in 1960. Deposits of low-grade iron ore exist near Lokoja at the Niger-Benue confluence. Many local crafts are practised but modern industries are few. Small industrial areas have developed at Kaduna and at Kano, where a modern textile plant produces cotton cloth and a type of calico known locally as baft. There are small hydroelectric power installations on the Jos plateau. In the 1960s construction of the Kainji dam marked the first stage of the Niger dams project.

Until the 20th century all trade from this part of west Africa was with lands to the north, from the great markets of Kano, Katsina, Sokoto (*qq.v.*) and Kuka. Remnants of trans-Saharan trade by camel caravan include the bringing of salt from the Sahara, but most of the region's external trade passes from or to the coast by road, rail or river. Lack of communications restricts economic expansion in some areas. A major extension of the railway from near Jos through Bauchi and across the northeast of the region reached Maiduguri in 1964. Kano is the premier commercial centre of Northern Nigeria and its airport is one of the main air junctions of Africa.

The two areas along the eastern border of the region forming the United Nations trust territory of the Northern Cameroons were incorporated in Northern Nigeria following a plebiscite held in 1961. For the provincial subdivision of the region *see* NIGERIA: *Administration and Social Conditions*. *See* also ADAMAWA; BORNU; ILORIN.

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NORTHERN PROVINCE, CEYLON, covers an area of 3,429 sq.mi. and had a population (1960 est.) of 690,000. It falls into two contrasting parts. The northern and smaller part is made up of the Jaffna peninsula and an associated group of small islands and although it has only about one-ninth of the area of the province it accounts for nearly six-sevenths of its population. The peninsula and the islands alike consist of Miocene coral reefs that have been raised above sea level, so that the bedrock is almost everywhere coral limestone. In places this is exposed, giving barren, rocky country, but much of the limestone is covered with sand with gray loams, or with fertile red soils. The limestone, being fissured, holds plentiful supplies of water, and it is perhaps to this more than to any other single factor that the dense population may be attributed. The peninsula is deeply intersected by an intricate network of lagoons, and would itself become a series of islands cut off from the mainland of Ceylon, given a very slight rise of sea level. The coast is low, made up of sandbars and miniature cliffs. The rest of the province is part of the mainland and is mostly a gently undulating lowland, much of it between 100 and 130 ft. above sea level, and floored by ancient crystalline rocks. In a strip down the northwest coast, including the Mannar Island, these outcrops are a version of the Jaffna limestones, while opposite Mannar Island, and again behind the lagoons of the northeast coast, there are stretches of usefully fertile alluvium. The coast is generally low, and on the east made up very largely of lagoon-enclosing sandbars, one of which links the Jaffna peninsula to the mainland.

The whole of the Northern province falls climatically within

Ceylon's lowland dry zone, with its marked alternation of heavy rains during the northeast monsoon and severe drought during the southwest (*see* CEYLON: *Physical Geography*). The Jaffna peninsula in fact suffers this seasonal rhythm in an exaggerated form, being particularly liable to long and searing drought; its underground water supplies are then a great boon. Much of the mainland part of the province is still covered with the jungles of the *Wanni*, to use its traditional name, though the Jaffna peninsula and islands, together with Mannar Island and much of the alluvium, have for the most part been cleared for cultivation.

The mainland part of the province contains many irrigation works and inscriptions testifying to its settlement in ancient times. The Jaffna peninsula originally had Sinhalese inhabitants, but from about the 2nd century B.C. onward Tamils from India made settlements there and along the coast of the mainland. The vast majority of the province's population are now Ceylon Tamils, though there is a group of Sinhalese villages in the southern *Wanni* and a number of Moors (Muslims) in Mannar. The chief town and provincial capital is Jaffna (*q.v.*).

Rice is grown on the gray loams of the peninsula and on alluvium and under tank irrigation on the mainland. Coconuts cover a sizable area in the peninsula, on Mannar Island, and on some of the coastal sandbars. The peninsula is also important for the intensive cultivation of tobacco, vegetables and other crops. Jaffna and other towns manufacture *bidis* (local cigarettes) and carry on a brisk trade in small ships with south India. (B. H. F.)

NORTHERN PROVINCE, SUDAN, the northernmost province of the Republic of the Sudan, extends southward to roughly latitude 17° N. and eastward mostly from longitude 27° 30' to about 34° E. Area 184,198 sq.mi. Pop. (1963 est.) 1,075,-250. The regional headquarters are at Ed Damer (1956 pop. 5,458), and the province is divided into five administrative districts. It was formed in 1935 from Halfa, Dongola and Berber provinces and it lies within the historic region of Nubia (*q.v.*).

The agricultural and settled area of the province is only about 500 sq.mi., restricted mainly to a narrow strip of alluvial land on either side of the Nile (*q.v.*). Granitic rocks of the basement complex along certain stretches allow the river to cut for itself only a very narrow bed with limited patches of cultivable land. Such reaches often have rocky bars causing cataracts and rapids. Where the river runs through rocks of the Nubian series, it carves a wider bed flanked by broader terraces. Because such areas are normally flatter, as in the Dongola reach, the river's meander through them has left basins or depressions which were once part of the river bed.

Most of the region is, in strong contrast, a flat Saharan desert plateau, with sand dunes, sandsheets and scattered hills. The eastern or Nubian desert is characterized by bare rocky hills which have been worn down to a featureless plain. Igneous and metamorphosed rocks of the basement complex appear at the surface, which is stony or sandy. Only a few big granitic hill masses are to be seen. In the western or Libyan desert the land is flat chiefly because of erosion under arid conditions and the nature of the underlying rock. The plain is of nearly horizontal sandstones and mudstones of the Nubian series, with a few outcrops of dissected hills of the basement complex. In some places, on both sides of the Nile, wadies interrupt the dead features of the plain.

The climate is extremely hot in summer and unexpectedly cold in winter. The prevalent wind is from the north during November–April and from the south during May–October (except in the Wadi Halfa district where southerly winds are exceptional). Sandstorms occur frequently between April and July. North of Atbara the region is virtually rainless, but in the south it receives an annual average of 6 in. On the desert plateau the vegetation reflects rainfall conditions, but the banks of the Nile show a different pattern. North of Atbara some vegetation exists in wadies and depressions stretching out from the river; otherwise desert conditions prevail. South of Atbara begins the acacia desert scrub region some of the plains being covered with drought-resisting trees and shrubs which can survive the dry season; but some areas have no trees and few shrubs. Along the banks of the Nile the vegetation is more plentiful, with date and doum palms.

Besides Ed Damer, the largest towns of the province (1956 pop.) are Atbara (36,298), Wadi Halfa (11,006) (*qq.v.*), Berber (10,-977) and Shendi (11,031). The railway shops at Atbara and the cement factory south of it offer employment to some of the people, but the economy of the province is predominantly agricultural. Rain cultivation is practised, to a variable degree, only south of Atbara. Irrigation is necessary for all important crops; thus the province's prosperity depends on the Nile. Methods of irrigation are inundation during high flood, basin irrigation, *sakia* (sakieh) and *shaduf* (shadoof) irrigation (*see* EGYPT: *Methods of Agriculture*), and systematic irrigation by pumps. The main commercial crops are dates, citrus fruits, mangoes and pulses (horse beans, haricot beans, etc.). Subsistence crops include vegetables and cereals. The cash crop (dates) of the Wadi Halfa district finds its markets mainly in Egypt, but most of the rest of the province looks southward to Khartoum and eastward to Port Sudan for the disposal of surpluses.

Because of cataracts, river transport is limited to certain stretches. A regular steamer service connects Karima (Kuraymah) with Kerma (Karmah), and another runs from Wadi Halfa to Aswan in Egypt. The main railway line from Khartoum to the north follows the Nile to Abu Hamed where it crosses the desert to terminate at Wadi Halfa. Branch lines run from Atbara to Port Sudan and from Abu Hamed to Karima. Motor transport serves most of the inhabited parts. There is an airport at Wadi Halfa and a smaller one at Atbara. (A. EL-S. O.)

NORTHERN REGION, GHANA, an administrative division, lies between Upper region to the north and Brong-Ahafo and Volta regions to the south. It extends across the republic from east to west. Pop. (1960 census) 531,573. Area 27,175 sq.mi.

The region belongs chiefly to the vast basin of the Volta and its main affluents, the Black and White Voltas, and, in the east, the Oti. It is floored with Paleozoic sediments in which sandstones predominate, flanked on the west by a continuation of the peneplain of Pre-Cambrian metamorphic and igneous rocks found in southern Ghana, of average altitude 1,000 ft. A prominent erosional scarp near Gambaga and a lesser one at Konkori mark respectively the northern and western edges of the Voltaian basin, but otherwise it has a gently undulating surface.

Climatic conditions are generally harsh. The annual rainfall, which is highly variable ranges from 50 in. in the south to less than 40 in. in the north and is concentrated into a single season followed by five months of drought, during which even the larger streams shrink sufficiently to permit crossing by drifts at a number of points. The vegetation is Guinea savanna woodland, much degraded by burning and cultivation. Soils vary with the underlying rock, the best and most friable being the ochrosols developed on the older rocks in the west and north, while the Voltaian sandstones within the basin usually produce thin, dry lateritic soils.

Most of the inhabitants appear to be elements of recent migrations and invasions from the north, and the tribal and ethnic pattern is extremely complex. Distance from the sea and the consequent feebleness of European influences greatly retarded the economic development of this region. The overall population density is low, partly because many workers emigrate southward in search of better opportunities in the mines, cocoa farms and urban centres of southern Ghana, but principally because of the widespread aridity and the ravages of tsetse diseases and river blindness (onchocerciasis), especially prevalent along the headwaters of the White Volta.

Large towns are few, most of the population concentrations being found in the "compound villages" of round, thatched-roofed conical huts scattered amid cultivated fields, which are commonest north of Tamale, the regional capital. Tamale (*q.v.*; pop. [1960] 40,443) is the largest town, followed by Yendi (16,096) and Savelugu (5,949). The Northern region was constituted with eight administrative districts but in the early 1960s the number of these was increased by an ordinance conferring district status on all local and urban councils.

The main occupation is subsistence agriculture of the land rotation type based on the cultivation of millets, guinea corn and pulses in the northern parts and of yams, rice and cassava farther south, but there is a notable export of yams to other regions. Shea but-

ter, obtained from the fruits of the wild shea tree, is both an important local staple and an export item. This region is one of Ghana's chief potential sources of beef cattle, and further expansion of the industry was envisaged in the 1960s. A large veterinary station is located at Pong Tamale, 20 mi. north of Tamale. Mixed farming has been introduced and has gained ground under government sponsorship. Another significant government undertaking is the land-planning scheme centred at Damongo, near the Mole game reserve, for the resettlement of farmers from the overcrowded Fra Fra areas of the Upper region. The leading commercial crop around Damongo is tobacco.

Communications are generally poor; there are no railways and most of the main roads are primarily links with the south, with few east–west connections. Donkeys are employed on a limited scale for local transport, and the use of bicycles has spread among the farming populace. Tamale, around which commercial agricultural activities are mostly concentrated, is the principal focus of roads and the northern terminus of Ghana's internal air services. (Er. A. B.)

History.—The history of the Northern and Upper regions may conveniently be combined. The Gur-speaking peoples of the area were originally organized in many small independent kinship groups each under the most suitable male member, whose functions were as much socio-religious as political. From about the 13th century this situation changed through the influence of peoples developing trade and empire farther north by trans-Saharan contact with the Muslim civilization of north Africa. Invaders from the north and northwest created the first Akan (*q.v.*) states; *e.g.*, Banda, just north of the forest. These were soon subject to pressure from mounted warriors from the northeast who, by the 15th century, had organized two major kingdoms, Dagomba (*q.v.*) and Mamprusi, by imposing themselves as an aristocracy upon the local kinship groups. Elements of this aristocracy later created similar smaller states such as Wa in the west and Bimbila south of Yendi. Islam was brought to Dagomba and Mamprusi late in the 17th century by Hausa traders from the northeast, but meanwhile another Muslim influence, that of Mande (Mandingo, *q.v.*) traders and settlers from the northwest, had given rise to the rival state of Gonja (*q.v.*). During the 17th century, Gonja expanded northeastward at the expense of Dagomba, which sought compensation in new conquests farther east. In the 18th century, following the development of trade on the Gold Coast, the Akan empire of Ashanti (*q.v.*) began to raid and conquer north of the forest at the expense of Banda, Gonja and Dagomba, which became tributary states. The 19th century was one of increasing disorder because of the decay of the old trade routes to the north and of Ashanti power in the face of British advances. Much of the area was eventually overrun from the west by the Mande empire-builder, Samory, or subjected to the slave raids of Babatu's Zaberma (Songhai) from the northeast. In the 1890s, following the British conquest of Ashanti and in face of rival French and German advances, small columns of British troops organized what in 1902 was recognized as the Northern Territories protectorate, administered by a chief commissioner responsible to the governor of the Gold Coast. In 1957 the protectorate was ended when the territory became an integral region of Ghana. Northern region was in 1960 subdivided into Northern and Upper regions. (J. D. F.)

NORTHERN REGION, TANGANYIKA, renamed Arusha Region following a reorganization of administrative units in Tanganyika in May 1963, when the Kilimanjaro (Moshi) district was detached from it, is bounded north by Kenya, east by Kilimanjaro and Tanga regions, south and west by Dodoma and Singida regions, and northwest by Shinyanga and Mara regions. Area 31,900 sq.mi.; pop. (1963 est.) 447,630. It is a region of striking and attractive contrasts; to the northwest are the Serengeti plains, to the southeast the monotonous expanses of the Masai steppe, broken only by gneiss inselbergs. In between are the escarpments and hills, the Crater highlands, bordering the southern and branching portions of the Great Rift valley (*q.v.*). Volcanic activity associated with Tertiary faulting has produced wide lava plains and great volcanic massifs; such as Meru (14,979 ft.), the Ngorongoro crater, Hanang (11,215 ft.) and Oldeani (10,400 ft.). Mt. Ol Doinyo Lengai, near the Kenya border, is still occasionally active.

The drainage in the west is to the Rift valley lakes of Natron (soda lake, partially in Kenya), Eyasi and Manyara, but is separated by only a low watershed from drainage to Lake Victoria. Streams rising on Meru flow southeastward to the Pangani river and the Indian ocean. The mean annual rainfall varies widely with relief and aspect. The well-watered southern and eastern slopes of Meru (70 in.), exposed to the prevailing winds, contrast with the semiarid plains where rainfall is marginal and unreliable (less than 20 in.). Maximum rainfall is from March to May, with a marked dry season from June to October. Temperature varies with altitude, so that above the hot plains, near-temperate conditions are found on the highlands. Some of the most fertile soils in the country are volcanic soils on the mountain slopes. Plain soils, not leached, are characteristic of the Masai steppe with red earths on foot slopes. Vegetation types reflect the variety of climates: wooded savannas, montane forest on the moist slopes to about 9,500 ft., and Afro-alpine communities at higher altitudes.

The Serengeti National park (4,250 sq.mi.), part of which is in Northern region, has a wealth of wild life unexcelled in Africa. At Olduwai gorge, near Oldeani, the skull of an early stone-tool-making man of the australopithecine group was found in 1959. (J. M. Ke.)

In the Arusha district the Arusha numbered 68,100 at the 1957 census and the Meru 35,600. The Mbulu district is notable for having its chief tribes of widely differing origins, who are unintelligible to each other linguistically. They are: the Iraqw, 134,000; the Barabaig, 27,500; and the Mbugwe, 6,300. The 50,100 Masai share their large area with about 4,700 Sonjo and 1,000 primitive Dorobo hunters. There are some European settlers on the slopes of Mt. Meru and about 200 elsewhere in the region. The regional headquarters is at Arusha (pop. [1957] 10,038), at the foot of Mt. Meru.

The region is an important coffee-producing area, the crop being grown by both Africans and non-Africans. Other crops are maize (corn), beans, onions, cotton, pyrethrum, papain, sunflower and castor seed, groundnuts (peanuts) and wheat. The cattle trade is a feature of the economy, the Chagga (Kilimanjaro region) being the main purchasers and the Masai the main sellers. Some areas, especially in the Mbulu district, are tsetse infested. At Tengeru is a natural resources training school for agricultural and veterinary staff. Few minerals of any importance occur with the possible exception of meerschaum near the Kenya border, but active prospecting has continued.

The region contains some of the best big-game shooting grounds in Tanganyika, as well as the well-known game-filled Ngorongoro crater. More easily accessible but not so well known is the crater at Ngurdoto near Arusha, where elephant, rhinoceros, buffalo and other game can be seen at all times. Another national park is situated at Lake Manyara. Some of the rivers are stocked with trout.

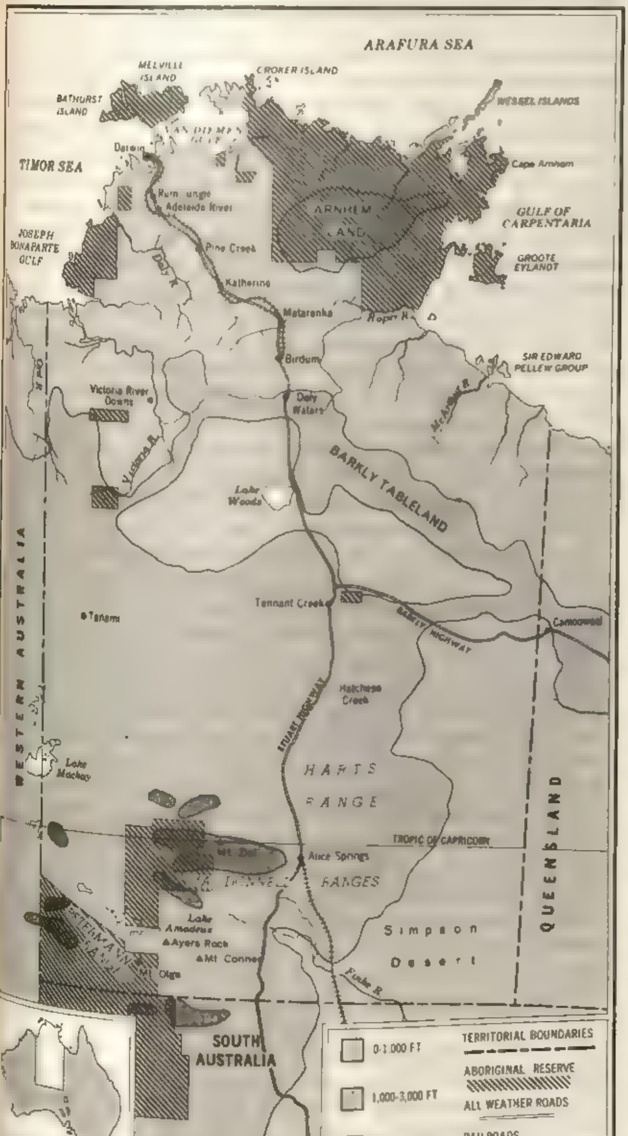
Arusha is the terminus of the Tanga railway; main roads link the town with Nairobi (north) and Mombasa (east) in Kenya, as well as with Tanga on the coast and Iringa and Mbeya (south).

NORTHERN SEA ROUTE, the name given in the U.S.S.R. to the Northeast passage, is a system of navigable waterways running along the Siberian coast of Asia. It has been much developed by a Soviet government department, Glavsevmorput, since 1932. The major freighting operations are transporting timber from the Yenisei (Igarka), and supplying the settlements of the far northeast. Ice has hitherto limited operations to only 8–16 weeks during July–October, even with icebreaker and aircraft support, but scientific and technological advances may extend the season. See Arctic, The. (T. E. A.)

NORTHERN TERRITORY, AUSTRALIA, one of the two federally administered territories of Australia (the other is the Australian Capital Territory), occupies the north-central part of the continent from latitude 26° S. to the northern coast and from longitude 129° E. to 138° E., lying almost wholly in the torrid zone, north of the Tropic of Capricorn. Area 520,280 sq.mi.

It is extensively but sparsely settled: pop. (1961) 46,799; density 0.09 per square mile. Darwin on the Timor sea, the chief port, is the administrative centre for the territory, and Alice Springs is the principal centre for the south.

Physical Features.—Much of the country is featureless. The indented coast, nearly 1,000 mi. long, is low, flat and generally thickly fringed with mangroves. Occasional sandstone marl and ironstone headlands, seldom as high as 100 ft., separate the sandy beaches and mud flats of the river estuaries. The largest rivers are the Victoria, entering the Timor sea near the northwest boundary of the territory, the Daly farther toward Darwin, the Roper flowing to Limmen bight on the western side of the Gulf of Carpentaria, and the McArthur about 120 mi. farther east. They flow from an area with lower rainfall to one with higher rainfall, and, though they are substantial streams in the wet season, they may become little more than a string of water holes during the dry season. Part of the highlands forming the watershed of these rivers is the Barkly tableland, whose northeastern edge runs roughly parallel with the coast of the gulf and about 100 mi. from it. This tableland, which, with the Victoria river district, contains the best grazing lands of the territory, is really the northeastern extension of the great plateau or Australian shield that stretches across Western Australia and covers more than half the continent. On the southwest side of the Barkly there is a gradual rise from about 700 ft. to over 1,000 ft. Northwestward there is a fairly



SURFACE FEATURES AND ABORIGINAL RESERVES OF THE NORTHERN TERRITORY

rapid falling away to the low plain bordering Joseph Bonaparte gulf. South of this area, with normal drainage to the coast, lies a shallow basin centred on Lake Woods, a marshy swamp that can become an extensive sheet of shallow water in the wet season. A further slight upward warp to the south separates the Lake Woods drainage area from that of Lake Eyre, in northeastern South Australia. None of the territory's rivers rising in the highlands of central Australia reaches Lake Eyre, and most have water in them only after rains. These tree-fringed courses usually have beds of water-bearing sand. The Macdonnell ranges, trending east and west and formed chiefly of gneisses and schists, rise to peaks of about 5,000 ft. Southwest of the Macdonnells, between them and the Petermann ranges, is another depression, Lake Amadeus. This "lake," about 90 mi. long and 2–15 mi. wide, is really an area of salt or dry salt-encrusted mud. To the south of Amadeus and at some distance from each other lie the huge monoliths known as Ayers Rock, Mt. Olga and Mt. Connor, famous for their grandeur and brilliant colour effects. The 300,000-ac. Ayers Rock-Mount Olga National park was established in 1958.

Climate.—The main characteristic of the climate throughout the Northern Territory is the markedly seasonal character of the rainfall. The whole territory has a dry winter (May to October): Darwin's total rainfall for the four months May–August averages less than ½ in., and that about 300 mi. south at Victoria River Downs homestead less than 1 in. for the six months May–October. The rainfall of the Alice Springs area, averaging between 9 and 11 in. per annum, is more regular than is usual in these arid lands; elsewhere the rainfall in the wet season shows great variations from year to year. Darwin's annual average is 59 in., whereas the southeast corner of the territory falls to an average as low as 5 in. (Simpson desert). Temperatures range from a mean maximum of 32° C. (90° F.) to a mean minimum of 24° C. (75° F.) at Darwin and from a mean maximum of almost 38° C. (100° F.) to a mean minimum of about 4° C. (39° F.) in the south.

Vegetation.—The climate and the generally poor soils associated with it give rise to tropical savanna vegetation over much of the area. The northern lowlands are covered with tall grasses of little value and sparse tree growth, which includes cypress pine (*Callitris intratropica*), ironwood (*Erythrophleum chlorostachys*) and paperbark, or bottle-brush plants (*q.v.*); these trees are cut and milled for local building use, being resistant to termites, but they were much reduced by their use for troops during World War II. Farther inland, especially on the Barkly tableland and parts of the Victoria river district, there are better perennial grazing grasses and some shrubs. Between the Barkly tableland and the ranges of the Alice Springs area a wide belt of sandy country is covered mainly with spinifex grass and low scrub; the Alice Springs ranges and uplands carry chiefly mulga, or dwarf acacia scrub, spinifex and other sparse grasses.

Animal Life.—This is similar to animal life elsewhere in tropical Australia and includes kangaroos and wallabies, crocodiles, a great variety of birds, snakes (many nonvenomous), frogs and freshwater fish. Buffalo, introduced from Timor in the early days, flourished in the far north and are now shot (under licence) for their hides. Gnats, mosquitoes and other insects are troublesome during the wet season, and termites are a considerable menace to construction in timber.

History.—Abel Tasman sailed along the Northern Territory coast in the 16th century. Malays and Indonesians visited the waters for bêche-de-mer and pearls. Matthew Flinders was the first to chart the coast on his voyage of 1803. In 1818 a further coastal exploration under Phillip King mapped some of the river mouths and inlets, including the opening of the harbour on which Darwin was later founded. Attempts at military settlement were made at Ft. Dundas on Melville Island (1824), at Raffles bay and at Port Essington (1838). In 1849 the Port Essington attempt was given up. These early settlements were mainly designed to forestall Dutch annexation. Since they were isolated and distant from any useful farming land, no permanent nonmilitary settlement resulted.

In 1862 John McDouall Stuart crossed the territory from South Australia to the mouth of the Adelaide river, the first crossing

of the continent from south to north. South Australia claimed the new territory, and despite other proposals the colonial secretary agreed that South Australia should administer it. Administration was organized, not overland from Adelaide, which would have involved regular crossing of the forbidding arid country of northern South Australia, but by sea, at first at a settlement near Adelaide river, then at Palmerston (later called Darwin). The building of the overland telegraph from Adelaide to Darwin in 1872 was the great achievement of this period. Running through nearly 2,000 mi. of unoccupied and largely desert and semidesert country, the line was finished within two years and remained the only telegraph in the territory until 1940.

Efforts to develop pastoral and agricultural industries, especially the growing of sugarcane, rubber and coffee, met with little success because of the rather dry monsoonal climate, the great distances and the unattractive land tenure system adopted. Chinese were imported to work on prospective plantations and on public works, but they joined in the gold rushes of the late 1870s, the only activity that drew many people to the territory, though they proved disappointing. There were more nonaboriginal people in the area during the census of 1891 than there were again until that of 1947. Railways were built by the South Australian government in the territory from Darwin 125 mi. S.S.E. to Pine Creek and in South Australia from Port Augusta on Spencer gulf (in the south) to Oodnadatta, within 300 mi. of Alice Springs, then a little settlement at the telegraph station.

On taking over the territory from South Australia in 1911, the Australian commonwealth government paid the state £4,000,000 compensation and bought the Port Augusta-Oodnadatta railway for another £2,250,000, agreeing also to extend the line to Alice Springs, which was done in 1929. It also agreed to continue it to Darwin at some future date. Commonwealth control began at a time when the efforts of the South Australian government were flagging in face of the difficult conditions. The population had fallen below 3,000, little more than half the number in 1890; there were only about 500,000 head of cattle; and little of the pastoral land was effectively occupied. In the next 20 years little progress was made, in spite of considerable expenditure; but the railway milage was nearly doubled, and the railway deficit much increased. A number of expert reports on various aspects of Northern Territory problems were commissioned by the commonwealth government from 1913 onward, and various changes in administration and direction of effort were made. In the 1920s the territory was split into Central Australia and Northern Australia but was reunited as Northern Territory in 1931. The territory remained a problem area, with much-publicized labour disputes in Darwin and little progress anywhere.

Darwin received a stimulus from the development of air services during the 1930s and from its use as a fueling centre and defense base for army, navy and air force. The Japanese threat to northern Australia, the bombing of Darwin in 1942 and the establishment of troops throughout the north led to greater interest in northern Australia generally. After the war more intensive surveys of both land and mineral resources were made, development was encouraged and a more advanced policy for the welfare of aborigines was formulated. The granting of voting rights to all full-blooded aboriginals was announced in 1962. Enrollment at special schools for aboriginals reached 2,500 in the early 1960s as compared to fewer than 500 as late as 1950. (*See* also AUSTRALIA, COMMONWEALTH OF: *History*.)

Population.—The 1961 census showed a nonaboriginal population of 27,095 (61% more than in 1954). Disparity between the sexes was always high among Europeans but has decreased, there being about 3 males to 2 females. There are only two substantial centres of population, Darwin (12,326 in 1961) and Alice Springs (4,648). Tennant Creek, main centre for the mining industry, has a population of about 1,400, and Katherine, centre of the northern cattle industry, about 800. Most of the nonaboriginal population is in these centres, about 70% being classed as urban. Full-blooded aboriginal population is increasing and in 1961 was estimated at about 17,500; there are also about 2,000 part aborigines.

Aboriginal Reserves.—Seventeen reserves with a total area of approximately 67,000 sq.mi. have been set aside for the aborigines. Some of these are small areas near towns, and many are in poor and arid country. The largest, Arnhem Land, is not well explored but is known to contain some relatively good land well supplied with game and fish. Other large reserves are Haast Bluff in the arid southwest, and reserves on Bathurst and Melville islands, Groote Eylandt and small islands like Croker, Goulburn and Elcho. There are 14 mission stations of four denominations said to be in more or less close touch with about 5,000 aborigines and receiving government subsidies.

Administration and Social Conditions.—*Government.*—A measure of constitutional reform was adopted in the passing by the commonwealth parliament of the Northern Territory (Administration) act, 1959. Under this act the legislative council was enlarged and its powers slightly increased, but its ordinances must still be approved by the administrator, who is both its president and the chief executive officer, or by the governor-general. A new (advisory) administrator's council, nominated by the administrator, was set up at the same time. The territory elects a member to the house of representatives of the commonwealth parliament. He has the right to take part in debates but not to vote.

Education.—Facilities for education are being expanded fairly rapidly. Schools are built by the commonwealth government, which also reimburses the South Australian department of education for the cost of providing staff and school services within the territory. In the 1960s there were 20 government schools, with an enrollment of over 4,500, of which about one-third were part-aborigine and Asian children, and 4 private schools, with a total of over 800 pupils. In addition, nearly 150 studied with the South Australian correspondence school, aided by the School of the Air, inaugurated in 1950 with two-way radio communication through the Alice Springs base of the Royal Flying Doctor service (*see* below). Beginning in 1949 several schools were established for aborigines, and by the 1960s there were 34 special schools, about half conducted by missions and half by the territorial administration welfare branch. A few were established on pastoral stations. Three preschool centres were conducted for aboriginal children. Aboriginal schools have a special syllabus, and free midday meals, milk and school clothes are supplied to pupils. Only about 5% of children attending school in the territory were over fourteen (at the 1961 census) although high schools were established in Darwin and Alice Springs. An apprentices board was set up to encourage theoretical training of apprentices through South Australian and New South Wales technical education correspondence courses.

Health and Welfare.—The Northern Territory medical service, part of the commonwealth department of health, assumes responsibility for medical and dental services and conducts four general hospitals, at Darwin, Alice Springs, Tennant Creek and Katherine. The aerial medical services of the department and the Alice Springs station of the Flying Doctor network provide ambulance and medical services to outlying areas (*see* FLYING DOCTOR SERVICES). Dental clinics are established at Darwin and Alice Springs, and there is also a mobile unit. All medical and dental services are also available to aborigines, and medical aid posts are established at government and mission stations. The government also provides essential services, such as electricity and water supplies, in Darwin, Alice Springs, Tennant Creek and Katherine.

Living Conditions.—The territory is notable for the large amount of land in pastoral occupation and the small number of people employed on these properties. Only about 12% of the nonaboriginal part of the employed population was classed in the 1961 census as employed in primary production, mainly in the grazing industry. More than twice as many aborigines were employed in the pastoral industry and are generally regarded as indispensable to it. Their rates of wages, even for skilled work such as interstate droving, are much below those paid to European workers. Wages for Europeans are rather higher than in the southern and eastern states, the basic wage north of the 20th parallel in the territory being usually about 7%–8% higher. The government has increased its responsibility for housing; this has always

been insufficient and has provided a serious bar to labour immigration into the territory.

The Economy.—*Pastoral Industry.*—The value of production from the pastoral and mining industries (other than uranium) now reaches about the same annual total, each somewhat above £A4,000,000; other products are of much less value. Despite the development of mining, the pastoral industry remains the most stable and important. Except in the Alice Springs area it is almost solely concerned with cattle, exported alive, principally to Queensland (about 60%), South Australia (about 30%) and small numbers to Western Australia and sometimes to Hong Kong and the Philippines. During the 1950s and 1960s the total number of cattle in the territory was above 1,000,000 but with no marked upward trend. Since the early 1950s, when several expert reports on the cattle industry were produced, the commonwealth government has paid more attention to the transport problems of pastoralists and has established more watering facilities on stock routes, built more access roads and increased attention to veterinary services and disease control by means of inspection and isolation and the establishment of treatment areas. Cattle still have to be driven over long distances to reach the railheads or the fattening areas, such as the Channel country of southwestern Queensland. "Road trains," large diesel-motor trucks with long trailers, are gaining in popularity for the transport of fat animals to market, but they damage the unsurfaced roads and are relatively expensive. The only sheep runs in the territory are in the Alice Springs area, but even there numbers declined after the early 1950s—from over 30,000 to half that number by the early 1960s.

Alterations have been made (1954) in the land tenure system aimed at encouraging a large number of smaller holdings, with conditions requiring that greater improvements be carried out. The largest holding is limited to 5,000 sq.mi., and leases up to 50 years may be granted.

Agriculture.—The low rainfall, concentrated in the summer months, the large amount of rocky and stony country and the distance from markets have limited agricultural development. Successful production of vegetables and fruit at several centres for consumption by the forces during World War II and concern about the undeveloped state of the territory led to more intensive surveys of the land resources and experimental work in suitable areas; e.g., at Katherine, chiefly on peanuts, sorghum and a variety of fodder crops; and at Berrimah, near Darwin, on tropical fruit and vegetables. At these and at other places experiments were also carried out with cotton, tobacco and other crops. The most ambitious effort was directed to the growing of rice, both by government stations and also by a private enterprise, with U.S. and some Australian capital, operating about 60 mi. S.E. of Darwin, but this proved commercially unsuccessful.

Mining and Industry.—The discovery of uranium at Rum Jungle, 50 mi. S. of Darwin, in 1949 and the opening of treatment works there in 1954 led to a great increase in the value of mining production. More than half the total value of mineral products (excluding uranium, the value of which is not disclosed) comes from copper, and nearly one-third from gold, Tennant Creek being the most important area for both minerals. Small quantities of manganese, mica (Harts range), tin and silver are also produced. The commonwealth government has assisted the industry, providing treatment plants, crushing and cartage subsidies, roads and water supplies to mining fields, and technical assistance and advice, including the promotion of prospecting. Large deposits of bauxite are known to exist at Wessel Island and Gove peninsula. Secondary industry employs less than 1,000 people and is mainly confined to service industries, building, printing, joinery, repairs, etc., and manufacture of ice cream, aerated (carbonated) waters and beer.

Fisheries.—The fisheries are unimportant; pearl-shell production increased during the 1950s but then seriously declined; a Japanese fleet operates in the area and obtains about three times as much shell, but this is also declining. Japanese shell is not marketed through Australia.

Trade and Finance.—Most of the territory's products are sent to other states, and requirements of manufactured goods, food, etc., come from them. Government expenditure in the 1960s was about six times the revenue collected by the administration under territory ordinances.

Transport and Communications.—Darwin has an international airport, and a number of overseas airlines call there regularly. It is also linked with all the state capitals by several Australian airlines, and the territory has a network of local lines operated by local companies, carrying mail, passengers and freight and subsidized by the commonwealth government. There are more than 100 government or licensed airfields, and the territory is relatively better served by air than by any other form of transport.

Rail transport from Port Augusta in South Australia to Alice Springs improved with the introduction of diesel-electric locomotives in the 1950s, but there is still a gap of 630 mi. in the long-promised north–south railway that begins again at Birdum with a further 317 mi. to Darwin.

The Stuart highway from Alice Springs to Darwin (954 mi.) and the Barkly highway from near Tennant Creek to Mount Isa in Queensland (403 mi.) were built during World War II. They now carry considerable freight to and from the railheads and also many tourists. About 12,000 mi. of other roads, mainly serving the pastoral and mining industries, are gravel or earth and largely unusable during the wet season.

Darwin is the only port in the Northern Territory capable of accommodating large vessels. It is linked by regular shipping services with Australian ports: one with the west coast (the most frequent), one with the east coast and one with Gulf of Carpentaria ports and Thursday Island. Overseas tankers call about ten times a year with petroleum products and a few other overseas vessels arrive at irregular intervals. The dominance of imports over exports (about ten times by weight) has an unfavourable effect on freight costs.

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NORTHERN WAR, the war of 1700–21, sometimes called the GREAT NORTHERN WAR, in which Sweden had Denmark-Norway, Saxony-Poland and Russia as principal adversaries, with Prussia and Hanover intervening against Sweden from 1714 onward.

The Anti-Swedish Coalition.—Sweden's expansion had antagonized the neighbouring states: Russia's access to the Baltic was blocked in Karelia, Ingria and Estonia; Denmark-Norway resented the loss of provinces in the Scandinavian peninsula, especially Scania (Skåne), and was also aggrieved by Sweden's alliance with the ducal house of Holstein-Gottorp, which contained Denmark from the south and prevented the Danish crown's reabsorption of ducal Schleswig and Holstein; the German princes disliked Sweden's power in the Holy Roman empire, and Brandenburg in particular coveted Swedish Pomerania; and many magnates of the Polish republic still thought of Swedish Livonia as Polish by right. The death of Charles XI in 1697, when his heir, Charles XII (*q.v.*), was but a boy of 14, became the signal for Denmark-Norway to organize an anti-Swedish coalition.

Christian V of Denmark-Norway and the elector Frederick Augustus I of Saxony, who in 1697 had been elected king of Poland as Augustus II, made an alliance in 1698 for simultaneous attacks on the Holstein-Gottorp possessions, on Scania and on Swedish Livonia; and Christian's successor Frederick IV renewed this alliance in 1699. Augustus' object was to conquer Livonia with Saxon troops and use it as a bargaining factor in dealing with those magnates who opposed his plans for a vigorous, hereditary monarchy in Poland. The two allies solicited Brandenburg's participation in the coalition, but had no immediate success since the elector Frederick was directing his attention to Franco-Austrian competition for his support in the event of war over the Spanish

succession. Tsar Peter the Great of Russia, however, was prepared to divert his expansionist plans from the Black sea to the Baltic. (*See* PETER I.) Grievously disappointed at Austria's decision to bring the war of the Holy League against Turkey to an end, he bound himself by an alliance with Frederick and Augustus, signed in Moscow in 1699, to attack Ingria as soon as he should obtain peace with the sultan. The exiled Livonian nobleman J. R. Patkul (*q.v.*) was active in all the negotiations which led to the coalition.

The European situation favoured an attack on Sweden. France, Austria, Great Britain and the Dutch republic were preoccupied with the Spanish succession issue. Sweden's efforts to get a greater share of the trade in Baltic naval stores antagonized the Maritime Powers (the British and the Dutch), and Swedish neutrality during the War of the Grand Alliance (1689–97) had caused a general distrust. None of the treaties made by the Swedes since Charles XI's death gave the desired guarantees for their own dominions; but by promising in the treaty of The Hague (Jan. 1700) to help the Maritime Powers if France should attack the Low Countries, Sweden obtained confirmation of the Altona guarantee of 1689 for the land and rights of the duke of Holstein-Gottorp—a guarantee felt to be vital to the security of Sweden proper.

The Strength of the Belligerents (1700).—Sweden and the Swedish dominions had a population of 2,500,000—3,000,000; an army of 40,000, which the system of peasant recruitment could easily expand in wartime; 25,000 mercenaries for garrison duties; 24 capital ships and some smaller vessels; and large economic resources in iron, tar and naval stores. But Sweden lacked capital, and had a bureaucracy which disliked innovations. Denmark-Norway, with the royal parts of Schleswig and Holstein, equaled the population of Sweden and had a good mercenary army of 45,000 and a navy of 26 big ships, but was economically weaker. The elector of Saxony had an army with a high European reputation and with military experience gained in the Turkish war; and though the population of Saxony was small, he counted on tapping Polish resources in manpower if need be. Neither Saxony nor Poland possessed economic resources for prolonged hostilities. Russia had a system of government which could readily exploit its immense reserves of men and material. The Russian army, however, was in the process of reorganization and most of its officers were foreigners. The navy was small and was confined to the Black sea.

The Swedish Victories (1700–06).—In 1700 a three-pronged attack was launched on Sweden: in February, Augustus opened hostilities against Riga with a Saxon army; in March, Frederick IV marched into the ducal parts of Schleswig-Holstein; in August, Tsar Peter crossed the frontier of Ingria to besiege Narva. Since the Danes attacked the duke of Holstein-Gottorp's possessions before Sweden proper, Charles XII received help from the guarantors of Altona. Diplomatic efforts were reinforced by the arrival of an Anglo-Dutch squadron in the sound; and then Charles landed on Sjaelland within a few miles of Copenhagen. By the treaty of Traventhal (Aug. 1700) Frederick IV was forced to restore the *status quo* and to leave the anti-Swedish coalition.

Sweden next contemplated a direct attack on Saxony to counter the Saxon invasion of Livonia in the same way as Frederick IV's invasion of the duchies had been checkmated by a Swedish descent on Sjaelland. The unwillingness of the Maritime Powers to risk disturbance in the Holy Roman empire made such a solution politically impracticable, and in Oct. 1700 Charles XII sailed with 10,000 men to Pernau (Parnu), intending to relieve the siege of Riga. At the news of the Swedish landing, however, the Saxons left their positions, enabling Charles to deal first with the Russians at Narva. The victorious attack of Nov. 30 on Tsar Peter's fortified camp of 23,000 men increased Sweden's prestige and removed the Russian threat to the Baltic provinces for some time. In July 1701 the Swedes successfully fought the Saxons for the crossing of the Dvina river and proceeded, on Augustus' withdrawal into Poland, to occupy Courland, a duchy under Polish suzerainty which had served the Saxon elector as a base for his Livonian operations. Charles now adopted the idea of dethroning Augustus and bringing about the election of a Polish-born king—the eldest of the three Sobieski brothers was the obvious candidate—who would ally himself with Sweden against Russia, accepting Polish expansion in the east as compensation for relinquishing Courland to Charles. The Swedish king was thus drawn into a Polish civil war in which there was both a "Saxon" party and a "Swedish" party, but where the majority of magnates strove for neutrality or at least for reduced military operations on Polish soil. Augustus' unscrupulous but clever move in arresting two of the Sobieski brothers on imperial territory (Feb. 1704) rendered Charles XII's task more difficult but he entered Warsaw in May 1702, defeated the Saxons at K[illegible]zow in July of that year, took Thorn (Torun) after a long siege in 1703, procured the election of Stanislaw I Leszczynski as king in July 1704 and signed a Polish-Swedish treaty of alliance and commerce in Nov. 1705.

The Invasion of Saxony (1706).—Augustus was forced to accept Charles XII's Polish settlement by the victory of Gen. Karl Rehnskiöld over the Saxons and their Russian auxiliaries at Fraustadt (Wschowa) in Feb. 1706 and by the invasion of Saxony in September. In the peace of Altranstädt (Sept. 1706) Augustus' plenipotentiaries sacrificed the Polish crown and the Russian alliance, delivered up Patkul and permitted the Swedish army to spend the winter in Saxony. Charles's headquarters now became the centre of diplomatic activities. France and the Maritime Powers each sought his help in the War of the Spanish Succession but as the two sides were fairly evenly matched, the Swedes, according to their traditional "balancing policy," did not feel called upon to intervene. Charles did, however, answer an appeal of the Protestants of Silesia (whose right of worship had been guaranteed by Sweden in 1648) and forced the emperor Joseph I to recognize their right by the treaty of Altranstädt of Sept. 1707. The main concern of Charles was to prepare an invasion of Russia which, it was hoped, would compel Peter to complete restoration of the *status quo*.

Russia had used the years 1702–06 well. St. Petersburg and Kronstadt had been founded in 1703; Narva had been captured in 1704; and when Charles had left for Saxony in 1706 Peter had occupied Courland and moved a large Russian army to Poland in the hope of fighting the battle for Russia on Polish soil.

The Swedes in Russia and the Ukraine (1707–09).—In autumn 1707 Charles XII marched with nearly 40,000 men east-northeastward through the supposedly impenetrable Mazovian woods, thus maneuvering the Russians out of their Polish positions. He reasoned that Peter would be forced to withdraw from the Baltic provinces if the Swedes threatened Russia proper and planned to advance on Moscow in the spring and summer of 1708, after junction with 12,000 men and an enormous supply train under Gen. Adam Lewenhaupt from the Baltic provinces. He hoped to benefit from the unrest in Peter's rear: from Kondrati Bulavin's rising on the Don (1707–08); from the ambitions of the hetman Ivan Mazepa (*q.v.*) for an independent Ukraine; from the hatred of the Crimean Tatars for the Russians; and from the Turkish desire to reconquer Azov. Tsar Peter did concentrate all his forces inside Russia as expected, but gave orders for the devastation of all territory, Russian and non-Russian, along the invasion routes and for the avoidance of pitched battles for as long as possible. The Swedes brilliantly forced one river crossing after another and won a major encounter at Holowczyn (Golovchin, northwest of Mogilev) in July 1708; but in September the king, then only a few miles from Smolensk, was forced to turn toward the Ukraine in search of food. Lewenhaupt, delayed by heavy rain, was intercepted by the Russians at Lesnaya in October before he had made contact with the king: he lost his supply train and only half his army reached Charles. Mazepa came out in favour of the Swedes but a superior Russian intelligence service coupled with political and military countermeasures put Charles XII in a difficult position. Communications between the Ukraine and Poland were interrupted and Stanislaw was tied down in his own kingdom by Russian-inspired troubles.

Poltava.—Swedes and Russians alike suffered terribly in the bitter winter of 1708–09, and the heavy thaw of the spring circumscribed military operations. By May, however, Charles and Mazepa had gained the co-operation of the Zaporozhian Cossacks

and were in diplomatic contact with the Crimean Tatar khan and the sultan. Peter's diplomacy was equal to that of the Swedes at the Porte; and the Russians maneuvered the Swedes into choosing either battle or retreat. Charles meanwhile was disabled by a wounded foot.

On July 8 (new style; June 27, old style), 1709, the Swedes, with 18,000 out of their now total strength of 22,000, attacked the Russian fortified camp of 45,000 near Poltava. The Russians fought well with superior artillery, and when more than 6,000 Swedes had been killed and more than 2,000 taken prisoner Charles agreed to a retreat toward the Dnieper. Russian destruction of the Zaporozhian fleet prevented the whole Swedish and Cossack army from crossing that river. The generals persuaded the king to put himself and Mazepa in safety with a small force, promising that the major part of the army (now reduced to some 15,000) would rejoin him on Tatar or Turkish territory by means of fords across the Vorskla river. But on the morrow of the king's departure (July 11) the demoralized generals capitulated at Perevolochna to a small Russian detachment.

The Period 1709–18.—Charles XII took refuge in Turkish Bessarabia and, when he learned of the surrender at Perevolochna, ordered a new army from Sweden to join him in Poland or Turkey so that he might take advantage of the now growing Turkish fear of Russian power. Charles XII's diplomacy at the Porte helped to bring about four Turkish declarations of war against Peter between 1710 and 1713; but circumstances prevented the Swedes from obeying their king's order speedily, and without a sizable army at his disposal he could not influence Turkish policy decisively. After the catastrophic defeat of Peter on the Pruth river in the summer of 1711, the Turkish negotiators made peace on condition that Russia should surrender Azov and promise not to interfere in Poland, whereas the tsar had expected to be forced to give up all his Swedish conquests, even Ingria.

Charles's dilemma arose from a revival of the anti-Swedish coalition and the European situation. Frederick IV of Denmark–Norway landed with 15,000 men in Scania in autumn 1709; and Russian forces helped to restore Augustus in Poland, overran the Baltic provinces once more and entered Karelia. Sweden's blockade of the Russian-occupied ports strained relations with the Maritime Powers, who also resented Charles's non-accession to the Declaration of Neutrality for the empire (The Hague concert of 1710) arranged by them with Sweden's enemies so as not to lose the hired Danish and Saxon troops vital in the war against France.

In 1712 the Swedes managed to send an army under Gen. Magnus Stenbock to Pomerania, but the Danes destroyed his supply fleet so that he could not proceed to a junction with Charles. Stenbock moved across Mecklenburg toward Holstein, defeating the Danish army at Gadebusch (Dec. 1712), but pursuit by Russian and Saxon, as well as Danish, troops drove him to take refuge in the fortress of Tönning (on the North Sea coast of Holstein), where he capitulated in May 1713. This surrender discredited Charles XII in Turkish eyes. The king had already had to use diplomacy and even force (as in the violent incident of 1713, known as the *Kalabalik*) to resist a Turkish attempt to drive him home via Poland, where he feared capture; now he departed voluntarily, but across Habsburg and imperial territory, to reach Stralsund in Swedish Pomerania in Nov. 1714.

By this time most of Sweden's possessions in the empire were enemy-occupied or threatened. The Danes had moved into Bremen and Verden; most of Pomerania was held by Russian and Saxon troops. Frederick William I of Prussia and George I of England, in his capacity as elector of Hanover, demanded land in return for continued neutrality; and when Charles would offer no more than temporary cession of parts of his German possessions they joined the anti-Swedish coalition. In Dec. 1715, just before Stralsund fell to his enemies, Charles returned to southern Sweden to reorganize his country effectively for a new stage of the war. A subsidy-treaty with France, a diversionary attack on Norway, negotiations with the British Jacobites to weaken George I's position and the issue of passes to Dutch ships against loans followed while Sweden's resources were mobilized and new armies raised. In April 1716 the last Swedish outpost on the German coast, Wismar, fell; but a joint Danish-Hanoverian-Russian descent on Scania, planned for the summer, came to nothing because of mutual jealousies inside the coalition. Charles skilfully exploited these jealousies, and two separate sets of peace negotiations were begun: one with Tsar Peter at a formal congress in the Åland islands, the other with George I more informally via Hessian diplomats.

The building of large magazines of food and the raising of the army to 60,000 men presaged a new military offensive to obtain peace terms that would maintain Sweden's position as a great power. The campaign began in Sept. 1718 when Charles invaded southeastern Norway with 30,000 men, but before the full intentions of the war plan were revealed he was killed at the siege of Frederikshald on Nov. 30 (O.S.).

The Conclusion of the War (1719–21).—As Charles left no children, Sweden had to settle the succession issue. Ulrika Eleanora, his only surviving sister, secured the throne with the help of her husband, Frederick of Hesse (*see* FREDERICK I of Sweden). The disappointed candidate, Charles Frederick of Holstein-Gottorp (the son of Charles XII's elder sister Hedvig), accepted refuge with the Russians, who had overrun all Finland and were raiding the coasts of Sweden. Frederick of Hesse, basing his peace plan on terms with George I in return for help against Peter, negotiated a series of settlements: Sweden ceded Bremen and Verden to Hanover and gave commercial advantages to Great Britain in return for promises of naval and diplomatic help to regain the Baltic provinces (Nov. 1719); gave up Stettin (Szczecin) and Pomerania south of the Peene river to Prussia (Feb. 1720); and, to please Denmark-Norway, renounced the alliance with Holstein-Gottorp and the right to free passage through the Sound (June 1720). The advantages expected in return for these sacrifices never materialized; Great Britain was paralyzed by the South Sea Bubble (*q.v.*), and George I's scheme for a European coalition against Russia evaporated. The Swedes were forced to sue for peace with Peter, and by the treaty of Nystad (Sept. 10, 1721), Ingria, Estonia, Livonia and a strip of Finnish Karelia with Viborg (Viipuri) were ceded to him.

Russia thus emerged as a major power in the Baltic, thanks to skilful leadership and superior resources, but also to the historical accidents of the years 1718 to 1721, not least of which was the survival of Peter. The other original members of the coalition gained little: Augustus had to be content with a Swedish recognition of him as king of Poland in the form of an armistice (Nov. 1719), but never obtained Polish Livonia, despite Russia's promises; Denmark could only incorporate ducal Schleswig under guarantee from England and France and occupy ducal Holstein without formal guarantee. Prussia and Hanover, the late entrants, did well: the former by adroit balancing between the western and eastern members of the coalition; the latter by exploiting the connection with England. For Sweden the German settlement, allowing the retention of Wismar, Pomerania around Stralsund and Rügen, was less galling than the Baltic one: expulsion from the Baltic provinces was humiliating and economically disastrous, and the Swedes long hoped to regain at least Narva or Riga.

See also SWEDEN: *History*. (R. M. HA.)

NORTH HOLLAND, a Netherlands province, lying between the North sea and the Zuider Zee (IJsselmeer) and bounded southward by the provinces of South Holland and Utrecht. Formed in 1840 by the division of Holland into North and South, its present area, including the island of Texel, is 1,124 sq.mi. Pop. (1960) 2,057,322. The island of Marken in the Zuider Zee since 1957 has been connected by embankment with the mainland; the former island of Wieringen, now incorporated with the mainland, is the starting point of the Afsluitdijk, the dike which encloses the Zuider Zee and connects North Holland and Friesland. Four natural regions can be recognized: (1) foreshore and sand dunes, (2) inner dunes and the geest grounds, (3) low fens and clay lands, and (4) the glacial region of the Gooi, in the most southeasterly part of the province.

The sand dunes form a long, smooth, unbroken protection for the other regions, and the lack of inlets explains the absence of industrial towns. However, the broad, gently sloping, sandy beach

is admirable for sea bathing and Zandvoort, Bergen aan Zee. Egmond aan Zee and Wijk aan Zee are gay and unconventional resorts. The fishing port of IJmuiden at the west end of the artificial North Sea canal is also the foreport of Amsterdam and noted for its huge locks. The North Sea canal area has developed into an important industrial district (IJmond). Opposite IJmuiden, blast furnaces connected with steel works, rolling mills and manufacture of fertilizers. have been established. There are paperworks at Velzen, and a chemical plant at Beverwijk. Haarlem (*q.v.*), once the residence of the ancient counts of Holland and an important industrial town since the 17th century, is now the provincial capital and the centre of bulb-trading.

The geest grounds, behind the inner dunes, contain some of Holland's famous bulbfields which stretch north to Haarlem and continue southward into South Holland, where hyacinths, tulips. narcissi and crocuses, in exact squares of brilliant and varied colours, attract numerous tourists each springtime. Aalsmeer (*q.v.*), about 12 mi. S.E. of Haarlem, has the most important flower auction hall in Europe. North of the North Sea canal, market gardening dominates on the geest. Near Haarlem are the extensive red brick ruins of Brederode castle, the seat of an old and illustrious family. To the north are remains of the castle of the counts of Egmond and the church of its famous abbey which has been rebuilt.

The third and by far the largest region lies at or below sea level. The oldest parts consist of peat, but clay predominates in the considerable reclaimed areas. To the north of the former IJ (inlet of the IJsselmeer) the Wormer, Schermer, Purmer and Beemster lakes were drained in the 17th century, but several sea polders to the north of these were not added to the mainland until the first half of the 19th century. Wieringermeer was reclaimed by 1930. This part of the province is traversed by the 46-mi. North Holland canal (1819–25), extending between Amsterdam and Den Helder; the IJ was drained, and the direct east-west 15-mi. North Sea canal was cut in its stead (1865–76). In the south, the Haarlemmermeer polder (110 sq.mi.) was reclaimed between 1840 and 1853. The landscape in this lowland division is typically Dutch (dotted with many windmills and losing to urbanization). Cattle rearing is the main industry. Most of the milk is consumed directly by the urban populations; but some Edam cheese is produced for export. Purmerend is the chief cattle market. Alkmaar (*q.v.*), which originally belonged to the lowland zone, has important historical associations, being the first town that successfully resisted the Spaniards in the Eighty Years' War; it has an ancient weighhouse, and is a marketing centre noted for cheeses. The northern polders, especially the Wieringermeer, are agricultural. Market gardening occurs in several places; cabbages are grown north of Alkmaar and seeds in the eastern part of west Friesland. The security offered by the Zuider Zee for shipping was the prime factor in development of the coastal part of this region, and Medemblik, Enkhuizen, Hoorn, Edam and Monnikendam (now small regional centres) possessed a large foreign commerce in the 16th and 17th centuries. Prosperity was later concentrated upon the IJ (Amsterdam) and the series of industrial settlements situated on its offshoot, the Zaan, of which Zaandam with sawmills, food and paint industries, is the most important.

The fourth region, the Gooi, consists of a glacial ridge, once covered with heath, with small rural villages. By mid-20th century, however, it had grown into a considerable residential and industrial region centred on Bussum and Hilversum (*q.v.*).

Of the islands, Marken tends to commercialize its own quaintness, though it is not yet entirely spoiled. The island of Texel is noted for its sheep and is a modest resort area. The fishing village of Volendam on the mainland has kept its traditional features.

For historical aspects *see* HOLLAND, COUNTY AND PROVINCE OF; NETHERLANDS, THE. (H. J. KE.)

NORTHINGTON, ROBERT HENLEY, 1ST EARL OF (*c.* 1708–1772), lord chancellor of England, was the second son of Anthony Henley, a Whig member of parliament. Robert was educated at Westminster school and St. John's college, Oxford, and was called to the bar in 1732. In 1747 he was elected member of parliament for Bath, of which he became recorder in 1751. In the same year he became a king's counsel. He acquired a lucrative practice at the bar and in 1756 was appointed attorney general. In the following year, he was promoted to the office of lord keeper of the great seal, being the last person so designated. He was given the title of Baron Henley in 1760 so that he could preside as lord high steward at the trial of Earl Ferrers for murder.

He became lord chancellor on the accession of George III in 1761, and in 1764 he was created earl of Northington. He was a member of the group known as "the king's friends," and was instrumental in procuring the dismissal of the marquess of Rockingham and the recall of Pitt to office in 1766. He joined this government as lord president of the council, but was increasingly incapacitated by attacks of the gout. He resigned office in 1767 and died at his home in Hampshire on Jan. 14, 1772.

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NORTH KAZAKHSTAN OBLAST (SEVERO-KAZAKHSTANSKAYA (OBLAST')), in the Kazakh Soviet Socialist Republic of the U.S.S.R., was established in July 1936. Area 15,869 sq.mi. It is divided into ten *raions* and has one town, the capital, Petropavlovsk (*q.v.*), and three "settlements of town type." After December 1960, it formed part of a newly created region (Tselinnyy *krai*, the Virgin Lands region, abolished in 1965). The *oblast* occupies the southern edge of the West Siberian Lowland (Zapadno-Sibirskaya Nizmennost) and is drained by the Ishim River. The climate is continental, the average January temperature being about −18° C (0° F) and the July average 19° C (66° F). The *oblast* is covered with a number of shallow fresh- and salt-water lakes. The northern part is wooded steppe and the southern, black earth.

The population (34% urban) was 456,999 in 1959, with Russians predominating but also including some Kazakhs, Ukrainians, Tatars, Mordvins, and Germans. There are nearly 600 schools and 8 special-training establishments, and Petropavlovsk has a museum. The economy is mainly agricultural, including the cultivation of wheat, oats, and millet, and dairy processing, as well as livestock breeding. The total sown area is about 5,000,000 ac., of which roughly three-quarters is under grain (mainly wheat) and one-quarter under fodder. There are small areas under vegetables and technical crops (flax and sunflower). The livestock consists mainly of sheep and cattle with a smaller number of pigs, goats, and horses. Industry is mainly concerned with food processing (meat packinghouses, flour mills, canneries).

The *oblast* is traversed by the Trans-Siberian railway with branches running south from Petropavlovsk to Kokchetav and from Bulayevo to Molodogvardeyskaya. It is also crossed by the Tuimazy-Omsk oil pipeline. (G. E. WR.)

NORTH PLATTE RIVER: *see* PLATTE.

NORTH RHINE-WESTPHALIA (NORDRHEIN-WESTFALEN), a *Land* (state) of the Federal Republic of Germany, bordered (south) by the Netherlands, Belgium and the *Länder* of Rhineland-Palatinate and Hesse, and (east) by Lower Saxony. Area 13,119 sq.mi.; its population at the 1961 census was 15,901,678 (including about 2,500,000 refugees), which is nearly 30% of the republic's total and more than one-third of its industrial workers. The *Land*, which has no historic unity, was created in 1946 through the amalgamation of the former Prussian province of Westphalia and the northern portion of the Prussian Rhine province; the state of Lippe was incorporated in 1947. For history of these constituent parts prior to World War II *see* RHINELAND; WESTPHALIA; LIPPE.

Physical Features.—The *Land* includes portions of three main physical divisions of Germany—the northern part of the Rhine plateau, the Weser hill country, and the North German lowland.

The Rhine plateau includes the northern section of the Eifel west of the Rhine, and the Sauerland and the Berg-Mark east of the Rhine. These are rolling plateau areas with a maximum height of 2,625 ft. (800 m.) and consist of impervious slates and sandstones, with a northeast-southwest strike, though areas of lower

and smoother relief with more fertile soils occur on the middle Devonian limestones both east and west of the Rhine. A fertile lowland lies at the confluence of the Moselle and the Rhine.

The Weser hill country is enclosed by two sharp ridges formed by the steeply tilted limestone strata of an eroded anticline, in which a variety of limestones and marls and clays (mainly of Triassic date) form a variegated pattern of local relief within the two inward-facing wooded scarps. At Ibbenbüren a small Carboniferous coalfield is near the surface. Loessic deposits occur in pockets in the area and the highest points reach about 1,640 ft. (500 m.).

The North German lowland comprises the Lower Rhine lowland (below Bonn) and the Münster lowland. The Lower Rhine lowland is formed of deep deposits of Upper Tertiary and glacial sands and gravels that were laid down by the fluvial ancestors of the Meuse and Rhine and cut during interglacial periods into a series of terraces at different levels. West of the Rhine these deposits were faulted and broken into three horsts, running northwest–southeast. The chief of these is the Ville (Vorgebirge) that stretches from the level of the high terrace at the Venusberg in Bonn. Two lesser parallel horsts lie west of the Ville which contains thick beds of lignite (brown coal) that are extensively exploited in vast opencut workings with adjacent briquette and electricity plants. The same beds are exploited in the small ridges to the west; intervening areas are filled with loess. The Münster lowland, plastered with glacial sands and clays, is a syncline developed on Cretaceous rocks. Limestone strata have outward-facing scarps, the chief of which is the Senonian scarp that lies around Münster. The main scarps (Turonian and Cenomanian limestones) form the Teutoburger Wald to the north, while to the south the strata are almost horizontal and form the dry Hellweg loess-covered limestone plateau with a scarp called the Haarstrang overlooking the valleys of the Ruhr and the Möhne.

The Rhine plateau is well drained and in the Eifel, and especially along the Ruhr, dammed lakes have been formed to supply industrial areas with water. The highest parts of the plateau to the south get the heaviest rainfall where it exceeds 40 in. a year. The Northern lowland gets about 28 in. annually and the central part of the Cologne bay, one of the driest areas in Germany, has under 24 in.

The richest soils are on the loess deposits in the Cologne bay, the Hellweg and the patches in the Weser hill country. Sands and clays predominate in the glaciated Northern lowland and thin sandy acidic soils cover most of the Rhine plateau.

Population and Administration.—A large part of North Rhine-Westphalia has been urbanized and one-half of its population lives in cities with more than 100,000 inhabitants. The cities sustained heavy war damage, and by 1945 their populations had been greatly reduced; on the other hand, the people living in the rural districts had substantially increased with the flow of evacuees. However, after 1950, the phenomenal revival of industry and the rapid construction of houses and apartments enabled the cities to grow with remarkable rapidity; most of the rural districts lost their surplus populations and many agricultural workers turned to industry and urban life. The majority of the cities in northwestern Germany now have more inhabitants than they had in 1939. At the 1961 census the population was 43% Protestant and 52% Roman Catholic. Institutions of higher learning include the universities of Cologne, Bonn and Münster, the technical high school of Aachen and the medical academy of Düsseldorf.

The constitution in force in the mid-1960s was approved by the *Landtag* (diet or consultative assembly) on June 6, 1950, and by the electorate on June 18. The *Land* government (*Landesregierung*) is presided over by the minister-president (*Ministerpräsident*) who appoints a cabinet of ministers. At the elections held July 8, 1962, there were 96 Christian Democrats, 90 Social Democrats and 14 Free Democrats returned to the *Landtag*. North Rhine-Westphalia is divided into six major administrative divisions (*see* Table), 38 urban districts and 57 rural districts. The capital is Düsseldorf, and Bonn, the federal capital, is situated in North Rhine-Westphalia.

The Economy.—North Rhine-Westphalia accounts for one-third of the production of electricity in the Federal Republic, virtually all the coal (with the exclusion of the Saar and the brown coal) and more than 90% of the iron and steel; it dominates the industrial economy of the republic to an even greater degree than it did as a part of the third *Reich*. By the mid-1960s more than half of its workers were engaged in industry and building, followed by those in (1) commerce and transport, (2) public and private services and (3) agriculture and fishing. The dominantly agricultural areas are in the lower Rhine bay, Münsterland and the Weser hill country. The main industrial groupings form a great rectangular block, focusing in the west-east belt of the Ruhr industrial region (*Ruhrgebiet*) and the Wuppertal area to the south of it. The corners of this block are defined by the towns of Dinslaken in the northwest, Opladen in the southwest, Hamm in the northeast and Lüdenscheid in the southeast. Attached to this vast complex is the Gladbach-Krefeld area west of the Rhine. Smaller industrial areas in the *Land* are Aachen-Düren (textiles, machinery, coal mining), Cologne-Bonn (with remarkable expansion since World War II in chemical plants and oil refineries on the Rhine and the development of brown coal workings in the Ville), the Siegerland (an old established iron- and steelworking area based on the deep mining of iron ores and imported Ruhr coal), and eastern Westphalia (textiles and machinery). The *Ruhrgebiet* has its main urban centres in Duisburg, Essen and Dortmund and its development is controlled by the *Ruhrsiedlungsverband* (Ruhr development association), established in 1921. This is the main seat of the coal-mining and iron and steel industries in Germany and indeed in the whole of western Europe (*see* RUHR).

Agriculture gives full-time employment to little more than 10% of all workers but about one-third are partly dependent on farming. The chief crops are potatoes, sugar beet, wheat, rye, barley and oats. Holdings of 5–50 ha. comprise 55% of the farming area and these form the real basis of agriculture in the *Land*. They have been consolidated for more than a century in the Cologne bay and the Hellweg, but there is still a need for consolidation of fragmented holdings. There has been much afforestation and the construction of windbreaks in the main cultivated areas is

Regierungsbezirke (Administrative Divisions) and Population of Principal Cities of North Rhine-Westphalia

	1961	1939
Düsseldorf		
Düsseldorf	702,596	541,410
Duisburg	502,993	434,646
Essen	726,550	666,743
Krefeld	213,104	170,968
Leverkusen	94,641	50,137
Mönchengladbach	152,185	128,306
Mülheim an der Ruhr	185,708	137,540
Neuss	92,916	59,654
Oberhausen	256,773	191,842
Remscheid	126,892	103,915
Rheydt	94,004	77,339
Solingen	169,930	140,466
Viersen	41,890	33,854
Wuppertal	420,711	401,672
Cologne		
Bonn	143,850	100,788
Cologne	809,247	772,221
Aachen		
Aachen	169,769	161,624
Münster		
Bocholt	45,675	35,099
Bottrop	111,548	83,385
Gelsenkirchen	382,689	317,568
Gladbeck	84,196	58,713
Münster	182,721	141,059
Recklinghausen	130,581	86,313
Detmold		
Bielefeld	174,642	129,466
Herford	55,663	42,339
Arnsberg		
Bochum	361,382	305,485
Castrop-Rauxel	87,910	56,610
Dortmund	641,480	542,352
Hagen	195,527	151,760
Hamm	70,641	59,035
Herne	113,207	94,649
Iserlohn	55,257	38,525
Lüdenscheid	58,239	41,710
Lünen	72,171	46,219
Siegen	49,404	40,269
Wanne-Eickel	107,197	86,680
Wattenscheid	79,202	61,449
Witten	96,462	73,548

Sources: *Statistisches Jahrbuch, 1952; Bevölkerung und Kultur, Volkszählung vom 6. Juni 1961.*

projected. Less than 20% of the wooded land is classed as coppice, where the tree growth is controlled and cut at regular intervals for the use of the owners.

Communications are dominated by the Ruhr network in which the main direction of routes is west to east, and by the south-north routes across the Rhine plateau, notably along the Rhine. In the Ruhr there are two canals, the Rhine-Herne and the Lippe, that connect the Rhine with the Dortmund-Ems canal. Barges up to 2,500 tons can navigate the Rhine as far as Strasbourg and small oceangoing boats can reach Cologne. The greatest river port in Europe is Duisburg at the western end of the Ruhr industrial area. The *Autobahn* from south Germany parallels the east bank of the Rhine and the main west-east route runs along the north side of the Ruhr urban areas to Bielefeld and Hanover. Other roads include the so-called *Ruhrschnellweg,* which runs west-east through the centre of the urban areas and traverses the centre of Essen by means of an underpass. (R. E. Di.)

NORTHROP, JOHN HOWARD (1891–), U.S. biochemist, winner of the 1946 Nobel prize in chemistry with Wendell M. Stanley and James B. Sumner for pioneering research in the crystallization of enzymes and related substances, was born July 5, 1891, at Yonkers, N.Y. Columbia trained (B.S., 1912; M.A., 1913), he received his Ph.D. in 1915 and studied as Cutting traveling fellow with Jacques Loeb at the Rockefeller Institute for Medical Research on theories of life duration. He became a member of the institute in 1924. In 1949 he was named research professor of bacteriology at the University of California, Berkeley.

Early work by Northrop on fermentation to produce acetone and ethyl alcohol during World War I led to the study of enzymes essential for digestion, respiration and general life processes. He showed that enzymes obey chemical laws. In 1930 Northrop prepared pepsin in pure crystalline form. With Moses Kunitz he succeeded in crystallizing the enzymes trypsin and chymotrypsin as well as their precursors trypsinogen and chymotrypsinogen. With Roger M. Herriott he isolated crystalline pepsinogen. He studied proteins of meat, viruses and antibodies. From the intestines of mammals, Northrop isolated a bacteriophage, a virus which destroys bacteria.

Northrop also made studies on starch, the kinetics of bacteriophage, agglutination of bacteria and temperature effect on insects, and purified diphtheria antitoxin (1941). He published *Crystalline Enzymes* (1939) and edited the *Journal of General Physiology* of the Rockefeller institute. He served in the U.S. army chemical warfare service in World War I as captain, and in World War II he was consultant to the National Defense Research committee.

(V. Bw.)

NORTH SEA (formerly also known as the German Ocean), a sea occupying a shallow basin between Great Britain and continental Europe. It extends southward from the edge of the continental shelf north of the Shetland Islands to the Straits of Dover, covering an area of about 220,000 sq.mi. Its bed generally slopes gently down from south to north. The southernmost areas are very shallow, with many low ridges of sand barely covered at low tide. Off the mouth of the Humber an east-west trench, the Silver Pit, has depths of nearly 50 fathoms in places. The Dogger bank is situated to the north of this trench and occupies about one-third of the width of the sea. Depths over the bank vary from 8 to 20 fathoms and are less than 10 fathoms over 250 sq.mi. of its area. The north face of the bank is steep but thereafter the seabed slopes very gently northward, though cut by several depressions, until the continental edge is reached. In the northeast the Norway deep is a remarkable feature. It starts off Ålesund as a break in the continental slope and extends southeastward as a narrow trench, parallel to the Norwegian coast, into the Skagerrak as far as Oslo. Its depth increases toward its head, depths of about 400 fathoms being recorded in the Skagerrak. Its edge rises very steeply on the Norwegian side, but much more gently on the west.

Geological History.—The main structural features that limit the North sea basin date from the time of the Caledonian and Armorican earth movements, the degree of submergence of the basin varying from geological era to geological era. At the end of the Pliocene period southern England was linked with Holland and Germany by a forested plain which was crossed by the marshy delta of the Rhine-Thames river system. Conditions became steadily colder and during the Pleistocene period the sea was covered by ice sheets which varied in extent during the different glaciations. At the time of the maximum glaciation the whole sea as far south as Holland and East Anglia was covered by ice. Thus there was no northern outlet for the Thames and Rhine systems and it is thought that these rivers drained into a glacial lake south of the ice front in the extreme south of the present North sea basin. The water in this later rose and eventually escaped through a Pliocene river valley which was later to form the Straits of Dover: this valley was greatly widened and deepened by the overflowing water. Toward the end of the Ice Age the North sea south of the Dogger bank became a low-lying plain crossed by meandering rivers. At first this plain had an Arctic climate, but later amelioration led to the afforestation of the area and to the Dogger bank's being occupied by a fen in which peat accumulated. Trawlers fishing on the Dogger have brought up masses of this peat, sometimes containing teeth and bones of animals which roamed the area at that time. After 6000 B.C. the sea level rose and the North sea and Straits of Dover assumed more or less their present form.

Coasts.—The coasts of Norway and Scotland are usually cliffed except along the more penetrating inlets; the cliffs being cut in highly resistant rocks. Farther south the coasts are composed of softer rocks, but cliffs of considerable height are present on the English coast as far as the chalky heights of Flamborough head. South of this point low cliffs of glacial material fronted by sandy beaches are characteristic of the English coast until the North Foreland is reached, when chalk cliffs occur again. The continental shores south of the Skagerrak are usually low and flat and backed by wide marshes and are sometimes protected by sand dunes or artificial dikes.

Temperature and Salinity.—Atlantic water, with a salinity of more than $35^0/_{00}$, enters the North sea through the Straits of Dover and between Shetland and Norway. The two inflows meet in the neighbourhood of a line extending from the Wash to the Skagerrak and give rise thereabouts to a complicated system of eddies. The water entering through the Straits of Dover is diluted on both sides by land drainage particularly from the Thames, Rhine and Elbe systems. The northern oceanic inflow mixes with land water from Scotland and northern England and with water of less than $30^0/_{00}$ which flows out of the Skagerrak northward along the coast of Norway: the low salinity of this latter water is due to its containing much brackish water from the Baltic. In February, the coldest month, the mean maximum sea surface temperature is about 6.5° C. (44° F.) and occurs in the two oceanic inflows. Near the Danish coast the sea freezes in an average winter. In August, the warmest month, the mean maximum surface temperature is 17.5° C. (63° F.) near the Dutch and Danish coasts: the lowest is 12° C. (54° F.) off northeast Scotland.

Tides.—The tides in the North sea are standing oscillations modified by the effects of the earth's gyration. There are two well-defined amphidromic systems, one in the centre of the Southern Bight and one west of Denmark, and a less well-defined system close to the southwest coast of Norway: three tidal oscillations progress round these points each in an anticlockwise direction. As the two northerly points are close to the continental shores the tidal range on those shores is small, less than 5 ft. at spring tides, while that on the English shore is much larger and reaches 20 ft. on the Lincolnshire coast. In the Southern Bight the central position of the amphidromic point results in the tidal range's being the same on the two coasts and to its being large, nearly 16 ft. at spring tides, close to the Straits of Dover, and smaller, about 7 ft., farther north at Yarmouth and Den Helder, Neth.

Fisheries.—The waters of the North sea are fertile because of the large amount of minerals brought into it by rivers and the strong stirring, caused by winds, tidal streams and winter cooling. This stirring ensures that the nutrient salts, upon which the plant plankton, the basis of the food chain in the sea, depends

are kept in good supply in the sunlit surface layers where plant production occurs. The fish depend, through the animal plankton, upon the plant plankton. The total annual catch of fish in the North sea is about 1,600,000 tons. Half of this catch consists of herring, 6% of cod, 6% of haddock, 5% of whiting and 5% of plaice. Intensive exploitation of the fish stocks has led to some of them being overfished. The principal nations sharing the catch are the United Kingdom, the Federal Republic of Germany and Denmark, 18% each, and the Netherlands and Norway, 13% each.

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NORTH SHIELDS: *see* TYNEMOUTH.

NORTHUMBERLAND, EARLS AND DUKES OF. This English title derived originally from the kings of Northumbria who became known as earls of Northumbria in the later Saxon period. From their fortress at Bamburgh they ruled the area approximately between the rivers Humber and Tweed. SIWARD (d. 1055) controlled the whole area by 1042. The earldom was then held briefly by TOSTIG (d. 1066) and then by MORCAR whose title was confirmed by William the Conqueror after 1066. Mocar rebelled in 1068 and 1071, joined Hereward in the Isle of Ely and was captured and imprisoned until his death. The earldom was then held from 1071 to 1072 by COSPATRIC and then by WALTHEOF (*q.v.*; d. 1076). The earldom was suppressed in 1095 by William II after the rebellion of ROBERT DE MOWBRAY (d. 1125?), who had been made earl in 1080 or 1081. In the 12th century the earldom was alienated to the kings of Scotland and was held briefly by HENRY (*c.* 1114–1152), the son of David I, and by WILLIAM (1143–1214) afterward William I, the Lion, king of Scotland.

The earldom again became famous when it was granted to the Percy family. HENRY DE PERCY (1341–1408), marshal of England, was created earl of Northumberland at Richard II's coronation in 1377. He served Richard in numerous capacities but after 1398 supported the duke of Hereford (afterward Henry IV) and took a prominent part in Richard's abdication. His son, Sir Henry Percy, known as Hotspur, figures prominently in Shakespeare's *1 Henry IV*. Hotspur was killed at the battle of Shrewsbury (1403) fighting the king, and Northumberland, after being attainted in 1406 for plotting against the king, was slain at Bramham Moor (Feb. 19, 1408). The Percys were Lancastrians and HENRY (1393–1455), 2nd earl and Hotspur's son, was slain at the first battle of St Albans fighting for Henry VI; while HENRY (1421–1461), 3rd earl, fell at the battle of Towton (1461). The earldom was then briefly given to JOHN NEVILLE (*q.v.*; *c.* 1431–1471) but returned to the Percys in 1470 when HENRY (*c.* 1449–1489), son of the 3rd earl, was restored as 4th earl by Edward IV. The 4th earl acquiesced in the accession of Richard III and submitted to Henry VII with whom he found favour. HENRY (1478–1527), 5th earl, known as the Magnificent, was prominent in the early years of Henry VIII. The earldom lapsed in 1537 on the death of HENRY (*c.* 1502–1537), 6th earl, whose brother was attainted for his role in the Pilgrimage of Grace (1536).

JOHN DUDLEY (1502–1553), earl of Warwick, was created duke of Northumberland on Oct. 11, 1551 (*see* NORTHUMBERLAND, JOHN DUDLEY, Duke of).

The earldom was restored to the Percy family in 1557 and continued in the male line until 1670. THOMAS (1528–1572), 7th earl, was beheaded for his part in the northern rebellion (1569) which aimed to release Mary Stuart and give toleration to Roman Catholics. HENRY (*c.* 1532–1585), 8th earl, also suspected of pro-Catholic plotting, was imprisoned in the Tower of London where he was found shot in 1585. ALGERNON (1602–1668), 10th earl, became a peer in his father's lifetime as Baron Percy in 1626. He played an important part in the English Civil War. At the trial in 1641 of his friend the earl of Strafford, he gave evidence which, though favourable on the important point of bringing the Irish army over to England, was on the whole damaging. He took an active part in the attempts to come to terms with the king but also helped to organize the New Model army. In 1645 he was entrusted by parliament with the charge of the royal children. He was opposed to the trial of Charles I and took no part in affairs under the Commonwealth and urged moderation after the Restoration. On the death of his son, JOCELINE (1644–1670), 11th earl, the male line became extinct.

GEORGE FITZROY (1665–1716), the illegitimate son of Charles II and Barbara Castlemaine, duchess of Cleveland, was created earl of Northumberland in 1674 and duke in 1683, but he died in 1716 without legitimate issue.

Elizabeth, daughter of the 11th earl, married Charles Seymour, 6th duke of Somerset. Their son, ALGERNON (1684–1750), was created earl of Northumberland in 1749. On his death the title passed to his son-in-law SIR HUGH SMITHSON (1715–1786), baronet, who took the Percy name and arms on inheriting the title in 1750. He was created duke of Northumberland in 1766. He took a prominent part in politics as a supporter of Lord Bute and was lord lieutenant of Ireland (1763–65) but he is best remembered for his cultivated taste. It was the 1st duke who spent much money on restoring Alnwick castle and in employing Robert Adam to remodel the interior of Sion house, near London. HUGH (1742–1817), 2nd duke, a statesman and soldier, commanded the 5th fusiliers, afterward known as the Northumberland fusiliers. GEORGE (1778–1867), 5th duke, was a cousin and heir male of the 4th duke. The son of the 1st earl of Beverley (a title created in 1790 for the 2nd duke's second son), he inherited the dukedom in 1865. HUGH (1914–), 10th duke, succeeded in 1940.

NORTHUMBERLAND, JOHN DUDLEY, DUKE OF (1502–1553), English politician and soldier who virtually ruled England from 1549 to 1553, was the eldest son of Edmund Dudley by his second wife Elizabeth, daughter of Edward Grey, Viscount Lisle, and co-heiress of her brother John, Viscount Lisle. Edmund Dudley was attainted in 1509 and executed in 1510, but John was restored in blood in 1512. A year or so earlier his mother had married an illegitimate son of Edward IV, Sir Arthur Plantagenet, who in 1523 was created Viscount Lisle in his wife's right. Dudley, after holding various minor posts, became deputy governor of Calais in 1538. After his stepfather's death, he was created Viscount Lisle on March 12, 1542. He became warden of the Scottish marches in Nov. 1542; lord high admiral in Jan. 1543; a privy councilor and knight of the Garter in April, and then served with Edward Seymour, earl of Hertford (*see* SOMERSET, EDWARD SEYMOUR, 1st Duke of), in the invasion of Scotland in 1544. Lisle led the assault upon Boulogne (Sept. 1544) and was given command of the town after its capture and commanded the fleet gathered in the Solent against an attempted French invasion in 1545. At court he supported Hertford and Archbishop Thomas Cranmer against the more conservative Howards and Bishop Stephen Gardiner. When the indiscretions of the young Henry Howard, earl of Surrey, brought the Howards down, he was one of the commissioners who found the earl guilty of treason in Jan. 1547. Lisle was also one of the regency council nominated in Henry VIII's will to govern the country during the minority of Edward VI. But upon Henry's death on Jan. 28, 1547, he acquiesced in Hertford's assumption of the office of protector and the title of duke of Somerset. His own rewards included the earldom of Warwick and the office of lord high chamberlain.

In the new reign the two men at first continued to work together. Warwick contributed greatly to Somerset's victory over the Scots at Pinkie in Sept. 1547 and in 1548–49 showed no sympathy with the intrigues of the protector's brother, Thomas Seymour. When, however, in the summer of 1549 Somerset proved unable or unwilling to deal firmly with the widespread popular unrest that his policies had encouraged or provoked, Warwick took the lead in restoring order. It was his victory at Dussindale (Aug. 27, 1549) that put an end to the most dangerous rebellion, that of Robert Ket in East Anglia. This made him the hero of the propertied classes. Religious reformers and conservatives alike rallied to him and the coalition thus formed effected Somerset's deposition and imprisonment in October. Yet even then the breach was not absolute. For the coalition soon fell apart over religion. War-

wick, greedy for the church's remaining wealth, put himself at the head of the advanced Reforming party and threw over those conservative allies who had helped him into power. But he did not yet feel strong enough to combine their expulsion from office and privy council with the continued proscription of Somerset. So the duke was released (Feb. 1550) and readmitted to the privy council in April. In June 1550 Somerset's daughter Anne was married to Warwick's eldest son John.

But reconciliation did not imply sharing power or altering policy. Warwick never assumed the title of protector or any position of formal superiority over the other councilors. But he gradually filled both council and administration with his creatures, binding them to him with the spoils of church and state. At the same time he won an ascendancy over the boy king's mind and affections by encouraging him to cast off the shackles of royal minority. On these foundations Warwick gradually built up for himself and his faction a virtual monopoly of office and authority. All this inevitably bred opposition; opposition that was embittered by the revolutionary character of his policies. Abroad, he speedily abandoned the Tudor designs upon Scotland and their traditional friendship with the Habsburgs and made an ignominious peace with France in March 1550, selling back Boulogne and withdrawing entirely from Scotland. The capitulation was underlined in July 1551 when Edward VI was pledged to marry, not Mary Stuart, as Henry VIII and Somerset had planned, but Elizabeth, daughter of the king of France. Neglect of the navy and the land defenses only accentuated the country's growing subservience to France.

At home Warwick reversed Somerset's more liberal agrarian policy and firmly repressed those who resisted enclosures. He pressed forward the spoliation of the church as well as its reformation by encouraging foreign Protestants to come in and in 1551 by depriving Gardiner and other bishops whose views on doctrine and church property were insufficiently compliant. His policies were not all unstatesmanlike. He made some effort to begin a reform of the repeatedly debased currency. He stimulated English, particularly London, merchants to seek out new markets to lessen England's dependence upon Habsburg Antwerp. He encouraged the opening of trade to Morocco and secured a charter for the syndicate that, with old Sebastian Cabot's advice, was preparing to seek out northward routes to Cathay. But these first glimmers of maritime expansion could not lighten the general unpopularity of his rule. A parliamentary movement in 1551 for Somerset's restoration forced him to keep the houses from meeting and so to deny himself much needed grants. He sought to strengthen his position by making himself duke of Northumberland; his henchman, the marquess of Dorset, became duke of Suffolk, and lesser rewards were scattered among his humbler followers. Thereupon he had Somerset arrested again in Oct. 1551, tried, and executed on Jan. 22, 1552.

He then plunged deeper than ever into revolutionary courses. In Jan. 1552 parliament authorized a new and distinctly Protestant Book of Common Prayer, backed by an Act of Uniformity imposing severe penalties on any who used or attended other forms of worship. Thus committed to Protestantism, Northumberland could not contemplate the possible accession of the Catholic Mary. Early in 1553 it became obvious that Edward was unlikely to live long. To preserve himself against the future, Northumberland embarked upon the most desperate of all his schemes. He married his son Guildford Dudley to Lady Jane Grey (*q.v.*) in May. In June he persuaded the dying king, not yet 16 years old, to will the crown to Jane and her heirs male, to the exclusion not only of Mary but also of Elizabeth and Jane's own mother, the daughter of Henry VIII's younger sister Mary. To this "devise" over 100 councilors, peers, bishops and others were persuaded to append their signatures on June 21. But Edward had no legal power for such an act; Northumberland was too unpopular even for many Protestants to approve it sincerely; and lack of money had compelled him to disband the mercenary troops that might perhaps have coerced those whom he could not persuade. So, when Edward died on July 6, 1553, Northumberland's supporters melted away within a fortnight. He was able to proclaim Jane queen in London on July 10 and then to ride out with a small force against Mary's adherents in East Anglia. There, however, he soon found himself faced by superior numbers. By July 20 he was himself Mary's prisoner and already on July 19 the councilors in London had proclaimed her queen. In a last bid for pardon he declared himself a Catholic, but on Aug. 22, 1553, on Tower hill he paid for his treason with his life.

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NORTHUMBERLAND, JOHN NEVILLE, EARL OF (c. 1431–1471), a leading partisan in the Wars of the Roses, was the son of Richard Neville, earl of Salisbury, and brother of Richard Neville, earl of Warwick, the "kingmaker." He was a ringleader in the conflict between the Nevilles and Percys in 1453, which was the real beginning of the civil war. This rivalry, involving an ambition to control the Scottish march, dominated his career. Despite close personal ties with Henry VI, Neville supported Edward IV and as warden of the east march, beat down the last traces of Lancastrian resistance in 1464, notably at Hedgeley Moor (April) and Hexham (May). For this he was created earl of Northumberland in May 1464. A hesitant man, he held aloof from Warwick's intrigues against Edward IV in the summer of 1470. But the king, suspicious of Neville, restored the earldom of Northumberland to Henry Percy (March 1470), creating Neville marquess of Montagu, a title without lands. Neville joined the rebels, which was the immediate cause of Edward's flight abroad (Oct. 1470), but did not attack him on his landing in Yorkshire in March 1471. However, he finally joined his brother at Coventry and was killed with him at Barnet, April 14, 1471.

See C. L. Scofield, *The Life and Reign of Edward IV*, 2 vol. (1923). (GY. T.)

NORTHUMBERLAND, the northernmost and fifth largest county of England, is bounded south by Durham, west by Cumberland, north by the Scottish counties of Berwickshire and Roxburghshire and east by the North sea. Its geographical area is 2,019 sq.mi. Considerable landscape contrasts exist between the coastal plain, the coalfield and industrial areas of the southeast centred on Newcastle, and the uplands of the west and border.

Physical Geography.—Along the borders with Cumberland and Scotland are the Cheviots, rounded hills rising in a series of plateaus between 1,000 and 2,500 ft., to reach 2,676 ft. in The Cheviot, a dome of granite and volcanic rocks of Devonian age. Round it carboniferous rocks dip north to the Tweed basin and east and south to the coast and the Tyne valley. The fells of the west, grits and impure limestones, are deeply cut by the narrow valleys of the Rede, the North Tyne and their tributaries.

To the east of this upland core, Glendale, the valley of the Breamish-Till rivers, follows the cementstone outcrop and is overlooked to the east by the bold, flat-topped Fell Sandstone escarpment of Rothbury and Chillingham forests. Gritstones and limestones stretch in an arc from the middle Tyne to the coast north of Amble and are traversed by more open valleys which contrast with the deeply cut dales of the North Pennines to the south of the Tyne gap, a broad corridor of under 500 ft. A notable feature is the dolerite intrusion of the Whin Sill, which forms the Farne Islands and Bamburgh Castle rock and carries sections of the Roman wall.

The coastal plain, underlain by limestone in the north and Coal Measures in the south, is largely covered by glacial clays, sands and gravels. Impedence and diversion of rivers during the Ice Age created glacial lakes now infilled by alluvial deposits (e.g., Milfield plain northwest of Wooler) and the lower courses of many rivers, including the Tyne, cut relatively deep valleys through glacial deposits to reach the sea.

In the coastal plain soils vary with the glacial drift; heavy loams and clays, notably in the southeast, light sands and gravels are all found. Upland soils are generally thin and acid, with peat on the more poorly drained surfaces. Alluvial haughs alongside the streams of upland valleys provide important stretches of deeper soil.

The county's northerly position and its altitude and exposure to

easterly winds make for a cool climate. Winter is hard, with snow lying for up to 40 days per year on the higher ground. Spring is late, and cool easterly winds, often bringing sea fogs, keep down temperatures on the coast. The highest summer temperatures rarely exceed 15.5° C. (60° F.). However, the climate is relatively dry, most areas below 400 ft. having less than 30 in. of rain per annum (as little as 25 in. on the coast) rising to 50 in. in the Cheviots.

Original woodland was cleared early. Heather moor now characterizes the drier uplands, with *Molinia* grass and cotton-grass moor on peat; on less acid soils *Nardus* gives useful grazing. Since 1926 considerable upland afforestation has been carried out by the Forestry commission, notably in Kielder (north of Tynedale beyond Falstone), Wark and Redesdale forests. There are nearly 100,000 ac. under trees, mainly Norway and Sitka spruce, some Scots and Lodgepole pine and Japanese larch.

The indigenous red deer is extinct, but roe deer are common; wild goats are found in the Cheviots and there is a herd of wild white cattle in Chillingham park (near Wooler). The county is rich in bird life, heather uplands providing grouse and a variety of birds of prey and the coastal areas many waders and seabirds, especially on the bird sanctuary of the Farne Islands (also a breeding ground of the Atlantic gray seal).

The Northumberland National park has 398 sq.mi. of fell (including the Cheviots), while a further 126,000 ac. in Kielder, Wark and Redesdale forests form most of the Border National Forest park. A further 70 sq.mi. of the coast (including the National trust bird sanctuary on the Farne Islands) are classed as an area of outstanding beauty. The National trust owns 14,282 ac. (1961) in the county. (Ri. L.)

History.—In the Neolithic Age, settlements existed in the lower levels of the limestone area running northeast from Hexham to Alnwick. The evidence of beaker pottery suggests that migrants from across the North sea settled at the beginning of the Iron Age. The Roman hold on Northumberland dates from A.D. 122 when the emperor Hadrian built a wall from the Tyne to Solway firth. In 547 Ida laid the foundations of the kingdom of Bernicia, which later extended from the Tyne to the Forth, by building the fortress of Bamburgh which became the seat of the Saxon kings. His grandson, Aethelfrith the Destroyer, established the predominance of the Angles in 603 by defeating the combined forces of Strathclyde Britons and Scots at Degsastan and in 605 annexed the neighbouring kingdom of Deira. Henceforth the region between the Forth and the Humber was known as Northumbria (*q.v.*) and for about 80 years its kings were the most powerful rulers of the Anglo-Saxon states. Lindisfarne, the modern Holy Island (*q.v.*), was the centre for the spread of Christianity throughout this kingdom.

The north was ruthlessly harrowed by William the Conqueror but the Normans later refounded Lindisfarne, Tynemouth and Hexham and established new monasteries, while they built castles which protected the county against invasion from Scotland or over the North sea. The county is not mentioned in Domesday Book, but the account of its revenues appears in the Pipe or Great Roll of the exchequer in 1131. From this period the county palatine of Durham included large parts of Northumberland and the bishops of Durham exercised great influence. These detached parts of the county, called "North Durham," and other separate franchises, were gradually returned to Northumberland.

The county assizes have been held in Newcastle upon Tyne since 1140. From 1843 they have been held there jointly with those of the city of Newcastle. The shire court was statutorily established at Alnwick in 1549. The first reference to the division of the county into wards is in the Hundred Roll of 1295. Two members sat for Northumberland in the parliament of 1290 while in 1295 Bamburgh, Corbridge and Newcastle each returned two. In 1882 Northumberland (originally included in the diocese of Durham) became a separate diocese with the see at Newcastle.

Its political history until the union of the English and Scottish crowns in 1603 is largely a record of border warfare. It was invaded by the Scots in the 12th century and before the battles of Bannockburn (1314), Halidon Hill (1333), Otterburn (sometimes called Chevy Chase after the ballad; 1388), during the Wars of the Roses and before the battle of Flodden (1513). In 1569 the Catholic north rose in support of Mary queen of Scots and Newcastle was captured by the Scots in 1644.

Ancient monuments of the county include castles at Bamburgh, Warkworth (*qq.v.*), Dunstanburgh and Norham; Warkworth hermitage, Lindisfarne priory, Elizabethan ramparts at Berwick-upon-Tweed and the Roman station at Corstopitum, ½ mi. W. of Corbridge. Other castles are at Alnwick, Morpeth (*qq.v.*), Prudhoe, Ford, Chillingham, Langley, Wark-on-Tyne and Newcastle upon Tyne. There are abbeys at Alnwick, Brinkburn, Hulne (the first English Carmelite priory), Blanchland, Newminster and Tynemouth. The priory church at Hexham (*q.v.*) is the oldest in Northumberland. The most impressive stretch of the Roman wall still standing is on either side of Housesteads (Borcovicium). At Chester are the remains of a Roman fort (Cilurnum) and an important collection of Roman antiquities. (*See* also HADRIAN'S WALL.)

Population and Administration.—The population of the administrative county (1,944 sq.mi.) in 1961 was 479,487. The larger towns are situated in the southern and eastern third of the county, which contains in addition, especially near industrial Tyneside, tracts of urban settlement based on large industrial and mining villages, interspersed with agricultural land. The remainder of the county is largely depopulated, and consists of rough fells and difficult uplands, served by the small country market towns of Wooler, Rothbury and Bellingham.

Tyneside was particularly affected by the depression of the 1930s and was included in the "special area" over which a commissioner was appointed by act of parliament in 1934. There are 2 county boroughs, Newcastle upon Tyne (pop. 1961, 269,678) and Tynemouth, including North Shields (70,091); 5 municipal boroughs, including Berwick-upon-Tweed (12,178), a historic county of itself; 11 urban districts; 10 rural districts and 154 parish councils. For parliamentary purposes Tynemouth, Wallsend, Newcastle upon Tyne (four members) and Blyth are constituencies outside the three county divisions which each return one member. The county is in the northeastern circuit and assizes are held at Newcastle. There is a court of quarter sessions for the county at Newcastle and a separate court for the city of Newcastle, and there are 14 petty sessional divisions. The county boroughs and Morpeth have their own police forces.

The Economy.—The county is famous for its wild and exposed scenery, and in earlier times was prosperous from its wool production. Exports in the middle ages were chiefly wool and hides. About half the total acreage of the county is mountain and rough hill pasture, 45% is medium quality land and 5% is good quality. Crops and grass, excluding rough grazings, cover about half the county, oats and barley being the chief crops. There are roughly 4½ times as many sheep as cattle.

The most important mineral resource is coal. It was mined in Roman times and the coal trade of the Tyne developed rapidly from the 13th century. Shipbuilding grew up there as a consequence, and in the early 19th century new investment and inventions, including the steam turbine, created the great shipbuilding and ship-repairing works which now dominate the economy. Iron shipbuilding developed in the 1830s and encouraged local iron foundries, though these have now largely migrated to County Durham. Iron had been smelted in the 13th century, but the lack of heavy timber in the county prevented much development. Other industries that depended on coal took its place: salt panning at the river mouths, particularly at Warkworth, Blyth and North Shields (this industry created in the 17th and 18th centuries a smoke nuisance that has marked its older buildings); and glassmaking, introduced to Tyneside in the reign of James I from German Lorraine. For about a century the Tyneside chemical industries were among the most important of the country but, like the glassworks, failed to maintain themselves. Of industries not dependent on coal, tweed weaving is the most important, being worked originally by hand or by water power; mills may be found on the banks of the Rede and the Wansbeck. Salmon fisheries, particularly in the Tyne and the Tweed, have flourished from the time of Henry I;

there are inshore fisheries based on North Shields. Lead, silver and iron were mined in Allendale and elsewhere from the 12th to the late 19th centuries; stone and brick-clay quarrying has left marks on the countryside throughout. Modern industries, concentrated on the Tyne and Blyth rivers, also include the manufacture of heavy electrical machinery, pottery and soap.

The two principal roads are the Great North road and the west road from Newcastle to Carlisle. The industrial and urban area of the southeast has a network of roads and is also served by local electric railways. The main London to Edinburgh (North Eastern region) railway runs through Newcastle and Berwick-upon-Tweed, and a main line runs west from Newcastle to Carlisle. The principal harbour facilities are those of the Tyne and port of Newcastle. There are passenger services to the Baltic and Scandinavia. There are harbours at Blyth (coal trade) and, less importantly, at Amble and Berwick. The regional airport at Woolsington (Newcastle) operates regular air services to main towns in the British Isles.

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(Mi. G. C.)

NORTHUMBRIA was one of the most important of the Anglo-Saxon kingdoms, reaching at its greatest extent from the rivers Humber and Ribble or Mersey to the Firth of Forth and the Ayrshire coast. Its name is derived from Old English *Norþanhymbre* which in a Latinized form was used by Bede to signify all those people of English race who lived to the north of the Humber. The kingdom emerged from the coalescence of two originally independent states, Bernicia to the north and Deira to the south, with the boundary between them marked during the lifetime of Bede by the river Tees. The inhabitants of these two states were known in Old English as Bernice and Dere, names which seem ultimately to be of Welsh rather than English origin. The nucleus of Deira (*q.v.*) lay in the east riding of Yorkshire where many pagan burials have yielded objects indicating that the earliest English settlements took place there long before the time of its earliest recorded king, Aelli (*q.v.*), who was reigning in the second half of the 6th century. The kingdom of Bernicia (*q.v.*) was in origin no more than a pirate settlement established by Ida on the rock of Bamburgh in 547, and so it remained for about 50 years during the reigns of the next six rulers, one of whom, Theodoric, is said to have been besieged in Lindisfarne by a Welsh army led by Urien, king of Rheged.

A rapid expansion occurred during the reign (593–616) of Aethelfrith (*q.v.*), of whom Bede said that he conquered more British territory than any other English king. In 603 he defeated Aidan (Aedan), ruler of the Scottish kingdom of Dalriada, at an unidentified place called Degsastan. Shortly after this he won possession of Deira, thereby creating the kingdom of Northumbria, and he also led a raid deep into Welsh territory to win another victory near Chester.

In 616, however, Aethelfrith was killed in a battle fought near the river Idle against Raedwald of East Anglia, who was supporting Edwin (*q.v.*), the representative of the Deiran dynasty. On the eve of Easter 627 Edwin was baptized at York and so became the first Christian king of Northumbria. He was active in warfare against the Welsh, conquering the kingdom of Elmet (a territory corresponding with part of the West Riding of modern Yorkshire), besieging Cadwallon, king of Gwynedd, in the island of Priestholm off the coast of Anglesey and laying both Man and Anglesey under tribute, but in 632 Edwin was himself defeated and slain by Cadwallon in Hatfield Chase. Northumbria fell apart momentarily but in 633 Oswald (*see* Oswald, Saint) restored the Bernician dynasty by overthrowing Cadwallon in a battle fought near the Roman wall. During Edwin's reign the Bernician royal family had sought refuge among the Picts and Scots and several of them, including Oswald, were converted there. Shortly after his restoration Oswald invited Scottish monks to Northumbria and monasteries were established at Lindisfarne and elsewhere.

Northumbria continued to expand rapidly toward the north during the reign (633–641) of Oswald and of his successor Oswiu (*q.v.* 641–670) and it is probable that Northumbrian rule had reached the Forth shortly before 640. Abercorn became the seat of a Northumbrian bishopric about 680 and Dunbar the seat of an English earl at about the same date. Before the accession of Egfrith (*q.v.*) in 670 the Northumbrians had imposed their rule on Pictish territories between the Forth and the Tay, but in 685 Egfrith, after leading an army across the Tay, was defeated and killed in a battle fought at a place called Nechtanesmere near Forfar. After this defeat the Northumbrian frontier fell back to the Forth where it remained until mid-9th century. The rate of Northumbrian expansion toward the western sea between Clyde and Mersey is difficult to determine. In 750 Eadberht, king of Northumbria, added parts of Ayrshire to his kingdom but it is probable that possession of these lands soon reverted to the British kingdom of Strathclyde whose capital lay at Dumbarton. A Northumbrian bishopric was established at Whithorn in Wigtownshire shortly before 731 and Carlisle may have been reached as much as 100 years earlier.

In Lancashire, estates adjacent to the Ribble formed part of the endowments of the church at Ripon soon after the middle of the 7th century. Northumbria's southern boundary was marked by the Humber on the east and the Ribble or the Mersey on the west. In its central sector it lay roughly along the line of the existing boundary between Yorkshire and Derbyshire. South of this border lay the kingdom of Mercia which became a formidable power during the reign of Penda (d. 654). On several occasions Penda invaded Northumbria, once penetrating as far north as Bamburgh, and it was at the hands of Penda that Oswald met his death in 641. At times during Penda's reign the southern part of Northumbria became a dependency of Mercia, but in 654 a Mercian army, supported by contingents from East Anglia and Wales, was defeated by Oswiu in a battle fought near an unidentified river called Winwaed and Penda was killed. Northumbria's military strength was at its greatest in the 7th century during which the supremacy of three of its rulers, Edwin, Oswald and Oswiu, was recognized by the southern English kingdoms as well as in Northumbria. In later years the power of the monarchy was greatly weakened by internal disorders and many of the 8th- and 9th-century kings had short reigns and met violent deaths.

In the century which followed the death (685) of Egfrith the importance of Northumbria was less in matters political and military than in the intellectual and artistic achievements of what has been called a golden age. The twin monasteries at Wearmouth and Jarrow achieved pre-eminence in the intellectual life not only of England but also of western Europe as a whole. It was at Jarrow that Bede wrote the *Historia ecclesiastica gentis Anglorum* (*Ecclesiastical History of the English Nation*), the supreme example of his own historical and scholarly genius and itself to be accounted among the great literary monuments of the European middle ages. The library at Jarrow was probably matched by libraries of similar quality at Hexham, Whitby and Lindisfarne. Almost all of their contents were destroyed during the Danish invasions but there still survives from Lindisfarne the famous Gospel book which was written and illuminated in about 700 by Eadfrith, bishop of Lindisfarne, and which in its kind is no less a work of genius than Bede's *History*. This book, now known as the Lindisfarne Gospels, remains one of the greatest treasures of the British museum. The skill of Northumbrian sculptors in this age is represented by the stone crosses which are still to be seen at Bewcastle and Ruthwell as well as by many sculptured fragments of comparable beauty.

The intellectual and artistic achievements which characterize the age of Bede could not have been brought to completion without the conditions provided by monastic life, yet it was in part the overgrowth of monasticism which led to a weakening of Northumbria's political power. The transfer of lands to the church made it difficult for the nobility to provide adequately for their sons and many spurious monasteries were founded in which noblemen and officers of government lived with their wives and families, thereby

avoiding the burdens of taxation and military service which would otherwise have fallen upon them. Bede foresaw that if this process were allowed to continue the military strength of the kingdom would not be great enough to enable it to defend itself, and so it proved when the great Danish army which had landed in East Anglia in 865 advanced upon York in the following year. The capture of York by the Danes was the first episode in a process which lasted for two centuries and which reduced the extent of the kingdom to the size of the modern county of Northumberland. After campaigning in different parts of the country for nine years a large part of the Danish army, led by Healfdene, settled down to permanent homes in an area corresponding broadly with the modern Yorkshire. English kings continued to reign at Bamburgh but they were of no importance politically. In the early years of the 10th century Northumbria's southwestern quarter, from the Solway to the Mersey, came under attack from Scandinavian invaders, approaching from Ireland and the Isle of Man. Entering the estuaries of the Dee and the Mersey, they established themselves not only in Lancashire, but also in Westmorland and Cumberland and along the northern shores of the Solway firth. Some of these newcomers sought to win control of the Danish settlements in Yorkshire and during the first half of the 10th century a succession of Norse kings ruled in York. Meanwhile, farther north, the amalgamation in about 850 of the formerly independent kingdoms of the Picts and the Scots created the kingdom of Scotland which began to exert pressure toward the south. In this way Lothian was gradually absorbed into Scotland.

The Tweed first came to be formally recognized as the boundary between Northumbria and Scotland about 975 and there were times when it seemed likely to be pushed farther south to the Tyne or even the Tees. The situation in the northwest at this time is very obscure but it seems probable that the rulers of the kingdom of Strathclyde took advantage of Northumbria's greatly weakened position to push their frontier south to Carlisle and perhaps farther.

The dismemberment of the kingdom of Northumbria was accompanied by changes of a different kind in the midlands and south where a succession of great West Saxon kings—Alfred, Edward the Elder and Aethelstan—not only consolidated their position south of the Thames but also, by absorbing the once independent states of the midlands, brought the kingdom of England into existence. At a gathering at Bakewell in Derbyshire in 920 Edward the Elder received the submission of all the people of Northumbria, whether English, Danes, Norsemen or others. The supremacy of his successor, Aethelstan, was recognized at a similar gathering held in 927 at Eamont, near Penrith. In 934 Aethelstan invaded Scotland and in 937, at an unidentified place called Brunanburh, he defeated a coalition of Scots, British and Norsemen. After Aethelstan's death in 939 the Norsemen regained control of York for a short time, but his successor Edmund later made good the loss (944) and with the expulsion of Eric Bloodaxe from York in 954 the line of Scandinavian rulers there came to an end. From this date there ceased to be any independent kings in Northumbria, which then became an earldom within the kingdom of England. During the 11th century it was held successively by Eric of Norway, by Siward who stoutly defended it till his death in 1055 and by Tostig, one of the sons of Godwin, earl of Wessex. In 1065 the Northumbrians rebelled against the rule of Tostig and he was replaced by Morcar, brother of Edwin, earl of Mercia, but in 1066 Tostig returned, entering the Humber with a large fleet commanded by Harald Hardraade, king of Norway. The invaders were engaged by Edwin and Morcar who were defeated after a hard battle. A few days later Harold II, king of England, arrived from the south and in a battle fought at Stamford Bridge, about three weeks before the Norman victory at Hastings, Tostig and Harald Hardraade were both killed and their army routed

See also references under "Northumbria" in the Index.

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(P. H. BR.)

NORTH-WESTERN PROVINCE, CEYLON, covers 3,016 sq.mi. of mainly lowland country stretching inland from the west coast to the foothills of the central highlands. Pop. (1960 est.) 1,086,000. Its coast consists largely of lagoons behind sandbars and spits. Inland the country becomes higher and more rolling but nowhere is there strong relief, except for the hills on the southeastern margin of the province and for isolated summits and ranges like those that give so much character to the provincial capital, Kurunegala (*q.v.*). The province is for the most part underlain by ancient crystalline rocks, but Miocene sediments outcrop in the north. The climate is varied: along the southern border wet zone conditions prevail, then in an east-west belt through Kurunegala the climate is transitional, till, roughly north of the Deduru Oya (river), true dry zone conditions set in, with their characteristic alternation of a rainy season (November to January) and a marked drought (May to September). Rainfall decreases northward, and north of Puttalam is under 50 in. annually. (*See* CEYLON: *Physical Geography*.) The former rain forests of the wet zone part of the province have largely disappeared, but dry zone tropophilous forest (of plants adapted to alternating wet and dry conditions) still covers large areas; it degenerates into thorn scrub in the more arid north. The province includes part of the Wilpattu National park, where a variety of wildlife may be seen.

The inland dry zone part of the province shared in ancient times the civilization based on Anuradhapura (*q.v.*), and a fair number of ruins, inscriptions and irrigation works remain; but there seems to have been relatively little ancient settlement nearer the coast. During the Polonnaruwa (*q.v.*) period in the 8th century A.D. certain sites in the district were used as rock fortresses (*e.g.*, Yapahuwa, near the modern Maho junction) and later, as the old centres became insecure, places like Dambadeniya (just north of the Maha Oya) and Kurunegala were for a time the seats of kings. In Kandyan times Puttalam was used as a port by the Sinhalese kingdom. (*See* also CEYLON: *History*.) The wet zone part grows rice and coconuts; the latter also extend in a belt up the coast as far as Puttalam. In dry zone regions villagers grow rice by irrigation, and there are several recently restored major irrigation works. A branch railway extends up the coast to Chilaw, and the main northern line runs through Kurunegala and the eastern part of the province. There is a reasonably good road network, though no main road runs up the coast north of Puttalam.

The province has a mixed population. In many places Kandyan Sinhalese predominate, but in parts of Puttalam district there are more Ceylon Tamils and Moors (Muslims) than Sinhalese, while in Chilaw district there is a heavy preponderance of Low Country Sinhalese. The population is very unevenly distributed, a high density in Chilaw district and in southern Kurunegala district grading to a very low density in the far north of the province.

(B. H. F.)

NORTHWESTERN UNIVERSITY, a privately controlled, coeducational institution of higher learning, established in 1851 through a charter from the Illinois general assembly. The university maintains two campuses on the shores of Lake Michigan: one in the Chicago suburb of Evanston and the other on Chicago's near north side. *See* EVANSTON.

NORTHWEST FRONTIER, the belt of mountain country constituting the frontier in the northwest of West Pakistan and east of Afghanistan. These borderlands known as the frontier regions, or more commonly as the tribal areas, extend in the north to Chitral as far as the Hindu Kush (*q.v.*) mountains, and in the south as far as Baluchistan (*q.v.*). Between 1901 and 1955 there existed a separate province, the North-West Frontier province, which comprised not only the frontier regions but also six settled districts farther east: Peshawar, Mardan, Kohat, Bannu, Dera Ismail Khan and Hazara. The province was amalgamated with West Pakistan in 1955.

Chitral (*q.v.*), the most northerly of the tribal areas, is a region of deep valleys and lofty ranges, of snow-covered mountains and rich pine forests, though some of the hills are dry and bare. To its south lie the thickly wooded hills of Dir (*q.v.*) and Bajaur and the fertile valleys of the Panjkora and Swat rivers. The Hindu Raj range in the west of Bajaur and Dir, flanked by the Kunar

river on the west, runs northeast and merges by a curving line of hills into the Hindu Kush. The old route eastward from Kabul was through the Kunar valley and the Malakand pass. The Safed Koh range, running east from Afghanistan, forms the divide between the basins of the Kabul and the Kurram rivers and constitutes the Khyber hilly tract, with its historic Khyber pass (*q.v.*) leading from Jamrud Fort to Dakka in Afghanistan. The Kurram valley provides a route to both Kabul and Ghazni beyond Parachinar through the Peiwar Kotal (pass) (8,531 ft.) on the Durand line (*see* below) and through the Shutargardan pass (11,900 ft.) on the spurs of the Safed Koh beyond it. Parachinar is connected by road with Thal (to the southeast) and beyond it by rail with Kohat. Farther south between the Kurram and the Gumal rivers lies Waziristan (*q.v.*), the core of which is a mass of mountains about 11,000 ft. high. The hills are mostly barren and treeless except for pine forests on some of the higher ranges. There are *kachis* or patches of fertile alluvium in the saucers of the Wana plateau to the south. The route from Ghazni along the Tochi valley runs through north Waziristan. It was along this route (according to local tradition) that Mahmud of Ghazni occasionally swept down, when Multan and Sind rather than Peshawar and the Punjab were his immediate objectives. The Gumal pass (*q.v.*) provides an easy route between Ghazni and Tank. It was formerly much frequented by the Powindahs (traveling Pathan merchants). The Afghan frontier crosses the Gumal river at Domandi.

The tribal areas of West Pakistan are separated from Afghanistan by the Durand line, named after Sir Mortimer Durand under whose guidance it was demarcated in 1893. The line extends about 1,400 mi. from north Gilgit (*q.v.*), where the Himalayas and the Hindu Kush meet, to Kuh-i-Malik Siah near the meeting point of the boundaries of Afghanistan, Iran and Pakistan. Its northern portion of about 350 mi. from Gilgit to Bajaur runs along the crest of almost impassable mountains, offshoots of the Hindu Kush and the Himalayas. The southern portion of about 350 mi. from Nushki to the Malik Siah is a desert of deep sand and barren hills where drinking water is scarce and there are no means of communication. The middle section, of 700 mi. between Bajaur and Nushki, crosses mountains 6,000–11,000 ft. in height and is traversed by several important passes including the Khyber, Gumal and Bolan-Khojak. It has long been the keystone of the defense of the frontier.

For administration the tribal areas are divided into six political agencies: Malakand (*q.v.*) including Dir; Swat and Chitral; Mohmand; Khyber; Kurram; and Waziristan, North and South. There are also tribal (now called Special) areas adjoining the settled districts of Hazara, Mardan, Peshawar, Kohat, Bannu and Dera Ismail Khan. For tribal areas outside the agencies, the deputy commissioner of the adjoining district acts as the political agent. Each agency, except the Mohmand, has its own military organization, known as Scouts, commanded by officers of the Pakistan army. These organizations carry out police as well as military functions. The states of Dir, Swat and Chitral have small armies of their own. The national and provincial laws of West Pakistan do not apply to the tribal areas. Except for Chitral, Dir and Swat the frontier regions have a form of democratic government. The administration of justice and the solution of local problems are the concern of elected tribal *jirgas* (councils of elders). (*See* also PATHAN.)

Population.—The 1961 census of Pakistan gave the population of the frontier regions of West Pakistan as 3,260,369 in an area of 22,598 sq.mi. The settled adjoining districts of Peshawar and Dera Ismail Khan divisions, into which the old frontier province was divided, had a population of 4,317,817 and an area of 16,685 sq.mi. The frontier regions are inhabited predominantly by tribesmen, followers of Islam, known variously as Pathans, Pakhtuns (Pashtuns or Pukhtuns) and Afghans. While the tribesmen most often call themselves Pakhtuns, the word Pathan is generally applied to those living in Pakistan; "Afghan" has come to have a connotation of nationality, usually implying those living in Afghanistan. The Pathans are known for their physique, fighting qualities, bravery, hospitality and indomitable spirit of independence. They speak Pashto (*q.v.*), or Pushto, closely related to Persian. Their most important tribes are the Yusufzais of the Malakand agency; Afridis of the Khyber agency and of the Kohat pass; the Orakzais, the Turis and Zaimukht of the Kurram agency; the Wazirs of Waziristan and their kinsmen the Mahsuds of South Waziristan, the Daurs of North Waziristan; and the Bhittanis and Shiranis of the Dera Ismail Khan border. In Chitral the unwarlike Kho, with central Asian rather than Pathan affinities, are the dominant tribe. Their language Khowar (Chitrali) is a Dardic tongue. An ancient people, the Kafirs, live in remote villages. (*See* NURISTAN.)

In the adjoining settled districts, the chief tribes are the Yusufzais of Mardan; the Khalils; Mohmands; Muhammadzais; Daudzais; Gigianis and Khattaks of Peshawar; the Khattak and Bangash of Kohat; the Marwats, Bannuchis and Wazirs of Bannu; and the Gandapurs, Kundis and Mian Khels of Dera Ismail Khan district. There are other minor tribes such as the Jaduns of Hazara and Swabi and the Shinwaris and Mullagoris of Khyber. The strongest in number are the Yusufzais, followed by the Khattaks and Marwats. The Afridis, the Mahsuds and the Wazirs are known as guerrilla fighters while the Yusufzais and Khattaks are noted for their fine physique and martial qualities. Next to the Pathans the numerically strongest people are the Awans. Like the Pathans they are agriculturists, and are scattered over the whole area

Every frontier village has a separate quarter called *kandi* inhabited by one clan called Khel. Each *kandi* has its own chief (*malik*) whose duties are the settlement of disputes, the equitable distribution of crops, etc., and each has its own *jamaet* (mosque), *hujra* (assembly hall) and *burj* (watchtower). The *hujra* serves as public room, court, guest house and social and literary club. Green tea without milk is the common drink. Although Pathans are mildly contemptuous of dancing there are characteristic Pathan dances such as the whirling Khattak dance and the *mashal* (torch dance, which provide splendid physical exercise.

History.—The earliest history of the region is mainly connected with the ancient kingdom of Gandhara (*q.v.*) which included the Peshawar valley and part of the Kabul river valley. In the 6th century B.C. these lands became part of the Persian empire. Later they were successively held in part by the Greeks, by the Mauryan kings of India, by the Indo-Bactrian kings, the Sakas, the Parthians (Pahlavas) and the Kushans (*see* YÜEH-CHIH). The Arabs began incursions into the area in the 7th century, but it was the Turks who established Muslim hegemony there. Subuktigin was the first ruler to extend Muslim rule up to Peshawar. His son Mahmud of Ghazni invaded India from the northwest many times during A.D. 1000–30. With the rise of the Ghoris the frontier territories changed hands again, and Shahab ud-Din Ghori pushed far into the Punjab and established Turkish rule there. A regular stream of immigration of Pathan tribesmen into these regions from Afghanistan continued up to the 18th century. After the decline of the Ghoris, the frontier was successively held by Muslim Afghan dynasties, the Moguls and the Afghan Durranis, ruling either from Kabul or from Delhi. The invasion in 1738 of Nadir Shah of Persia is a landmark in the history of the frontier. From his death to the rise of the Sikh king Ranjit Singh, the frontier districts remained an appanage of the Durrani kingdom. Little control was exercised by Kabul, however, and the country was administered by local chiefs or Afghan sirdars. The Sikh invasions began in 1818. After the second Sikh War, by the proclamation of March 29 1849 the frontier districts were annexed by the British. Later the settled districts were included in the Punjab, while the independent tribes were controlled at different times by the Punjab government and the government of India.

In 1901, the frontier regions with the six settled districts were constituted into a separate province, the North-West Frontier province, under a chief commissioner. It was given provincial autonomy along with the other provinces of India by the Government of India act of 1935. In July 1947, at the partition of the subcontinent, a referendum was held, and the people of the province including those of the tribal belt elected to join Pakistan

After independence propaganda was carried on in the frontier area by Afghanistan for an independent Pathan state variously called Pakhtunistan or Pathanistan which would comprise the whole of the old North-West Frontier province including the set-

tled districts. In July 1949 the Afghan national assembly repudiated its treaties with Britain, regarding the tribal territory, specifically disavowing the Durand line as an international boundary. Afghanistan's attempts to promote Pathan separatism were intensified in 1955 when the North-West Frontier province was integrated with West Pakistan, and led to an armed incursion of the tribes on the other side of the Durand line in the Bajaur sector in Sept. 1960 and again in March 1961. For a time diplomatic ties between the two countries were broken off. From 1963, however, the Pakhtunistan agitation ceased.

See also INDIA-PAKISTAN, SUBCONTINENT OF: *History*; PAKISTAN: *History; The Economy.*

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NORTHWEST PASSAGE, a sea route along the north coast of North America between the Atlantic and Pacific oceans. Search for the passage commenced in the 16th century when Europeans became eager to discover a short route to the riches of the far east, and the great chartered trading companies of England were outstanding sponsors of early expeditions that probed the eastern Arctic for routes. The vast prolonged search for Sir John Franklin's lost expedition of 1845 contributed much to Arctic knowledge. In 1854 Robert McClure first completed a crossing, partly on foot, and in 1903–06 Roald Amundsen in the 47-ton "Gjöa" first sailed the passage, traveling east to west. The Royal Canadian Mounted Police schooner "St. Roch" made the first west to east passage (1940–42) and the first entirely in one season (1944). All four potentially feasible routes pass through Lancaster sound, suffer handicaps from rock-strewn passages in the east and shallow waters in the west and require reinforced ships, usually icebreaker escort, and ice reconnaissance to combat heavy ice. *See* also ARCTIC, THE: *Northwest Passage.* (J. R. M.)

NORTHWEST TERRITORIES, that part of Canada lying outside and to the north of the provinces but excluding the Yukon territory (*q.v.*). The territories extend from the northern limits of North America south to the 60th parallel of north latitude west of Hudson bay; farther east the boundary is drawn to include the islands in Hudson bay, Hudson strait and Ungava bay but to exclude the mainland of Labrador-Ungava. To the west, the boundary with the Yukon territory corresponds roughly with the watershed of the Mackenzie-Yukon rivers; and to the east the boundary is the limit of territorial waters except in the northeast where it lies midway between Canada and Greenland in the narrow seas extending from Smith sound to Robeson channel. Canada also claims sovereignty over any islands that remain to be discovered in the Arctic ocean in the triangular sector formed by the north pole at the apex and the meridians 60° west and 141° west. Such islands would also lie in the territories.

The political unit of the Northwest Territories evolved from "Rupert's Land and the North-Western Territory," which were acquired by Canada from the Hudson's Bay company in 1869, and from the British possessions farther north which were annexed ten years later. With the creation of new provinces and the extension of older ones, the Northwest Territories were reduced in area, until by 1920 they reached the area of 1,304,903 sq.mi. They were divided for administrative purposes into three districts: Keewatin, which was formed in 1876, when it included large parts of Manitoba and northwestern Ontario; and the districts of Mackenzie and Franklin, which were created in 1895. The boundaries were drawn so that all the islands except those in Hudson bay lay in Franklin, the land tributary to Hudson bay was included in Keewatin and the area adjacent to the Mackenzie river formed the district of Mackenzie. In the 1960s it was proposed that the territories be divided into Mackenzie territory, including the mainland west of the 105th meridian and Banks, Victoria and a few other small islands, and the territory of Nunassiaq, consisting of the districts of Keewatin and Franklin (less the islands in Mackenzie) and that part of the former Mackenzie district east of the 105th meridian.

Physical Geography.—Climate and scenery vary widely in the territories which contain both the highest mountains in eastern North America and some of the broadest lowlands. Dominating the geography and forming a fundamental division is the tree line. More accurately described as a zone of transition, the tree line extends from the delta of the Mackenzie to Hudson bay, near Churchill, Man. To the north and east are the treeless barren grounds that by geographical definition constitute the arctic; to the southwest and covering less than a quarter of the territories is a section of the Canadian boreal forest.

Although trees are not found in the arctic, woody shrubs, particularly the willow, are widespread. Close to the tree line they may reach a height of 10 ft. in sheltered valleys and may form extensive thickets. Such luxuriant growth is frequently found from Bathurst inlet to the Mackenzie delta, but is more limited around Lake Harbour, southern Baffin Island. Arctic vegetation is extremely varied. In the west rich grasslands are common while on some of the far northern islands, on the plateaus and on the limestone plains vegetation is absent. Marshland is significant in places, notably on Southampton Island and east of Foxe basin. Wherever there is plant life the short arctic growing season leads to a brief but often spectacular flowering period after the snows melt; at this time the tundra is covered with colour. The rate of plant growth is slow and, although the vegetation often appears rich, it requires long recuperation after being cropped by animals.

Trees extend into the barren grounds along such rivers as the Thelon and Coppermine, often giving a false impression of the timber resources; the higher exposed land between the rivers may retain its tundra vegetation for 100 mi. or more southwest of the tree line. Although the boreal forest in the south of Mackenzie district is a coniferous forest dominated by white and black spruce, there is an admixture of deciduous trees including poplar, aspen and paper birch. Spruce attains considerable size along the Mackenzie but only in the better drained areas south of Great Slave lake are the stands large enough for commercial exploitation.

The climate of the territories shows considerable differences between the Mackenzie lowlands and the remainder of the area. The former is relatively warm in summer; mean July temperatures of 60° F. (about 16° C.) are found along the Mackenzie river as far as the Arctic circle. At least once a year the temperature exceeds 90° F. (about 32° C.) along the southern part of the river and a high of 103° F. (about 39° C.) was recorded at Fort Smith. The summers are generally pleasant with long periods of sunshine and limited precipitation (four to five inches in the four months June to September), although this is the wettest part of the year. The winters in contrast are long, dark and cold. The mean temperature in the three months January to March varies from −15° to −20° F. (−26° to −29° C.) with occasional readings each year below −50° F. (−46° C.). Winds are light, however, and the snowfall is not heavy.

The climate of the rest of the territories is more rigorous. The dividing line between the two regions is frequently strongly marked, particularly in the spring when the temperature may drop 20° over a distance of 100 mi. northeast from the Mackenzie lowland. The arctic sector of the territories has little summer; temperatures remain in the 30°–40° F. range except at some inland points. The weather is generally cloudy and continuing light rain is common. Winter begins when the mean temperature falls below the freezing point, generally in the first half of September, and lasts until it rises above the same point sometime in late June or July. The winters are therefore long, with continuous darkness for many weeks in the northern islands. Temperatures are rarely lower than those of the Mackenzie valley but are frequently accompanied by strong northwesterly winds. Snowfall in the central arctic and far north is light but increases rapidly toward the east coast where over 200 in. have been recorded in some winters.

Over three-fourths of the territories is in the arctic but because of the low snowfall there are no large ice fields except in the highlands of Baffin, Bylot, Devon and Ellesmere islands, where ice caps and innumerable small glaciers are found; at only a few points does the ice reach the sea, being mainly restricted to the plateaus.

Elsewhere there are only minute glaciers, the most westerly being on Melville Island. On the mainland permanent ice is restricted to the local glaciers in the Mackenzie mountains.

Mean annual temperatures throughout the territories are far below the freezing point and in consequence the ground is permanently frozen except south of Great Slave lake, where there are scattered areas having permanently frozen subsoil, or permafrost (*q.v.*). The depth of the permafrost is not known, although it is probably in excess of 1,200 ft. in the northern islands. The thickness of the active layer (the upper layer of ground that thaws in summer) varies, depending on many factors, but in general it is many feet in the southwest of the territories and only a few inches in the north. Permafrost causes many construction difficulties. The problems are generally most severe in fine-grained soils such as silts, particularly common in the western Canadian arctic and the lower Mackenzie valley. This was one of the major factors which made it necessary to move the town of Aklavik, from a site in the Mackenzie delta to higher ground to the east of the delta (1954–58). Permafrost is also present in the eastern part of the territories but the problems associated with it are less severe there because of the nature of the soil.

Sea, lake and river ice conditions are serious throughout the territories; shipping comes to a complete halt in October and November. All the seas including Hudson bay are completely frozen over in winter. The first open water appears off the east coast in May but it is not until late July that shipping can move with any certainty. Hudson bay, Hudson strait and the seas adjacent to the northwest mainland become virtually clear of ice by late summer but elsewhere pack ice remains; many of the channels between the Queen Elizabeth Islands and the Arctic ocean are never passable. The Mackenzie, the only river that carries any appreciable traffic, is open from June to mid-October, although toward the end of the season low water often restricts navigation.

Physiographically the territories may be divided into five major regions. On the west, bordering Yukon territory, are the Mackenzie, Franklin and Richardson mountains, which are the northern extension of the Rocky mountains. The average height of the peaks is about 6,000 ft. with a few summits over 7,000 ft. To the east forming the second region are the Mackenzie lowlands which have developed on horizontal sedimentary rocks, mainly limestone and sandstone. Although the lowlands are for the most part plains with numerous lakes and poorly drained areas, they also contain small groups of hills such as the Cariboo and Horn mountains. The Mackenzie river flows in the lowlands except between Wrigley and Fort Good Hope where it occupies a deep valley between the Franklin and Mackenzie mountains. Two large lakes, Great Bear and Great Slave, are found in the east part of the Mackenzie lowlands on the edge of the third region, the Canadian shield.

The Canadian shield occupies virtually all the remainder of the Mackenzie and Keewatin districts. It is formed of crystalline rocks in places overlain with basaltic lavas, notably on the south side of Coronation gulf, and with sandstones, particularly along the Thelon river. The scenery varies from rock hills along the western margin and on the northwest side of Hudson bay to broad sand and clay-covered plains in the centre. In the Franklin district the shield forms a fourth region where it rises in Baffin, Bylot, Devon, and Ellesmere islands to make a mountainous, deeply dissected fjord rim to the continent. Physiographically associated with this region, although geologically distinct, are the mountains of northern and western Ellesmere and Axel Heiberg islands. The remainder of the arctic archipelago may be considered scenically one region although in detail it is complex. In a pre-Ice Age era the islands and channels were apparently one land mass drained by rivers flowing in broad valleys. Subsequently the sea partially drowned the land to produce a maze of channels separating some of the largest islands in the world, including Baffin Island (183,810 sq.mi.) and Victoria Island (81,930 sq.mi.). The land is underlain by arches of shield rocks, broad horizontal areas of limestones and sandstones and more restricted folded rocks. Today they form low hills, plateaus and plains, often covered with thick layers of shattered rock and clay.

History.—The earliest records of exploration in the territories are those of Martin Frobisher, who in 1576 examined the southeast coast of Baffin Island in a search for a northwest passage. When other voyages in the next 55 years failed to discover the passage, interest in the arctic ceased. In 1670 the Hudson's Bay company was granted a trading charter and established posts around the southern shore of Hudson bay. Apart from short voyages on the west side of the bay early in the 18th century, the company undertook no arctic exploration. The first account of the interior of northern Canada was published after Samuel Hearne on his third attempt (1770–72) had walked 2,000 mi from Churchill to the vicinity of Coppermine on the Arctic ocean in a search for native copper. Meanwhile French traders from Montreal were advancing along the prairie rivers. When trading recommenced after the conquest of French Canada in 1760, their successors were able to begin the exploration of the Mackenzie river system. By 1788 Peter Pond had mapped the waters of the upper Mackenzie and had established a trading post on Great Slave lake. The following year Alexander Mackenzie of the Northwest company descended to the mouth of the river that bears his name. Trading rivalry along the Mackenzie river was intense until 1821, when the Hudson's Bay company absorbed the Northwest company.

European penetration into arctic Canada in the 19th century was mainly concerned with renewed exploration for the northwest passage. The search for the lost Franklin expedition of 1845 led to the mapping of many of the arctic islands and the discovery of the northwest passage (*see* FRANKLIN, SIR JOHN). By this time temporary shore whaling stations had been established on Baffin Island and small semipermanent settlements soon followed. After the Dominion of Canada obtained the Hudson's Bay territory in 1869 and the northern islands in 1880, there were a number of federal government expeditions. The territories have been mapped from air photographs, though detailed exploration continues.

Resources.—Until relatively recently wildlife was the only important natural resource of the territories. Animals provided the main source of food and clothing for the native peoples, and the furs and ivory, whalebone and blubber from sea mammals were the only objects of commercial value. The most important large land mammals were the barren-ground caribou and the musk oxen in the arctic, and the woodland caribou and wood buffalo (bison) and moose in the forest. At the end of the 19th century the barren-ground caribou was found throughout the arctic sector of the territories; it was hunted by Eskimos from spring to fall and by the Indian in the winter when parts of the caribou herds migrated to the edge of the boreal forest. The introduction of firearms among the native peoples led to a rapid decrease in the caribou. They vanished from many of the islands; on the mainland, herds which numbered 1,750,000 at the beginning of the 20th century had been reduced to 200,000 by the beginning of the second half of the century. The caribou Eskimos of central Keewatin, who depended entirely on the caribou for food, were reduced to starvation and relocation became essential for their survival.

In 1935 a herd of 2,370 reindeer was driven from Alaska to the east side of the Mackenzie delta in an effort to introduce a domesticated animal into the Eskimo economy. The experiment had only limited success. Growth was slow and after 20 years there were about 6,000 reindeer. The original herd was split into four; three herds were maintained by the federal government for the benefit of the native population and a fourth was privately owned. A controlled herd of 1,200 wood buffalo was maintained in Wood Buffalo park south of Great Slave lake. Excess animals are slaughtered annually for meat.

Musk oxen were once numerous but in the 19th century, after buffalo robes were no longer obtainable, musk oxen skins increased in value and they were hunted extensively. In view of their possible extermination on the mainland, musk oxen were given total protection in 1927 and their numbers increased thereafter, particularly in the Thelon game sanctuary. They continued to be numerous in the unpopulated far northern islands.

Among the smaller mammals the white fox has been most significant. Found throughout the Canadian arctic, it has been the

main article of commercial value since the beginning of the 20th century when the first fur trading settlements were established north of the tree line. Rapid changes in the value of fox pelts in response to world demand and unrelated to natural fluctuation in fox numbers made it an unstable base for Eskimo economy. Indians trap muskrat, mink, beaver and some other fur-bearing animals along the Mackenzie river. Fur production for the territories normally is valued at more than $1,000,000 annually.

The original economic motive bringing Europeans into the Canadian north was the search for sea mammals, particularly the whales, but overfishing and falls in world prices reduced that activity to negligible proportions. Seals, walrus and in some areas white whales are still important to coastal Eskimos. Fish have always been a limited source of food for Eskimos and Indians. Beginning in 1945 attempts were made to establish commercial fisheries. The most immediately successful was at Great Slave lake, where from 5,000,000 to 9,000,000 lb. of whitefish and lake trout, valued at $1,000,000 to $2,000,000 was taken annually.

Land suitable for agriculture is limited and is found only in the Mackenzie valley. In the second half of the 20th century there were only six farms of more than three acres and the cultivated area was less than 100 ac.

Undoubtedly the most valuable resources of the territories are the minerals. By analogy with the section in southern Canada, the Canadian shield was expected to contain rich deposits of metallic minerals, and the sedimentary rocks of the Mackenzie lowland and the arctic islands, petroleum and natural gas. By the second half of the 20th century, however, there had been widespread prospecting only in the vicinity of the Mackenzie valley where river transportation could be used in any development.

Oil seepages were discovered at Norman Wells on the lower Mackenzie river in 1911 but oil was not produced on a commercial scale until the early 1930s. Production increased at Norman Wells after newly established mines along the Mackenzie river created a market. During World War II a 400-mi. pipeline was built across the Mackenzie mountains to Whitehorse, Yukon territory; in 1944 production reached a peak of 1,223,675 bbl. Thereafter oil was supplied only to the Mackenzie valley and the western arctic; annual production during the 1950s was about 1,000,000 bbl.

The next mineral resources to be developed were the pitchblende ores at Port Radium at the east end of Great Bear lake in 1930. At first radium was the main product with copper, silver and cobalt subsidiary. The mine closed for a short period in the early part of World War II. When it reopened a few years later the main product was uranium, which was later mined north of Great Slave lake. The Port Radium uranium mine was closed again in 1960 when ore reserves were used up. In 1933 gold was discovered at Yellowknife on the north arm of Great Slave lake and production began five years later. These mines became the most important in the territories, and they form the economic basis for the largest town, Yellowknife (pop. [1961] 3,245).

Nickel and copper mining began in 1957 in the arctic at Rankin Inlet on the west side of Hudson bay. Other nickel deposits are known in the same area, as well as copper and nickel near Coppermine, iron ore on Baffin Island and lead-zinc at Pine Point. Commercial development of these areas is hindered by high transportation costs. Hydroelectric plants were constructed on the Snare river, 94 mi. N.W. of Yellowknife and at Bluefish lake, 15 mi. N. of the same town.

Government.—Government is in part directly by the federal government from Ottawa and in part by a territorial legislative body, the council, with approximately the same responsibilities as a Canadian provincial government. The council is composed of nine members, five of whom are senior government officials appointed by the governor general-in-council; the remaining four are elected by the residents of four constituencies in the Mackenzie district. Administration is the responsibility of a commissioner who acts under instructions from the governor general-in-council and the minister of northern affairs and national resources.

Population and Settlement.—The population of the territories in 1921 was 8,143, in 1941 was 12,028 and in 1951 was 16,004. In 1961 it was 22,998, of which about one-fifth was Indian and one-third Eskimo. The Indians and about 1,500 Eskimos live in Mackenzie district. The Indians for the most part occupy settlements along the Mackenzie river; fur trapping, fishing and hunting are their principal occupations. The Eskimos are more widely distributed, being found throughout the arctic section of the territories (except for some of the far northern islands) and in the Mackenzie delta. When Europeans first visited the Canadian arctic they found Eskimos in isolated seminomadic groups around the coasts, where they lived on sea mammals, and in the interior of Keewatin, where they were dependent on caribou and fish.

The earliest European settlements were established by fur trading companies in regions where natives were known to congregate, particularly in the winter and early spring in areas where trapping was thought to be rich, or at places which the natives could easily reach. In the northwestern forest all settlement was along the Mackenzie river and its tributaries; in the arctic (with the exception of Padlei, in southern Keewatin), the posts were located at points that could be reached by ships. Many of the Mackenzie settlements were founded in the early 19th century but the oldest existing arctic settlements are only 50 years old.

The first government representatives were the Royal Canadian mounted police; as the responsibilities of government expanded, nursing stations and hospitals were created in the larger communities and traveling medical, dental and X-ray units visited the smaller settlements at least once a year. The first schools were operated by missionaries; by the 1960s there were about 40 federal schools, some of which were boarding schools.

At first the settlements had little effect on the distribution of the population, which had to remain on the traditional hunting grounds in order to obtain sufficient fur-bearing animals and food. As the settlements grew, however, they attracted more and more Indians and Eskimos who came to live permanently in the vicinity, often in wooden cabins. Food was still partly obtained by hunting but was augmented by purchases with family allowances and government relief. By 1939 the growth of mining towns in the Mackenzie lowland had already begun to influence the population distribution in the west. In the arctic it was not until 1955 that government policy and military developments led to significant population changes.

During World War II the construction of airfields in the eastern arctic at Coral Harbour, Southampton Island, and at Frobisher Bay, Baffin Island, made access to these areas much easier and led to the employment of some Eskimos. However, it was not until the building of the Distant Early Warning (DEW) line—a network of installations across the 70th parallel which report and plot aircraft operations in the polar regions—that a widespread demand developed for Eskimos who could speak some English and had manual skills. Many moved into the construction camps and earned high wages. After the DEW line building program was completed some Eskimos remained on the sites; others found their way to northern settlements where further employment was available. The most important of these settlements in the eastern arctic is Frobisher Bay. The Frobisher Bay airfield, operated by the Canada department of transport, is used by transpolar flights to Europe from the west coast of North America. Frobisher Bay, the largest town in the North American arctic (pop. [1961] 512), became the administrative centre in the eastern arctic. A second town in which federal government planning was active was a new town, Inuvik, built to replace Aklavik in the Mackenzie river delta.

No Eskimos were living in the far northern islands when they were first explored, although there had been in prehistory. In the 1960s settlement in the islands was restricted to four weather stations supported from a main base created in 1946 at Resolute Bay, Cornwallis Island. Some Eskimo families had been relocated in the northern islands from impoverished areas farther south.

The largest communities in the whole of the territories are not, however, a direct outgrowth of the trading settlements. They are the mining towns of Yellowknife, Port Radium, and Rankin Inlet, as well as some of the more complex settlements along the Mackenzie river.

Transportation.—Economic development of the territories has

been hampered by the lack of transport facilities. Until about the middle of the 20th century the usual form of transportation was by water; in Mackenzie this meant the Mackenzie river system. Traffic for the western arctic originates at railhead at Waterways, Alta., and is carried north from there by tug and barge, with transshipment by road around a 16-mi. stretch of rapids between Fort Fitzgerald and Fort Smith. From there, boats can reach Tuktoyaktuk on the Arctic ocean, where there is a second transshipment for ports in the western arctic. The shallowness of the channels in this area restricts shipping to schooners and small vessels. All coastal settlements in the eastern arctic are reached by sea and until the end of World War II were visited only once a year by ships. Expansion of the settlements and the rapid growth of military installations, particularly those associated with the DEW line, resulted in convoys of ships escorted by icebreakers penetrating northern waters. Harbour facilities are lacking and all unloading is by lighter.

In the Mackenzie district an all-weather transportation route was opened in 1949 with the completion of the Mackenzie highway from Grimshaw, Alta., to Hay River on Great Slave lake. Construction was continued thereafter to extend that road around the north end of Great Slave lake to Yellowknife and northward into adjacent mining areas. During the winter months tractor trains operate from many western settlements moving supplies and heavy equipment to isolated points. Construction on the 438-mi. Great Slave Lake railway, the first railway to cross the 60th parallel into the territories, began in 1962.

Passenger transportation has been provided increasingly by aircraft. Construction of all-season airstrips in many parts of the territories permitted scheduled flights by various companies along the length of the Mackenzie valley, to Cambridge Bay on Victoria Island, and to Frobisher Bay on Baffin Island. Where large aircraft are not warranted smaller airplanes on wheels, skis or floats operate from various centres, including Fort Smith, Yellowknife, Hay River, Aklavik and Frobisher Bay. The far northern weather stations and some of the DEW line sites are serviced entirely by aircraft.

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NORTHWICH, a market town, urban district and parliamentary division of Cheshire, Eng., 17½ mi. E.N.E. of Chester by road, at the confluence of the Weaver and Dane rivers. Pop. (1961) 19,542. Northwich's streets are narrow and irregular, with some houses at fantastic angles because of subsidence resulting from the pumping of brine. Its brine springs have been used since Roman times, and the chemical industry, developed from the older salt trade, is a large concern. The centre of the salt trade moved to Winsford, several miles away, and the old Salt union has become the Salt division of Imperial Chemical Industries. There are also steel and iron works, leather, carpet and clothing factories.

NORTON, CAROLINE ELIZABETH SARAH (1808–1877), English poet and novelist, whose matrimonial lawsuits made her a notorious figure in Victorian society, was born in London, probably on March 22, 1808. One of the three beautiful granddaughters of the dramatist Sheridan, in 1827 she married the Hon. George Norton, brother of Lord Grantley. He proved to be a dull, quarrelsome husband, content to live off his wife's earnings and to make use of her Whig connections. Her friendship with Lord Melbourne secured him a judgeship, but in 1836 he brought an action against Melbourne for seducing his wife. This may have been a political move designed to discredit Melbourne, for the evidence was flimsy and the jury decided against Norton without leaving the box. He then refused his wife access to their children and her pleas were instrumental in introducing the Infant Custody bill, which was finally carried in 1839. In 1855 she was again involved in a prominent lawsuit when her husband refused to continue her allowance. Her indignant protests, which included *A Letter to the Queen*, had a great influence on the Marriage and Divorce act of 1857 which abolished some of the injustices to which married women were exposed.

Mrs. Norton's main outlet was her literary activities. She began writing while still a child, when a bookseller published her light-hearted satire, *The Dandies' Rout*, and she published volumes of poetry throughout her life. Her reputation stood high among her contemporaries: her name was coupled with that of Elizabeth Barrett Browning, and Hartley Coleridge, reviewing *The Dream, and other Poems* (1840) in the *Quarterly*, hailed her as "the Byron of modern poetesses." She also wrote four novels based mainly on her own unhappy experiences, edited various literary annuals and wrote many popular songs. She was a passionate, generous, indiscreet woman, whose charm is well conveyed by the portrait of her in *Diana of the Crossways* (1885) by George Meredith (*q.v.*), in which a painful incident in 1845, when she was wrongly supposed to have sold to the *Times* a political secret thought to have been revealed to her by her close friend, Sidney Herbert, is treated as true. Her husband died in 1875, and she had a brief period of happiness as the wife of Sir William Stirling-Maxwell before her death in London on June 15, 1877.

See J. G. Perkins, *The Life of Mrs. Norton* (1909); A. Acland, *Caroline Norton* (1948).

NORTON, CHARLES ELIOT (1827–1908), U.S. scholar and man of letters, was an idealist and reformer by temperament, who exhibited remarkable energy in a wide range of activity. Born in Cambridge, Mass., on Nov. 16, 1827, and graduated from Harvard in 1846, he opened a night school in Cambridge; was director of a housing experiment in Boston; worked zealously as an editor for the Union cause; was coeditor (1864–68) of the *North American Review* and one of the founders of the *Nation* (1865). From 1874 to 1898 he lectured on the history of art at Harvard, where he was one of the most popular teachers of the day and an "oracle of the humanities." A friend of many literary greats, including Carlyle, Emerson, Ruskin, Longfellow and Lowell, he contributed valuable editions of their letters and other biographical material.

Norton also wrote on art and edited collections of poetry, notably the poetry of John Donne (1895, 1905). Probably his best literary work was his prose translation of the *Divine Comedy* (1891–92). His *Letters . . . With Bibliographical Comment* were edited by Sara Norton and M. A. De Wolfe Howe (1913). Norton died on Oct. 21, 1908.

See E. W. Emerson and W. F. Harris, *Charles Eliot Norton* (1912); T. W. Higginson, *Carlyle's Laugh* (1909).

NORTON, THOMAS (1532–1584), English poet and playwright who, with Thomas Sackville, wrote *Gorboduc*, the earliest English tragedy, was born in London in 1532. Educated at Cambridge and admitted to the Inner Temple, London, in 1555, he contributed to *Tottel's Miscellany* (1557) and to Thomas Sternhold and John Hopkins' rhyming psalter (1562). He wrote *Gorboduc* in 1560; it was first printed in 1565 (*see* SACKVILLE, THOMAS; ENGLISH LITERATURE). He also translated John Calvin's *Institutes of the Christian Religion* (1561) and Alexander Nowell's *Catechism or First Instruction of Christian Religion* (1570).

Norton became member of parliament for Berwick in 1562 and entered into political and religious controversy, writing numerous anti-Catholic pamphlets. His punishment of the Catholics, as their official censor from 1581 onward, earned him the nickname of "rackmaster-general." At last he was deprived of office and thrown into the Tower of London. He died soon after his release, on March 10, 1584, at Sharpenhoe. (P. Dw.)

NORWALK, a city of Fairfield county, Conn., U.S., is located 14 mi. W.S.W. of Bridgeport on Long Island sound at the mouth of the Norwalk river. The site, purchased from the Indians in 1640 by Roger Ludlow and Daniel Patrick, was first settled in 1649 by a small group of colonists from Hartford.

In 1779, during the American Revolution, Norwalk was burned by Loyalist forces under Gen. William Tryon, colonial governor

New York, and it was from Norwalk that Nathan Hale crossed Long Island sound to Huntington, L.I., where he was captured by the British and executed as a spy. The manufacture of hats, long the town's principal industry, was begun before the Revolution. In the 19th century Norwalk was an important centre for shipbuilding and the production of earthenware, coaches, wagons, sleighs, tallow candles and shoes. Later textiles, clothing, electric and electronic equipment, typewriters and rubber products were added to the list of manufactures. From the time of first settlement Norwalk oysters were famed for both quality and quantity. After 1880, however, the oyster fishery declined because of overexploitation of the oyster beds and inadequate legal regulation of the industry. The rapid industrialization of the 20th century and the pollution of the waters by industrial wastes brought Norwalk's oystering virtually to an end.

The town of Norwalk, organized in 1631, contained two cities, Norwalk (incorporated as a borough in 1836 and as a city in 1893) and South Norwalk (incorporated in 1870), as well as the villages of Rowayton, East Norwalk, West Norwalk, Cranbury, Winnipauk, Silvermine and Broad River. In 1913 all this territory was consolidated and incorporated as the city of Norwalk. Pop. (1960) 67,775; standard metropolitan statistical area (Norwalk, Westport and Wilton), 96,756. For comparative population figures *see* table in CONNECTICUT: *Population*. (GL. W.)

NORWAY (KONGERIKET NORGE; KINGDOM OF NORWAY), is a country of northern Europe, occupying the western and smaller part of the Scandinavian peninsula. Its eastern frontier borders Sweden, except in the extreme north where Norway adjoins Finland and the U.S.S.R. It is bounded on the north, northwest and west by the Barents sea, the Norwegian sea and the North sea. The Skagerrak washes it on the south and southeast. The most southerly point is the island of Kråga near Mandal, the most northerly is Cape Knivskjelodden west of the North cape, on the island of Magerøy. The northernmost promontory of the mainland is Nordkyn, the southernmost, Lindesnes. The most western island, Steinsøy, lies off the mouth of Sognefjord and the easternmost point is Hornøya, near Vardø. The length of Norway (southwest to northeast) is about 1,100 mi. The extreme breadth is 267 mi., the narrowest 4 mi. The length of the coastline is difficult to estimate; excluding indentations and islands it is about 1,650 mi., but including the fjords and the islands it is probably 12,000 mi. The total area (including water area) is 125,181 sq.mi.; and, including Svalbard (*q.v.*), the Spitsbergen group of arctic islands, 149,139 sq.mi. Small islands also under Norwegian rule are Jan Mayen in the Arctic sea, and Bouvet and Peter I in the Antarctic. Queen Maud Land, on the Antarctic continental coast between longitude 20° W. and 45° E., is also under Norwegian control. The capital of Norway is Oslo.

This article is arranged in the following sections and subsections:

I. PHYSICAL GEOGRAPHY

1. Geology and Structure.—The rocks of Norway south of Hardangerfjord are mostly of Pre-Eocambrian age, consisting largely of schists, gneisses and migmatites of various kinds with basic, anorthositic intrusions near Egersund, and a few equally ancient sedimentary rocks in the Norefjell area. These Archaean rocks are interrupted in the Brevik-Drammen-Oslo-Hamar area by a fault-shattered belt about 20 mi. wide of lavas and plutonic rocks of Permian age flanked, especially on the western side and also at Oslo, by Cambro-Silurian sediments.

North of this is a square area, which includes Gudbrandsdal (*q.v.*) and the mountain massif of Rondane, of Eocambrian sparagmites and other sedimentary rocks, perhaps of similar age to the Torridonian of western Scotland. Between Rondane and Kvenangen, north of Tromsø, the rocks are largely of Cambro-Silurian age with a return of Eocambrian sedimentaries in northern Finnmark, and Pre-Eocambrian in southern Finnmark.

There are several small areas of Devonian rocks, mostly sandstone and conglomerate, such as in the Solund Islands (Solundøyane) at the mouth of Sognefjord, north of Florø and at Stjørna, near the mouth of Trondheimsfjord. The youngest solid rocks of Norway occur at Andøy, the most northerly island of the Vesterålen group, where there is a patch of about five square miles of Jurassic-Cretaceous rocks. Apart from this there are no Mesozoic-Tertiary sedimentary rocks in the whole of Norway, which is, in fact, one of the oldest land masses in the world.

Structurally the country may be divided into three areas by two lines: (1) along Hardangerfjord, through Granvin, Ulvik, north of Finse and Gol to Gjøvik; (2) north-northeast from the west coast about ten miles south of Bergen, to cross Sognefjord between Vik and Leikanger; continuing northeast, it separates Jostedal from Jotunheim, passes through Lom and thence north of Rondane to a little south of Røros, beyond which it passes into Sweden. The structure of the area to the south of the "Hardanger" line is of Cambrian or Pre-Cambrian age, although it may have been modified slightly by later earth movements. To the north of the "Leikanger" line the structure is almost entirely of Caledonian age, and the rocks have mostly been greatly altered from their original form, often to such an extent that it is now almost impossible to place them in the geological sequence. This applies especially to those in the western half of the country between Bergen and North Trøndelag.

Between the lines lie the great thrust belts of the Bergen arcs, the Gudvangen area, and the Jotunheim. The whole of northern Europe from Scotland to Scandinavia experienced a considerable compression in the mountain building stage of the Caledonian orogeny, which came to a culmination at the end of Silurian times. At that period, the Baltic Shield (now southern Norway, Sweden, Finland and the land to the east) moved nearer to North Atlantis, the continental land mass then to the west of Scotland. This produced great contortions, folds and faults in the rocks between. At either edge of the compression, that is, on the west coast of northern Scotland and in the belt between the Leikanger and Hardanger lines of Norway, the peripheral areas were forced to ride over those beyond, as great thrust masses. In Norway, the western rocks moved over the more easterly, and the area between the two lines is one of numerous overthrusts of great complexity. North of Røros the thrust planes are in Sweden, but they return to Norway in the far north, and divide Finnmark into the Pre-Eocambrian on the southeast of the line, which runs from near Reisduoddarhaldde to Rastigaissa and Tanafjord, and the altered Eocambrian rocks to the northwest.

At the same time, as is usual in such circumstances, there was considerable igneous activity. This formed an almost continuous

intrusion of granitic rocks south of Nordland to Sagfjord, and gabbro in the extreme west of Finnmark. Lofoten and Vesterålen comprise plutonic rocks, largely granite and syenite, which are also thought to be of Caledonian age, although this is not certain. The "Lofoten wall" is a striking topographic feature which seems to mark the boundary between massive rocks and the schistose gneisses to the southeast.

The Bergen arcs are a number of bands of varied igneous and altered rocks whose outcrops form a series of arcs centred on Bergen from whence their name is derived. They result from a horizontally curved folded structure of somewhat complex pattern, but since the different rocks are of more or less alternating resistance to erosion, the relief has a banded pattern and a series of concentric ridges and valleys encircles Bergen city on its eastern side.

Such intense compression as these Caledonian movements produced could not result merely in a simple set of thrusts, and there is a detached area of Cambro-Silurian sediments and Caledonian intrusive rocks with numerous thrust planes in the area from Jaeren to Hardangervidda.

2. Physiography.—*Mountains.*—Although these Caledonian structures are very much younger than the Pre-Cambrian and Pre-Eocambrian rocks, they still belong to relatively early geological time, and probably about 400,000,000 years have elapsed since this great upheaval. During that long period, the area has been land, and weathering and erosion have gradually worn away the rocks, until what is now left are the mere remnants of these ancient masses.

There is scarcely any lowland, and even the 20% of the country which lies below 500 ft. is mostly hills or valley floors. It seems certain that the erosive action of rivers had reduced Norway to a gently rolling peneplain by Miocene times with some mountain ranges such as the Jotunheim, Dovre and Rondane massifs rising about 3,300 ft. above it. Gentle, but long-continued, uplift then elevated this plain, so that its surface now forms the plateau of Jostedal and the accordant summit levels around Geirangerfjord to the north and the Hardanger district to the south, all at about 5,000 ft. This uplift greatly accelerated the flow of the rivers, and a new era of active downcutting was initiated. The valleys were deepened and especially rapid erosion occurred on the highest mountain summits, so that the Jotunheim, Dovre and Rondane now project less than 2,000 ft. above the fjeld, the elevated remnants of the old plain.

The highest peaks in Norway are in these areas. Galdhøpiggen (8,100 ft.) and Glittertind (8,104 ft.) are the only two to exceed 8,000 ft., and are both in the Jotunheim. The highest peak in Dovre is Snøhetta (7,474 ft.), and in Rondane there is Rondeslottet (7,162 ft.).

A further uplift in Pliocene times introduced a tilt, so that in southern Norway the *vidde* or high plain which is peripheral to the Miocene plain already described, descends from 3,600 ft. in the west to 2,300 ft. in the southeast. Occasional residual mountains rise out of this, as, for example, Gausta, 6,178 ft., near Rjukan.

Eastern Norway (*Østlandet*).—Tertiary earth movements intensified fluvial erosion and so have had a great influence upon the present topography. In the east (Østfold, Akershus, Hedmark, Oppland, Buskerud, Vestfold and Telemark) the drainage is south or southeasterly. The principal valleys and rivers often change name along their length, but they are generally known as: Østerdal, with the Glomma river (*q.v.*), 365 mi. in length, the longest Norwegian river; Gudbrandsdal, with the Lågen river, flowing into Lake Mjøsa (*q.v.*), the largest lake in Norway, 141 sq.mi. in area and 1,473 ft. deep, the outlet of which is the Vorma river, a tributary of the Glomma; Valdres-Begnadal-Ådal, which enters Tyrifjord (a lake); Hallingdal, where the Snarum river joins the outflow from Tyrifjord and becomes the Drammen river (*q.v.*; 192 mi.); Numedal (Lågen river, 212 mi.); and Tinnedal (Tinne river). The region is mountainous and the valleys carry the chief railways and roads converging on the coastal area between Kragerø and Oslo. Oslofjord primarily occupies a partly infilled and partly reexcavated geological graben. It has an area of 766 sq.mi. and is 62 mi. in length. Compared with the west coast fjords, its sides are relatively low. At the seaward end it is flanked mostly by bare rock, but the inner parts are wooded.

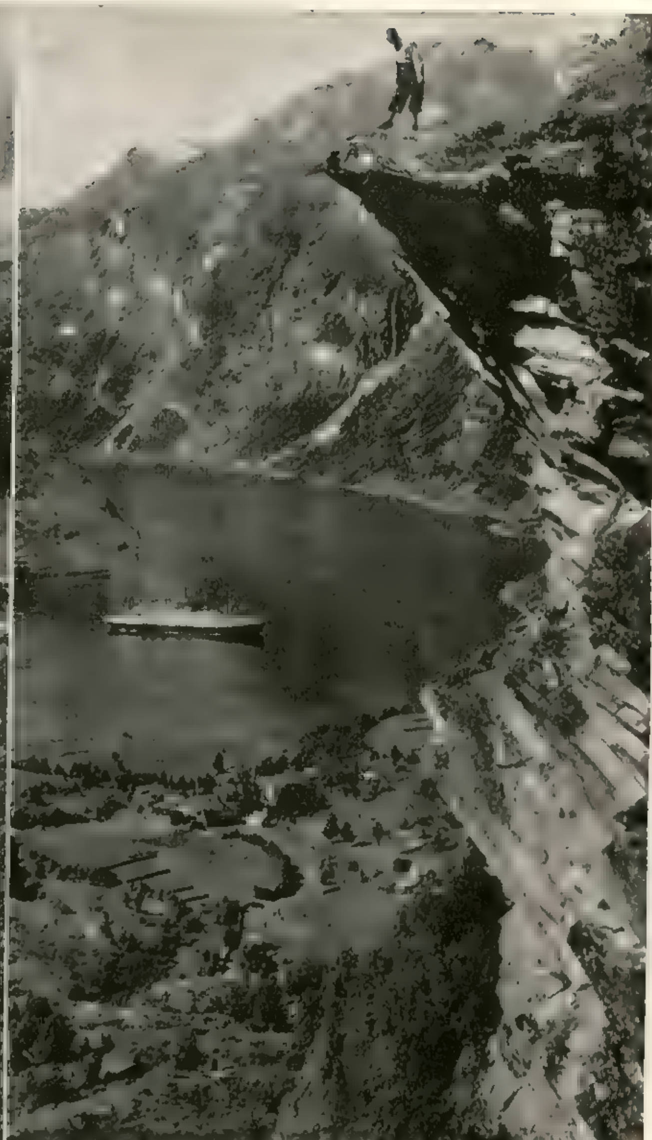
This part of Norway has the greatest number of lakes—many thousands. The general lower relief of the *vidde* as compared with the high plateau and mountains of the west led to a somewhat less intense glaciation, so that most of the valleys were not deepened sufficiently to be drowned by the sea and become fjords. Yet the glaciers modified the river profiles to produce frequent rock hollows, now flooded to form finger lakes.

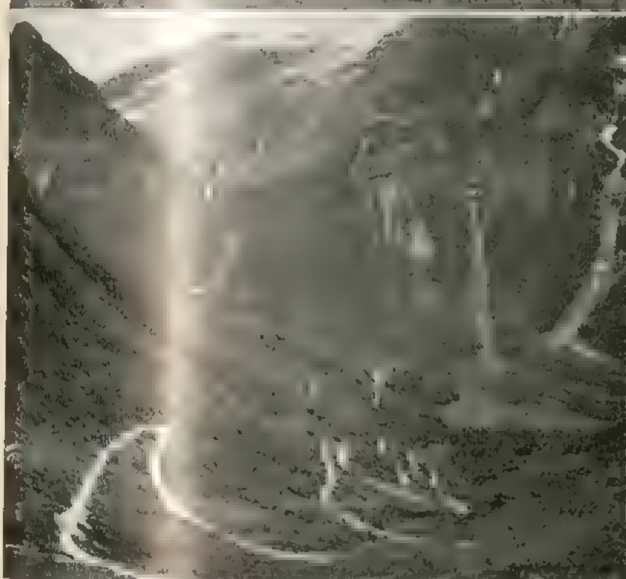
Southern Norway (*Sørlandet*).—Aust- and Vest-Agder could be termed Southern Norway. The topography is very similar to that of eastern Norway with very little lowland beyond the river valleys. The principal ones are Niddal or Arendal (99 mi.), Tovdal (91 mi.), and Otradal with Setesdal (150 mi.). The coast is rocky along its whole length, and although very much indented contains only three fjords of any size. These are Topdalsfjord near Kristiansand, Lyngdalsfjord near Farsund, and Fedafjord.

Western Norway (*Vestlandet*).—The western portion of southern Norway comprises Rogaland, Hordaland, Sogn og Fjordane and Møre og Romsdal. It is the area of the greatest fjords and some of the most spectacular mountain and valley scenery. The fjords are characterized, especially in their upper reaches, by their precipitous sides which often rise 3,000 to 5,000 ft. almost sheer out of the water, and by their great but irregular depths. The deepest sounding in Sognefjord (*q.v.*) is 4,291 ft. The fjords were originally river valleys, adopted by glaciers during the Pleistocene, and greatly deepened and completely reshaped by them. At that time the North sea was dry or ice-covered, and the fact that their floors are now below sea level to their mouths is purely adventitious. As a result they are flooded by the sea and their water is salt. There are many similar valleys whose floors contain barriers of rock or moraine sufficiently high to prevent marine invasion. Hornindalsvatn (Hornindal lake) in northern Sogn og Fjordane is an example. It is the deepest lake in Europe (1,686 ft.), separated from Eidsfjord, a branch of Nordfjord, by a rock barrier only 3 mi. in length and of no great height. The lake surface is 174 ft. above sea level and has an area of 20 sq.mi. The longest fjords are Sognefjord (*q.v.*), 114 mi. (to Skjolden) and Hardangerfjord (*q.v.*), 77 mi. (to Odda). Because the fjords penetrate so far inland, the rivers are short and relatively unimportant.

Glaciation typically produces sharp steps in valley floors and also discordant valley-junctions (hanging valleys), so that Norway is a land of waterfalls. Vøringfoss, east of Hardangerfjord, has a sheer drop of 597 ft., the Syv Søstre (Seven Sisters) of Geirangerfjord, the Tokagjel falls near Norheimsund, the falls north of Odda and those at Rjukan are particularly famous. Rjukan is situated in Eastern Norway, but many of the most spectacular falls are in Western Norway. Many of the falls at Odda and Rjukan, as well as at other places, have been harnessed to produce hydroelectric power, which will probably be the most important single economic factor in Norway's future. At Rjukan the output of electricity approaches 1,000,000 horsepower, and surveys indicate that Norway could economically produce about 12,000,000 horsepower in this way, reckoning on the minimum water supply and 75% efficiency.

The glaciers often divided and thus encircled areas of land which may now have become islands. These are frequent along the whole of the west coast, but are found especially in Vestlandet. It is possible to navigate the coast with an almost continuous protection of islands on the western side, and this is so great an aid to shipping that they are termed the *skjaergård*, a similar word to the English *skerries*, and indicating "coast protector." Many of these islands are in the shelf (*strandflat*) of rather low, uneven rocky ground, which has an average height of about 150 ft. and forms a narrow fringe to the mountain land. They were created when the ice cut channels in the shelf. The *strandflat* is a true shelf, for in most parts it is bounded by cliffed mountain slopes on its landward edge and by an equally abrupt fall in level beneath the sea at its western edge. This latter is believed to be a fault scarp along most of its length, and to be genetically connected with the Norwegian channel, the great deep which lies off the south





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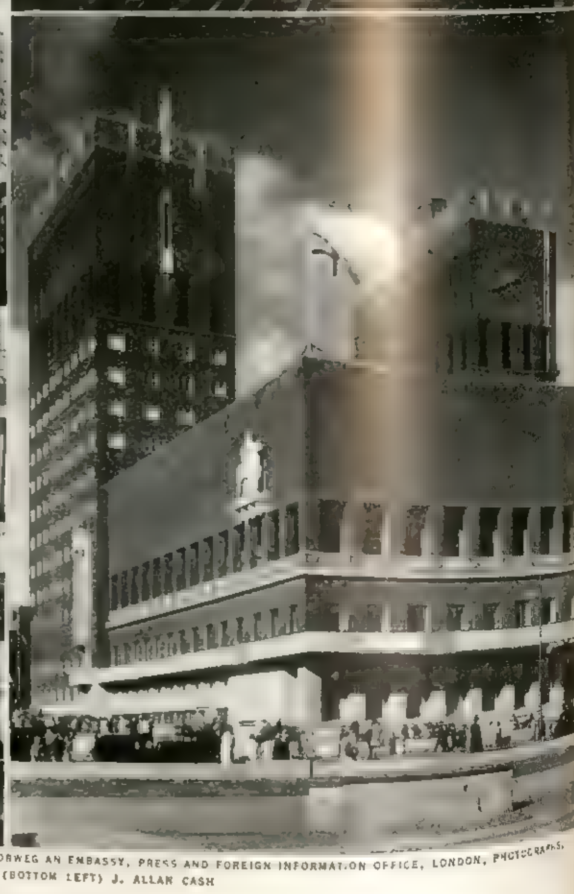
VIEWS OF NORWAY

Top left: Lom, central Norway. In the background is an 11th-century stave church

Top right: Gorge near Geirangerfjord, western Norway

Centre left: Highway twisting through the mountains near Strynevatnet (Stryn lake), western Norway

Bottom: Cod fishing fleet, Lofoten Islands, off the northwest coast



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OSLO AND BERGEN, NORWAY

Top left: View of Oslo from the parliament building. The royal palace is in the left background

Top right: The funicular railway above Bergen

Centre left: Rural scene at Sjorfjord near Bergen

Bottom left: Open-air market, Bergen

Bottom right: Town hall, Oslo. Planned for 35 years, the building was opened in 1950 on the 900th anniversary of the founding of Oslo

and southwest coasts of Norway for about 560 mi. and reaches a maximum depth of 2,300 ft.; it is a true graben of Tertiary age. The inner limit of the *strandflat* is not, however, along a fault line, and it is believed that it was initiated largely by coastal glaciers at a time when the snowline was down to sea level prior, at least, to the last glaciation, and that later ice sheets smoothed out many of the irregularities left by the individual coastal glaciers. Wave action in a relatively higher-level sea has also added much to the feature, but many consider that in view of the width, plan and irregular relief of the *strandflat* it is unlikely that it was produced entirely by marine processes.

Vestlandet contains the only substantial low-lying coastal area of Norway—Jaeren, south of Stavanger. It is about 35 mi. in length and 8 mi. in width, and is the only large outcrop of Cambro-Silurian sedimentaries that flanks the open sea, which there is almost devoid of fringing islands. It provides the largest single area of arable farming in the whole country and also has considerable industrial development on sites favourable to factories.

Northern Norway (*Nordlandet*).—From Nord- and Sør-Trøndelag to Troms the country is very greatly reduced in width, and this portion, together with Finnmark, the most northerly *fylke* (county), forms Northern Norway. It is an area of high mountains and emptiness. Its countryside is largely occupied by a very great number of fairly small lakes and by wide, branching fjords. Since the glaciers there were shorter than in Vestlandet, and came from mountains of lower average height, the fjords are less deep. There are fewer islands also, although the *strandflat* is well developed. There are, however, the Lofoten, Vesterålen and Hinnøy islands. The last named is structurally uniform with the adjoining mainland across a narrow glacier-produced strait, but its southern end, which links geologically with the Lofoten group, trends toward the southwest, whereas the general trend of the main coast is here more nearly north-south. The line of islands thus diverges from the general coast and Moskenesøy, the most southerly large island of the Lofoten group, has about 50 mi. of open sea between it and the mainland. The scenery is spectacular. Small local Pleistocene glaciers eroded the land leaving precipitous, pointed peaks, the highest of which is Higrafstind (3,809 ft.) on Austvågøy. The sea around these islands is shallow over a wider area than elsewhere off the Norwegian coast, and this gives rise to the extensive fishing grounds for which the Lofotens are well known. The famous tidal whirlpool, the Maelstrom, occurs off Moskenesøy.

The topography of Finnmark differs markedly from other parts of Norway and is essentially an undulating *vidde* ranging from 1,150 to 2,000 ft. in height with a southeast-facing escarpment near the limit of the Caledonian thrusts. It is a country symbolic of icecap glaciation rather than of valley glaciers; and drumlins, eskers, ground moraine molded into long ridges, and similar glacial features are common.

Glaciers and Icecaps.—It is estimated that there are now about 1,700 glaciers existing in Norway, and that, together with plateau icecaps, they cover a total area of about 1,300 sq.mi., about half of which is in Vestlandet. Icecaps are typical of present conditions and mostly give rise to numerous short valley glaciers at places were they overflow from the plateaus. Jostedalsbreen, just north of Sognefjord, has an actual cap area of 315 sq.mi. at about 6,400 ft., and is the largest in continental Europe. It gives rise to 24 or more valley glaciers; the best known of these are Tunsbergdals-, Nigards-, Bøyum-, Suphelle-, Briksdals- and Kjenndalsbreen. Other icecaps are Folgefonni (85 sq.mi.) and Hardangerjøkulen (37 sq.mi.) to the south and northeast of Hardangerfjord respectively, and Svartisen (189 sq.mi.) and Blåmannsisen (48 sq.mi.), both in Nordland.

The only area of numerous valley glaciers not fed by icecaps is the Jotunheim, where glacial conditions in the past led to the formation of pyramidal peaks which contrast with the relatively flat top of the nearby Jostedal.

These glaciers and icecaps are not remnants of the last Ice Age, for about 3000 B.C. the temperature was at its highest (climatic optimum) in postglacial times. At that time all, or almost all, the ice would have melted. With the cooler conditions that followed, ice returned and archaeological evidence indicates that in the middle ages the glaciers were about the same size as today, although in the first half of the 18th century they were considerably larger. Most of them have been shrinking in the 20th century.

3. Climate.—The striking and unique feature of the climate of Norway is the presence of the largest positive temperature anomaly on the surface of the globe, which results in such unusual conditions as average temperatures within the Arctic circle which are higher than those of places farther east and as much as 20° S. This temperature anomaly results from the warm North Atlantic current (terminal section of the Gulf stream) and air drift across the Atlantic ocean onto the shores of Norway. January is the coldest month, and southeastern Norway then has a mean temperature of below freezing point (Oslo −4° C. [25° F.]), but the coldest parts in this area are the Glomma valley, between Tynset and Røros (near the Swedish border). At Røros (altitude 2,067 ft.) the January mean is −10.5° C. (13° F.) and an absolute minimum of approximately −37° C. (−35° F.) has been recorded. Even this intense cold has been exceeded near the Norway-Sweden boundary in Lapland. Along the western and northern Norwegian coasts winter temperatures are higher, the January mean being 2° C. (35° F.) in Bergen, −1° C. (30° F.) in Bodø and −5° C. (23° F.) in Vardø. In these coastal districts February is on the average colder than January. The number of days on which frost occurs varies between 45 at Ona and 240 in certain parts of Finnmark; North cape has about 190. The fjords are not penetrated by cold water from the open ocean and are always icefree except along shallow coastal stretches during unusually severe winters when small patches of ice form.

Summer temperatures range between slightly below 10° C. (50° F.) in the extreme north (Troms 11° C. [52° F.] July average), and 17° C. (62° F.) at Oslo in July. Røros, with much greater altitude, has 11° C. average in the same month. The southeast of Norway is the warmest part in summer. At Bergen the warmest month is also July (14° C. [57° F.] average). Absolute maxima are high: Skudenes, 29° C. (84° F.); Bergen 32° C. (90° F.); Oslo 35° C. (95° F.) and even Karasjok, in Finnmark, has recorded 31° C. (88° F.). The annual range increases from west to east generally and from south to north along the coast.

Though the southwest wind is usually prevalent over Norway and very marked in summer, yet the winter high-pressure area causes outflowing winds—northeast on the Skagerrak, south and southeast on the western coast and southwest on the northern. Gales are frequent on the western coast, averaging three to four per month in winter and one to two per month in summer. In the interior and east, gales are comparatively rare. Gales from the southwest bringing rain are the most common; next in frequency are gales from the northwest bringing snow. Calm weather is rare on the western coast but frequent in the interior. December and January are the stormiest months. Hail and thunderstorms are infrequent.

The number of days on which rain or snow falls is greatest on the northwestern and northern coasts, least in the southeastern districts and the interior of Finnmark. In the north and northwest precipitation occurs on 150–200 days in the year. On Dovrefjell and the southeastern coast the average is about 100 days. Snowfall is least frequent in the south (*e.g.*, at Mandal 25 snowy days out of 116 on which precipitation occurs), increasing to 50 days at Oslo and Dovrefjell, to 90 at Vardø and to 100 at the North cape. Hence in the north and in the upland tracts snow occurs at least as frequently as rain. Snow may fall in any month in Finnmark and in areas over 3,300 ft. above sea level. Precipitation exceeds 100 in. per annum in the mountains a few miles from the coast north and south of Sognefjord. On the outer islands there is a slight decrease; inland the decrease is rapid and great. On the eastern side of the mountain ridge, in the upper part of Gudbrandsdal, the average is less than 12 in. In the extreme south of the country the average is about 39 in. There is a diminution eastward along the northern coast and a further rapid decrease toward the northern interior, where the average is 16 in., with strongly marked local variations.

Cloudiness is intense. The coast of Finnmark has more than

three cloudy days to one clear day; in the interior of the country clear and cloudy days are about equally divided. Summer fog is frequent on all coasts but fog is rare in winter, though it occasionally occurs in the southeast. Sometimes in severe winters a frosty fog ("smoke frost") appears on the western fjords, caused by the cold land wind passing over the relatively warm water.

Norway was one of the first countries to establish a meteorological service; the Meteorological institute in Oslo was set up in 1866. There are also 825 stations where observations and measurements are taken. The stations at Bergen, on Jan Mayen Island, on Bjørnøya (Bear Island) in Svalbard and on the peaks of Fanaråken and Gausta are of special importance for weather forecasting. Forecasts are made five times a day and broadcast regionally from Oslo, Bergen and Tromsø.

4. The Midnight Sun.—Part, at least, of the sun's disk is above the horizon at the North cape continuously from May 12 to August 1, and at Bodø, in latitude 67° 17′ N., from June 1 to July 13. Even at Trondheim there is practically no night from May 23 to July 20, while the long twilight gives the extreme south of Norway no real darkness from the end of April to the middle of August. In winter, on the other hand, the sun does not rise above the horizon at the North cape for more than two months, when the aurora borealis or northern lights is often visible and there is only a twilight at midday. In the extreme south, midwinter night is 17½ hours long. (R. K. Gr.)

5. Vegetation.—The forests of Norway, which cover about a quarter of the country, consist chiefly of conifers. The principal forest regions are in the southeast and south. In the Trondheim area and in Nordland there are extensive forests of pine and spruce with the pine on the drier, higher and less congenial parts. In southeastern Norway the conifer tracts extend from sea level to about 3,000 ft.; in the Trondheim region the upper limit is 2,000 ft.; on the coast it is 1,200 ft.; farther north the spruce disappears and the upper limit of pine falls to 900 ft. at about latitude 70° N. Above and north of the conifers is the birch belt; next follow various species of willows and the dwarf birch; and below the snow line is the lichen belt in which the reindeer moss is always conspicuous but there are also a few flowering plants, shrubs and dwarf trees. Among the conifers there is a sprinkling of other trees—lowland birches, aspens and rowans in the high north, and ash, elm, lime, oak, beech and black alder in the lower south. The beech is much rarer than in Sweden and, in fact, flourishes only near the Skagerrak; there and elsewhere the extreme coastal region is destitute of forest. The richest flora is found in the inland fjord valleys. The Dovrefjell district contains within narrow limits a greatly varied arctic vegetation.

6. Animal Life.—The great forests were once the haunt of the bear, the lynx and the wolf. The bear and the lynx are now almost extinct. Wolves decreased very suddenly in southern Norway about the middle of the 19th century, probably because of disease, and continued to decrease thereafter in the north, but they are still found in the Røros district and northward to Finnmark where they are more common. Wolves are the worst enemy of the reindeer. The elk occurs in the eastern forests and near the coast in the Trondheim district. The red deer is confined chiefly to the western coast between the Haugesund district and Trondheimsfjord. On the high fjells there are wild reindeer, glutton, lemming and the now rare arctic fox. The wild reindeer, too, is now very rare in Finnmark, though large tame herds are kept by the Lapps. The lemming is noted for its curious irregular migrations; at such times vast numbers of these small animals spread down country, even swimming lakes and fjords. They are pursued by beasts and birds of prey, and even the reindeer kill them for the sake of the vegetable matter they contain. Hares and red fox are common all over Norway up to the snow line, and badger and hedgehog also occur in the south and southeast. The beaver, formerly widespread, began to decrease in the mid-18th century, but in the [illegible] that protection was introduced and this has saved it. It occurs only in a few of the southern valleys.

Game birds are abundant in most districts. Black grouse are widely distributed south of Finnmark. Hazel grouse are found mainly in the spruce forests of the southeast and east and fairly generally in the north, as are capercaillie which are ... near certain fjords. Woodcock and snipe are moderately ... The partridge, an immigrant from Sweden, occurs princ... the east and southeast. A very large proportion of the No... avifauna consists of migratory geese and ducks, various ... prey, golden plover, etc. These birds leave in autumn by ... well-defined routes—one from Finnmark into Finland ... Oslo valley and one by the western coast, where they ... in large numbers on the lowlands immediately south of S... —but certain high arctic birds as the king eider, Spitsbe... lemot and the little auk move on to the northern coast of ... from higher latitudes at the end of summer. The arctic ... bunting, the snowy owl and the rough-legged buzzard are ... ous. In some localities the puffin and kittiwake form great ... (*fugleberg*, "bird cliffs").

The common seal is very frequent and arctic seals visit ... northern coasts. A large number of the best European food ... ies occur along the coasts, including cod, herring, mackerel ... flatfish, and sprat in the fjords. Various species of whales ... the coast; the most important is the fin whale and the ... is the blue whale, which appears off the coast of Finnmark ... June to August. The bottlenose, humpback and pilot whales ... also seen. Of freshwater fish the Salmonidae are by far the ... valuable and perch, pike, grayling and minnow are all common.

Southern Norway is richer than western Norway in insects and the north has many characteristic arctic types. (L. H. ...)

II. THE PEOPLE

1. Racial Types.—Many Norwegians, especially in the ... populous southeast, are of the so-called Nordic type, but ... racial elements are well represented. The immigration of ... headed prehistoric people, serfs introduced by the Vikings ... termixture with Lapps and Finns, have produced regional ... tions. The Nordic type is purest in the great eastern ... broadheaded (but infrequently dark) types are common along ... western coast and especially in the Jaeren plain in the ... In the western valleys mesocephalic tall blonds are common ... Finnmark partial intermixture with the Lapps (*see* Lapla... reduced average stature and introduced broader heads and ... than elsewhere.

2. Language.—Norwegian, Danish and Swedish are closely ... lated. During the long union with Denmark, Danish was ... among townsfolk, but many rural areas, geographically ... retained their dialects. In the 1840s Ivar Aasen produ... of written Norwegian, *landsmål*, mainly from the western ... In the previous century, the spoken language of the sou... *riksmål*, began to be more widely adopted. *Landsmål* ... officially known as *nynorsk* (Neo-Norwegian) and ... *bokmål* ("book language"); the latter is used by the na... and by most authors. Either language may be selected ... tion and local government services and *nynorsk* is freq... chosen by rural districts. Since 1907 orthographic reforms ... languages have tended to reduce the differences betw... The reform of 1938 prepared the way for their gradu... tion. (*See* also Norwegian Language; Norwegian Lite... Scandinavian Languages.)

3. Religion.—Norway's state religion is Evangelical ... (*see* Lutheranism), to which about 96% of the p... formally adhere. The church is administered by the ... ecclesiastical affairs and education, and salaries and ... clergy are regulated by law. Bishops are nominated ... Clergy are trained in the theological faculties of Oslo ... universities and in the Independent Theological college ... are nine dioceses (*bispedømmer*) with more than 90 ... (*prostier*), 570 clerical districts (*prestegjeld*) and ... parishes. The bishops were outstanding as resistance ... ing World War II. Dissenters number about 135,00... half comprise members of the Lutheran Free Church, M... Baptists and Pentecostals. The Salvation Army has ... philanthropically since the 1890s.

4. Culture.—The Norwegians are well educated ... read in their own and in foreign literature. The overseas ...

[illegible] mercantile nation have long enriched their culture. In some [illegible] of government and welfare services Norway has led other European countries; women were enfranchised in 1907. The larger towns support one or more theatres and broadcasting services reach a good standard.

The struggle with the harsh, hostile, and sometimes untamable [illegible]ent has engendered a virile, imaginative and independent [illegible] within Norway, and has caused many migrations from its shores. Norway has produced explorers of the calibre of Fridtjof Nansen, Roald Amundsen and Thor Heyerdahl, and many fine seamen. The beauty of the mountains, fjords and shores is outstanding and well appreciated by Norwegians. The majority of the urban population have leisure cottages and cabins in these areas. They are owned or shared by all income groups and are an important factor in Norwegian life. High urban living standards, with a rural population thinly spread over a large and rugged country demand a constant effort by Norway's 3,700,000 people. Men and women work hard in both town and country and recreation is often also strenuous. Mountain walking is a common pastime; there are more than 200 youth hostels and the Norwegian touring club has about 40 huts and 45,000 members. The Association for the Promotion of Skiing, the major Norwegian sport, has about [illegible],000 members. (MA. D.)

III. HISTORY

A. PREHISTORY AND EARLY HISTORY

Stone and Bronze Ages.—The earliest traces of man in Norway are to be found in the far north, along the coast of Finnmark, [illegible] the west north of Stadlandet. Only primitive stone implements have been discovered, and the material is too scanty to supply evidence of when the people using these tools settled in these districts. The coastal fauna provided a means of livelihood for [illegible] fishermen and hunters, and migrants from Russia and Finland may have made their way south along the Norwegian coast [illegible] 7000 B.C. when the interior was still covered with ice, but [illegible] has also been advanced that these peoples came from [illegible] and followed the coast northward considerably later.

In the south of the country dwelling sites have been found dating [illegible] about 5000 B.C. Finds from these sites, which include [illegible] and stone tools from the entire coast, give a clearer idea [illegible] life of the hunters and fishermen. The implements vary [illegible] shape and are made of different kinds of stone; those of later [illegible] are more skilfully made. Rock carvings have been found, [illegible] near hunting and fishing grounds. They represent game [illegible] deer, reindeer, elk, bears, birds, seals, whales and fish, [illegible] for the survival of the coastal peoples.

Between 3000 and 2500 B.C. new migrants settled in eastern [illegible]. They were farmers who grew barley and kept cows and [illegible]. The hunting-fishing population of the west coast was also [illegible] replaced by farmers, though hunting and fishing remained useful secondary means of livelihood.

From about 1500 B.C. bronze was gradually introduced, but the [illegible] of stone implements continued; Norway had little riches to [illegible] bronze goods and the few finds consist mostly of the [illegible] weapons and brooches which only the chieftains could [illegible]. Large burial cairns built close to the sea are characteristic [illegible]. The motifs of the rock carvings differ from those [illegible] age. Representations of the sun, animals, trees, [illegible] and men were all now strongly stylized, probably as [illegible] connected with the religious ideas of the period.

[illegible] Age (500 B.C.–A.D. 1050).—Little has been found dating [illegible] the early iron age (the last 500 years B.C.). The dead [illegible] cremated and their graves contain few burial goods. During [illegible] centuries A.D. the people in Norway were in contact [illegible]-occupied Gaul. About 70 Roman bronze caldrons, [illegible] as burial urns, have been found. Contact with the [illegible] countries farther south brought a knowledge of runes. [illegible] known Norwegian runic inscription dates from the 3rd century (see RUNE). At this time the settled areas in the country [illegible], a development which can be traced by a study of place [illegible]. The oldest root names such as *nes*, *vik* and *bø* (cape, [illegible] and farm) are of great antiquity, dating perhaps from the Bronze Age, while the earliest of the groups of compound names with the [illegible] or [illegible] Bergen, Sarheim, [illegible] date from the first centuries A.D.

The period of the collapse of the Roman empire in the west (A.D. 400–600) [illegible] weapons and gold [illegible]. Hill forts were built on precipitous rock [illegible] defense against [illegible] tribes from the south. Excavation has revealed the stone foundations of farmhouses 60–90 ft. long (one even 150 ft. long), the roofs of which were supported on wooden posts. These houses were family [illegible] where several generations lived together, men and cattle under one roof. From this period and later (600–800) nascent communities can be traced. Defense works presuppose co-operation and leadership, so that petty states of some kind with a defense and administrative organization must have existed.

These states were based either on clans or tribes, *e.g.*, the Hørder of Hordaland in western Norway. By the [illegible] century these small states had assemblies (*thing*), where yeomen, free men who owned their farms, settled disputes in accordance with agreed laws. The small states or *fylker* (counties) were divided into smaller districts each with a *thing*. The larger *thing* united to form even larger units, assemblies of yeomen's representatives from the various regions. In this way the *lagting* (lawmaking assemblies) developed—the *Gulating* in the west, the *Frostating* in Trøndelag and the *Eidsivating* in the east. These had come into existence by about the year 900. The *thing* meeting place and the *hov*, the heathen temple, were usually situated on the best and oldest farms belonging to the chieftains and the wealthiest farmers.

The Vikings.—The years 800 to 1050 were those of the Viking (*q.v.*) age, when Scandinavians set out on innumerable plundering expeditions abroad. Surplus population, superior ships and weapons, well-developed military organization and a spirit of adventure seem to have combined to cause this great movement. The Norwegians mostly sailed westward, raiding and settling in Ireland, Scotland, England, France, the Shetlands, Orkneys and Hebrides, the Isle of Man and in the unpopulated Faeroe Islands and Iceland. Men of Norwegian descent settled in Greenland and undertook expeditions to Vinland (the northeast coast of America). Many Vikings returned home and this meeting with western Europe was decisive for the development of Norway.

B. MEDIEVAL NORWAY

Knowledge of the exploits of many heroes of the Viking age is derived from the scaldic poetry (*see* ICELANDIC LITERATURE) and from chronicles, such as the Anglo-Saxon Chronicle, written in the countries the Vikings raided or in which they settled. For the history of Norway [illegible] the work of the [illegible] the two centuries following the Viking age provided important sources [illegible] saga writers [illegible] Snorri Sturluson (d. 1241) whose *Heimskringla* provides biographies of the kings up to 1177. These sagas and the oldest known written records, laws and official documents date from the 12th and 13th centuries and throw light on the important period when the country was achieving political entity.

Formation of a United Norway (900–1035).—The force that lay behind the Viking expeditions [illegible] the formation of larger states in Norway. [illegible] strong enough to repel Viking [illegible] the chieftain [illegible]. To maintain his [illegible] he had to [illegible] territory.

By A.D. [illegible] the [illegible] of Lade [illegible] under his dominion an area [illegible] Trøndelag and [illegible] Hålogaland, now Nordland, the land so far north as Norwegians had settled—Ottar or Ohthere who visited King Alfred [illegible] in England was from the northernmost district. [illegible] in the country other chieftains and jarls ruled over territories of varying size. The Danish king owned [illegible] the land around [illegible] but Vestfold, the territory west of the [illegible] was [illegible] by powerful Norwegian chieftains. At [illegible] and at [illegible] in Vestfold are the sites of two large [illegible] a great variety of rich equipment has been found dating from this period

By that time, too, members of the Yngling dynasty had been ruling as kings in Vestfold for perhaps 150 years. Harald I Haarfager or Fairhair (d. *c.* 940), son of Halvdan the Black in Vestfold, carved out for himself a state in western Norway, decisively defeating his opponents at Hafrsfjord (near Stavanger) in a battle traditionally dated 872 but which probably took place *c.* 900. To posterity Harald stands as the man who united Norway, but he probably had effective control only in the west. Along the south coast and perhaps in the east he had some sort of nominal authority.

Harald's son Eric (Eirik) Bloodaxe (d. 954) quarreled with the chieftains and with his brothers and had to leave the country (*c.* 945), eventually becoming king of York, in England. He was replaced by Harald I's youngest son Haakon I the Good (d. *c.* 960), who had grown up at the court of Aethelstan in England. Haakon contented himself with the westcountry kingdom. He persuaded the yeomen to agree to the *leidang*, a system by which they themselves raised ships and crews for the king's use. Haakon fell fighting Eric's sons, of whom the eldest, Harald II Graafell or Graycloak (d. *c.* 970) subsequently gained control of the jarl of Lade's territory so that the whole coast from Haalogaland southward to Agder was united. But the jarls of Lade had not been finally subjugated and they continued to contest their territory with the descendants of Harald I well into the 11th century. The loser generally appealed to the Danish king who wanted to secure his position in the east.

In the late 10th century, the Vikings again attacked England. Among them were two descendants of Harald I, the future kings of Norway Olaf I Trygvesson and Olaf II Haraldsson, who both won wealth (danegeld) for themselves. On their wanderings they were converted to Christianity, and in Norway both tried to convert their subjects. Olaf I (reigned 995–1000) fell in battle against Sweyn I of Denmark and Eric, jarl of Lade. Olaf II (1015–30) conquered the Danish territory in the east and was thus the first king of all Norway. In the consequent clash with Canute, king of both Denmark and England, whom many Norwegian chieftains joined, Olaf was forced to flee to Russia (1028). On his return he fell in battle at Stiklestad (1030). Miracles were reported directly after the battle, Olaf was immediately reputed a saint and his body was enshrined in 1031. After Stiklestad Canute placed Sweyn, his son by his Anglo-Saxon mistress Aelfgifu, on the Norwegian throne. But Sweyn got no help from abroad and left the country, the saint's son Magnus the Good succeeding him in 1035.

Both Olafs brought with them missionaries from England, but it was Olaf II who first organized the work of conversion. He built churches and, advised by the Anglo-Saxon bishop Grimkell, drew up a church law which the yeomen ratified at the *thing*. The Anglo-Saxon missionaries trained Norwegians as priests. As a result church organization and ecclesiastical law in Norway, caligraphy and to some extent the earliest written Norwegian were all based on Anglo-Saxon models. By posterity St. Olaf has been regarded above all others as the lawgiver both for the church and the state, the two most potent institutions for the establishment of peace and order in the community (*see* also OLAF).

It is not known exactly how the *thing* administered and enforced the law. Men who were able to expound the law at the *thing* acquired special authority. By the 12th century they were called *lagmenn* (lawmen) and were drawn from among the yeomen themselves. The only punishments were fines and banishment. At first the king's influence was largely dependent on his presence so that he was constantly traveling about the country. But since punishment presupposed a central authority able to enforce sentences, the crown gradually extended its power.

Magnus I to Sigurd I (1035–1130).—Canute's empire disintegrated after his death in 1035. Peace was negotiated between the rivals Magnus I the Good (1035–47) and Canute's son Hardicanute so that after Hardicanute's death (1042), Magnus became king of Denmark. His position was challenged, however, and Harald III Hardraade or Hardruler (d. 1066), a half-brother of St. Olaf, who from 1046 shared the kingdom with Magnus, had to yield up Denmark. Harald, who had been in the service of the emperor Michael IV at Constantinople, controlled the chieftains rigorously. He set out with the Anglo-Saxon earl Tostig on a campaign against England and fell at Stamford Bridge in 1066 (*see* ENGLISH HISTORY).

Of the kings who followed, the brothers Magnus (1066–69) and Olaf III Kyrri or the Quiet (1066–93), Magnus II Barfot or Bareleg (1093–1103) and the brothers Eystein I (1103–22) and Sigurd I Jerusalem-farer (1103–30), only Magnus II was an active warrior. In two campaigns he subdued the Hebrides and the Isle of Man, fought in Wales and finally fell in battle in Ireland. Within Norway this was a period of peace and order. *Lendmenn* (royal thegns holding land from the king) and *aarmenn* (royal officials) managed the royal estates, collected fines and punished raiders and thieves. The king obtained some revenue from oversea trade, selling abroad fish, furs and walrus teeth from Greenland. The main trading centres were Bergen, Nidaros (Trondheim) and Oslo.

The Age of Civil Wars (1130–1240).—Before the death of Sigurd I, Harald IV (1130–36), a son of Magnus II, arrived from Ireland, claimed the throne and fought against Sigurd's son Magnus III the Blind (1130–39). Later others appeared saying they were kings' sons, and at that time all the king's sons, legitimate or illegitimate, had an equal claim to the throne. As these pretenders were each supported by some of the magnates, there was constant fighting. But few of the farmers were involved in these struggles and the work of establishing the church continued unhindered.

Originally the Norwegian church came under the archbishopric of Bremen and from 1104 under Lund, then part of Denmark. In 1152 the English cardinal Nicholas Breakspear (later Pope Adrian IV) went to Norway to establish at Nidaros a metropolitan see, the province of which was to comprise 11 bishoprics, 5 in Norway and 6 in the areas where Norwegians had settled in the Viking age. The western isles were under the nominal suzerainty of the Norwegian crown and Iceland and Greenland were economically dependent on the connection with Norway. The cathedral built at Nidaros was the largest and most magnificent cathedral in the north. Monasteries had been established in Norway in the first half of the 12th century and the church obtained a regular income from tithes.

The ecclesiastics were then sufficiently established to assist in extending the king's authority. In 1161, with the support of the church and of the magnates, Magnus IV Erlingsson (1161–84), the five-year-old son of Sigurd I's daughter, was chosen as king despite the fact that he was not a king's son. But he was legitimate and after his coronation (1163) he called himself "king by the grace of God," and affected to hold his kingdom as the vassal of St. Olaf, thus symbolizing the association of crown and church. The promoters of this alliance, Magnus' father, Erling Skakke or the Crooked and Archbishop Eystein (*q.v.*) also arranged the succession after Magnus; in the future the king's eldest legitimate son was to ascend the throne.

From then on the country's leading men, both lay and clerical, the royal officials and representatives of the yeomen were summoned on important occasions to take part in a great council. *Sysselmenn*, officials appointed by the king, were responsible for ruling the various districts and at the *thing* the *lagmenn*, then holding office from the crown, gradually took over judicial functions. The people's obligation to raise the *leidang* (army) was at length converted in peacetime into the first tax levied by Norwegian rulers.

Claimants to the throne still appeared. The most dangerous was Sverre (1177–1202), brought up in the Faeroe Islands and ordained priest. Both Erling and Magnus IV fell fighting against Sverre, who by 1184 was unchallenged king. He quarreled, however, with Archbishop Eric Ivarsson who in 1190 fled the country. The king was excommunicated and his enemies combined against him, peace between church and state being reestablished only after his death. Sporadic struggles continued, however, until 1240, when the last claimant to the throne was killed.

The Period of Greatness (1217–1319).—During the civil wars there had been long intervals of peace and the authority of the crown was steadily strengthened. From the time of Haakon IV

Haakonsson (1217–63) there was only one king in Norway and he wielded considerable power. From then onward a conscious attempt to organize the king's council and establish an efficient central government can be traced.

As undisputed king, Haakon IV had larger revenues than his predecessors. He used them to increase the splendour and prestige of the monarchy and to raise Norway culturally to a European level. He was crowned in 1247 by a papal legate and, copying English models, built in Bergen a royal hall of stone (Haakonshallen). He also showed great interest in literature, encouraging the translation into Norwegian of chivalric romances. *Konungs skuggsjá* ("The King's Mirror," *c.* 1250), a guide to conduct for princes which also throws light on the ideals and theories of the time, is a more original work. Haakon exchanged gifts and corresponded with the princes of other countries. He was on friendly terms with Henry III of England, which led in 1217 to a treaty of friendship and a commercial treaty by which Norwegian and English merchants could enter each others' country freely. This is the oldest commercial treaty known in the history of either country. On several occasions Haakon was granted the right to buy grain when its export from England was otherwise forbidden.

From 1250, when Haakon concluded a treaty with Lübeck, the German towns gradually acquired a dominating commercial position in Norway. Germans settled in the country, especially in Bergen, competing with the natives so successfully that they became a problem for both crown and city. But the Norwegians had become so dependent on the import of German grain and other goods that neither Haakon nor his successors could do more than attempt to limit the activities of German merchants.

Bergen was an entrepôt port for wares from abroad which were reexported to Iceland and Greenland. Iceland was torn by feuds in which Haakon intervened, with the result that in 1262 the Icelanders agreed to accept his suzerainty on condition that he enforced the peace and ensured the annual arrival in Iceland of six shiploads of merchandise. The settlers in Greenland had accepted (1261) the same conditions, the king agreeing to maintain regular communications between Greenland and Norway.

In 1262 Alexander III of Scotland, who had already tried to persuade Haakon to cede the western islands, attacked Skye and seemed about to invade the Hebrides. So Haakon sailed out to defend the Hebrides and Man (1263); but he had to give up the campaign and died on the Orkneys. By the treaty of Perth in 1266 Magnus V Lagaboeter or Lawmender (1263–80) ceded the Hebrides and Man to the Scots in return for an annual rent.

Magnus V is best known for his gradual replacement of the old regional laws by a national code, based mainly on the systems then in existence. These new laws ran everywhere except in the towns, which received their own code. These codes remained the law of the realm for more than 400 years. A new church law was drawn up by Archbishop Jon and an agreement to secure peaceful relations between church and state was worked out. The financial advantages then gained by the church led, after Magnus' death, to trouble between the archbishop and the regents governing on behalf of the young king Eric II (1280–99). The church was forced to give them up but retained the right to try spiritual matters in the ecclesiastical courts. Eric married (1281) Margaret (d. 1283), daughter of Alexander III, and was the father of Margaret (the Maid of Norway), heiress to the Scottish throne. He married (1293), as his second wife, Isabella, sister of the future Scottish king Robert I the Bruce.

German merchants and craftsmen became more and more noticeable in Bergen. In 1294 the Hanseatic cities secured exceptional commercial privileges in Norway, escaping nearly all the obligations and dues laid upon Norwegian merchants. From the time of Haakon IV the king had usually resided in Bergen, but as the royal revenues from trade declined and contact with the western isles dwindled, the eastern part of Norway became more important to the monarchy and foreign policy more concerned with Sweden and Denmark. Trained knights in armour were then superseding the *leidang* fleet as the basis of warfare. Eric's brother Haakon V (1299–1319) lived in Oslo where he built a fortress (Akershus). Haakon V kept a close hand on the administration of the country and, following French and English models, instituted a check on the activities of local officials.

Scandinavian Politics (1319–97).—In the middle ages, in Norway as elsewhere, the most important source of wealth was land. It has been calculated that about the year 1300 the king, the great men and the church together owned more than half the landed estates in Norway, and the independent farmers rather less than 40% of the cultivable land. The farmers paid tithes to the church, *leidang* tax to the king and often rent to the landowner, all of which had to be paid either out of what the farm produced or in fish. The ruling classes were therefore dependent on the farmers' efforts, so that when in 1349 the Black Death reached Norway from England and killed both rich and poor the country's economic foundations collapsed. It is estimated that between one- and two-thirds of the population died during the plague, but even the lower figure must have been catastrophic for so thinly populated a country. When the farmers left their farms or were unable fully to cultivate them, not only they, but also king, church and nobles lost the means of livelihood. The whole country became desperately poor and it took centuries for this economic regression to be overcome; this is one important reason why Norway failed to assert its own policy and to maintain its independence.

In the 14th century it became difficult for members of the few great families to find suitable marriage partners in Norway, with the result that Swedish noblemen often became the owners of large Norwegian estates. The royal family also looked to its neighbours for partners; Haakon V, who had no sons, married his daughter Ingeborg to a Swedish prince. Their three-year-old son Magnus VI Ericsson became king of Norway (1319–43) and of Sweden (1319–1363). The union of the crowns did not at first affect the government of the two countries. Most of the time while Magnus was a minor, a regency governed in Norway, and another was set up when Magnus gave up the Norwegian throne in favour of his younger son, the three-year-old Haakon VI (1343–80), but when Haakon came of age he began to rule Norway himself and also parts of Sweden in conjunction with his father.

Haakon VI chose as his queen, Margaret, daughter of Waldemar IV of Denmark, and their only son Olaf IV became king of Denmark (1375–87) and Norway (1380–87). He died at the age of 17, and was the last of the old royal lines in all three Scandinavian countries. Margaret, while taking over officially the government of both Denmark and Norway and a little later that of Sweden, worked for the union between the three Scandinavian countries which was ratified at Kalmar in Sweden when Eric of Pomerania (1397–1442) was crowned king of Denmark, Sweden and Norway.

See also Icelandic Literature; Norwegian Literature; Viking; and the articles on the various kings of Norway.

(C. Jo.)

C. Danish Rule

Eric of Pomerania continued Margaret's unitary policy, with the consequence that, since support for the crown came primarily from Denmark, lands, offices and sees throughout Scandinavia were generally assigned to Danes. National resentment at this led to Engelbrekt Engelbrektsson's rebellion (1434) in Sweden, which was followed by two Norwegian peasant risings in the Oslo district under Amund Sigurdsson in 1436 and under Hallvard Graatopp in 1438. But the Danish nobility itself then turned against Eric, who was deposed in 1439, and Norway came to accept his nephew and successor Christopher of Bavaria (Christopher III of Denmark) as king in 1442. Henceforth till 1814 the Danish kings ruled Norway (*see* Denmark: *History*). The Norwegian fleet and army decayed, and Norway's written language gradually gave place to Danish; Germans plundered its coasts and monopolized its commerce, and after 1450 Danes began to appropriate the higher administrative posts. When in 1448 Karl Knutsson (Charles VIII) was chosen king by the Swedes and Christian of Oldenburg by the Danes, it was by force that Norway fell to the latter. The Norwegians protested, and in some districts Karl Knutsson was recognized as king, but the next year the Swedes assented to the separation. Christian I (1450–81) gave Norwegian estates and offices to his Danish subjects and Norway's ancient possessions, the

Orkneys and Shetland Islands, to the king of Scotland as security for a dowry which remained unpaid. His son John (Hans; 1481–1513; jointly recognized by Denmark and Norway in 1483) purchased the obedience of the Norwegian nobles by concessions to their power and by limitation of the trade privileges of the Hanseatic league. The imposing union continued in name, but the weakness of the nation and its government had been strikingly illustrated in 1455 when the Germans in Bergen besieged a monastery in which a high official had taken refuge and killed the official and a bishop.

After the exile and imprisonment of Hans's son Christian II (1513–23) the position of Norway was changed for the worse; the Norwegian council of state was abolished in 1536, and the country was ruled for a century and a quarter by Danish officials. Its churches and monasteries were sacked by Danes, and Danes were installed as pastors after the Reformation, which the Norwegians were compelled to accept in 1539. Soon Norway was dragged by Denmark into the Seven Years' War of the North (1563–70) against Sweden. However, the power of the Hanseatic league in Bergen had been finally broken during the reign (1534–59) of Christian III. The rule of the Oldenburg dynasty proved neglectful rather than tyrannical, and under it the mass of the peasants was not flagrantly oppressed. Christian IV (1588–1648), who founded Christiania (Oslo), may almost be said to have discovered Norway anew. He reformed its government, reorganized its defense and strove to develop its resources according to the principles of mercantilism, but his foreign policy involved the loss of Jemtland (Jämtland) and Herjedalen (Härjedalen), which were ceded to the Swedes by the peace of Brømsebro (1645). The Danish war of revenge against Charles X of Sweden resulted in further loss by Norway. Trondheim and Baahuslen (Bohuslän) were ceded by the peace of Roskilde (1658) and although the former was restored by the peace of Copenhagen (1660) the Norwegian population fell possibly below 450,000. From the middle of the 17th century, however, the Dutch and English made their influence felt, and the political status of Norway could no longer be regarded as a purely Scandinavian affair. The establishment of hereditary autocracy in Denmark by Frederick III in 1660 conferred some benefits upon Norway, such as better government control over the local officials and a more just system of taxation. The Norwegian peasant remained a freeman while his counterpart in Denmark was a serf. Norwegian law, already recodified by Christian IV, was again revised under Christian V (1670–99), who was well served by the Norwegians in his unsuccessful attempt to regain the lost provinces from Charles XI of Sweden.

Under the sons of these monarchs, Frederick IV of Denmark and Charles XII of Sweden, Norway was once more compelled to pay for Danish warfare against Sweden (the Great Northern War). Norwegian shipping, which had experienced a sudden boom in the 1690s, was severely depleted, partly because of the renewed war from 1709, and in 1716, when driven from continental Europe, Charles XII attacked Norway. Only his death, in 1718, averted the danger. During this war Peder Wessel, the greatest among a long series of Norwegian heroes who served in the Danish fleet, won undying fame: in 1716 he was ennobled under the name of Tordenskjold. Before the close of the 18th century increasing prosperity developed the national consciousness of Norway. The extensive cultivation of more land, the growth of the mining industry and especially of the timber trade with England gave rise to a great increase in wealth and population. In a century and a half the number of the Norwegian people was doubled, so that by 1814 the population was about 900,000. In 1788 the oppressive law (imposed in 1735) that grain should be imported into southern Norway only from Denmark was repealed. Due moreover to the Scandinavian policy of neutrality, Norway actually drew financial profit from the wars of the French Revolution.

In 1770 freedom of the press was introduced temporarily by the reforming zeal of the German doctor Johann Friedrich Struensee, who exercised at that time a more real power in Denmark-Norway than did his insane master Christian VII (1766–1808). The national aspirations of Norway were then at once voiced, though at first they went little further than the demand for a Norwegian university, which was to be conceded by Frederick VI in 1811. The crisis destined to break the union did not develop until 1807, when the coup against the Danish fleet, planned by the British foreign secretary, George Canning, drove Frederick, the crown prince regent, to abandon neutrality and to support Napoleon. Norway suffered great and immediate damage from a British blockade and was more or less cut off from Denmark, so that a separate administrative commission had to be set up. In 1809 the head of this commission, Prince Christian Augustus of Augustenburg, was elected by the Swedes as heir to Charles XIII of Sweden in pursuance of a plot, originated by the Norwegian national leader, Herman Count Wedel Jarlsberg, to transfer the allegiance of Norway to that country. Christian Augustus, however, relinquished his connection with Norway immediately after his election and the scheme was finally frustrated by his death in May 1810, whereupon the choice of Sweden fell upon Napoleon's marshal Jean Bernadotte, in the hope that so distinguished a soldier might recover Finland (taken by Russia in 1808–09). But Bernadotte was too wise to attempt this and planned to annex Norway instead. With this object he forced Frederick VI, by the treaty of Kiel (Jan. 14, 1814), to renounce his sovereignty over Norway in favour of the king of Sweden. In return for his help against his former master Napoleon, the allied great powers had given their support to Bernadotte's policy.

D. Union With Sweden, 1814–1905

The treaty of Kiel was, however, immediately repudiated by the Norwegians, who claimed the right to determine their own sovereignty. The leader of this independence movement was the viceroy Christian Frederick, who was heir to the Danish throne and hoped later on to be able to restore the Dano-Norwegian union. A representative assembly, convened at Eidsvoll, prepared and adopted on May 17, 1814, a national constitution based on the democratic models of the U.S., France (1791) and Spain (1812) and unanimously elected Christian Frederick as king of Norway. A Swedish invasion followed, but negotiations were almost simultaneously opened, and it was agreed that Norway should retain its independence and its new constitution, subject to a merely personal union under the Swedish king. Christian Frederick abdicated and left the country, and the terms drawn up in the convention of Moss (Aug. 14) were ratified and worked out in detail by an extraordinary *storting* (national legislative assembly) in November.

Reign of Charles XIV John (1818–44).—The settlement thus reached held from the first the seeds of conflict and misunderstanding. Even Bernadotte, who succeeded to the dual monarchy as Charles XIV John on Charles XIII's death in 1818, believed that circumstances would soon bring about the complete amalgamation of Norway and Sweden, as he had originally planned—a view rendered plausible enough by the poverty and trade depression in Norway which followed the end of the Napoleonic wars. Swedish opinion generally continued to regard Norway as a conquered country and the treaty of Kiel as the title deed to it. Such an attitude naturally made the Norwegians more than ever determined to guard and to emphasize their newly won independence. Moreover, the national constitution, based on Montesquieu's theory of complete separation between executive, legislature and judiciary (*see* Montesquieu, Charles Louis de Secondat), promoted conflict rather than collaboration between the first and second of these powers. The king, as head of the executive, controlled among other things the foreign affairs of both his kingdoms, on which he was advised by a Swedish foreign minister; and his Norwegian councilors were excluded from membership or even from attendance in the legislature. Thus, while the *storting* grew increasingly democratic, executive power still rested with a bureaucracy appointed by the crown. The king was principally resident in Sweden and was represented in Norway by a *statholder* or viceroy who was, until 1829, a Swede. Swedish influences predominated in all questions where the interests of the two countries differed.

Such a case arose in the "Bodø case" of 1818–21, when an English merchant who had been arrested on charges of smuggling and other irregularities succeeded, through British diplomatic pressure on the king and his Swedish advisers, in securing heavy damages

which the Norwegian government was reluctantly compelled to pay. But even earlier the inevitable conflict had begun. When the Norwegian *storting* passed a bill (1815 and again in 1818) for the abolition of titles of nobility, the king at once exercised his constitutional right of veto and only reluctantly sanctioned the bill on its being passed by a third successive *storting* (1821). A further dispute arose over the settlement with Denmark of Norway's share in the joint national debt of the two countries. Charles XIV John, with British mediation, concluded in Sept. 1819 a convention with Denmark, by which Norway was made liable for no more than 3,000,000 *riksdaler*. These terms, however, were only tardily accepted by the *storting* and the delay made the king doubt the Norwegians' sincerity and, apparently, contemplate a *coup d'état*. In July 1821 he assembled a force including 3,000 Swedish troops near Christiania (Oslo), ostensibly for maneuvers, having previously circularized the powers (June 1) with a note courting their sympathy for an attempt to force a revision of the constitution. Induced to abandon this idea, he submitted his proposals for revision to the *storting*, which, however, unanimously and repeatedly rejected them, thus coming to be regarded as the defender of the constitution against a would-be autocrat.

Trouble also arose over the king's attitude to the celebration of May 17 (on which day Christian Frederick had become king) as the anniversary of Norwegian independence, which he considered as a demonstration of disloyalty toward himself. His attempts to prohibit these celebrations culminated in 1829 in the *torvslag* or "battle of the market place," when an inoffensive gathering, which included women and children, was charged by soldiers on the orders of the Swedish viceroy. No one was wounded.

In addition to these conflicts between the executive and the legislature, an antagonism soon developed in the *storting* itself between the views of representatives of the old governing class and the growing democratic aspirations of the peasantry. The constitution of 1814 granted parliamentary suffrage to the peasants who owned their land or had rented it for five years and to the urban middle class. Nevertheless, for some time afterward political power remained in the hands of the old official class, from which the majority of the candidates for the *storting* were taken. The seeds of democracy, however, began to germinate after the "July revolution" in France and the similar disturbances throughout Europe (1830). From 1833 the peasant representation in the *storting* increased in number and acquired a competent leader in Ole Gabriel Ueland, and an opposition consisting of peasants and city liberals developed to challenge the supremacy of the bureaucracy in the legislature as well as in the executive. The first important victory for democracy was won in 1837, when, after considerable difficulty in obtaining the royal assent, the local government of the country was placed on a popularly elected basis—a measure which contributed more perhaps than anything else to awaken and educate the political consciousness of the general population.

The tension between the king and the *storting* reached its climax in 1836, when Charles XIV John arbitrarily dissolved the legislature and the latter retaliated by impeaching and fining a minister who had supported the king's decision. From this date to the close of his reign Charles XIV John became more conciliatory, acquiring before his death remarkable popularity with his Norwegian subjects. An important step toward this change was made later in 1836, when the post of *statholder* was conferred on Count Wedel Jarlsberg. Another royal concession was the permission, granted in 1838, for merchant ships to fly the Norwegian flag in all waters, its use having been previously severely restricted. The question of the general use of the national flag was one of the items under consideration by a mixed committee of Norwegians and Swedes at the time of the king's death.

Reign of Oscar I (1844–59).—Charles XIV John's son and successor Oscar I soon showed his desire to meet the wishes of the Norwegian people, decreeing that in all documents concerning the internal government of Norway that country's name was to stand first in the royal title; that Norway and Sweden should each carry its own national flag as the naval flag, with the mark of union in the upper corner; but the mark of union was also imposed on the Norwegian merchant flag.

The condition of the country had considerably improved, and the 1840s and 1850s were marked by important legislative reforms. The old privileges and restrictions in handicraft and trade were modified or abolished. The prison system was reformed and the criminal law was made less harsh. Freedom of religious worship for all Christians and Jews was introduced, although Jesuits, banished since 1624, were still banned from the country. New roads were made, the first railway built (1854), steamship routes established, lighthouses erected and trade and shipping developed. The abolition of the English navigation acts in 1849 and 1854 opened up a great future for the Norwegian merchant fleet. The removal of the English ban on export of machinery in 1843 made it possible to establish the first cotton textile factories and engineering workshops in Norway in about 1850.

However, the lower classes still felt the economic pressure of the rapid growth of population. Emigration to America rose to nearly 4,000 a year in the 1850s and averaged about 15,000 in the later 1860s. In the years 1849–50 the first nationwide labour movement was created by Marcus Thrane who found his strongest support among cottagers, artisans and town workers. But the movement was crushed through legal prosecution, and it was not till the 1870s that the first trade unions were organized.

In the 1850s Sweden and Norway abandoned the pro-Russian foreign policy followed by Charles XIV John. In 1851 Russia demanded for its frontier Lapps the right to fish on the Norwegian coast and to settle upon a portion of the coast of the Varangerfjord. Serious complications might have ensued if Russia had not been diverted by fresh developments in the Eastern question. During the Crimean War (1854–56) King Oscar concluded a treaty with England and France by which these countries guaranteed Norwegian and Swedish territory against Russia (the November treaty, 1855).

Reign of Charles XV (1859–72).—Because of King Oscar's ill-health his son, Crown Prince Charles, was appointed regent in 1857, and in 1859 he succeeded as Charles XV. He desired to inaugurate his reign by giving proof of his willingness to meet Norwegian claims, especially with regard to the problem of the office of viceroy. According to the constitution the viceroy might be either a Norwegian or a Swede. Since 1829 no Swede had held the post, and since 1855 it had been vacant. But the paragraph in the constitution still existed, and the Norwegians naturally wished to have this stamp of "dependency" obliterated. A proposal to abolish the office was passed by the *storting* in 1859. The king had privately promised that he would sanction the proposed change in the constitution; but when a violent outcry arose in Sweden, he refused his sanction.

In 1860 the Swedish government pressed for a revision of the Act of Union with the purpose of strengthening the institutional bonds between the two countries and of codifying the actual supremacy of Sweden in the union. Because of a strong resolution of the *storting*, based on the work of a special committee, the Norwegian government rejected the proposal, but its members disagreed over the form of the reply. The more obstinate among them resigned, and others, of a more pliable nature, were appointed; their leader was Frederik Stang, who had been minister of the interior from 1845 to 1856, and who hoped to bring about a better understanding between Sweden and Norway. This cause was aided by the king's advocacy of a revision of the Act of Union designed to inaugurate a real equality between the two countries. It was also strengthened by the growth of pan-Scandinavian sentiments in Norway, partly stimulated by fear of Germany. In 1865 a second union committee was appointed and its report was published in 1867. But opponents to the government soon showed that the new draft would emphasize the supremacy of Sweden and would considerably strengthen the union. The Stang ministry accepted it, but it was rejected by an overwhelming majority in the *storting* in 1871.

While the union movement was being fought, pan-Scandinavian sentiment had declined. Denmark's troubles over Schleswig-Holstein (1863–64) had threatened to draw Sweden and Norway into war on Denmark's side. At that time King Charles favoured a defensive alliance with Denmark, but the majority of the *storting*

would only consent if an alliance could also be effected with at least one of the western powers. As this was not achieved, the Danes were left isolated and their defeat in 1864 spread disillusion among the advocates of Scandinavianism in Norway and Sweden.

In 1869 a resolution was passed making the sessions of the *storting* annual instead of triennial. Its passage marked the final alliance between two opposition groups: the Peasant party led by Søren Jaabaek, and the city radicals, mostly lawyers, under the leadership of Johan Sverdrup. Thus was founded (although not yet formally organized) the great national democratic (liberal) party of the Venstre (the Left). In the *storting* they formed a strong majority which in 1872 carried a bill proposing that ministers should be admitted to the *storting* and should take part in its proceedings. In the preceding half century the government party had several times introduced a similar bill, but the opposition had feared lest the superior skill and experience of the ministers would give them undue influence. The opposition by that time had gained more confidence in its own strength, and Johan Sverdrup, at least, regarded the admittance of the ministers to the *storting* as a step toward full parliamentary government. But, on the advice of the Conservatives under Stang, the king refused his sanction and even insisted that the ministers should stay in office in spite of the *storting*'s vote of censure against them.

Reign of Oscar II (1872–1905).—In Sept. 1872 Charles XV was succeeded by his brother Oscar II, who in 1873 sanctioned the abolition of the office of viceroy, the president of the ministry being thenceforward recognized as the prime minister. Because of this change the *storting* had to alter the wording of the bill that was constantly brought up to propose the admittance of the ministers. It was again passed in 1874, 1877 and 1880, but the king steadily refused his sanction. In defiance of this veto the *storting* resolved (June 9, 1880) that the bill should be declared to be the law of the land, but the king and his ministers declared the resolution invalid. The prime minister, Stang, then resigned and was succeeded by Christian August Selmer, a firm Conservative who was intent on continuing the conflict, and the antagonism between the government and the *storting* increased. Not even after the sweeping victory of the Left at the elections in 1882 did the ministry and the king show any sign of yielding, and in Feb. 1883 the *odelsting* (the lower division of the national assembly) decided to impeach the whole of the ministry for having acted contrary to the interests of the country by advising the king to refuse his sanction. After ten months' trial, the *riksrett* (a court where the majority of the judges are taken from the *lagting*, the upper division of the *storting*) in 1884 sentenced Selmer and seven of his ministers to be deprived of their offices, while three were heavily fined. Selmer advised the king to ignore the judgment, and Oscar II had in fact had plans of a *coup d'état*, but after some hesitation he yielded, not least because he lacked the support of his Swedish government. However, in his declaration that the judgment would be carried into effect, he upheld the constitutional prerogative of the crown, and asked one of the ministers who had been fined to form a ministry. This ministry was a failure, and after another attempt to get a "ministry of reconciliation," the king was at last compelled to appoint Johan Sverdrup. Thus the first Left ministry in Norway came into being (June 1884). In the same year the two parties, the Left and the Right, became organized on a national scale, and the latter soon accepted the principle of ministerial responsibility to parliament although it has never been codified in the constitution.

The Struggle for Separate Diplomatic Representation and the Achievement of Independence.—During the years of the Sverdrup ministry (1884–89), some important reforms were achieved; trial by jury was introduced and the elementary school system was reorganized. The Left, however, was soon split, partly over a question of church reform. Sverdrup lost his absolute majority in the elections of 1888, resigned in 1889, and a Conservative ministry was formed by Emil Stang, the son of Frederik Stang. This was defeated in 1891 on the "Diplomatic question." The Norwegians wanted equal representation with Sweden on the special joint council handling foreign affairs (the ministerial council of state); after 1885 the Swedes were willing to grant this numerical equality, but only provided that the joint minister of foreign affairs should continue to be a Swede, and this the Norwegians would not accept. In 1891, after the *storting* had virtually censured its negotiations with the Swedes, the Stang ministry resigned, and a Left ministry under Johannes Steen was appointed. The Left then adopted a determined line of action in the union question, and the *storting* in 1892 and 1893 passed resolutions for the establishment of a separate consular service for Norway; but the king refused his sanction; the Left ministry therefore resigned in 1893, and Emil Stang formed a minority Conservative ministry. He gained no adequate support in the elections in 1894, and his ministry resigned in 1895. The Swedes then resorted to drastic measures and doubled their defense budget. On June 7, 1895, the *storting* yielded and ceased to press for a separate consular service; shortly afterward a coalition government was formed, with the conservative Georg Francis Hagerup as prime minister. A new committee of Norwegians and Swedes spent more than two years in fruitless labour on the question of separate diplomatic representation. At the elections in 1897 a stronger Left majority was returned, and in 1898 Hagerup was replaced by Steen. The appropriations for the defense were raised considerably during those years; another expression of the national feelings was the adoption, after bills for the purpose had been three times vetoed, of the "pure" Norwegian flag in 1898. In the same year universal political suffrage for men was passed. Women received local government franchise in 1901 and a restricted parliamentary suffrage in 1907. Universal political suffrage was extended to them in 1913.

The rising government expenditure caused by armaments and various social reforms was made possible by the rapid economic progress in the 1890s and by the introduction of state income tax in 1892 (made progressive in 1895). A fraction of the Left were, however, opposed to this development, and joined with the Right in a broad, conservative "consolidation party," which gained the majority at the elections in 1903. Hagerup formed another coalition ministry, and hoped to be able to settle the question of a Norwegian consular service on the basis of a Swedish-Norwegian agreement of March 24, 1903. Then suddenly, in Nov. 1904, the Swedish prime minister, E. G. Boström, submitted to Norway new conditions for the establishment of separate consuls. These conditions were almost unanimously considered unacceptable, and the Norwegians felt themselves compelled to take the matters into their own hands. Hagerup resigned, and in March 1905 Christian Michelsen (*q.v.*) formed a ministry of both parties, pledged to carry through the unilateral establishment of a Norwegian consular service. A bill to this effect was passed by the *storting* but on May 27, 1905, the king refused to sanction it. The Norwegian ministry immediately resigned; the king refused their resignation, but they declined to withdraw it. On June 7 the *storting* unanimously resolved that the personal union with Sweden was dissolved because the king was unable to have an alternative government formed. The resigning ministry was authorized to exercise the authority vested in the king.

The decision aroused bitter feelings in Sweden, but due to the influence of the king and of the Swedish Liberals and Socialists the *riksdag* (Swedish parliament) agreed to negotiate on the issue raised, on certain conditions. One of them was a general plebiscite in Norway; this was held on Aug. 13, resulting in 368,208 votes for severance of the union and 184 against it. On the other conditions an agreement was reached on Sept. 23. This provided for a neutral zone on both sides of the frontier, the Norwegians undertaking to dismantle some fortifications in the zone. On Oct. 26, after ratification by *storting* and *riksdag*, King Oscar II relinquished the crown of Norway. Failing acceptance by a Bernadotte, it was conferred upon Prince Charles of Denmark, grandson of King Christian IX, after a second plebiscite in which the voting was approximately four to one in favour of monarchy rather than a republic. On Nov. 25 the king, having adopted the name Haakon VII, and his wife Queen Maud, the youngest daughter of Edward VII of England, entered the Norwegian capital. (D. Ma.)

E. Modern Norway

Early 20th Century and World War I.—The truce to party politics created by unanimity on the question of terminating the

Swedish union did not long survive the retirement of Michelsen in Oct. 1907. The coalition government continued for five more months, under the leadership of its former foreign minister Jørgen Løvland, but for the next 12 years the Liberal or Left (Venstre) party generally maintained its predominance, though the elections of 1909 brought it a temporary setback in consequence of a split on the question of the Concession laws, which constituted the main political issue in the earlier years of that period. These laws were designed to control the power of foreign capital and, in the minds of the more radical politicians, of capital generally. They made the industrial exploitation of the natural resources of the country subject to a government concession, with eventual reversion to the state of the property involved, together with the plant and buildings erected upon it, without compensation. In consequence of the secessions from his party, Gunnar Knudsen's Liberal government, which was in power from 1908 to 1910, was succeeded by a coalition of Conservatives and moderate Liberals, first under Wollert Konow and then under Jens Bratlie, till 1913, after which Knudsen ruled without a break until 1920.

The industrial developments with which the Concession laws were concerned were, however, symptomatic of a fundamental change in the economic life of the country, which fortuitously coincided with the restoration of Norwegian independence in 1905 and had far-reaching political and social consequences, including a disturbance of the existing balance of political forces. It was in 1905 that Samuel Eyde founded Norsk Hydro, the great Norwegian nitrate organization, based on the use of hydroelectric power. The harnessing of Norway's enormous resources of water power started an industrial revolution with a suddenness which created problems and conflicts of capital and labour not previously experienced. Industrial disputes promoted the growth of organized labour and of a political Labour party the strength of which had hitherto been negligible. In these circumstances the dominance of the old Liberal party could not long continue.

On the outbreak of World War I the three Scandinavian countries at once proclaimed a policy of neutrality primarily designed to preclude any possibility of hostile action between them. They co-operated closely, and numerous conferences were held between their representatives. Norwegian shipping, however, rendered most valuable services to Great Britain, and from 1917 such services were the subject of a comprehensive agreement with the Norwegian Shipping association. Losses of life and tonnage were heavy, but the profits earned were extremely large. The wave of speculation which ensued brought temporary prosperity to a new and undesirable class of capitalists and thus further embittered the relations between capital and labour.

1919–39.—The Labour party, at this stage, was of an extreme revolutionary type, and in 1919 it joined the Third (Communist) International. Its growth in numbers, which in 1921 gained it 29 seats in the *storting*, reduced the Liberal forces to approximate equality with the Conservatives, though these old parties were still each considerably stronger than the Socialists: this situation and the adoption of a system of proportional representation (abandoned in 1949) led to a succession of short-lived governments, alternating between Conservative and Liberal, between 1920 and 1928.

In 1923 the Labour party withdrew from the Third International, and a Communist party was formed by its recalcitrant left wing. This split, however, did not entail any substantial loss, and in 1927 Labour became the strongest single party in the *storting*, with 59 seats. Its policy was still extreme enough to excite fear and suspicion in bourgeois circles, and when in Jan. 1928 it first assumed power as a minority government under Christopher Hornsrud it only survived for 18 days, being replaced by a Liberal administration under Johan Ludwig Mowinckel (*q.v.*), who remained prime minister till 1935, except for a break in 1931–32, when an Agrarian government under Peder Kolstad was in office. Kolstad died in March 1932, and the leadership passed to Jens Hundseid until the fall of the government in Feb. 1933. The elections of Oct. 1933, however, gave Labour 69 seats, and from 1935 they remained securely in power, under Johan Nygaardsvold, though without an overall majority until 1945.

After the settlement of the Concessions question, the principal domestic issue in the decade following World War I turned on the prohibition of intoxicating liquors, which had been introduced as a temporary expedient during the war and the continuance of which was supported by a referendum in Oct. 1919. The experiment proved unsatisfactory, leading to widespread smuggling and other evasions of the law, beside producing a trade conflict with Spain and Portugal which caused heavy loss to the fishing industry. The measure was repealed, except in relation to spirits, in 1923; the prohibition of spirits was likewise abandoned in 1927.

In external affairs the most important events were the recognition of Norwegian sovereignty over Svalbard (Spitsbergen) from 1925, and a dispute with Denmark over Norwegian rights in east Greenland, which was decided in favour of Denmark in 1933, by the Permanent Court of International Justice. For the last ten years preceding World War II Norway was seriously affected by the world economic crisis, and widespread unemployment promoted the progress of socialism.

World War II.—In the years following World War I, Norway had been a loyal and active member of the League of Nations, in the work of which Fridtjof Nansen (*q.v.*) played a conspicuous part. But the experience of the Italo-Abyssinian conflict shook the country's faith in the security offered by the league, and on July 1, 1936, Norway, together with its associates in the "Oslo group" (Belgium, Netherlands, Luxembourg, and the other Scandinavian states), repudiated the obligation to assist in the enforcement of sanctions under the covenant. The Norwegian government announced in April 1938 its intention to abstain from participation in the event of war.

On the eve of the outbreak of World War II in 1939 the Scandinavian countries together proclaimed their reversion to a policy of strict neutrality. This policy seemed at first sight to be more disadvantageous to the western allies than to Germany, which was able to use a long stretch of sheltered territorial waters for the conveyance of Swedish iron from the Norwegian port of Narvik. During the Russo-Finnish campaign of 1939–40, in which Norwegian sympathies were strongly pro-Finnish, France and Great Britain tried to induce Norway to abandon its neutrality sufficiently to allow the transit of Allied troops through Norway to Finland, but the request was refused. In Feb. 1940 British naval forces entered Norwegian territorial waters to rescue a number of Allied prisoners from the German vessel "Altmark," which had taken refuge in Jøssingfjord. On April 8 the Allies went further and announced the mining of various points in Norwegian territorial waters, with the object of preventing their use for the safe conveyance of German supplies. It was not, however, from the west that Norwegian neutrality was seriously threatened: on April 9, 1940, the country was suddenly invaded by Germany.

This event found the Norwegian people completely unprepared. During the interwar period, the defenses of the country had been neglected by all political parties for a variety of reasons. Faith in the protection afforded by the League of Nations and the prevalent view that the reduction of armaments was a virtue played an important part in the earlier stages. With the rise to power of the Labour party, motives of economy or of diverting expenditure from military to social objects combined with the ingrained pacifism of the older Socialists (who were also afraid that the army might be used in internal conflicts to the detriment of the working class) to produce a similar result. Halvdan Koht, the foreign minister, while he tried to the last to maintain a strictly neutral policy, was also obsessed with the idea that this neutrality was threatened from the west rather than from Germany. He accordingly ignored a number of warnings that reached him during the final days preceding the invasion.

The project of a German occupation of Norway, however, was under consideration in Germany as early as Oct. 1939, where it was strongly pressed by the admiralty. By the middle of Jan. 1940 the plan was adopted by Adolf Hitler, who had been more or less converted after an interview with the Norwegian traitor Vidkun Quisling (*q.v.*) in the previous month.

The destruction of the German cruiser "Blücher" by the Oscarsborg batteries in the narrows of the Oslofjord threw out the

German timetable sufficiently to enable the king and his government to escape from the capital to Elverum, where an extraordinary meeting of the *storting* voted full powers to the government to act during the emergency. The German demands, which included the appointment of Quisling as premier, were rejected by the king and his ministers, and active resistance by the improvised forces available began at once. This was continued for about two months, but by the beginning of June dangers on other fronts compelled the withdrawal of the assistance meanwhile provided by the Allies, including their abandonment of the port of Narvik (*q.v.*). The king and government moved to England, and active hostilities in the country came to an end. From London, nevertheless, the king and his ministers retained continuous radio contact with the loyal elements in Norway, while from the first they had succeeded in diverting practically the whole Norwegian merchant fleet to the service of the Allies. (*See* also WORLD WAR II: *German Campaigns in Denmark and Norway*.)

The Germans were slow to grasp the extent of the antagonism that they had aroused in the Norwegian population and made a particularly serious mistake in supporting Quisling and his party, who were despised by all but a fraction of the people. In the temporary depression induced by the fall of France, indeed, there was a dangerous moment when the presidential board of the *storting* was prevailed upon to request the abdication of the king and the resignation of the government. But when this demand was met with a dignified refusal a bolder spirit quickly developed, and in September Germany abandoned the hope of giving the occupation any appearance of voluntary acceptance by the Norwegians. A German *Reichskommissar*, Josef Terboven, was appointed, under whom various members of Quisling's party were given administrative charge of the different departments of state. On Feb. 1, 1942, Quisling himself was raised to the position of "minister president" over a puppet government of his supporters, but this move effected no real change in the situation.

A Home Front growing spontaneously from the uncoordinated efforts of individuals became increasingly organized under a central leadership whose members were soon in continuous touch with the Norwegian government in England. The directives issued to the people through secret channels by this organization found a ready and loyal response which seriously obstructed the plans of the occupying power and its puppets, while a large number of "illegal" newssheets kept the population informed. Resort to guerrilla warfare or to unauthorized acts of sabotage was wisely discouraged, though a secret military organization existed and was approved. The Home Front was drawn from all political parties and classes of the nation, and it thus fostered a new spirit of unity that ignored political differences.

Postwar Years.—Norway was liberated in May 1945. The wartime government headed by Johan Nygaardsvold immediately resigned and was succeeded temporarily in June by a coalition under the prime ministership of the Labour party leader, Einar Henry Gerhardsen (*q.v.*). A general election on Oct. 8 returned the Labour party again to power, with 76 seats out of 150. The Communists won 11 seats at the close of the war, but they lost them all in the election of Oct. 10, 1949, in which the Labour party increased its representation to 85. Gerhardsen continued as prime minister until Nov. 1951, when he was relieved for a time by his colleague Oscar Torp, resuming the premiership in Jan. 1955.

Domestic policy in those years mainly centred on problems of finance and reconstruction inherent in the postwar situation. These were for the most part approached on lines laid down in a program agreed upon by all parties at the close of hostilities. In its external affairs, however, Norway made a striking departure from its traditional attitude of neutrality. For the first few years, indeed, the aspiration of all the Scandinavian states was to build a bridge between the conflicting ideals of the western world and the U.S.S.R., while avoiding association with either side. As early as the close of 1947, however, Norway began to entertain serious misgivings, and the Communist coup in Czechoslovakia in Feb. 1948 convinced it of the impracticability of this "bridge-building" policy. The three Scandinavian states thereupon discussed the alternatives of association with the North Atlantic Treaty organization (NATO) and a neutral defensive alliance among themselves as preferred by Sweden); but early in 1949 agreement proved impossible, and Norway joined NATO. In Nov. 1959 Norway was a signatory to the convention setting up the European Free Trade association (EFTA), which came into effect in May 1960. Norway's application (1962) to join the European Economic community (EEC) was shelved following the breakdown (Jan. 1963) of negotiations concerning a similar application by Britain.

The elections of Oct. 12, 1953, followed an important amendment (1952) of the electoral law, which abolished the preponderance of rural over urban representation laid down in the constitution of 1814. At the elections of 1957 and 1961 Labour remained by far the largest party in the *storting*, although in 1961 it just lost its overall majority. But in 1963, after 28 years in office, the Labour party fell from power, and John Lyng, leader of the Conservatives, took office at the head of a coalition government on Aug. 28. On Sept. 18, however, Lyng's policy statement was rejected in the *storting*, and Labour returned to power under Gerhardsen.

In 1965 Labour was again defeated, 80 seats in the *storting* being won by the Conservative, Centre, Christian People's and Liberal parties, against Labour's 68. Per Borten, leader of the Centre party, became prime minister. Increased taxation in 1966 somewhat neutralized a major wage settlement negotiated by compulsory arbitration. Neither event hindered economic expansion, though credit restrictions were tightened in the autumn. On Jan. 1, 1967, a new wage-based pension plan came into force.

In 1955 Norway had celebrated the conclusion of 50 years of national independence and the jubilee of its king, to whose firm though strictly constitutional leadership the whole nation recognized its indebtedness. On Sept. 21, 1957, King Haakon died at the age of 85. His 54-year-old son was immediately sworn in as the new monarch, King Olav V (*see* OLAF). (G. M. G.-H.; X.)

IV. POPULATION

The population of Norway at the census of Nov. 1, 1960, was 3,494,089 as compared with 3,278,546 at the 1950 census and 2,814,194 in 1930. At Jan. 1, 1964, it was estimated at 3,680,622. The table shows its distribution over the 20 *fylker* (counties).

Norway is the most thinly populated country in Europe, with an average population density of 29 per square mile. Towns are few, and apart from Oslo (whose boundaries were greatly extended in 1948) and Bergen (*qq.v.*) none has a population of more than 100,000. According to the census of 1960 Trondheim had 58,196, Stavanger 50,949, Drammen 30,530 and Kristiansand 27,941. Most of the built-up areas are found along the coast, in the lowlands of the east (Østlandet), in the area around Trondheim (Trøndelag) and in the larger valleys. The most sparsely populated area is the north, particularly the county of Finnmark, where most of Norway's 20,000 Lapps are found. By mid-20th century less than one-tenth of the Norwegian Lapps (*samer*) were reindeer keepers; most had deserted their nomadic existence and settled as farmers and fishermen along the coast.

The population of Norway in 1801 was less than 1,000,000 but from 1815 there was a fairly rapid increase, much of it, however absorbed by emigration, chiefly to the United States. Between 1836 and 1936 the total number of emigrants was 860,694. After 1931 emigration declined considerably, in view of immigration restrictions in the United States and increased economic opportunities at home. Between 1946 and 1962 the number of emigrants was 34,809, with a peak in 1952 of 2,958.

The number of live births rose steadily from 41,321 (the lowest figure recorded in the 20th century) in 1935 to 70,727 in 1946. In 1963 it was 64,105. The excess of births over deaths was 27,546 in that year. The live-birth rate in 1963 was 17.5 per 1,000 inhabitants, the death rate 10.0. The marriage rate, at 9.5 per 1,000 inhabitants, reached its peak in 1946. In 1960 there were 1,789,403 men and 1,801,831 women—an excess of women over men of 12,428 as compared with 70,356 in 1930. The percentage of illegitimate live births fell from 7.1 in 1930 to 3.7 in 1960.

The age distribution of the population after World War II was strongly influenced by the great variation in the birth rate, the all from 1920 to 1935 and then the subsequent rise. While the popu-

lation as a whole has increased steadily, the proportion of old people has increased most.

V. ADMINISTRATION AND SOCIAL CONDITIONS

1. Constitution and Government.—Norway is a constitutional and hereditary monarchy. The constitution or fundamental law (*grunnlov*) was adopted by the constituent assembly at Eidsvoll on May 17, 1814, and amended at various times since. Executive power is vested in the king, exercised through a council of state consisting of the prime minister (*statsminister*) and at least seven other councilors (*statsråder*). The councilors are the heads of the ministries (*departementer*); they also sit in the parliament (*storting*) but do not vote. The king has no power to dissolve parliament, its life being fixed at four years. The 150 members (*stortingsmenn*) of parliament are elected directly by the people in electoral districts which correspond to the 20 counties.

The right to vote is enjoyed by all Norwegian citizens, men and women, over 21 years of age who have resided five years in the country. Candidates must have resided ten years in the country and must be over 21 years of age. Since 1953 candidates need not be resident in the constituency in which they stand for election. Substitutes as well as members are elected. Since 1961 the *storting* is elected in September every fourth year, and meets in Oslo on the first weekday in October each year, remaining assembled as long as is necessary. After the opening, parliament divides itself into two sections, the *lagting* consisting of 38 members and the *odelsting* of the remainder. A bill is first introduced in the *odelsting* and, if passed, is sent to the *lagting*. If the two sections do not agree, the bill is returned to the *odelsting* for further deliberation, and the *odelsting* may return it to the *lagting* with or without amendments. If the *lagting* still does not agree a joint session is held and a decision made by a two-thirds majority of the combined votes. A bill can become law without royal assent if passed by two ordinary sessions of parliament after two separate and successive elections (these sessions having to be separated by at least two other ordinary sessions of parliament) provided no divergent legislation has been passed between the first and last passage of the bill. Budget proposals and other questions not taking the form of bills are dealt with by parliament as a single body. There are a number of standing committees where most questions are discussed before reaching the full assembly.

Local Administration.—The country is divided into 20 *fylker* (see Table) including the cities of Oslo and Bergen. In 1964 there were 49 urban (*by-kommuner*) and 476 rural districts (*herredskommuner*), rearrangement having reduced their numbers from respectively 58 and 647 since 1962. The local districts are run by councils (*kommunestyre*) elected every fourth year. Each council elects a presidency of one-quarter of its members. In each county except Oslo and Bergen there is a county council (*fylkesting*) consisting of members of the commune councils. Each commune council elects one representative to the county council per 6,000 inhabitants of the commune. The county council is presided over by a chairman elected by the council from among its members. A county governor (*fylkesmann*) appointed by the

Norway: Fylker (*Counties*) *With Areas and Populations*

Fylke (County)	Area in sq.mi.	Population (1960 census)	*Fylke* (County)	Area in sq.mi.	Population (1960 census)
Southern			Western		
Oslo (city)	175	475,562	Rogaland (Stavanger)	3,531	238,662
Østfold (Moss)	1,614	202,641	Hordaland (Bergen)	6,021	225,296
Akershus (Oslo)	1,895	233,747	Bergen (city)	14	115,689
Hedmark (Hamar)	10,635	177,195	Sogn og Fjordane (Hermansverk)	7,154	99,844
Oppland (Lillehammer)	9,773	166,109	Møre og Romsdal (Molde)	5,821	213,027
Buskerud (Drammen)	5,719	168,328	Sør-Trøndelag (Trondheim)	7,227	211,648
Vestfold (Tønsberg)	904	174,362	Nord-Trøndelag (Steinkjer)	8,673	116,635
Telemark (Skien)	5,919	149,828	Northern		
Aust-Agder (Arendal)	3,562	77,061	Nordland (Bodø)	14,798	237,193
Vest-Agder (Kristiansand)	2,811	108,876	Troms (Tromsø)	10,152	127,549
			Finnmark (Vadsø)	18,783	71,982
				125,181	3,591,234

king supervises administration. The scope of municipal affairs in Norway is very wide. Revenue derives from local income tax, municipal trading profits and state grants.

2. Political Parties.—Of these the principal ones are: the Arbeiderparti or Labour party (with 74 seats in the *storting* of 1961–65), whose object is the development through parliamentary means of economic and social democracy where all able men and women associate in the responsibility for and control of their own livelihood; the Høyre or Conservative party (29), which regards the productive powers of individuals in free competition as the basis for the economic and social well-being of the whole community; the Venstre or Liberal party (14), which considers that the principles of respect for the individual and of national solidarity should be protected under government supervision; the Senterparti or Central party (16), formerly the Bondeparti (Farmers' or Agrarian party), which stands for a society where everybody is equally rewarded according to his contribution to the national product; the Kristelig Folkeparti (Christian People's party) (15), which holds Christianity as the foundation of democracy, defined as freedom, brotherhood and justice in accordance with the law of God; the Sosialistisk Folkeparti (Socialist People's party) (2) which urges disarmament, the country's withdrawal from NATO and a speedy course toward socialism; and the Communist party (0), with its dogmatic marxist program.

3. Taxation.—Direct taxes are levied by local authorities as well as by the central government on personal income and property. Taxes are progressive in relation to income and property, but are assessed according to the taxpayer's family responsibilities. Total taxes on an average income amount to about 25% of the income for a single person and 10% for a family of five. Tax on property varies from about 0.4% up to 1–2%. Maximum taxation payable is 80% of the income received.

4. Living Conditions.—*Wages.*—Wages are in general fixed by rates agreed upon by employers' and employees' confederations for a 2–4 years' period. Contracts may be amended within the period if the cost of living index numbers fluctuate beyond limits laid down. In the early 1960s male workers' average earnings in manufacturing and construction industries corresponded to a yearly income of kr. 10,000–15,000 ($1,400–2,100); farm workers' wages to about kr. 10,000 yearly. Depending on qualifications and responsibilities yearly salaries for office employees averaged about kr. 12,000–33,000 ($1,700–4,600), for technical employees kr. 13,000–47,000 ($1,800–6,600). About 75% of the economically active population are wage earners. Seasonal unemployment in construction and some other industries averaged about 30,000 in January and 4,000 in July.

Housing.—By 1960 the demand for housing had increased greatly because of the increase in population after World War II and the lack of building during the war. There was also a demand for improved living conditions resulting from a general rise in personal incomes. An average family spends 10–12% of its income on housing, light and fuel. Nearly all homes have electricity and main water supply, and in the towns and other densely settled areas no house is built without modern plumbing, and such amenities are being extended to rural areas.

Trade Unions.—In the 1960s about two-thirds of the total number of employed persons were members of trade unions or associations of employees. About 80% of these were members of unions organized by Arbeidernes Faglige Landsorganisasjon i Norge (Norwegian Federation of Trade Unions), the largest of which are the unions of Iron and Metal Workers, Municipal Employees, Building Industry Workers, Seamen, and Commercial and Office Workers. About 62% of all members of trade unions and employees' associations were employed by enterprises which are members of employers' associations, the most important of which is the Norsk Arbeidsgiverforening (Norwegian Employers' Confederation).

Social Security.—There are national insurance plans to meet most contingencies. Compulsory health insurance was enacted in 1909 and old-age pensions were introduced in 1936 for all citizens 70 or more years of age. There are accident-insurance plans (which originated in the 1900s) for industrial workers, seamen and

fishermen. Compulsory unemployment insurance was introduced in 1938; family allowances in 1946; and three-week vacations with pay for all workers in 1947 (extended to four weeks from 1965).

Health Services.—Norway had in the early 1960s more than 4,000 licensed medical practitioners and 2,500 dentists. In each of more than 400 public health districts a medical officer controls the enforcement of health laws, makes provisions against epidemic diseases and advises the local authorities on public sanitation. In some isolated areas he is the only available doctor. Medical care is introduced in elementary and secondary schools, and dental care for the majority of school children. Mass X-ray of the lungs is compulsory for all inhabitants. Norway has more than 200 general hospitals, in addition to hospitals for tuberculosis, mental hospitals and nursing homes for the mentally diseased and feebleminded. Hospitals are mainly controlled by public authorities, some being the care of humanitarian or religious organizations.

5. Justice.—A special feature of Norwegian legal procedure is that civil cases are usually brought first before a mediation council (*forliksråd*), from which an appeal lies to the commune courts (*by- og herredsrettene*), which are also tribunals of first instance. The town and county courts have a professional judge, sometimes assisted by two lay judges. There are five courts of appeal (*lagmannsretter*) in Oslo, Bergen, Trondheim, Skien and Tromsø, composed of three professional judges; and a supreme court (*høyesterett*) in Oslo, whose decision is final. The *lagting* (section of the *storting*) and the *høyesterett* together form the high court of the realm (*riksrett*) for the trial of ministers and members of the *storting* and the *høyesterett* itself. Criminal cases are tried either in the *lagmannsrett* with three judges and ten jurors, or in summary court (*forhørsrett*) with one professional judge, or in town and county courts with a professional judge, usually assisted by two lay judges. The *lagmannsrett* is for more serious offenses; the others for minor offenses. Capital punishment has been abolished (1905) except for certain military and treasonable crimes. There is a state police force subordinate to the ministry of justice.

6. Education.—This is financed jointly by the state, the municipalities and private funds. All instruction is free. Elementary education has been free and compulsory for all Norwegian children between 7 and 14 years of age since 1860. In the early 1960s there were more than 4,000 primary schools with about 430,000 pupils. There were also one-year primary continuation schools. Since 1959 the extension of school-leaving age to 16 has been authorized by law and this extension had been applied in some primary schools by the early 1960s. There are about 300 secondary schools (state, communal and private) most of which can grant certificates. There are also technical, industrial, art and other schools, and teacher-training colleges. Norway's two universities are at Oslo (1811) and Bergen (1948). Other higher educational institutions are the state colleges or institutes of agriculture (Ås district), veterinary science (Oslo), technology (Trondheim), a school of economics and business administration at Bergen, and an independent theological college at Oslo.

7. Defense.—The king is supreme commander of the armed forces. Under the ministry of defense is a defense staff with combined control of all land, sea and air forces. There is a system of local command areas for the three services. A considerable reconstruction of the armed forces was started in 1945 and accelerated after 1949, when Norway joined NATO. Compulsory military service in peacetime was fixed at 12 months; it was increased to 16 months in 1954 for army recruits and 18 months for the navy and air force. In the early 1960s the standing army strength was estimated at 23,000 men; but about 200,000 men could be mobilized at short notice in all branches, including the national guard. The army could mobilize field units corresponding to about two divisions, with many of the men trained in West Germany (where Norway after World War II maintained an occupation brigade of about 4,000). The national guard was formed in 1946 and soon had a membership of about 100,000, mostly volunteers. The air force had about 200 jet fighters and other aircraft. The navy had as its main strength three destroyers, five frigates, eight submarines, as well as a number of corvettes, minesweepers and motor torpedo boats. Coastal artillery, with powerful batteries left by the Germans, was concentrated in particular areas, and antiaircraft artillery was strengthened.

VI. THE ECONOMY

1. State Control and Ownership.—After 1945 (when the Labour party first secured a parliamentary majority) the economy of Norway was fairly strictly controlled and directed along the lines set out in the annual national budgets. Those budgets laid down economic policy in such spheres as investment, consumption, imports, exports, manpower and materials. A system of licences, quotas, price controls and subsidies was used to ensure the desired development of the national economy. The government also influenced economic development by direct or indirect ownership or part-ownership of mines, factories and other concerns in such fields as aluminum, hydroelectricity, chemicals and transport. State monopolies over grain and alcohol had been established before World War II. In 1960 Norway signed the European Free Trade association (E.F.T.A.) treaty.

2. Agriculture and Forestry.—Agriculture has remained one of the principal resources of the country, though in the early 1960s it supported 15% of the population, compared with 30% in 1930. According to the agricultural census of 1959, 2.7% of the land area was cultivated and there were more than 138,000 farms and holdings of 2 ha. or more, mostly small and nearly all owned by the farmers. Natural conditions are favourable to fodder growing and livestock keeping, and Norway is self-sufficient for nearly all livestock products. Only half the domestic consumption of cereals is produced in Norway; nearly 70% of grain harvested is barley and most of the rest oats. More than 1,000,000 tons of potatoes and over 3,000,000 tons of hay and straw are produced annually.

Farmers derive an important part of their income from forest holdings. Forests cover about a quarter of the land area. About 80% of the forest area is privately owned, while the state and local authorities own the rest. There are about 125,000 forest holdings. For centuries sawn and planed timber had been Norway's main forest export, but most of the timber is now exported as pulp and paper. In the early 1960s about 275,000,000 cu.ft. of timber were cut yearly for sale and about 1,500,000 tons of pulp and more than 800,000 tons of paper and paperboard were produced.

3. Fisheries.—According to the fishery census of 1960 there were more than 60,000 fishermen, of whom 45,000 had fishing as their sole or main occupation. Fishing vessels exceeded 36,000, of which about 12,000 were decked motor vessels, mostly owned by the fishermen themselves. Fishing is carried on for the most part close to the shore. Catches exceed 1,300,000 tons a year and consist mainly of herring and cod. Much of the herring catch is processed into oil and meal. Pelagic whaling was pioneered by the Norwegians in the antarctic early in the 20th century. Norway sends several whaling expeditions to the antarctic annually and whale and sperm oil are produced.

4. Industry, Mining and Power.—An extraordinary expansion in the industrial life of Norway set in at the end of the 19th and the beginning of the 20th century as the result of the development of cheap and plentiful hydroelectric power. This expansion was further accelerated after 1945. It has been particularly notable in the electrochemical and electrometallurgical spheres. The manufacture of pure nitrogen in the early 1960s was more than 300,000 tons (equivalent to about 1,500,000 tons of fertilizer products), and more than 500,000 tons of ferroalloys and aluminum were produced, nearly all for export. The construction of electrical and other machinery and shipbuilding also made marked headway. The mining industry, extracting mainly iron ore and pyrites, is concentrated mostly in the northern part of the country. Copper and zinc are by-products. The steel output was about 500,000 tons. The output of sulfur declined to about 45,000 tons compared with more than 100,000 tons in the early 1950s. The production of ferrosilicon became important.

After 1945 a high rate of investment, particularly in hydroelectric development, industry and shipping, was instituted. Of Norway's estimated exploitable water power of about 15,000,000 kw., more than 4,000,000 kw. had been harnessed by the early 1960s

The output of electricity per capita was the highest of any country in the world. As the result of this expansion, the industrial production index had more than doubled since 1949. In farming, fishing and forestry, production also improved through mechanization despite the loss of labour to industry.

5. Foreign Trade.—Norway's foreign trade, which had always been large in relation to population, increased further after 1945, and by the early 1960s the value of imports ran at nearly kr. 16,000,000,000 and that of exports at about kr. 8,000,000,000. The trade deficit was largely financed by freight earnings of the merchant fleet. Principal imports were machinery and apparatus, ships ores and metals, fuels, chemicals and textiles. Exports included pulp and paper, fish, fish products and marine oils, fertilizers and other chemicals, and ores and metals. Relatively few types of commodity are exported; the products of the pulp and paper industry, the electrochemical and electrometallurgical industries and the fisheries together account for about 60% of exports. The chief trading partners were the United Kingdom, West Germany, Sweden and Denmark.

The Norwegian merchant fleet amounted in the early 1960s to more than 13,000,000 gross tons (ships over 100 gross tons), about half the tonnage consisting of tankers. This fleet, the fourth largest in the world, lost half its tonnage during World War II but was rapidly rebuilt after 1945, with replacements mostly from British and Swedish yards. The majority of the vessels are engaged in overseas traffic between foreign ports.

6. Currency and Finance.—The unit of currency is the krone, divided into 100 øre. The value of the krone is fixed at 20 to the pound sterling and (since devaluation of sterling in 1949) at 7.14 to the U.S. dollar. In the early 1960s the gold and foreign exchange holdings of Norges bank (the Bank of Norway) totaled about $300,000,000.

Norges bank, founded in 1816 and state-owned since 1949, is the sole note-issuing institution. During World War II the note circulation increased sixfold to about kr. 3,000,000,000, largely because of heavy drawings (about kr. 11,000,000,000) made on Norges bank by Germany. More than half this sum was repaid by Germany after the war, but, as a result of postwar reconstruction and economic expansion, the note circulation exceeded kr. 4,000,000,000 in the early 1960s.

The state budget had so increased as to become a decisive factor in the national economy, expenditure and revenue averaging kr. 11,000,000,000 and kr. 10,000,000,000 respectively. Taxes on income and capital raised about one-fifth of the revenue, the rest deriving mostly from purchase tax and other indirect taxes. The national debt stood at about kr. 14,000,000,000 of which one-sixth was owned abroad.

7. Communications.—Norway, with its long, narrow stretch of land, its fjords, mountains and islands and its sparse population, presents transport problems of especial difficulty. Coastal shipping and ferry connections play an important role, hydrofoil craft being used on some routes. The public road system totaled more than 33,000 mi. in the early 1960s. There were then about 500,000 motor vehicles, of which more than 300,000 were private cars. The first railway, from Oslo to Eidsvoll, was opened in 1854. The railway system covers more than 2,750 mi., of which more than 40% is electrified. International air traffic to western Europe is based on the airports of Oslo, Stavanger, Kristiansand and Bergen. Connection with transworld services is made via Copenhagen, Den. All-year daily internal services operate from these airports and also from Ålesund, Trondheim, Bodø and Tromsø. Seaplane services operate from April to October in northern Norway.

Telecommunications have a special importance in Norway because of its physical character. Telegraph and telephone services are mostly nationalized. In the early 1960s there were about 100 telegraph stations and 2,000 long-distance telephone stations, with about one telephone per five inhabitants. There are international telephone services and radio-telegraph and telex services. Broadcasting and television are the monopoly of the Norwegian National Broadcasting service (Norsk Rikskringkasting). Its headquarters are in Oslo, and there are 40 substations transmitting the national program; some substations transmit a local program for a short time daily. It was expected that in 1965, 80% of the population would be covered by television. *See* also references under "Norway" in the Index. (L. H. Hg.)

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NORWEGIAN LANGUAGE is one of the Scandinavian languages (*q.v.*). Written Norwegian exists in two distinct and rival norms, known since 1917 respectively as *bokmål*, "book language," and *nynorsk*, "New Norwegian," but also referred to by their older names of *riksmål*, "national language" and *landsmål*, "country-wide language." The former, which may be called Dano-Norwegian since it stems from the written Danish introduced during the union of Denmark and Norway (1380–1814), has been modified in the direction of Norwegian speech by three spelling reforms (1907, 1917, 1938); the latter, which may be called New Norse since it was intended by its creator Ivar Aasen (1813–96) to carry on the tradition of Old Norse, was interrupted in the 15th century. Dano-Norwegian and New Norse are legally equal and are taught in all schools in forms regulated by the ministry of church and education under mandate from parliament. A permanent advisory language commission (*Språknemnda*) was appointed in 1952, with an equal number of representatives for each language nominated by various interested institutions. Governmental planning and natural diffusion have gradually reduced the differences between the two norms; and their eventual amalgamation in *samnorsk*, "common Norwegian," was envisaged—a plan which met with vigorous opposition.

Spoken Norwegian is divided into urban and rural dialects; the former has spread at the expense of the latter. Urban speech falls into standard and substandard social dialects. Standard urban

speech is reasonably uniform throughout the country and serves as a model, although some educated people prefer to speak a normalized New Norse or retain their rural dialects. The standard urban dialect is a compromise between traditional Norwegian speech habits and written Dano-Norwegian, as developed by the old official and professional class. Substandard urban dialects are closer to the surrounding rural dialects of each city, being historically the speech of rural-urban migrants. The rural dialects differ from parish to parish, but fall into broad regional types which reflect the paths of communication in medieval and early modern times: western (the fjord country from Romsdal to Setesdal), eastern (from Telemark to the Swedish border and north to the Dovre mountains), Tröndər (in the trading area of Trondheim), and northern (the three northernmost counties). New Norse has its strongholds in the western dialects, on which Aasen drew most heavily for his grammatical and lexical framework.

In general, Norwegian is a language with a complex, musical phonology, a greatly simplified grammar and an internationalized vocabulary. While the vocabulary is basically native, it contains a great number of originally Low German words for features of urban culture; in addition it has adopted the usual international words for modern technology and borrows new terms freely, most recently from English. New Norse is somewhat more puristic than Dano-Norwegian and attempts to eliminate especially the German and Danish elements from its vocabulary.

Great variety and flexibility are tolerated and even encouraged in the written language in Norway. Writers often resort to local urban or rural dialects. The most widespread and firmly entrenched is Dano-Norwegian, in which are written all daily newspapers, most translations from foreign languages, and from 80% to 90% of original writing. In the schools about 75% of the children learn it as their primary medium of writing.

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NORWEGIAN LITERATURE. Among the literatures of modern Europe, Norwegian literature is remarkable for being so comparatively late-flowering and yet at the same time so impressively deep-rooted. Not until after the separation of Norway from Denmark in 1814, which brought with it a large measure of political independence, is it possible to point to a corpus of literature that is unambiguously Norwegian; yet so vigorous and so luxuriant was its development that by the end of the 19th century Norwegian literature—particularly by virtue of the massive achievement in drama of Henrik Ibsen (*q.v.*)—occupied an influential position.

Early Literature.—The roots of Norwegian literature reach back over 1,000 years, beyond the early Christian era and into a pagan past; there it becomes inextricably intertwined with early Icelandic literature. Although a large part of this early literature was composed either in Iceland or elsewhere in Scandinavia by Icelanders, the Norwegian element in it is considerable and indisputable, even though this cannot always be isolated and defined; in many instances, it is obvious that some of the literature derives from a time before the Scandinavian settlement of Iceland in the 9th century; and in other cases it must have happened that the composers of the works had resided for long periods in the mother country of Norway. At all events, Norwegian literature as it eventually took shape in modern times would have been unthinkable but for the impetus and the specific direction given to it by this ancient literary tradition—above all, by the mythological and heroic lays of the *Poetic Edda* (*see* Edda), by the scaldic poetry and by the myths of the sagas (*see* Icelandic Literature; Germanic Mythology and Heroic Legends).

Three Latin works from the late 12th century have perhaps more philological than strictly literary interest. *Historia de antiquitate regum Norvagiensium* (*c.* 1180), a history of the Norwegian kings from Harald I Haarfager to Sigurd I Jorsalafar, was written by Theodricus, a Benedictine monk from near Nidaros; *Profec Danorum in Terram Sanctam* (*c.* 1200) describes a crusade fro the years 1191–92 in which Norwegians and Danes took part; a *Historia Norvegiae* (discovered by P. A. Munch in 1849 in Sc land) offers an interesting but historically unreliable account Norway, in not very good Latin, giving brief details of No way's geography and fauna and including some interesting marks about the Lapps. The seminal influence of Snorri Sturl son's *Heimskringla*, a history of the kings of Norway to 11 written in Iceland in the first half of the 13th century, is al clear. Of great interest to the historian is *Konungs skugg* ("The King's Mirror"), written in Norway *c.* 1250; this is didactic work in verse which discusses the manners, customs an practices of the day. In the 13th century, the ballad also flou ished as an oral tradition, of which the *Draumkvæde* ("Drea Ballad"), a great visionary poem, is the most impressive survivi example. It describes the dream of Olav Aasteson, who sle from Christmas Eve to Twelfth Day, and, awaking in time to ri to church, recounted there the substance of his dream of purgator hell and heaven.

Translation was much encouraged by King Haakon V Magnu son during his reign (1299–1319); and a translation, with com mentary, of the Bible was begun, but progressed only as far a Exodus 18.

Danish Domination: 14th to 18th Centuries.—From th 14th century onward, the destiny and culture of Norway becam increasingly closely linked with and subservient to those of Den mark. Political union between the two countries came in 138 more and more the Danish language began to impose itself throug out the territory, especially in the towns, until it eventually becam both the official and the literary medium; and Copenhagen wi its university, established itself as the cultural capital of the "twi kingdom." Not until after the Reformation are there faint sig of renewed literary activity in Norway itself, after centuries virtual silence: Absalon Pederssøn Beyer (1528–75) and Pede Claussøn Friis (1545–1614), two clergymen, left their marks th former by his description of and rather nostalgic apologia fo Norway, *Om Norgis Rige* (written 1567; published 1781), and th latter by his translation of Snorri Sturluson. The most origina and most conspicuously Norwegian writer of this age was, how ever, Petter Dass (*q.v.*), whose *Nordlands Trompet* (*The Trum pet of Nordland*) gives a lively picture in verse of the life of a clergyman in northernmost Norway; although almost certain completed before the turn of the century, this work was no printed until 1739. His verses still live; the religious poems his contemporary, Dorothe Engelbretsdatter (1634–1716), on th other hand, possess only historical significance.

Distinguished above all others in this Dano-Norwegian tradi tion is Ludvig Holberg (*q.v.*), the "Molière of the North"; Nor wegian by birth, he lived for the greater part of his life in Copen hagen where he held a series of academic appointments at th university. From his first *succès de scandale*, the publication his mock-heroic poem *Peder Paars* in 1719, until his death he dominated Scandinavian literature; by his comedies of the 1720s— the best known of which are *Jeppe paa Bjerget* (*Jeppe of the Hi* and *Erasmus Montanus*—by his volumes of essays *Moral Tanker* (1744) and *Epistler* (1748–54), by his novel *Niels Kli* (1741, originally written in Latin) and by his scholarly and his torical publications, he has rightly come to be regarded both a the founder of modern Scandinavian literature and as the crea of the modern Dano-Norwegian literary language (*see* also Dan ish Literature).

In the second half of the 18th century, there was little nativ literary talent in evidence within Norway, apart perhaps from Christian Tullin (1728–65), a Christiania businessman, whose nature poems have some merit. But there were other signs tha Norway was beginning to assert its cultural aspirations: a Roya Norwegian Society of Learning was established in 1760 in Trond heim; and the so-called Norwegian society (Det norske Selskab rather less official but no less vigorous for that, was formed in 1772 by some young Norwegians resident in Copenhagen after one of their number, Johan Nordahl Brun (1745–1816), had wo

a literary competition with his tragedy *Zarine* (1772). This society, which lasted until 1812, set out to resist what its members felt to be the excessive German influence on Scandinavian literature; in addition to acting as the focus for a number of minor literary talents—Claus Fasting (1746–91), Claus Frimann (1746–1829) and Jens Zetlitz (1761–1821), for example—it provided the stimulus for the one deathless work associated with it: the uproarious tragicomedy *Kierlighed uden Strømper* ("Love Without Stockings"), written in 1772 by the gifted but wayward Johan Herman Wessel (*q.v.*). But when seen in historical perspective, the society's achievements were probably rather more nationalistic than strictly literary.

The Age of Wergeland.—After 1814 a new, exciting and difficult age began for Norway: difficult, because the problems—political, economic, social—were formidable; exciting, because an opportunity seemed to be offered for developing an independent and genuinely Norwegian culture and way of life. But there were deep differences of opinion as to how this could best be achieved. There were those, of whom J. S. C. Welhaven (*q.v.*) was the chief representative, who insisted that the existing Danish element in the country's culture should not, and indeed could not, be neglected; on the other hand there were those, for whom Henrik Wergeland (*q.v.*) was the acknowledged leader and spokesman, whose nationalistic pride led them to demand that the break with Denmark be as abrupt and complete as possible. In literature, as well as life, Welhaven stood for a coolly intellectual approach, for restraint and control, for a conscious sense of artistry, of which his own sonnet-cycle *Norges Dæmring* ("Dawn of Norway," 1834) is a characteristic product. Wergeland's was a more passionate and revolutionary spirit, impatient for action, politically engaged, aggressive and spontaneous, of which his enormous epic poem *Skabelsen, Mennesket og Messias* ("Creation, Humanity and Messiah," 1830) is a youthful but not untypical example, although it is generally held that his best poetry is to be found in the maturer works, like *Jan van Huysums Blomsterstykke* ("Jan van Huysum's Flower-Piece," 1840), for example, and *Den engelske Lods* ("The English Pilot," 1844). It was Wergeland who, by the sheer force of his personality, dominated the age: as a poet, as an orator, as a social reformer, even; and the clash between him and Welhaven, between the two factions associated with them—the "Patriots" and the "Intelligentsia," as they were called, respectively—and between the two viewpoints they represented, marked the beginning of an ideological conflict that persisted throughout the century and that still persists, in various modified forms.

National Romanticism.—The literature of the mid-19th century, often referred to as Norway's "national romanticism," continued to reflect the country's larger aspirations. A lively interest in its own native past underlay the compilation and publication, between 1841 and 1844, of the *Norske Folkeeventyr* ("Norwegian Folk Tales") by Peter Christen Asbjørnsen and Jørgen Engebretsen Moe (*see* ASBJØRNSEN, P. C. AND MOE, J. E.); in 1853 M. B. Landstad (1802–80) performed a similar service for the country's folk songs by bringing out his *Norske Folkeviser* ("Norwegian Folk Ballads"); P. A. Munch (1810–63) by his eight-volume history of the Norwegian people (1851–63) encouraged popular pride in the nation's great historical traditions; while Ivar Aasen (1813–96) was the creative spirit behind the *landsmål* movement, the establishment of a literary language based on rural dialects that were fairly intimately linked with the Old Norse language (*see* NORWEGIAN LANGUAGE). Many of the literary publications of these years—and not least the earlier works of Ibsen and Bjørnson in the 1850s and 1860s—turned consciously, both for inspiration and for their thematic material, to Norway's heroic past, and to what seemed to be its most direct modern descendants and natural heirs—the peasants. To these years belongs also the lyric poetry of Aasmund Olafsson Vinje (1818–70), the most striking characteristic of which is what the author himself called its "twin-sighted" ambivalence (*tvisyn*).

Realism.—In 1855 Camilla Collett (*q.v.*), Wergeland's sister, published *Amtmandens døttre* ("The Governor's Daughters"); this novel, by virtue of its discussion of the place of women in society and in marriage, might well be taken as marking the beginning of that trend in Norwegian literature which, with encouragement and stimulus from the immensely influential Danish critic Georg Brandes (*q.v.*), culminated in the 1870s and the 1880s in the realistic "problem" literature of Ibsen and Bjørnson and their contemporaries. *Samfundets støtter* (*Pillars of Society*), in 1877, was the first of a succession of problem dramas by Ibsen which soon created for their author a worldwide reputation—although it should not be overlooked that by this date he already had more than a quarter of a century of dramatic authorship behind him, including his two important verse dramas, *Brand* (1866) and *Peer Gynt* (1867), and his long and ponderous "double-drama" in ten acts, *Kejser og Galilæer* (*Emperor and Galilean*, 1873). *En fallit* (*A Bankruptcy*), the first substantial drama of this type by Bjørnstjerne Bjørnson (*q.v.*), appeared in 1875, following his highly successful debut in 1857 with *Synnøve Solbakken*, the first of a series of "peasant tales." Although never the world figure that Ibsen became, Bjørnson was the leading personality of his age within Norway, not only in literature as a novelist, dramatist and lyric poet but also in many aspects of public affairs.

Traditionally associated with Ibsen and Bjørnson to form the "Big Four" of Norway's literature are the novelists Jonas Lie (*q.v.*) and Alexander Kielland; among them they made of the years 1879 to 1884 something of a minor miracle of productivity: Ibsen's *Et Dukkehjem* (*A Doll's House*), *Gengangere* (*Ghosts*), *En Folkefiende* (*An Enemy of the People*) and *Vildanden* (*The Wild Duck*); Bjørnson's dramas *Leonarda*, *Det ny system* (*The New System*), *En Handske* (*A Gauntlet*), *Over Ævne I* (*Beyond Our Power*) and his novel *Det flager i byen og på havnen* (*The Heritage of the Kurts*); Lie's novels *Rutland*, *Gaa Paa* ("Go Ahead"), *Livsslaven* (*One of Life's Slaves*) and *Familjen paa Gilje* (*The Family at Lilje*); and Kielland's *Garman & Worse*, *Arbeidsfolk* ("Workers"), *Skipper Worse*, *Gift* ("Poison") and *Fortuna*. Lie's first novel, *Den Fremsynte* (*The Visionary*, 1870), did not appear until its author was 37; his sense of telling detail, so typical of his art, is however seen more clearly in some of the later works, *Tremasteren 'Fremtiden'* (*The Barque "Future,"* 1872) and *Lodsen og hans Hustru* (*The Pilot and His Wife*, 1874), for example, and later still in *Kommandorens døttre* (*The Commodore's Daughters*, 1886); while the works of the final section of his career, such as *Onde Magter* ("Evil Powers," 1890) and *Trold* (1891–92), tell of the secret and uncontrollable forces that lurk deep in the personality. Kielland was the foremost stylist of his age, an elegant and witty novelist, though possessed of a strong social conscience and an active reforming zeal that owed much to his admiration for John Stuart Mill; after a prolific decade of authorship in the 1880s, during which he wrote eight novels, three plays and a number of shorter pieces, he virtually gave up writing and produced little during the rest of his life.

In the literature of the 1870s, with its emphasis on the individual's right to free development and free expression in defiance of the allegedly stultifying influence of organized authority—the state, the church, the press—and of outmoded convention, there was a belief in the possibility of social improvement that can only be called optimistic; in the following decade, a growing skepticism and even disillusionment made these literary attacks more bitter and more audacious, and they were directed against many of the social institutions widely regarded as essential to "respectability"—the family, marriage, religion. The publication of *Fra Kristiania-Bohêmen* ("From the Christiania Bohème") in 1885 by Hans Jaeger (1854–1910) created, by its seeming advocacy of sexual licence, a great public scandal. The most extreme exponent of Naturalism in these years was however probably Amalie Skram (1846–1905), especially in her four-volume novel *Hellemyrsfolket* ("The People of Hellemyr," 1887–98). Much more difficult to classify, but also a much greater writer, was Arne Garborg (*q.v.*), in whose works the successive movements of romanticism, realism, naturalism and neo-romanticism can be seen stratified. His wider reputation was first established with the novel *Bondestudentar* ("Peasant Students") in 1883, in which the details of student life in the Norwegian capital in the 1880s are movingly described; and he continued in the naturalist style in a

number of later novels. He was also a dramatist and critic; but many would claim that his greatest achievement was the poem-cycle *Haugtussa* (1895), some poems from which were set to music by Edvard Grieg.

The New Irrationalism.—A deliberate break with the older and more socially orientated literature came with the 1890s, when the established great ones of Norwegian literature came under fire from the new generation of writers. The real manifesto of the new ideas was the essay published in 1890 in the periodical *Samtiden* by Knut Hamsun (*q.v.*), "Fra det ubevidste Sjæleliv" ("From the Unconscious Life of the Mind"), which exhorted writers to give their attention rather to what was individual and idiosyncratic than to what was typical and everyday. Hamsun's own early novels splendidly exemplify these ideas: *Sult* (1890; *Hunger*), *Mysterier* (1892; *Mysteries*) and *Pan* (1894); his later novels, of which his *Markens Grøde* (1917; *Growth of the Soil*) is the best known, are in this respect less extreme, as well as being more moralist, more conservative, though still shot through with a strong and sometimes savage irony. Hamsun won the Nobel prize for literature in 1920. More than 20 of his novels—practically his entire output—have been translated into English.

Lyric poetry also flourished with new vigour in this decade, the most remarkable figure being Sigbjørn Obstfelder (1866–1900), whose lyrics and prose poems show a close affinity with the prevailing Symbolist movement in Europe; Nils Collett Vogt (1864–1937) also produced some of his best lyrics in the '90s. In drama, the new spirit found clearest expression in the works of Gunnar Heiberg (1857–1929), who combined a sharply satirical wit with a lyric deftness, whereby sometimes the one predominates as in *Kong Midas* (1890), and sometimes the other, as in *Gerts Have* ("Gert's Garden," 1894); both his *Balkonen* (*The Balcony*, 1894) and his *Kjærlighetens Tragedie* (*Tragedy of Love*, 1904) are impressive in their erotic force.

Of the same generation as Hamsun, and in large measure sharing his preoccupation with the irrational side of human conduct, was Hans Kinck (1865–1926), a writer of tremendous power and penetration; Kinck however was a much more reflective and intellectual writer than Hamsun, and his work was more analytical, especially his verse-drama *Driftekaren* (*The Drover*, 1908) and his three-volume novel *Sneskavlen brast* (*The Avalanche Broke*, 1918–19).

The 20th Century.—Surprisingly for a country in which, in the persons of Ibsen and Bjørnson, the tradition of drama had been so strong, the real achievements in Norwegian literature in the first half of the 20th century were made less in drama than in the novel—especially in the works of the later Hamsun, of Kinck, of Sigrid Undset and of Olav Duun—and in lyric poetry; drama, with the exception of the later works of Gunnar Heiberg and the plays of Nordahl Grieg, produced by comparison little of conspicuous merit. Throughout the early decades of the century a strong tendency toward regionalism showed itself in a number of ways, particularly but not exclusively in the novel, whereby an author became identified with some particular region or even valley; to emphasize this local connection, many authors deliberately adopted a form of language—either of *landsmål* (later called *nynorsk*) or of *riksmål* (later called *bokmål*)—that was strongly coloured by dialect. The west country was, for example, represented by Jens Tvedt (1857–1935); the east by Hans Aanrud (1863–1953); the south by what was almost a "school," including the brothers Thomas and Vilhelm Krag (1867–1913 and 1871–1933) and Gabriel Scott (1874–1958); and the "middle north" region of Trøndelag by Olav Duun, Johan Bojer (*q.v.*), Peter Egge (1869–1959) and Kristofer Uppdal (1878–1961)—the latter's ten-volume novel-cycle *Dansen gjenom skuggeheimen* ("The Dance Through the Shadow World," 1911–24) being one of the most remarkable products of this age. Pervasive, too, was the tendency, again most strongly marked in the novel, to treat the conflicts that arose in Norwegian society from the spread of industrialism—a process to which Norway was subjected rather later than most other European countries, and also rather differently. The most expressly proletarian writer, both by upbringing and by the themes in his works, was the novelist Oskar Braaten (1881–1939); but altogether superior as an artist is Johan Falkberget (1879–) who writes in his novels with understanding, affection, and his ... insight about the miners of Røros in central eastern Norway, especially in *Christianus Sextus* (1927–35) and in *Nattens brød* ("Bread of Night," 1940 *et seq.*).

Two other great figures in the history of the novel in the first half of the century were Sigrid Undset (*q.v.*), who won the Nobel prize for literature in 1928, and Olav Duun (*q.v.*). Though the setting of Miss Undset's novels ranges in time from the late Middle Ages to the 20th century, their general concern is to examine the whole problematic range of women's loyalties within the framework of their role in society and at various times in history. ... her historical novels, the three-volume *Kristin Lavransdatter* (1920–22; Eng. trans. 1923–27) is one of the undisputed masterpieces of Norwegian literature; the later *Olav Audunssøn* (4 vol. 1925–27; trans. as *The Master of Hestviken*, 1928–30) is generally thought less successful. Of her modern novels, the early *Jenny* (1911) is forcefully realistic; the later ones, including *Gymnadenia* (1929; *The Wild Orchid*, 1931) and *Den brændende busk* (1930; *The Burning Bush*, 1932), were written after her conversion to Roman Catholicism, and bear the clear imprint of this conversion. Duun's masterpiece is his *Juvikfolke* (1918–23; *The People of Juvik*, 1930–35), a novel cycle in six volumes in which he follows the fortunes of a Trøndelag family through the century beginning with Norway's independence from Denmark and ending with World War I; his strength as a novelist lies chiefly in his profound understanding of the deeper sources of human conduct, and in his penetrating insight into life as an endless conflict.

In the years immediately before World War I, several lyric poets of merit made their debut: the easily spontaneous Herman Wildenvey (1886–1959), the disciplined and reflective Olaf Bull (*q.v.*), the dramatically intense Tore Ørjasæter (1886–), and the mystical *landsmål*-poet Olav Aukrust (1883–1929). Between World Wars I and II, however, it was more particularly the socially committed writers who impressed their personalities on the age, particularly the poet Arnulf Øverland (*q.v.*), whose poems of this period showed a steady drift toward the polemical; the novelist and critic Sigurd Hoel (1890–1961); and the dramatist and critic Helge Krog (1889–1962). Another distinguished "engaged" author of these years (though of a slightly later generation) was Nordahl Grieg (*q.v.*), who was killed in World War II.

After the war, a number of writers who had already created something of a reputation for themselves before 1940 further consolidated and enhanced their position. Tarjei Vesaas (1897–), a *nynorsk* novelist and poet widely regarded as the heir to Olav Duun, wrote a remarkable series of novels, beginning with the highly symbolic *Huset i mørkret* ("House in Darkness," 1945) and including *Bruene* ("Bridges," 1966); Cora Sandel (pseudonym of Sara Fabricius, 1880–), who had made her first major contribution to literature with her *Alberte* trilogy (1926–39; Eng. trans. 1962–65), continued to write after the war, as did Aksel Sandemose (1899–1965), Danish by birth but Norwegian by adoption, an experimental writer whose novels of the 1930s many people found shocking; and Johan Borgen (1902–), whose most accomplished early work was probably his short stories, and who made a new reputation with his *Lillelord* trilogy (1955–57) and with the autobiographical *Barndommens rike* (1965).

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NORWICH, ALFRED DUFF COOPER, 1st Viscount (1890–1954), British author and politician who, as first lord of

the admiralty (1937–38), ordered the mobilization of the British fleet during the Czech crisis of Sept. 1938. The agreement the British and French governments made with Hitler and Mussolini at Munich a few days later met with his strong disapproval and he resigned from Neville Chamberlain's government on Oct. 1, 1938. When Winston Churchill formed his wartime coalition government in May 1940, Duff Cooper returned to office. His knowledge and love of France secured him the appointments as British envoy to the French Committee of National Liberation in north Africa (Nov. 1943–Sept. 1944) and as ambassador extraordinary and plenipotentiary to France (Sept. 1944–Oct. 1947). He was knighted in 1948, and was created a viscount in 1952.

Duff Cooper was born in London on Feb. 22, 1890, and educated at Eton and at New college, Oxford, before entering the foreign office. During World War I he was commissioned into the Grenadier guards (1917), served with them in France and was decorated (1918). In 1919 he married Lady Diana Manners, daughter of the 8th duke of Rutland (whose beauty became famous through her appearance in the leading role in Max Reinhardt's spectacle, *The Miracle*). The measure of the Duff Coopers' devotion was given most movingly by Duff Cooper in his autobiography, *Old Men Forget* (1953). Having entered politics, he was Conservative member for Oldham from 1924 to 1929, when he lost the seat. He reentered parliament in March 1931, as the victor in a stormy by-election in the old St. George's division of Westminster, a seat he held until 1945. He fought the by-election in 1931 as champion of Stanley Baldwin, who was then the object of a violent newspaper attack. While in parliament Duff Cooper held various ministerial offices. He was respected but failed to endear himself to the house. Indeed, he probably never tried to do so. He wrote several books of which the best is *Talleyrand* (1932), a biography of the French statesman. *The Rainbow Comes and Goes* (1958), *The Light of Common Day* (1959) and *Trumpets From the Steep* (1960) are the three volumes of his wife's autobiography. He died at sea near Vigo, Spain, on Jan. 1, 1954. (J. F. B.)

NORWICH, GEORGE GORING, Earl of (1585–1663), English royalist who played a prominent part in the second phase of the English Civil War, was the son of George Goring of Hurstpierpoint and Ovingdean, Sussex. Knighted in 1608, he became a favourite with James I and his court. He accompanied Prince Charles to Spain in 1623 and later helped to negotiate his marriage with Henrietta Maria. He was made Baron Goring in 1628 and a privy councilor in 1639. He benefited from monopolies granted by Charles I, including those for gold and silver thread, for tobacco, and for the licensing of taverns. As the rift widened between Charles and parliament, Goring devoted himself and his fortune freely to the royal cause. He went with the queen to the Netherlands to raise money for the king in 1642 and, as ambassador to France, he negotiated with Mazarin for money and arms in 1643. These proceedings were revealed to parliament in Jan. 1644 by an intercepted letter to Henrietta, and Goring prudently remained abroad until 1647, when he received a pass from the parliament under the pretext of seeking reconciliation. In Nov. 1644 the king had renewed for him the title of earl of Norwich previously held by his uncle.

Goring had little success as a military commander. The Kentish levies, which he led, were dispersed by Fairfax at Maidstone in June 1648. Then, having failed to raise royalist support in London, he moved into Essex but was besieged in Colchester until compelled by starvation to surrender unconditionally (Aug. 1648). He was condemned to death on March 6, 1649, but, partly because of petitions for mercy, the house of commons reconsidered Norwich's case, and his life was spared by the speaker's casting vote. He next joined the exiled court of Charles II, who employed him to negotiate with the duke of Lorraine for a marriage between the duke's daughter and the duke of York, and for help toward an expedition to Ireland. Norwich had, however, no more success as a diplomatist than as a general. He became captain of the king's guard at the Restoration, and in consideration of the fortune he had expended in the king's service a pension of £2,000 a year was granted to him. He died at Brentford on Jan. 6, 1663, and was buried in Westminster abbey. (S. R. Bt.)

NORWICH, a cathedral and university city, county and parliamentary borough, and county town of Norfolk, Eng., on the navigable river Wensum, 20 mi. W. of the east-coast seaport of Great Yarmouth and 111 mi. N.E. of London by road. Pop. (1961) 119,904.

In the middle of the city lies the market place (markets held twice a week), overlooked by the red-brick City hall (1938), centre of administration and housing the civic regalia; the flint Guildhall (1407–13) with its Tudor council chamber; and the magnificent 15th-century parish church of St. Peter Mancroft, where Sir Thomas Browne (1605–82), author of *Religio Medici*, is buried. Prominent on a mound to the east is the castle (12th century, refaced 1833–39) and since 1894 the principal museum and art gallery. It is particularly rich in archaeology and paintings of the Norwich school; outstanding are the Colman family's gift collections of John Crome (1768–1821) and John Sell Cotman (1782–1842). On low ground near the Wensum stand the cathedral and remains of the Benedictine monastery founded (1096) by Bishop Herbert de Losinga two years after the ancient see, founded by St. Felix, had been moved from Thetford. The cathedral church of the Holy Trinity is largely 12th century, with a distinctive Norman apse and nave, enhanced by Perpendicular and other additions; it is 461 ft. long. The roof of the nave was built by Bishop Walter Lyhart (1449–72) to replace a wooden roof, and that of the chancel by Bishop James Goldwell (1472–99) who also built the lofty stone spire, 315 ft. high. The many treasures of the cathedral include the pre-Norman bishop's throne, the only example north of the Alps of a throne in the ancient basilican position and still used by Herbert's successors, numerous painted bosses, 14th-century examples of local painting and well-preserved 14th–15th-century cloisters, the largest in England. The extensive precincts are entered from the ancient fairground of Tombland by the richly sculptured Erpingham gate (1420) and St. Ethelbert's gate (1316). Life's green in the precincts contains the grave of Nurse Edith Cavell (*q.v.*). South of the City hall stands the Central Public library (1963), a rectilinear building of flint, glass and concrete containing an American library, and a courtyard fountain, given by the 2nd Air division, 8th U.S.A.A.F., in memory of the 6,032 members who lost their lives 1941–45; there also are the Colman and Rye libraries of local history (40,000 volumes), the City library (1608) and the Norfolk and Norwich Record office. Adjacent are the Assembly rooms, the finest example of Georgian architecture in Norwich, built by Thomas Ivory (1754), now a municipal cultural centre. Among the city's 30 medieval churches are St. John Maddermarket, rich in memorials to great Norwich citizens including Nugent Monck (1878–

KENNETH SCOWEN

ELM HILL, A SIDE STREET IN NORWICH

1958), founder of the nearby Maddermarket theatre; St. Andrew's church in which parish Anthony Solen established the first Norwich printing press (1567) and where, about 1602, John Robinson, pastor to the Pilgrim Fathers, troubled the church by his radical puritanism; and the rebuilt Saxon church of St. Julian, with a modern chapel dedicated in memory of Julian of Norwich, the 14th-century anchoress and mystic who wrote the *Revelations of Divine Love* there. St. Andrew's hall, which takes its name from the neighbouring church, is the nave of the former church of St. John the Baptist, built by the Dominicans in the 15th century. Later it housed the Dutch congregation and is now an exhibition and concert hall. Nearby are three municipal museums, the mainly medieval Strangers' hall (domestic life), the 14th-century flint Bridewell (local industries) and St. Peter Hungate church (ecclesiastical museum). Significant in the history of nonconformity are the Congregationalist Old Meeting house (1693), the Unitarian Octagon chapel (Thomas Ivory, 1754) and the Quakers' Gildencroft (1699, rebuilt).

Fast railway passenger and freight services link Norwich with London (two hours), the east coast and the midlands. The river port, taking ships up to 600 tons, with 400 ft. of public quay and a yachting station for pleasure craft, imports coal, timber and grain. A new 35-ac. livestock market was opened in 1960; with the city's corn, vegetable and provision market, and 1,500 retail shops, it serves a large agricultural hinterland. Norwich ranks high among English cities in the making of footwear, which employs 9,000 workers and exports to western Europe and the Commonwealth. Other main industries with an export trade are the manufacture of wire netting, packing machinery, heating-plant and electric motors, and the production of mustard, soft drinks and confectionery; insurance, banking and printing are also important. Norwich was subjected to a series of heavy air attacks during World War II and since then extensive rebuilding and town planning have taken place.

Schools include the Grammar school, founded by Edward VI although there was previously a monastic school on that site. George Borrow and Horatio Nelson were pupils. Establishments for advanced education include a teachers' training college, an art school, and the City college which attracts students from all parts of the Commonwealth; in 1963 the University of East Anglia was opened in the pastoral setting of Earlham park, long associated with the Gurneys, a Quaker family of bankers and social reformers, among whom was Elizabeth Fry. Prominent features of the city's cultural life are the Archaeological society, Philharmonic society, Art circle and the Maddermarket theatre. The Norwich festival of choral music and the arts is held triennially. There are two television broadcasting stations. Increasingly Norwich attracts tourists both for its own interest and as the approach to the Norfolk coast and the system of lakes known as the Broads.

The first permanent settlements on the site were Saxon villages on the gravel terraces above the Wensum, three miles north of the site of the Roman town of Venta Icenorum (Caistor St. Edmund). One of them, Northwic, where coins were minted (925–940) by Aethelstan, gave its name to the subsequent town, already a thriving trading centre when sacked by the Danes (1004). By the Norman Conquest it had 5,500 inhabitants and during the next seven centuries was one of the most prosperous of English provincial towns; by 1662 it was probably the largest with nearly 30,000 inhabitants. The surrounding fertile country provided timber, hides, grain and wool (stone was brought from overseas) and sustained the early building, leather, brewing and woolen industries, which were financed by a prosperous 12th-century Jewish community. Enormous impetus was given to the wool trade when Edward III induced Flemish weavers to settle in 1336, and again when Dutch, Flemish and Walloon Protestant refugees came in the reign of Elizabeth I. In 1579 there were 6,000 foreigners in a population of 16,000. A generation later many Norfolk Puritans left to found townships in the new American colonies. In 1643, at the time of the Civil War, the Puritans were dominant, churches and the cathedral were sacked, and Bishop Joseph Hall was forced to leave his palace.

Recurrent outbreaks of bubonic plague, particularly severe in 1349, 1579 and 1665, destroyed a third of the population. Unsuccessful peasant revolts were led by John Litester (1381) and Robert Ket (Kett) (1549). The first charter dates from 1158 and a second charter was given by Richard I in 1194. Henry IV's charter of 1404 made Norwich a county, with a mayor and two sheriffs. It became a county borough in 1888 and the title and dignity of Lord Mayor was bestowed upon the chief magistrate in 1910. Since 1298 it has returned two members to parliament.

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(F. D. SA.)

NORWICH, a city of southeastern Connecticut, U.S., is located 13 mi. N. of New London, at the confluence of the Yantic and Shetucket rivers which there form the Thames; one of the seats of New London county. Norwich is accessible to the sea by way of a Thames river channel capable of handling ships up to about 10,000 tons. Shipbuilding and shipping were important in the 18th century, and from the American Revolution to the American Civil War firearms were made there. Subsequently, however, Norwich became an important centre for the manufacture of textiles, vacuum bottles, metal and leather products, machinery paper boxes, clothing, plastics and chemicals.

The town was founded in 1659 by settlers from Saybrook under the leadership of Capt. John Mason and the Rev. James Fitch. The land was purchased from Uncas, a Mohegan chief and an early friend of the settlers, who is buried under a monument on Sachem street. The city, part of the town of Norwich which also included Norwichtown, Taftville and part of Yantic, was chartered in 1784. In 1951 the city and the town were consolidated and a council-manager form of government was inaugurated.

Norwich is the birthplace of Benedict Arnold and the home of the Huntington family, many members of which were leaders in early American civil and military affairs. Many houses dating from the 17th and 18th centuries still stand. These include the Leffingwell inn (1666) and the Glebe house (1748). Pop. (1960) 38,506; for New London–Groton–Norwich standard metropolitan statistical area *see* NEW LONDON. For comparative population figures *see* table in CONNECTICUT: *Population*. (W. D. LO.)

NORWID, CYPRIAN KAMIL (1821–1883), the most original and least appreciated Polish poet of the 19th century, whose works have been rediscovered in the 20th century and have influenced modern Polish writers, was born at Laskowo-Gluchy near Warsaw, on Sept. 21, 1821. In 1837 he began to study drawing and painting; and in 1842 set out for Italy. In 1846 after an incident with the Russian envoy in Berlin, he was arrested and, on his release, deported to Belgium. He went to Rome again in 1847 and to Paris in 1849. In 1852 he sailed for the United States but in 1855 returned, via England, to Paris, where he led a life of penury and obscurity and where he died on May 22, 1883.

His lack of literary success in his own day was due to the idiosyncratic and difficult style of his many writings in prose and verse—poems (*Poezye*, 1863), plays (*Krakus*, publ. 1863; *Wanda*, publ. 1901; *Kleopatra*, publ. 1904) and treatises (*e.g.*, *Promethidion*, a treatise on aesthetics, in prose and verse, included in *Poezye*) His poetry is essentially philosophical. It shows profound understanding of history, respect for the individual, a fine sense of irony, intellectual integrity and a self-effacing subordination to his subject which results in the utmost verbal economy. Norwid's work was restored to posterity by Zenon Przesmycki (Miriam) who began publishing his works in 1901. For portrait *see* article POLISH LITERATURE.

See J. Pietrkiewicz, "Introducing Norwid," *The Slavonic and East European Review*, vol. xxvii (1948); translations of Norwid's letters and poems in *Botteghe Oscure*, vol. xxii (1958). (L. R. LA.)

NORWOOD, a city of Hamilton county in southwestern Ohio, U.S., is completely surrounded by the city of Cincinnati (*q.v.*). Norwood, originally Sharpsburg after John Sharp, one of its earliest settlers, began as a crossroads coach stop in 1809. Its position on the upland between the Great and Little Miami rivers, away from the early major routes of commercial travel, resulted

in very slow growth compared to nearby valley cities. It was laid out in 1873, incorporated as a village under its present name in 1888 and chartered as a city in 1903. By 1900 it had become a minor railway centre and residential suburb, especially for merchants of Cincinnati. Soon after, it began attracting industries that wished to locate in Cincinnati but found the larger city too crowded. Leading industries include printing and lithographing and the manufacture of automobiles, automobile bodies, paints, machine tools, electric motors, playing cards, women's shoes, office equipment, laundry machinery and cans. Norwood is the seat of Athenaeum of Ohio, a Roman Catholic college for men, founded in 1829 as the Seminary of St. Francis Xavier. For comparative population figures on Norwood (part of the Cincinnati standard metropolitan statistical area) *see* table in OHIO: *Population.*

(J. L. TH.)

NOSE, the organ of the sense of smell in man and other animals; it also acts as a filter and a warmer for inspired air.

See OLFACTORY SYSTEM; SMELL AND TASTE.

NOSE, DISEASES OF. Diseases of the nose lead to dysfunction, characterized chiefly by impaired nasal breathing. The primary function of the nose is to serve as an air conditioner for all the inspired air before it reaches the lungs, but the nose also serves as an organ of smell, the olfactory sense.

Diseases of the nose are subdivided into acute and chronic rhinitis (rhinitis meaning an inflammatory reaction of the mucous membrane lining of the nose). In the acute form, such as a head cold (*see* COLD, COMMON), rhinitis is accompanied by a profuse watery discharge, which always impairs nasal breathing. Unless secondary infection occurs, these symptoms last for a period of usually seven days. Allergic rhinitis, which produces similar symptoms, may be caused by any allergen, such as ragweed or dust, and is commonly called hay fever (*q.v.*). The symptoms of this condition persist and do not subside until the offending allergen is discovered and removed. Chronic rhinitis, which usually is due to repeated attacks of acute rhinitis, produces in the early stages hypertrophy or enlargement of the mucous membrane, termed hypertrophic rhinitis. The hypertrophy leads to impairment of nasal breathing and usually is accompanied by a thick, tenacious discharge. If this condition persists for a long period of time it is followed by atrophy and the presence of dry offensive-smelling crusts, a condition called atrophic rhinitis.

Impairment of nasal breathing frequently is occasioned by irregularities or deformities of the central partition of the nose (nasal septum), occurring as a general rule as the end result of external injury to the nose. The tip and nasal vestibule of the nose are prone to staphylococcus infection because of the presence of hair follicles inside the nose.

Continued irritation from infection or allergy can give rise to nasal polyps, usually on the middle turbinate. Gradual enlargement of these polyps leads to increasing difficulty in breathing through the nose. *See* also NOSEBLEED; SINUS.

See W. W. Morrison, *Diseases of the Ear, Nose and Throat* (1948); R. L. Cecil and R. F. Loeb (eds.), *A Textbook of Medicine*, 10th ed. (1959).

(G. W. McA.)

NOSEBLEED (EPISTAXIS) is common and usually of little importance in childhood. It may result from local conditions or inflammation, small ulcers or polypoid growths, or severe injuries to the skull. Vascular disease, such as high blood pressure, may provoke it, and such diseases as scurvy and hemophilia also may be responsible for it. Usually it is easily controlled by rest, application of cold and pressure. On occasion it may require expert care.

(F. L. A.)

NOSTRADAMUS (1503–1566), a French astrologer of Jewish descent, who is still remembered for his prophecies. His real name was Michel de Notredame or Nostredame, and he was born at St. Rémy in Provence on Dec. 14, 1503. At Avignon he studied philosophy, and then at Montpellier he read medicine, graduating in 1529. He first practised at Agen, and in 1544 established himself at Salon, near Aix, where he became noted for fine work during outbreaks of the plague at Aix and Lyons.

Nostradamus began to make his prophecies about 1547, publishing at Lyons in 1555 a book of rhymed prophecies entitled *Centuries*. Astrology was at a peak at this time, and an enlarged second edition, dedicated to the king, was published in 1558. The *Centuries* consisted of quatrains grouped in hundreds, each set of quatrains being called a century.

Some of Nostradamus' prophecies seemed to have become fulfilled, and his fame became such that he was invited to visit Catherine de Médicis and himself received the duke of Savoy at Salon. Charles IX appointed him physician-in-ordinary. He died on July 2, 1566, but his predictions were eagerly read for long after. Much controversy has been aroused because of the indefinite nature of their meaning, and some have been believed to foretell the distant future. The famous 33rd quatrain of the 5th century, *e.g.*, has been interpreted as a prophecy of the "drownings" of Nantes under the Committee of Public Safety, 1793:

> "Des principaux de cite rebelle
> Qui tiendront fort pour liberte r'avoir,
> Detrancher masles, infelice meslee
> Cris, hurlemens a Nantes piteux voir."

That is: "The city's leaders in revolt, will in the name of liberty slaughter its inhabitants without regard to age or sex. There will be screams and howls and piteous sights in Nantes." (*See* CARRIER, JEAN BAPTISTE.) The prophecies have been the subject of many commentaries, but in 1781 they were condemned by the Congregation of the Index, the body set up by the Roman Catholic Church for the examination of books and manuscripts.

See E. Bareste, *Nostradamus* (1840); C. A. Ward, *Oracles of Nostradamus* (1891); E. Leoni, *Nostradamus: Life and Literature* (1961).

(CH. A. R.)

NOSY BE (NOSSI-BÉ; Be, "great," Nosy, "island"), a volcanic island about 8 mi. off the northwestern shore of the Malagasy Republic (Madagascar), is 19 mi. long and 12 mi. wide with an area of 129 sq.mi. Pop. (1956) 25,787. It has numerous craters and crater lakes and its highest point is Mt. Passot (1,079 ft.). The climate is hot and damp with temperatures ranging from 35° to 18° C. (95° to 64° F.) and a rainfall of 78 to 118 in. a year. Nosy Be is an island of sugarcane and aromatic plants, with forests containing lemurs, a great variety of birds, strange spiders and an endemic frog. Its chief products are sugar and essential oils for perfumery. It also produces rum, quality cacao, vanilla, black pepper, and bitter oranges. The chief town and capital is Hellville, on a sandy bay on the southern shore. It is a seaside resort, a port of call for the Messageries Maritimes (foreign services shipping line), with excellent anchorage, a centre for the coasting trade along the western shores of Madagascar, and the river port for Ambanja on the mainland opposite. There is an airfield at Fascène (7 mi.).

The arrival of Captain Passot's warship "Colibri" in 1840 was the first step in the cession of the island to the French. A treaty of protection was signed between Queen Tsioméko and Captain Passot and the latter named the town Hellville after his commander in chief, Admiral de Hell. Some houses dating from that time are the only curiosities in a town built of iron-roofed bungalows and with no outstanding features. The island is part of Majunga province and has been administered from Madagascar since 1896.

(J. AR.)

NOTARY (NOTARY PUBLIC), a public official whose chief function is to authenticate contracts, deeds and other documents by an appropriate certificate to which is attached the notarial seal.

In Roman law the *notarius*, from which the modern term comes, was originally a slave or freedman who took notes of judicial proceedings in shorthand. The work of the modern notary, however, corresponds more to the Roman *tabularius*, who took and preserved evidence. In medieval times the notary was an ecclesiastical officer nominated by a church official to preserve evidence by attesting important documents. His duties were, and are, mainly secular.

The notary is today appointed by a secular official such as a governor or a president of a republic. This appointment is usually made on application and becomes effective on payment of a fee, the taking of an oath of office and, in many parts of the United States, on deposit of a bond with sureties conditioned upon the proper performance of his duties.

In the United States, qualifications for the position of notary vary little from state to state. In general, a notary must be a citizen of legal age, a resident of the place in which he desires appointment and a person of good moral character. In about 12 states of the United States a woman may not qualify for the position. In countries such as France and Italy and in Quebec, Canada, which follow the civil-law tradition, there are educational requirements similar to those for lawyers and other professions.

In the United States a special jurisdictional problem exists for notaries. The jurisdiction of the notary's office is a state or, in some states, only the county in which he resides; thus, a notary appointed for the District of Columbia may not act in Virginia or in the Maryland suburbs of Washington. If a document is to be used in a county or state in which the notary is not ordinarily qualified to act, a certificate is usually required from an official such as a county clerk showing that the notary is authorized to act in that jurisdiction.

In the civil-law countries of western Europe, including Scotland, and in the Latin-American and French areas of North America, the office of notary is a much more important position than in the United States and England. In these places a notary may be roughly described as a "lawyer" who specializes in the law relating to real estate, sales, mortgages and the settlement of estates but who is not allowed to appear in court. Documents prepared by him or authenticated in the proper manner are, in these countries, admissible in court without further proof of their authenticity. The notary guarantees the identity of the parties.

In the Anglo-American law countries, on the other hand, courts will not accept the facts that a notary has certified as true except in the case of a bill of exchange protested abroad. Nor may a notary draw up legal documents such as wills, contracts, mortgages and deeds for a fee, for such work constitutes the practice of law. Nevertheless, many statutes require that the authenticity of specified documents be certified by a notary, the most common in the United States being those requiring the acknowledgment of a deed conveying land. An acknowledgment is a declaration by the person who has executed (*i.e.*, signed) it that he in fact executed it. It is made before a notary who certifies to that fact and to the identity of the acknowledger. A notary should not, therefore, take the acknowledgment of a person who does not appear before him or from a person who is not known to him unless evidence of identification is presented.

Certain other officials may be given notarial functions by statute, such as justices of the peace, consular officials, certain military officers and various court officials. (A. DM.)

NOTITIA DIGNITATUM, an official list of all offices, civil as well as military, in the eastern and the western halves of the Roman empire. It was one of the duties of a high official, known as the *primicerius notariorum,* to prepare and issue the diplomas of their appointments to all the higher officials of the empire. The insignia of each office were represented on the relevant diploma; and hence the *primicerius* of the west as well as of the east had a list of all the officials in his half of the empire together with information about their subordinates. The surviving *Notitia Dignitatum* happily includes lists of the officials in both parts of the empire and is one of the chief sources of information about the administration, civil as well as military, of the late Roman empire. In addition the *Notitia Dignitatum* gives much geographical knowledge of great value.

The extant manuscripts include copies of the illustrations of the various officials' insignia of office. The problem of the precise date of the document is of great importance and has been much debated. The truth may be that the *Notitia* was drawn up toward the end of the 4th century but was revised and more or less brought up to date in later decades. It was the opinion of J. B. Bury, which has been widely accepted, that the text which survives is a copy of the lists which were in the hands of the *primicerius* in A.D. 427 or not much later. It does not follow, however, that the *Notitia* gives an accurate picture of the administrative hierarchy as it existed in that year. Thus, although the imperial officials in Britain are recorded, it does not follow that Britain was still under Roman administration in 427: these officials would not have been erased from the list unless Britain had been formally ceded to some non-Roman power. They were retained in the record in the hope that the administration of Britain, which seems to have been lost to the empire *c.* 410, would one day be resumed by the emperors. But, when used with care, the *Notitia* is of fundamental importance.

The text was edited by O. Seeck (1876) and it was reprinted in 1962. (E. A. T.)

NOTKER, a name borne by several medieval ecclesiastics. BLESSED NOTKER BALBULUS (*c.* 840–912), "the Stammerer," entered the Benedictine monastery of St. Gall, Switz., and became librarian in 890 and then master of its school. He is known for his composition of sequences, a rhythmic text following the gradual of the Mass, and is commemorated on April 6.

NOTKER (*c.* 940–1008), named bishop of Liège in 972 by his uncle, the emperor Otto I, was active in the reform of his own clergy and that of the abbey of Lobbes, whose Abbot Heriger is the author of the *Lives* of saints attributed to Notker.

NOTKER LABEO (*c.* 950–1022), monk and master of the monastic school at St. Gall, whose translation of sacred and secular Latin texts into Old High German earned him the epithet of "the German." (H. G. J. B.)

NOTORNIS (TAKAHE) (*Notornis hochstetteri*), a chicken-sized flightless gallinule (family Rallidae) of South Island, New Zealand. It is a colourful species with brilliant blue and coppery-green plumage and a large red bill, continued onto the forehead in a frontal shield. Considered extinct for 50 years, the notornis was rediscovered in 1948, living in small groups in several remote, thickly wooded glacial valleys at 2,000 ft.

It is a browsing species, stripping seeds from grasses by running the bill along the stems. The nest is on the ground and the two eggs are dull cream with brown blotches; the young are black and downy. Both parents are believed to share in the incubation, and the young may be able to breed at the age of one year. See also RAIL. (W. J. BE.)

NOTRE DAME, UNIVERSITY OF, a Roman Catholic institution of higher learning for men, at Notre Dame, Ind., was founded in 1842 by brothers of the Congregation of Holy Cross, a religious community that originated in France. *See* SOUTH BEND.

NOTTAWAY, a river of western Quebec, Can., drains Lake Mattagami at 765 ft. above sea level and flows northward 140 mi. into Ruperts bay at the south end of James bay. Many rivers flow into Lake Mattagami, the largest being the Bell, Chibougamau and Waswanipi, and each adds over 150 mi. to the main stream. The swift-flowing Nottaway with its many rapids and falls was explored by Robert Bell, Canadian government geologist, in the 1870s. (J. D. I.)

NOTTINGHAM, EARLS OF. This English title was created in 1377 for JOHN DE MOWBRAY (1365–1383), and after his death it was recreated in 1386 for his brother and heir, THOMAS (*c.* 1366–1399), who became duke of Norfolk in 1397 (*see* NORFOLK, THOMAS MOWBRAY, 1st Duke of). The earldom remained a subsidiary title in the Mowbray family until the death of JOHN (1444–1476), 4th duke of Norfolk. It was then recreated for RICHARD (d. 1483), duke of York (*see* YORK, RICHARD, Duke of), who was murdered in the Tower of London, and the title was then granted in 1483 to WILLIAM DE BERKELEY (d. 1492), on whose death the title lapsed. HENRY FITZROY (*c.* 1519–1536), an illegitimate son of Henry VIII, held the title as a subsidiary honour to the dukedom of Richmond. On his death without heir, the earldom reverted to the crown until it was re-created for CHARLES HOWARD (*c.* 1536–1624), Lord Howard of Effingham (*see* NOTTINGHAM, CHARLES HOWARD, 1st Earl of). On the death of CHARLES (1610–1681), 3rd earl of this line, the earldom became extinct but the barony of Effingham passed to his cousin and heir male.

HENEAGE FINCH (1621–1682), the lord chancellor, was created earl of Nottingham a few months before his death on Dec. 18, 1682. The Finch family was of Kentish origin, and Thomas Finch (d. 1563) was knighted for his part in suppressing Sir Thomas

Wyat's rebellion in 1554. His son, Sir Moyle Finch (d. 1614), married Elizabeth, daughter of Sir Thomas Heneage; she was created countess of Winchilsea in her own right in 1628. Her fourth son, Sir Heneage Finch (d. 1631), a distinguished lawyer, was speaker of the house of commons, recorder of the City of London and the father of Heneage Finch, the lord chancellor. The latter was called to the bar in 1645, appointed solicitor general at the Restoration, attorney general in 1670 and lord chancellor in 1675. He was created baron in 1674 and earl of Nottingham in 1682.

DANIEL (1647–1730), 2nd earl, took a prominent part in politics after 1688 and was secretary of state 1688–93 and 1702–04. He was a Tory who had considerable influence over Mary II, but suspicion of Robert Harley and Henry St. John led him to join the Whigs in 1711. In 1729 he inherited the earldom of Winchilsea, and thereafter the earldom of Nottingham was merged in the Winchilsea title. The earldoms passed in 1826 to GEORGE (1791–1858), 10th earl of Winchilsea and 5th earl of Nottingham, who adopted the additional surname of Hatton. CHRISTOPHER (1936–), 11th earl of Nottingham and 16th earl of Winchilsea, succeeded in 1950.

NOTTINGHAM, CHARLES HOWARD, 1ST EARL OF, and 2ND BARON HOWARD OF EFFINGHAM (1536–1624), English lord high admiral who commanded the fleet in the defeat of the Spanish Armada. He was the eldest son of William, 1st Baron Howard of Effingham, lord high admiral. He was closely connected with Elizabeth I, since his father's sister, Elizabeth Howard, was the mother of Anne Boleyn. He was sent as ambassador to France in 1559 to congratulate Francis II on his accession and was general of the horse under the earl of Warwick in suppressing the rebellion of the north in 1569. Next year he commanded a squadron sent to watch the Spanish fleet which came to conduct the queen of Spain from Flanders. In the parliaments of 1563 and 1572 he represented Surrey. He succeeded to his father's title of Lord Howard of Effingham in 1573; was installed a knight of the Garter in 1575; and made lord chamberlain of the household in 1584, an office he retained until he became lord high admiral in 1585. He was one of the commissioners for the trial of the conspirators in the Babington plot and of Mary Stuart in 1586.

When the English naval forces were mobilized against the Armada, Howard hoisted his flag as commander in chief on the "Ark" in Dec. 1587 and in May 1588 sailed with the main fleet from the river Thames to join Sir Francis Drake's advance force at Plymouth. Drake became his vice-admiral and John Hawkins his rear admiral. These two, with five other officers, formed his council of war and the harmony that his personality and authority imposed upon his more brilliant subordinates was an important factor in the victory. Like them, he was eager to seek out the Spanish fleet upon its own coasts. But when he at length won Elizabeth's consent, adverse winds thrice frustrated him and while he was refitting in Plymouth after the third attempt, the Armada appeared off the Lizard (July 19). In the ensuing actions, the English ships outsailed and outmaneuvered the enemy, but Howard, at first probably outnumbered and even outgunned (for short-range fire), did not dare to close with them. Instead, he harassed them from longer range, plucking "their feathers by little and little," and shepherding them slowly up the English channel. Rasher spirits criticized these tactics, but, as Sir Walter Raleigh said, "had he entangled himself with those great and powerful vessels, he had greatly endangered this kingdom of England." He was perhaps more open to criticism for lagging behind the rest of the fleet to attack the crippled "San Lorenzo" at Calais on July 29, at a moment when the Armada, its close formation broken by the English fireships, was straggling in disorder past Gravelines. Nevertheless, he contributed nobly to a famous victory and his fame hardly needed the support of the rather one-sided "Relation of Proceedings," published in *State Papers Relating to the Defeat of the Spanish Armada*, ed. by Sir J. Laughton for the Navy Records society (1894), drawn up at his direction. (*See* ARMADA.)

Howard's next important service was the expedition of 1596 to Cadiz, which he commanded jointly with the earl of Essex. Supported by the council of war, he rejected Essex' proposals for further operations after the capture of the town and the next year Essex' anger was increased when the queen created Howard earl of Nottingham (Oct. 1597). Nottingham was again busy with preparations against invasion in Feb. 1598; and also in the summer of 1599, when he was given the exceptional office of lord lieutenant general of England. In 1601 he took a leading part in suppressing Essex' rebellion and served as a commissioner at his trial. It was to Nottingham that Elizabeth named James I as her successor on her deathbed.

Under the new king Nottingham continued in his office of lord high admiral. He was one of the commissioners to treat with Spain in 1604 and went as ambassador extraordinary to receive the Spanish ratification of the peace treaty in 1605. He served on numerous commissions, including those on the union of England and Scotland in 1604, for the trial of the conspirators of the Gunpowder plot and of the Jesuit Henry Garnett in 1606, and for reviewing the articles and rules of the order of the Garter in 1611 and 1618. He attended Princess Elizabeth to Flushing with a squadron on her marriage to the elector palatine in 1613. Nottingham, who, unlike many of the Howards, was a stanch Protestant, was commissioner in Surrey for inquiring after recusants, and in the diocese of Winchester for hearing ecclesiastical causes; he sat on the government commission for discovering and expelling Roman Catholic priests, and was mentioned in 1602 from Douai as one of the three enemies most feared by the recusants. On the report of the commission on the navy in 1618, Nottingham, who was over 80, vacated his office of lord high admiral (Jan. 1619), though no blame was attached to him for the abuses then exposed.

He died at Haling house, near Croydon, Surrey, on Dec. 14, 1624, and was buried at Reigate, a monument being later placed to his memory in St. Margaret's church, Westminster.

Nottingham married first, in 1563, Catherine, daughter of Henry Carey, 1st Lord Hunsdon; and secondly, in 1603, Margaret, daughter of James Stuart, earl of Murray. Charles (1579–1642), his second son by his first marriage, succeeded as second earl of Nottingham. On his death without male issue, he was succeeded by his half brother, and when he died childless in 1681 the earldom became extinct. (R. B. WM.)

NOTTINGHAM, a municipal, parliamentary and county borough (1888), the county town of Nottinghamshire, Eng., stands on the river Trent 123 mi. N.N.W. of London by road. The town was raised to the status of a city in 1897 and the title and dignity of lord mayor was conferred in 1928. Pop. (1961) 311,899.

The main feature of the city is the Old Market square, 5½ ac. in extent, one of the largest in England and which has existed from Norman times. Dominated on the eastern side by the Council house, opened in 1929 replacing the earlier Exchange building of 1726, the square is flanked by shops with a central area reserved for pedestrians.

Nottingham is linked with the Robin Hood folk legend, commemorated in the Robin Hood statue by James Woodford on the Castle green. In the Low Pavement and Castle Gate are some fine examples of 18th-century houses. It was at Standard hill that King Charles I raised his standard in 1642, marking the outbreak of the English Civil War. The castle was demolished in 1651 on the orders of parliament. William Cavendish, the 1st duke of Newcastle, built on the site in 1674 a town mansion, which was burned during the Reform Bill riots of 1831; the burned-out shell was acquired and renovated by the corporation (1875–78) and now houses the museum and art gallery.

The oldest parish church is St. Mary's, a mainly Perpendicular cruciform structure with a fine central tower. St. Peter's dates from the 12th–15th centuries. St. Nicholas' was rebuilt in 1678 after it had been demolished by the Parliamentarians during the Civil War. Nearby in Castle Gate is Newdigate house (1670), where the French Marshal Tallard, who was taken prisoner at the battle of Blenheim (1704), lived. The Roman Catholic cathedral of St. Barnabas, designed by Augustus Pugin, was consecrated in 1844.

The grammar school, founded in 1513 by the benefaction of Dame Agnes Mellors, moved in 1868 to its present buildings on Arboretum street, and is known as the High school. The Notting-

ham High School for Girls (1875) is one of the Girls' Public Day School Trust foundations. University college was opened in 1881 and was moved to its present site of more than 260 ac. on Highfields in 1928, the land being given by Lord Trent (Jesse Boot, founder of Boots Pure Drug company). The university was incorporated in 1948 and began to confer its own degrees in 1950. The old University college buildings on Shakespeare street now house the Nottingham and District Technical college. The Theatre Royal on Theatre square (1865) replaced an earlier theatre built in 1760 in St. Mary's Gate. A new Civic theatre was opened in 1963. Trent Bridge cricket ground, one of the finest in the country, is the home of Notts County Cricket club.

The Arboretum was opened as a park in 1852. The Elizabethan Wollaton hall, together with its park of 744 ac., was bought by the corporation in 1925. The hall houses the Natural History museum. Newstead abbey (11 mi. N.W. of the city), a 12th-century Augustinian priory converted into a residence in 1540 and the ancestral home of Lord Byron, is owned by the corporation and contains the Roe-Byron collection. The grounds are also open to the public.

The Trent is navigable as far as Nottingham for barge traffic. The city is linked by a two-hour rail service with London, and is a centre of main roads.

Nottingham is in the heart of the east Midland coalfield, and there are three collieries within the city boundaries. Frame knitting as a trade was important there by the close of the 17th century and with the inventions of spinning machinery by Richard Arkwright and James Hargreaves, Nottingham became a centre for the hosiery trade, which it still is. It was famous for the making of lace and although this trade has declined its lace is still in demand as a fashion fabric. There are allied industries of dyeing and bleaching and much knitted wear is manufactured.

Nottingham has important pharmaceutical and tobacco industries and is the location of one of the largest bicycle plants in the world. Many other trades are carried on, notably light engineering, brewing and furniture manufacture, forming a diversified economy which has given the city continuous prosperity.

The settlement probably grew up because at this point an ancient highway crossed the Trent. The Anglo-Saxons, who occupied the site in the 6th century, gave the settlement the name of Snotingaham, the ham or village of Snot's people. Occupied by the Danes in the 9th century, it was one of five towns of the Danelaw and in pre-Conquest times was known as a city. After the Conquest the Normans founded the Norman borough which existed side by side with the older Saxon borough, both having separate administrations until about 1300. Nottingham's first known charter (1155) confirmed to the burgesses the liberties they had held under Henry I, referred to a market on Saturdays and forbade the working of dyed cloth, except in Nottingham, within ten leagues of the borough. King John confirmed this and granted a guild merchant. Henry III allowed the burgesses to hold the town in fee farm, and Edward I granted them a mayor and two bailiffs. Henry VI in 1449 confirmed all preceding privileges, first incorporated the mayor and burgesses, instituted the office of sheriff and granted that the town, except the castle and jail, should be a county of itself. Parliaments were held at Nottingham in 1334, 1337 and 1357, and it was the scene of the conference of the judges with Richard II in 1387. In the course of its history several fairs were granted to Nottingham; one, the Goose fair, is still held for three days in October. In 1815 it was the centre of riots organized by the Luddites (*q.v.*).

Nottingham's literary associations include Byron, D. H. Lawrence, Philip James Bailey, Samuel Butler and Henry Kirke White.

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NOTTINGHAMSHIRE, a midland county of England, is bounded north and northwest by Yorkshire, west by Derbyshire, south by Leicestershire and east by Lincolnshire. It is roughly oval, 51 mi. long by a maximum of 27 mi. wide, and its geographical area is 859 sq.mi.

Physical Features.—The higher western part of the county forms the eastern fringe of the southern Pennines, and the lower eastern part merges into the lowlands of Lincolnshire. The rocks are sedimentary, and mainly dip gently eastward or southeastward with little disturbance. The Coal Measures are exposed along part of the western border and extend east beneath newer formations to underlie the whole county except a small area in the south. Below the Coal Measures are grits and limestones which in several parts, and notably in the Eakring area near the centre, yield oil. Above the Coal Measures and to the east is a narrow belt of dolomitic or magnesian limestone, with a sharp west-facing scarp, and having the highest land in the county, more than 600 ft. O.D. (Ordnance Datum) near Kirkby-in-Ashfield. To the east again is a belt of Bunter Sandstone, much of which was occupied by the old Sherwood forest. The outcrop is 40 mi. long from Bawtry in the north to Nottingham in the south, and is about 6 mi. wide. The high porosity of the sandstone makes the area almost riverless, and forest and heath is the natural vegetation. Most of east Nottinghamshire consists of Keuper rocks, especially the red Keuper Marl, again forming a west-facing scarp. This area abounds in small streams with comparatively deep valleys, and it is bisected by the vale of the river Trent, covered with alluvial deposits, including patches of river gravel. In the extreme south of the county Keuper and Lias rocks are covered by thick boulder clay which forms the Wolds, rising to about 400 ft. O.D., and extending into Leicestershire.

The river Trent enters the county in the southwest and, curving left, forms the Nottinghamshire-Lincolnshire border in the northeast. Originally the middle Trent drainage discharged eastward via the Ancaster gap, but during the Pleistocene era it flowed through the Lincoln gap for a time, the Trent cutting a shallow trench between Nottingham and Newark-on-Trent and depositing gravels between Newark and Lincoln along a part of its course now abandoned. Its diversion to a still more northerly outlet to the Humber is a comparatively recent development. In the extreme north of the county the Bunter and Keuper rocks decline beneath a low but very fertile alluvial and peat fenland, now artificially drained.

Climate varies little over the county, but because of its situation well to the east in England, Nottinghamshire's range of mean monthly temperature is fairly wide (Jan., 3° C. [38° F.]; July 16° C. [61° F.]). Ground frost occurs on an average of 100-120 days a year, and the Trent vale is especially susceptible to it. The prevailing wind is southwest to west, but cold northeast to east winds are common in spring. The mean annual rainfall varies between 22 in. and just over 30 in., falling evenly both in winter and summer. The mean daily sunshine figure for Nottingham is 3.63 hr., but cloud and fog are frequent in winter, and the December average is only 0.90 hr.

Most of Nottinghamshire is either heavily industrialized and urbanized, or else intensively farmed, but the Sherwood forest area includes large tracts of seminatural vegetation, in the form of oak and birch woods with an undergrowth of bracken interspersed with open areas of heather, ling and gorse. In earlier times the red deer was abundant, and wolf, pine marten, polecat, badger and otter were all common in the forest, but only the last two are still found. More than 150 varieties of birds are still encountered in the county, but many are resident only in the forest area. In 1961 the National trust owned 3,784 ac. in the county. (F. A. BA.)

History.—Implements of Paleolithic Age have been found in the limestone caves near Creswell, on the Derbyshire border, together with the remains of the mammoth, hyena, cave lion and rhinoceros. Evidence suggests Mesolithic settlements in the north of the county, and more frequent Neolithic and Bronze Age settlements in the open country of the south and east. There are noted Bronze Age settlements at Clifton, and Iron Age sites at Broxtowe. In pre-Roman times there seems to have been a crossing of the Trent, near the site of Nottingham, for the tracks along which salt was carried from Cheshire and Worcestershire. The width of the Trent, with Sherwood forest running immediately on its north, seems to have caused the deflection of the Fosse way northeast-

ward from Leicester toward Lincoln via Newark; thus all the larger Roman sites are on this line, including those at East Stoke, East Bridgford (Margidunum) and Willoughby, while a settlement (Segelocum) at Littleborough shows the Roman penetration from across the Trent westward. The earliest Anglian settlers advanced, not later than the 5th century, either from Lincolnshire along the Fosse way, or from Leicestershire down the Soar valley, and settled in the fertile districts of the south and east. At the end of the struggle between Northumbria and Mercia, the area that later became Nottinghamshire remained as part of Mercia; after the treaty of Wedmore (878), Nottingham became one of the five Danish boroughs. For a short period after the breakup of Mercia the area became annexed to the earldom of the Middle English, but in 1049 it was again included in Leofric's earldom of Mercia. The first mention of the shire of Nottingham occurs in 1016, when it was harried by Canute. The boundaries have remained practically unaltered since the time of the Domesday survey. The growth of the great ecclesiastical "Liberty of Southwell" dates from the period when the archbishop of York was unable to maintain himself in the Scandinavian and heathen north; Southwell minster was founded in the mid-10th century, and the land granted to support the minster was the core of the liberty. At this time, too, Nottinghamshire was transferred from the see of Lichfield to that of York in the province of York, where it remained until 1837, when the archdeaconry was transferred to the see of Lincoln. In 1884, however, a new diocese of Southwell was created, in the province of York, which contained the counties of Nottingham and, until 1927, Derby.

In Domesday Book the fief of William Peverel represents the "Honour of Nottingham" and in 1068 he was appointed constable of the castle which the Conqueror had raised in Nottingham. The chief lay tenant was Roger de Busli, while the archbishop's lands remained undisturbed. The Staunton family probably held land at Staunton at the time of Domesday Book, and other well-known families such as the Pierreponts made their appearance in the county before 1300. Archbishop Cranmer was a descendant of the Cranmers of Aslockton. After the Dissolution several of the monastic houses in the county became the homes of powerful landowners, in an area now familiarly known as the "Dukeries"; Welbeck abbey (since 1953 an army training school) became the seat of the Cavendish family, Rufford abbey that of the Saviles, and Newstead (now owned by the city of Nottingham) that of the Byrons. Further royal grants of land in Sherwood forest included Clumber park, the seat of the dukes of Newcastle (now owned by the National trust), and Thoresby hall, that of the Earls Manvers. Wollaton hall, built for Sir Francis Willoughby in 1580–88 and till 1925 the seat of Lord Middleton, but now owned by the city of Nottingham and containing a natural history museum, is the most spectacular of the great buildings, but only Thoresby hall is still privately occupied, and both Clumber and Rufford have been pulled down. Other great ecclesiastical buildings and ruins include the priories of Thurgarton, Worksop and Blyth. Southwell (*q.v.*) minster, cathedral since 1884, is a magnificent Norman church, with exquisite 13th-century carving in the Chapter house.

Until 1568 Nottinghamshire was normally united with Derbyshire under one sheriff; on the other hand until the 19th century there were two clerks of the peace, one for the shire and one for the extensive secular jurisdiction of the "Liberty of Southwell and Scrooby" which covered the old lands of the archbishop of York, and was paralleled by the ecclesiastical jurisdiction of Southwell chapter and prebends, or the "Peculiar of Southwell."

Among notable historical occasions in the history of Nottinghamshire there may be mentioned the frequent presence of King John in Nottingham or in his manor at Edwinstowe, and his death at Newark. The county was chiefly on the Yorkist side in the Wars of the Roses, and Lancastrian Henry VII defeated the Yorkist pretender Lambert Simnel at Stoke near Newark in 1487. At the beginning of the first Civil War Charles I raised his standard at Nottingham, and at the end surrendered (1646) to the Scots commissioners at Southwell after the prolonged siege of the Royalist-held Newark. Of the old castles the principal remains are those at Newark; there is a fine motte-and-bailey earthwork at Laxton. Laxton is famous as the only village in England that has retained the open-fields system of agriculture. Scrooby was the home of some of the original Pilgrim Fathers.

Population and Administration.—The area of the administrative county, which excludes Nottingham, is 815.1 sq.mi. and its population (1961) was 591,089. The city of Nottingham (pop., 311,899) is a county borough, and there are four municipal boroughs, East Retford (17,792), Mansfield (53,218), Newark-on-Trent (24,651) and Worksop (34,311). There are ten urban and six rural districts. There are six county constituencies, each returning one member to parliament.

The increase in population (by census) from 1901 to 1951 was 92.7%, nearly three times the national increase. The only old towns are Nottingham, Newark-on-Trent, Retford, Southwell, Mansfield and Worksop (*qq.v.*), the remainder being modern residential, industrial or colliery towns.

Shire hall, an 18th-century building by John Gandon, is in the centre of the city of Nottingham but administratively it is in a parish of its own, exclusive of the city. A large new county hall has been built in West Bridgford at Trent bridge facing the famous cricket ground of the Nottinghamshire County Cricket club.

The Economy.—From early times Nottinghamshire has been an industrial as well as an agricultural county. About 73% of the total area is under cultivation. A large part of the county was occupied by Sherwood forest and though most of the old timber had been felled by 1600, the area was still preserved as a royal forest. Reafforestation began in the 18th century and is now carried on by the Forestry commission. Hops used to be grown in the Newark area, and Warsop was a centre for liquorice; but neither are grown there now. The principal crops are barley, wheat, oats, sugar beet, potatoes and grass. There are orchards and market gardens; apple and pear are the principal trees planted, the original Bramley's seedling being raised there. Beet sugar factories are at Colwick and Kelham. Dairy farming (mostly Friesian cattle) occupies most of the heavier land. Sheep have increased in number since 1955 and pigs and poultry are also reared.

The malting and woolen industries flourished in Norman times, and coal and gypsum were mined at an early date. The woolen industry declined in the 16th century, but with the invention of the stocking frame in 1589 by William Lee of Calverton, the hosiery trade was soon established, and Nottingham remains its centre. Many cotton mills were built in the 18th century, together with a few silk mills. The manufacture of tambour lace in the 18th century, greatly increased by the introduction of new machines in the 19th, made Nottingham the world centre for cheap laces, especially curtains, and it still retains this position. Three modern major industries are bicycles, tobacco and pharmaceutical goods, and there is some heavy engineering. The early gypsum mining produced the famous Nottinghamshire alabasters of medieval times, now used for plaster and cement. Nottinghamshire is a principal centre of the gravel industry, there being big deposits in the Trent valley and elsewhere, and clay and sand are also largely extracted. Limestone and sandstone are quarried, and some oil is pumped from wells in the Eakring area. Molding sand is found in the Mansfield area.

The principal mineral extracted has always been coal. First mentioned in 1259, when Queen Eleanor complained of the smoke from the sea coal at Nottingham, the open coal seams in the extreme west of the county began to be developed in the 16th century by men such as Sir Francis Willoughby, whose fortune from coal enabled him to build Wollaton hall at the end of the reign of Elizabeth I. The invention of the steam pump made it possible to extract coal from greater depths, and collieries now extend as far eastward as Boughton, Bilsthorpe, Gedling and Cotgrave. Nottingham is a centre of the garment industry. It has also been for a long time a distribution centre for a large area and the ancient Goose fair still survives, as an amusement fair.

The Midland and Eastern region of British railways serve the county. The river Trent is navigable throughout the county, and the Idle from Bawtry to the Trent. The canal system is largely disused and the small boatbuilding industry at West Stockwith has

completely disappeared since the decline of sailing vessels.

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NOUAKCHOTT, capital of the Islamic Republic of Mauritania, west Africa, lies on a plateau near the Atlantic coast, about 270 mi. N.N.W. of Dakar, Senegal. Pop. (1961 est.) 5,510. Although it is in the Sahara, its situation near the sea makes the climate bearable (it has 5 in. of rain during August–October). Before it replaced St. Louis as the capital in 1957, Nouakchott was only a small administrative post with about 400 inhabitants. The new city includes residential districts, an administrative centre, a commercial quarter and a workers' suburb. Between the plateau and the airport is a projected industrial area with power station and slaughterhouses. Water is supplied from wells at Idini. (J. D.)

NOUMENON, a philosophical term put into currency by Kant (*q.v.*) and not much used except in definite reference to his doctrine. In the Kantian system the term "noumena" means things-in-themselves as opposed to "phenomena" or things as they appear to us. According to Kant the human mind is such that it can never penetrate by its speculative powers to things-in-themselves, but can only know phenomena. Thus we have the odd position that noumena, or the contents of the intelligible world, are just the things to which thought can never penetrate. The term, however, is a relic of an early period of Kant's mental development. In his fully mature or critical position he held that the noumenal was inaccessible to the speculative reason, and yet that we are not altogether excluded from it, since the practical reason, *i.e.*, our capacity for acting as moral agents, assures us of the existence of a noumenal world wherein freedom, God and immortality have a real place.

The relation of noumena to phenomena in the Kantian system is a most difficult one; and, in view of the fact that the acutest intellects in Europe have been engaged vainly for more than a century in reconciling the various passages on the subject, the safest conclusion is that they are irreconcilable. The course adopted by Kant's immediate successors in German idealism was to reject the whole conception of noumena, for the reason that what is essentially unknowable has no existence for our intelligence.

Kant, however, protested strongly against this development when it was propounded by Fichte, and held that he had precluded it by his "refutation of idealism": he stood unshakably to the belief in an absolutely real world behind phenomena.

Kant's position may be illogical as he himself stated it, but it is the expression of a sound principle: we must connect it with his general tendency to recognize the dynamic side of things. He saw, what so many of his successors failed to see, that the world as we know it is an expression of power; and he could not imagine whence the power could come if not from a world beyond phenomena. *See* PHENOMENON.

NOVA AND SUPERNOVA. A nova is a variable star that brightens up for a short time to a luminosity far exceeding that of its normal state. A supernova is a nova of great absolute brightness, and is distinguished by a type of spectrum different from that of common novae.

Novae.—Although the initial stages never have been observed, except for recurring novae, the objects subject to nova outbursts are almost certainly stars. The increase in brightness of a star during a nova outburst may be from a hundredfold to a millionfold, and it takes place within a few days. The brightness after maximum may decline at various rates, and it often fluctuates. After a few years, the brightness of the nova remnant usually becomes steady again. Only a few dozen good light curves of novae are recorded.

Some of the novae of greatest apparent brightness are Nova Persei 1901, Nova Aquilae 1918 (almost as bright as Sirius) and Nova Puppis of 1942. Around the remnant stars of these novae gas clouds can still be observed, expanding with velocities of hundreds of kilometres per second. The spectra of these clouds show emission lines of atomic hydrogen, the nebulium lines and λ 3727 of doubly and singly ionized oxygen atoms. The spectral changes from the outburst to the final stages are complex. During the first hours Nova Persei 1901, Nova Herculis 1934 and Nova Lacertae 1936 had continuous spectra with absorption lines, similar to A- and B-type stars. Later on, normal and forbidden emission lines of the elements hydrogen, helium, carbon, nitrogen, calcium, iron, titanium, scandium, chromium, strontium, yttrium and others appear. These lines are widened around their normal places because light comes from shells of gas expanding about the star, the front portions approaching the earth, the rear receding. The dark lines, on the other hand, can originate only in that part of the shell between the earth and the disk of the remnant star that furnishes the background light. Since this part of the shell moves toward the earth, a shift toward the violet results. Spectra of the postnova stars are mostly continuous, with no pronounced absorption lines showing. Even 100 years after a nova outburst, however, faint emission lines are present whose Doppler broadenings indicate that gases steam off the remnant stars with velocities of about 200 km. per second. (*See* DOPPLER EFFECT.)

The absolute magnitudes of novae at maximum brightness can be determined only if the distances are known. There are several methods for estimating the distances, such as from the strength of the "steady" absorption lines due to the presence of interstellar gases along the line of sight to a nova. The most reliable distances are obtained from the observation of the angular diameter of the ejected gas clouds and the comparison of their lateral rates of expansion with the spectroscopically observed radial velocities of these clouds. Thus the absolute magnitudes at maximum of Nova Herculis 1934, Nova Aquilae 1918, Nova Persei 1901 and Nova Puppis 1942 were found to be respectively $M_v = -5.5$, -9.0, -9.2 and -10.0. Common novae therefore reach an absolute visual luminosity in the range from 10,000 to 1,000,000 times that of the sun. The total energy emitted during a large nova outburst in the visual range is of the order of 10^{45} ergs, equal to the radiation from the sun during 10,000 years.

Novae in the Milky Way and in the great nebula in Andromeda (Messier 31) appear most often in the densely populated parts, perhaps at the rate of from 20 to 50 per year. A few common novae have also been discovered in small nearby galaxies, such as NGC 205, the faint elliptical companion of Messier 31.

The spectra of recurrent novae such as T Corona Borealis (1866, 1946) and R. S. Ophiuchi (1898, 1933, 1958) differ materially from those of the bright common novae, and their range in brightness from maximum to minimum amounts to less than nine magnitudes. As to the cause of nova outbursts it has been conjectured that they represent the transition from a normal star into an electronically degenerate star whose density is of the order of 10^6 g. per cubic centimetre.

Supernovae.—These become much brighter than common novae. Pending on the determination of a reliable distance scale for extragalactic nebulae which, in individual cases, is probably uncertain by as much as a factor ten, it seems certain that the brightest supernovae at maximum attain an absolute visual brightness several billion times that of the sun. In any event supernovae often become as bright or brighter than the galaxies in which they appear. For instance, the brightest supernova discovered in the 20th century (in Aug. 1937) was 100 times brighter than the dwarf spiral galaxy (IC 4182), in which it appeared. The total radiation emitted by a bright supernova as visual light during one year is of the order of 10^{50} ergs or more, or equal to the energy radiated by the sun during 1,000,000,000 years.

The light curves of supernovae are varied. Most of those that could be observed sufficiently frequently show a rapid rise during a few days to maximum brightness, near which they may stay for a week or two. The decline in brightness is generally smooth and amounts to 15 or more magnitudes in the course of a few years.

The difference between the brightness at maximum and the final stages is much greater than for common novae.

Most if not all spectra of supernovae have so far defied identification, representing thus one of the most tantalizing puzzles of modern astronomy. Spectroscopic observations reveal at least two types of supernovae. The spectra of bright supernovae, type I, are closely comparable at corresponding times after maximum. They show a bewildering and changing array of wide bands of unknown origin. Some of the fainter supernovae have a type II spectrum that is characterized by a strong ultraviolet continuum and faint emission lines that have been interpreted as atomic hydrogen lines, enormously broadened because of their origin in gas clouds ejected with velocities of 5,000 to 7,000 km. per second. The spectra of supernovae of the type II somewhat resemble those of bright common novae such as that of Nova Sagittarii 1936.

Altogether about 60 supernovae have so far been definitely identified as such. A concerted search by Fritz Zwicky and J. Johnson at Palomar, from 1936 to 1941, netted 19 supernovae. From this search a frequency of one supernova per galaxy per 360 years was derived, if only 1,200 of the brightest galaxies are considered. Supernovae appear in all types of galaxies. In contradistinction to novae, supernovae appear most often in the thinly populated parts of galaxies.

Three supernovae that have made their appearance in the Milky Way system have been definitely identified from historical records. The supernova of 1054 A.D. in Taurus, which was observed by the Chinese to be brighter than Venus, has given rise to a nebulosity, known as the Crab nebula, the gases of which expand with a mean velocity of about 1,100 km. per second. A blue star of the 16th apparent magnitude, with a completely featureless continuous spectrum, may be the very hot dwarf remnant star from the supernova outburst of 1054 A.D. The Crab nebula is also a strong radio source and the continuous visible radiation is polarized giving rise to a most puzzling basket weave pattern when the nebula is subjected to the method of composite analytical photography.

Tycho's Nova of 1572 and Kepler's Nova of 1604 are the other two historically recorded supernovae in the Milky Way. In neither case could a stellar remnant be found, but some expanding wisps of emission nebulosities have been observed in the locations of the two supernovae.

Large ringlike nebulosities such as the famous Cygnus loop are suspected to be remnants of supernovae whose outbursts date more than 10,000 years ago. In the second half of the 20th century radio surveys have led to the discovery of objects like the strong radio source in Cassiopeia, which is associated with diffuse gaseous condensations showing radial velocities of the order of 5,000 km. per second, which indicates that it might be the remnant of a supernova of type II.

No initial stage of any supernova has ever been seen, and it is not certain whether all initial stages are stars. For instance, a large gas and dust cloud, becoming unstable and collapsing, could be the cause of some supernovae. Another likely cause for some supernovae is the collapse of ordinary stars into neutron stars a few kilometres in diameter and with a density of the order of 10,000,000 tons to the cubic centimetre, equal to the density within atomic nuclei.

The further study of supernovae is of importance because they involve a series of new phenomena that promise to clarify views on the evolution of stars, galaxies and the universe in general. Supernovae also bid fair to serve as distance standards for the mapping of the universe to the limits reached with the largest telescopes.

See also references under "Nova and Supernova" in the Index.

See C. Payne Gaposchkin, *The Galactic Novae* (1957), "The Novae," *Handbuch der Physik*, vol. 51 (1958); F. Zwicky, "Supernovae," *Handbuch der Physik*, vol. 51 (1958). (F. Zy.)

NOVACULITE is a hard, compact, homogeneous, finely granular rock closely resembling chert and consisting of nearly pure silica. The rock has typically a vitreous lustre and white colour. It breaks with conchoidal fracture, and thin edges are translucent. The largest known deposits, Devonian in age, are in the Ouachita mountains of Arkansas and Oklahoma where novaculite occurs as beds from a few inches to ten feet thick, interbedded with shales, forming many of the mountain ridges. It was first quarried in the early 19th century to make whetstones for sharpening fine tools; hence its name, Latin *novacula*, "sharp knife." Indians used novaculite for weapons and implements. Novaculite has been considered to be metamorphosed chert, replacement by silica of a dolomite or limestone, and a deposit of colloidal silica accumulated on the sea floor. (A. W. G.)

NOVAK, VITEZSLAV (1870–1949), Czech composer and teacher. Born at Kamenitz (Kamenice-on-Lipa), then in Bohemia, on Dec. 5, 1870, he studied at the Prague conservatory under Dvorak and in 1909 joined the teaching staff there. His early music was influenced by the romantic school, but after he made a visit to Moravia his music shows a national character. He was also influenced by Debussy and Richard Strauss. His work includes four operas, two ballets and the orchestral works *V Tatrach* ("In the Tatra"), the "Slovakian Suite" and others inspired by Hans Christian Andersen and F. L. Celakovsky. *De Profundis* for orchestra and the "May Symphony" were among his works written during World War II. He also wrote chamber works, songs and many choral works including the "Autumn Symphony." His pupils included many Czech composers of the following generation. He died at Skutec on July 18, 1949. (J. S. Wn.)

NOVALIS, the pseudonym of Georg Friedrich Philipp, Freiherr von Hardenberg (1772–1801), German poet and important early Romantic theorist, was born on May 2, 1772, on his father's estate of Oberwiederstedt in Prussian Saxony. His family, which belonged to the Protestant Lower Saxon nobility, had also called themselves de Novali in the 13th century. After completing his schooling he began to study law, first at Jena (1790), then in Leipzig. Meetings with Schiller, his friendship with F. von Schlegel and his introduction to the critical philosophy of Kant and Fichte's *Wissenschaftslehre* were landmarks in these years. He read philosophy and history as well as law and after finishing his studies in 1793, at Wittenberg, he used his period of training in local government to enlarge his knowledge further, particularly in natural sciences. In 1795 he became engaged to the 14-year-old Sophie von Kühn. Her death in 1797 turned him into a citizen of two worlds, life and death. Six *Hymnen an die Nacht* (1800; Eng. trans., *Hymns to the Night*, 1948 and 1960), prose poems interspersed with verse, celebrate death as entry into a higher life in the presence of God. In 1797 he went to Freiberg to study mining and in 1800 took an administrative post in the Saxon salt works. In 1798 he had again become engaged, to Julie von Charpentier, but died of tuberculosis on March 25, 1801, at Weissenfels, before he could marry. His last years were astonishingly creative, filled with encyclopaedic studies and with the draft of a philosophical system based on Idealism. A giant collection of fragments—even now not fully exhausted—was to be the basis of a "scientific Bible." His real poetic work also belongs to this period.

Two collections of fragments which appeared during his lifetime, *Blütenstaub* (1798) and *Glauben und Liebe* (1798), indicate the range of his mind, which attempted to unite poetry, philosophy and science in an allegorical interpretation of the world. He wrote two novels, both fragments, the natural philosophical *Die Lehrlinge zu Sais* (1798; Eng. trans., *The Novices of Sais*, 1949) and *Heinrich von Ofterdingen* (1799–1800; Eng. trans., 1842), his most important work. Like his Romantic friends, Novalis believed that Heinrich von Ofterdingen (a *Minnesinger* who only survives as a name) was the author of the *Nibelungenlied*. Set in an idealized vision of the middle ages, the book's theme is the mission of the poet to transform the world into the poetry of fairy tale through the magic power of the imagination, symbolized by the blue flower for which the hero searches. The essay *Die Christenheit oder Europa* (1799) depicts the history of Christianity as the threefold process of unity, disintegration and new unity. A universal Christian church was to restore, in a new middle ages, a Europe which had been split by Reformation and Enlightenment. Appearing only after Novalis' death, the essay was long understood as establishing the trend of the Romantic generation toward the Roman Catholic Church.

Novalis' influence on the later Romantics and on symbolism in

Germany, France and England was considerable, although it was his *Geistliche Lieder* (1799; Eng. trans., *Sacred Songs*, 1956) which had the most direct effect. Encouraged by F. D. E. Schleiermacher (*q.v.*), he meant these to be hymns for the new church he envisaged.

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NOVA LISBOA, a town of Angola, southwest Africa, chief town of the district of Huambo. Pop. (1960) 70,629, including 53,526 Africans, 12,510 Europeans and 4,589 mixed. Nova Lisboa, founded in 1912 and originally intended to become the capital of Angola, lies in the heart of the country, 300 mi. S.E. of Luanda, at an altitude of 5,580 ft., and enjoys a climate suitable for European settlement. It is an important centre of the road network, internal airlines and the Benguela railway. Its railway repair shops are the largest in Africa. The town has a considerable industrial and commercial activity—shipping maize, wheat, rice, fruit, hides and skins—and an active cultural life. It was called Huambo till 1928. (A. A. G. P.)

NOVARA, a town of northwest Italy, region of Piedmont, capital of the province of the same name, lies on the Agogna river, 29 mi. (47 km.) W. of Milan by road. Pop. (1961) 90,699. The town is situated on a low, flat ridge above the surrounding plain of the Po. The cathedral was rebuilt 1863–65 except for the 10th-century octagonal domed baptistery and the 11th-century campanile. The basilica of S. Gaudenzio was built 1577–1659, and the town hall dates from the 13th century. The 15th-century palazzo del Podestà (mayor's palace) stands beside an 18th-century loggia. The 12th-century castle is used as a prison. Other features are a museum of antiquities, the Istituto Geografico di Agostini and the much-restored Broletto, an assemblage of buildings of various dates. Novara is on the main railway from Milan to Turin; other lines run to Genoa, Bergamo and the shores of Lake Maggiore. It is at the intersection of national highways. The most important industry is the production of various kinds of cheese, especially Gorgonzola. Minerals, chemicals (especially gas), metals, textiles, glass, ceramics, electrical equipment and clothing are also produced. Novara is an important sport and tourist centre.

Known as Novaria to the Romans, the town has a rectangular plan probably surviving from those days. After a long period of independence it accepted the protection of Milan in the 12th century. In 1706 it passed to Savoy and was ruled in turn by Austria, Savoy, France (when it was the capital of Agogna *département*) and again Savoy. The scene of Austrian victories in 1821 and 1849, it became part of the kingdom of Italy in 1861.

NOVARA PROVINCE stretches from the Pennine Alps and the Swiss frontier to the flat Po valley. Lake Maggiore forms part of its eastern boundary. The Simplon tunnel is partly in the province. Chief towns are Domodossola, the resorts of Intra and Stresa, Arona, Borgomanero, Omegna, Galliate and Trecate.

NOVA SCOTIA, a province on the east coast of Canada, composed of the peninsula of Nova Scotia and the adjoining island of Cape Breton. The extreme length from southwest to northeast is 371 mi. (Nova Scotia 266, Cape Breton 105); breadth 59 to 75 mi.; area 21,425 sq.mi. The isthmus of Chignecto, 17 mi. wide, connects it with the province of New Brunswick. The capital of Nova Scotia is Halifax (pop. [1961] 92,511; metropolitan Halifax, 183,946).

PHYSICAL GEOGRAPHY

Geology and Physiography.—Nova Scotia is composed of five upland and as many lowland areas. The former are underlain by hard crystalline rocks and comprise: (1) the Southern upland, which embraces the southern half of the peninsula and rises gradually from the coast to elevations of 600 ft.; (2) North mountain, a narrow, flat-topped belt (590 ft. high) extending for 120 mi. along the Bay of Fundy shore from Cape Blomidon to Brier Island; (3) the Cobequid mountains (average elevation 840 ft.) stretching for 71 mi. across Cumberland county from the head of the Bay of Fundy almost to Northumberland strait; (4) the highlands of eastern Pictou and Antigonish counties (elevation 800 to 900 ft.); (5) the upland belts and northern tableland (Cape Breton highlands, elevation 1,200 ft.) of Cape Breton Island.

The lowland areas are underlain by softer sedimentary rocks. The three more important are the Annapolis valley, a long trough-like depression lying between the steep walls of North mountain and the Southern upland; the lowlands surrounding Minas basin; and the lowland between the Cobequid mountains and Northumberland strait.

Nova Scotia has a myriad of lakes, short rivers and streams. The salt water Bras d'Or lake (*q.v.*) of Cape Breton Island is particularly large and well known. The Bay of Fundy tides exceed 50 ft. in Minas and Cumberland basins, resulting in large areas of tidal marshlands.

Climate.—The climate of Nova Scotia is under both continental and oceanic influences, especially along the southwest coast which is both milder and wetter than other parts of the province. The average annual temperature is 45° F. along this coast, but only 40° in the interior uplands where temperature extremes of 95° in summer and −35° in winter have been recorded. Similarly, the frost-free season varies from 100 days or less in the uplands to 140 days along the south shore, Northumberland strait and in the Annapolis valley, and to 160 days in the Yarmouth area. Rainfall is normally ample and well distributed throughout the year—an annual average of 55 in. on the south coast; 40 in. elsewhere in the province. Less than one-fourth falls as snow; fog occurs on as many as 90 days along the southern shore.

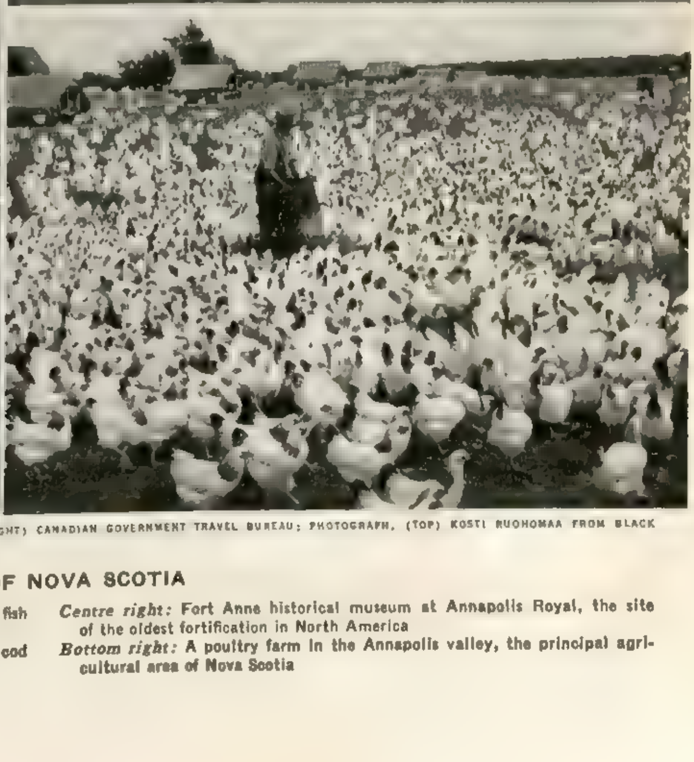
Vegetation.—Slightly more than 15,000 sq.mi. (70% of the province) is forested. Softwood stands account for 55% and hardwood stands for 6%, while the remainder is mixed. Balsam fir, spruce (red, white and black), eastern hemlock and white pine are the principal softwood species while yellow birch, sugar maple and red maple are the main hardwood types. With the widespread abandonment of agricultural land from 1900 the forested area has been continually expanding.

Nova Scotia has approximately 50,000 ac. of tidal marshland around Annapolis, Minas and Cumberland basins and along Northumberland strait. Dikes were begun by the Acadians in the early 1700s and the marshes are now largely in agricultural use.

Animal Life.—Nova Scotia has an abundance of wildlife which attracts many sportsmen to the province. Moose and especially deer are common. In addition there are many fur-bearing animals, including the bear, raccoon, beaver, muskrat, woodchuck, rabbit and red squirrel. Of the many species of birds, partridge (grouse) and ducks are most popular as game. Speckled trout and Atlantic salmon are the most valued fresh-water fish.

HISTORY

Nova Scotia may well have been the Markland of early Norse and Icelandic voyages, and Cape Breton was visited by the Cabots in 1497–98, but not until 1605 was any attempt at permanent colonization made by Europeans. In that year, Pierre du Guast sieur de Monts (1560–c. 1630) and Samuel de Champlain (1567–1635) after an unsuccessful attempt on an island in Passamaquoddy bay, founded the first settlement north of Florida on the north shore of Annapolis basin. The habitation was destroyed by English colonists from Virginia in 1613. In 1621 Sir William Alexander obtained a grant to the whole peninsula from James I and named it Nova Scotia (Latin for "New Scotland"), replacing the French name Acadie, à descriptive word of the Micmac Indians. Two settlements were established but with the restoration of Nova Scotia to the French by the treaty of St. Germain-en-Laye in 1632 most of the Scottish settlers returned home. French and British control of the peninsula alternated until the treaty of Utrecht (1713) when it passed into the possession of Great Britain. France retained the present areas of Cape Breton, Prince Edward Island and New Brunswick, and constructed the mighty fortress



BY COURTESY OF (BOTTOM LEFT, BOTTOM RIGHT) NATIONAL FILM BOARD, (CENTRE RIGHT) CANADIAN GOVERNMENT TRAVEL BUREAU; PHOTOGRAPH, (TOP) KOSTI RUOHOMAA FROM BLACK STAR

VIEWS OF NOVA SCOTIA

Top: Picking shad from nets in the Bay of Fundy at low tide. The fish are caught when the nets are under water at high tide

Bottom left: Schooners in dock at Lunenburg being made ready for cod fishing off the Grand Banks of Newfoundland

Centre right: Fort Anne historical museum at Annapolis Royal, the site of the oldest fortification in North America

Bottom right: A poultry farm in the Annapolis valley, the principal agricultural area of Nova Scotia

NOVA SCOTIA

BY COURTESY OF (TOP RIGHT, CENTRE RIGHT, BOTTOM RIGHT) NOVA SCOTIA FILM BUREAU, (BOTTOM LEFT) IMPERIAL OIL LTD.; PHOTOGRAPH, (TOP LEFT) MACKENZIE FROM MILES SERVICES

SCENES IN NOVA SCOTIA

Top left: The town clock in Halifax, erected in 1803
Top right: Peggy's Cove, a fishing village on the Atlantic coast
Centre right: Building a wooden "dragger" at Shelburne. Shipbuilding is a leading industry in Nova Scotia
Bottom left: Gathering sap for sugar at Mapleton, in northwestern Nova Scotia
Bottom right: The Champlain Habitation at Annapolis Royal, a replica of a building erected on that site by the French in 1605

of Louisburg on Cape Breton Island. In 1749 Halifax was founded as a counterpoise to Louisburg, and more than 4,000 British colonists were sent out. Moreover, the British attempted to exact allegiance from the French Acadian population. In 1755, fearing that the Acadians could not be neutral in the case of war, Gov. Charles Lawrence decided that they must either take the oath of allegiance or be deported. With their refusal there followed the tragic expulsion (made famous in Longfellow's *Evangeline*) in which approximately 6,000 Acadians were forced to leave the colony. After France lost its North American colonies in 1763, many returned to Nova Scotia, took the oath of allegiance and obtained new lands. (*See* ACADIAN.)

Soon after the Acadian expulsion, promises of free lands lured settlers from New England, Yorkshire, Ireland and Scotland. In 1758, in deference to the New Englanders in Halifax, the first popular assembly was elected. Cape Breton and Prince Edward Islands became parts of Nova Scotia in 1763, although Prince Edward Island was detached six years later and has remained a separate province ever since.

At the beginning of the American Revolution about one-half of the settlers in Nova Scotia were of New England origin but they did not share all the grievances of the southern colonists. The province strove to retain its neutrality through the struggle, although four delegates from Cumberland went to the continental congress in Philadelphia. At the close of the war about 35,000 Loyalists flocked to Nova Scotia and, as a result, New Brunswick and Cape Breton became separate colonies in 1784. Cape Breton was reunited with Nova Scotia in 1820.

In the first half of the 19th century a substantial increase in population (Scottish, Irish, Negroes) occurred along with new wealth and increased trade. The timber trade and fisheries boomed, and Nova Scotia shipbuilding enormously expanded. The colony had 2,583 vessels in 1846, representing one-third as much tonnage as that of France. However, political life lagged behind because of the peculiar privileges of a small official class. The struggle for responsible government, which marked the 1830s and 1840s, finally met with success in 1848 when Nova Scotia became the first British colony to have the principle of responsible government recognized.

Nova Scotia prospered greatly between 1855 and confederation as a result of improved British trade, the reciprocity treaty (1854) with the United States, and the American Civil War. The province bitterly opposed a union with Upper and Lower Canada, but the dynamic leadership of Charles Tupper (*q.v.*) led the province into confederation in 1867 (with New Brunswick, Ontario and Quebec). The case of the opposition was carried to London by the great orator and journalist, Joseph Howe (*q.v.*), but finally even he accepted a state of federated provinces.

Nova Scotia has had a sense of grievance ever since confederation and one political election (1886) was even won on the platform of secession. Several adverse factors including abrogation of the reciprocity treaty in 1866, the cessation of the American Civil War, the opening of the Canadian west and the changes in shipbuilding from wood and sail to steel and steam retarded the economy. Politics in the 20th century have largely turned on the province's economic status in spite of improvements effected by the steel and coal industries, by local manufactures, and by the development of Halifax, along with Saint John, N.B., as Canadian winter ports. In 1926 and 1934 royal commissions investigated the economic problems and reported in favour of better terms for the province. World War I stimulated the provincial economy along many lines but the depression that followed was not checked until the late 1920s. Another boom occurred during and after World War II and in the early 1960s economic progress continued to be favourable, net value of production having doubled since the war.

The province has had several disasters of international concern. Springhill has been the scene of three coal-mine explosions, one occurring in 1958 when 75 men were killed or died as the result of a "bump." The collision of two steamships, one carrying TNT, explosive acid and benzine, in Halifax harbour in 1917 resulted in the death of nearly 2,000 people.

There are seven national parks in Nova Scotia, six of which are national historic parks. Cape Breton Highlands National park is located in the northern part of the island and has equipped recreational and camping grounds. The Fortress of Louisburg National Historic park is also on the island, located at the site of the ruins of the French fort built between 1717 and 1758. An exact replica of the habitation built by Champlain has been erected at Port Royal. Fort Anne National Historic park commemorates early French settlement and a British fort at the present site of Annapolis Royal. Grand Pré National Historic park is located near Wolfville and preserves a site of early Acadian history made famous by Longfellow's *Evangeline*.

The Citadel at Halifax is also a national historic park. In addition there are numerous historic sites, plaques and cairns in all parts of the province.

POPULATION

The population of Nova Scotia was 737,007 in 1961, with slightly over one-half living in the rural areas. Almost two-fifths of the population was in the urban areas of Halifax and Sydney. More than 75% were of Anglo-Saxon origin while 11% were Acadian French. The latter live mainly in Digby, Yarmouth, Shelburne and Richmond counties.

There are 18 counties in the province.

*Nova Scotia: Places of 5,000 or More Population**

Place	Population				
	1961	1956	1951	1941	1921
Total province	737,007	694,717	642,584	577,962	523,837
Amherst	10,788	10,301	9,870	8,620	9,998
Dartmouth	46,966	21,093	15,037	10,847	7,899
Glace Bay	24,186	24,416	25,586	25,147	17,007
Halifax	92,511	93,301	85,589	70,488	58,372
New Glasgow	9,782	9,998	9,933	9,210	8,974
New Waterford	10,592	10,381	10,423	9,302	5,615
North Sydney	8,657	8,125	7,354	6,836	6,585
Springhill	5,836	7,348	7,138	7,170	5,681
Stellarton	5,327	5,445	5,575	5,351	5,312
Sydney	33,617	32,162	31,317	28,305	22,545
Sydney Mines	9,122	8,731	8,410	8,198	8,327
Truro	12,421	12,250	10,756	10,272	7,562
Yarmouth	8,636	8,095	8,106	7,790	7,073

*Populations are reported as constituted at date of each census.

GOVERNMENT AND PUBLIC FINANCE

The administration of Nova Scotia consists of a lieutenant governor appointed and paid by the federal government, and by custom a resident of the province; a premier and cabinet representing the party in power; federally appointed judges; and a nonpolitical civil service. The legislative assembly of 43 members meets at Halifax; elections may be called any time within a five-year period. Nova Scotia is represented in the federal government in Ottawa by 10 senators (from 1873). Membership in the house of commons is adjusted after each census; it was 12 after the 1956 census.

There are 2 incorporated cities, Halifax and Sydney (*qq.v.*) and 40 incorporated towns. In addition there are 24 municipalities, of which 12 are county municipalities and 12 are district municipalities representing 6 divided counties.

Under the terms of confederation the province is concerned with the protection of persons and property, transportation and communications in local undertakings, natural resources, education, health and welfare, and the incorporation of companies. The sources of revenue collected for provincial purposes are various and are augmented by federal government subsidies and grants as well as various tax-sharing agreements.

EDUCATION

Public education dates from 1811 and is compulsory, free of charge and nondenominational. In the second half of the 20th century there were approximately 2,000 schools, with about 125,000 attending elementary classes and 20,000 in secondary schools. There were approximately 5,000 attending classes in private schools and another 8,000–9,000 receiving precollege training in various other classes. The major institutions of higher learning are Dalhousie university, Halifax; University of St. Francis

Xavier, Antigonish; and Acadia university, Wolfville. Others are College Ste. Anne, Church Point; Convent of the Sacred Heart, Halifax; University of King's college, Halifax; Pine Hill Divinity hall, Halifax; Mount St. Vincent college, Halifax; Nova Scotia Agricultural college, Truro; Nova Scotia Technical college, Halifax; Holy Heart seminary, Halifax; Maritime School of Social Work, Halifax; and St. Mary's university, Halifax. The Nova Scotia Teachers' college (formerly the provincial normal school) at Truro was established in new quarters in 1961 and a new two-year teacher-training program was introduced.

MAJOR PHYSICAL FEATURES AND INDUSTRIAL AREAS OF NOVA SCOTIA

PRODUCTION

Agriculture.—Nova Scotia has very little agricultural land (under 5% of the total area). Aside from the Annapolis valley, the marshlands around Minas and Cumberland basins, and areas along the Northumberland strait shore, most of the province is too rugged, or has soils which are too thin and infertile to support the industry. Mixed farming (often part-time) is the rule with an emphasis on dairying in proximity to the larger urban centres. Over one-half of the cropland is in hay, with a large additional acreage in pasture. The Annapolis valley is well known as an apple-growing region, although production has declined because of the curtailment of the British market after World War II. Small fruits and vegetables are also grown commercially in that area. There is a livestock specialization in association with the marshlands and an increased egg and poultry production encouraged by the Bermuda market. Blueberry production has also increased greatly after World War II.

Forestry.—Lumbering was long the chief industry of Nova Scotia and, although the timber resources account for little more than 2% of the Canadian total, it is still a major source of provincial income. Most of the forests are privately owned and this, together with the dependence of the industry on a great many small waterways, has resulted in many scattered, small-scale lumber operations. A few large-scale operations, notably the pulp and paper mills at Liverpool (Brooklyn), New Germany, Hantsport, Point Tupper and Sheet Harbour, have developed along the larger river systems.

Mining.—Coal is the most important Nova Scotia mineral. The principal mining centres have been Glace bay, New Waterford, Sydney mines, and Inverness on Cape Breton Island; Stellarton and Westville in Pictou county; and until 1958, Springhill in Cumberland county. Several additional coal mines have been permanently closed. There are iron ore reserves in the Nictaux-Torbrook area but the ore for the blast furnaces at Sydney is imported from Newfoundland. Gold production reached a peak in 1939 (29,943 oz.), but had declined to negligible amounts by the second half of the 20th century. Large deposits of gypsum occur at Windsor, Milford station, Walton, Little Narrows and Dingwall. The province is the principal Canadian source of barite and a major salt producer.

Fisheries.—Fish has long been one of the important exports of the province. Dried cod, the traditional export item, is still important although fresh frozen fish has increased in value from 1945. Three-fifths of the value is obtained from the deep-sea fisheries, chiefly from cod and haddock; one-quarter from mollusks and crustaceans, particularly lobsters; and the remainder from the surface fisheries and other products. Digby and Wedgeport are noted for scallops and tuna respectively.

Industries.—Nova Scotia is naturally a sea-going province, and ship construction and fish packing and processing have always been major industries. Large supplies of raw materials (coal, limestone, iron from Newfoundland) have favoured Sydney as a primary steel centre. Other steel mills are located at New Glasgow, Trenton and Amherst. Iron and steel products and transportation equipment represent nearly one-third of the selling value of factory shipments, foods and beverages account for about one-fourth and pulp, paper and wood products for one-eighth, with the remainder divided among textiles, clothing, nonmetallic minerals, chemical products, printing and publishing and miscellaneous industries. The principal manufacturing centres are Halifax, Sydney, New Glasgow, Trenton, Pictou, Amherst, Dartmouth, Yarmouth, Truro, Lunenburg, Shelburne, Bridgewater, Louisburg, Windsor, Kentville, Hantsport and Berwick.

COMMUNICATIONS

The major railways of Nova Scotia are the Canadian National and Dominion Atlantic. The Canadian National enters the province near Amherst (from Montreal and Moncton) and has main lines leading to Halifax and Sydney and branch lines to Yarmouth and the Annapolis valley. The Dominion Atlantic, a subsidiary of the Canadian Pacific system, connects with Saint John, N.B., via ferry to Digby and serves Yarmouth, Halifax and Truro. Airports are located at Eastern passage, Kelly lake (both serving Halifax), Yarmouth, Trenton and Sydney. The province has had an impressive highway grading and paving program; out of a total road mileage of about 15,000, more than 2,000 mi. were paved by 1960. A deep causeway (218 ft.) connecting the mainland with Cape Breton Island was opened in 1955.

Ferry service operates between Yarmouth and Bar Harbor, Me.; Digby and Saint John, N.B.; and Caribou and Prince Edward Island.

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NOVATIAN (NOVATIANUS) (*c.* 200–*c.* 258), Roman theologian and one of the earliest antipopes, who gave his name to the Novatian schism. He was ordained at Rome and about 250 he occupied a leading position among the Roman clergy. In their name he wrote two letters to Cyprian, with whom he at that time stood

in his moderate attitude toward the Christians who apostatized during persecution. Later, when Cornelius became bishop of Rome (251), Novatian appointed himself as rival bishop and a champion of rigorism. He and his followers were excommunicated. The Novatian schism developed into a rigorist sect which spread all over the empire and lasted for several centuries. The assertion of the church historian Socrates that Novatian was martyred under Valerian seems to be confirmed by an inscription with the words *Novatiano . . . martyri,* found in 1932 in a cemetery near San Lorenzo in Rome.

Novatian was the first Roman theologian to write in Latin. His most important work, the *De trinitate,* sums up the orthodox doctrine of the Trinity. In *De cibis Judaicis* he points out that the food laws and other practical prescriptions of the Old Testament must be understood spiritually henceforth. In *De spectaculis* he condemns attendance at public games. *De bono pudicitiae,* on chastity, depends on Tertullian and Cyprian.

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NOVAYA ZEMLYA is an arctic archipelago off the coast of the Russian Soviet Federated Socialist Republic, U.S.S.R. Administered as part of Archangel *oblast,* it consists of two large islands separated by a narrow winding channel 56 mi. long, the Matochkin Shar (strait), and many small islands. It lies between latitude 70° 26′ and 77° N., and between longitude 51° 26′ and 69° 12′ E. and forms an elongated crescent, being more than 600 mi. long, with a width of 25 to 68 mi. and an area of about 31,382 sq.mi. It separates the Barents sea on the west from Kara sea on the east. With Vaigach Island 30 mi. to the south, and the mainland, Novaya Zemlya ("new land") forms a continuation of the Khrebet Pai-Khoi, a branch of the Ural folds.

The greatest heights occur near Matochkin Shar (about 3,500 ft.). Ice covers about a quarter of the total area, lying mostly in the north island.

A central zone of upper Cambrian and Devonian rocks extends along the islands. These quartzites, conglomerates and dolomites are flanked by carboniferous shales and limestones. Copper and other metallic ores are known. The coast is severely indented and has raised beaches which give good landing places.

Novaya Zemlya is colder than Spitsbergen (which lies more to the north) as in some degree it shares in the continental conditions of northern Russia and Siberia. The middle and northern parts of the west coast are not so cold as the east. Temperatures at Karmakuly on the west coast (the warmest part) are −17° C. (2° F.) in February and 6° C. (43° F.) in July. Snow is universal from October to May.

Vegetation is solely tundra and decreases from south to north. It is most luxuriant in the southwest. There are few trees or bushes. The flowering plants number about 200.

In the ice-free areas there are foxes, lemmings, bears and reindeer. Insects are numerous near the coast. Countless birds come from the south for the breeding season, and at certain parts of the seacoast the rocks are covered with millions of guillemots, while great flocks of ducks of various sorts, geese and swans swarm every summer on the valleys and lakes of the south. Whales, walruses and various seals are frequently seen. The arctic char and some salmonate species occur in the rivers, and cod frequent offshore waters.

The abundance of sea mammals and birds attracted Russian hunters, and even in the 16th century they had extended their huts to the extreme north of the island. Many of them wintered for years on Novaya Zemlya. Because of the ice in the White sea, Russian hunters found Novaya Zemlya less easy of access than did the Norwegians. But about 1877 systematic attempts at settlement were begun by the Russian government, several families of Samoyeds (Nenets or Nentsy) being established at stations on the west coast of the south island, including Malye Karmakuly on Moller bay, Pomorka bay and Belushya bay.

History.—Novaya Zemlya was probably known to Novgorod hunters in the 13th century and to Norse hunters earlier still. In 1556 Stephen Borough reached the south extremity of Novaya Zemlya, being the first western European to do so. Willem Barents touched the island (1594) at Sukhoi Nos (latitude 73° 46′) and followed the coast north to the Orange Islands (Ostrova Oranskiye) and south to the Kostin Shar. In 1596, after his discovery of Spitsbergen, Barents wintered at Ice Haven in 76° 12′ N. In 1760 Savva Loshkin cruised along the east coast, spent two winters there, and in the next year returned along the west coast, thus accomplishing the first circumnavigation; but the records of his voyage have been lost. In 1768 Lieut. F. F. Rozmyslov explored Matochkin Shar, where he spent the winter. The first scientific information about the island is attributable to the expeditions (1821–24) of F. P. Litke (Lütke; 1797–1882). Nearly all the west coast as far as Cape Nassau, as well as Matochkin Shar, was mapped and valuable scientific information obtained. In 1832 and 1835 Lieut. P. K. Pakhtusov mapped the east coast as far as 74° 24′. Karl Ernst von Baer made further investigations in 1837, and A. K. Tsivolka in 1838–39. Expeditions have become less dramatic and more numerous since the middle of the 19th century, particularly since 1920. A weather station has functioned at Karmakaly since 1896; to this was added an observatory at Matochkin Shar (1923), and further weather stations at Cape Zhelaniya (1931), Russkaya Gavan (1932), Capes Stolbovoi and Vykhodnoi (1934), and Cape Menshikova (1953). The settlements (pop. about 400) in the south island continue to exist, maintained by trapping, raising reindeer and collecting eiderdown.

See *Novaya Zemlya: Bibliograficheskiy ukazatel'* (1935).

(T. E. A.)

NOVEL. "A fictitious prose narrative or tale of considerable length (now usually one long enough to fill one or more volumes), in which characters and actions representative of the real life of past or present times are portrayed in a plot of more or less complexity"—so the *Oxford English Dictionary.*

There are obviously many difficulties about this (or any other) definition of the novel, and they have led some critics to deny that there really is such a thing as the novel form, or to assert that it is too vast, various and amorphous to be considered a literary kind or genre. It is certainly true that the novel, beginning much later than the other main literary kinds, never established a definite formal tradition based on its first recognized models of excellence, as the epic, for example, did with Homer's *Iliad.* But we obviously need a term to describe the mode of writing which has been the most characteristic literary phenomenon since the mid-18th century; usage has established the term novel; and a brief consideration of the problems raised by the various items in the definition above may clarify our understanding of the kind of narrative it denotes.

GENERAL DESCRIPTION

First, the problem of "fictitious." The novel is essentially a fictitious literary form; and yet its subjects are often taken from actual events, and its narrative methods typically attempt to create an air of literal truth. This dualism exactly reverses that of the epic, which had a sort of nonfictional, if not wholly historical, status, although its subjects were legendary and its narrative methods laid little emphasis on literal authenticity. The contrast is historically revealing: the novel arose in a much later civilization, and one whose outlook paid great attention to the distinction between fact and fiction. The novelist typically claims for his fictions the authority of fact; and many early novels imitated the letter and the memoir, modes of writing used to relate actual happenings.

The novel's being in prose follows from these considerations. For just as the content of earlier narrative is largely historical or legendary, its mode is usually poetic; similarly the novel's pretense at literal authenticity seems to demand prose, the medium of common speech. This requirement in turn leads to another larger historical contrast: mankind's early modes of literary expression were public, and public recitation or song apparently seemed to require the impressiveness and memorability of

formally patterned and ornamented speech; prose literature came later, and the novel is the only major literary form which was not shaped under conditions of public and oral delivery.

The "considerable length" of the novel raises difficult problems. Dramatic performance, or indeed any public occasion, tends to set up fairly standard expectations of length. Not so with the novel, nor indeed with any form intended mainly for private reading. The scale of novels varies widely, from the 2,000,000 or so words of Marcel Proust's *À la recherche du temps perdu* to the 250-page norm common today—roughly E. M. Forster's minimal specification of "over 50,000 words" (*Aspects of the Novel*, 1927). Below this lower limit, there are two other recognized forms of prose fiction: the short story, for anything up to about 50 pages; and the longer category intermediate between the short story and the novel, for which, English having no better term than the clumsy "long short-story" or the somewhat derogatory-sounding novelette, the French word *nouvelle* is often used. It must, however, be remembered that the Italian term *novella* and the German *novelle* are also applied to what we would call short stories.

The definition's stipulation that the novel portrays "characters and actions representative of the real life of past or present times" brings us to the heart of the problem. People have been quarreling about "reality" ever since the world began; and obviously any definition which arrogates all portrayal of "real life" exclusively to the novel, and which completely denies it to other literary forms, is hopelessly narrow and provincial. The character and actions of Homer's Odysseus have just as much reality in their way as those of Fielding's Tom Jones; the question of the meaning of "real" in such a context obviously needs further definition, to make clear that the novel's defining "reality" is a more mundane and literal one than that of the epic. Characters in a novel, if not statistically average, are at least not normally so far outside the usual dimensions of common life as to be patently of the heroic stuff of history or legend; and their actions are usually both more usual in themselves, and more deeply rooted in common life by a minuter description of the environment than is typical of other kinds of narrative. This steady attention to the surface of things—houses, goods, appearances, daily life, ordinary conversations—is typical of the novel's technique; but one must remember that although it can lead to the supreme truthfulness of a Tolstoi, what may be called the novel's realism of presentation does not ensure realism of assessment; convincing accuracy of surface description can mask an essential lack of understanding or judgment about the actual conditions and values of life.

According to the definition the novel may portray actions and characters "of past or present times." But—in this again unlike earlier kinds of narrative—it is more typically concerned with the contemporary. The word novel itself is ultimately derived from the Latin *novus*, meaning "new," via the Italian word for a short story, *novella*, which tended to mean not only "an original as opposed to a traditional" story, but also one that was, pretendedly at least, "of recent occurrence." When the word was adopted in English it kept some of this duality; novel could mean "news" as well as "a short prose fiction" until the 18th century, when its present meaning finally became established. Something of this connotation remains; fiction dealing with times long past, the historical novel, has a special name, and is surely felt to be rather a special case, probably because we cannot be so sure of the reality of things which neither we nor the author have directly experienced.

The last phrase of the *Oxford Dictionary's* definition, "in a plot of more or less complexity," raises an important though rather intangible problem, and one which helps to distinguish the novel from the prose fiction of other times and places. The word plot itself immediately involves a considerably higher level of narrative organization than normally occurs in a story or a fable. To quote E. M. Forster's formulation, a story is merely "a narrative of events arranged in their time-sequence," whereas a plot organizes the events according to a "sense of causality." This causal linkage of all the actions and characters is obviously very difficult to achieve in a narrative of novel length; it requires, therefore, the unity in variety denoted by the word complex; and historically, the novel developed as soon as causal narrative structures with sufficient scale and complexity were created. Such structures, in turn, depended on a set of basic assumptions which seem to be peculiar to modern western society. Since Aristotle western civilization has been permeated by the idea of causality; and this cause and effect thinking has taken an increasingly secular and individualist direction. It has therefore become natural to envisage a plot in which human life is seen as exclusively determined by the cumulative effects of individual actions. Only with such a plot could one get the kind of novel which led Henry James to ask: "What is character but the determination of incident? What is incident but the illustration of character?" Such plots are not found even in the supreme masterpieces of China and Japan, which went further than any other nonwestern country in the development of large-scale prose fiction. *The Dream of the Red Chamber* (18th century) and *The Tale of Genji* (11th century), for example, are wholly convincing in background and very sophisticated in psychology, but their plots are not controlled by the sense of the reciprocal causality of character and action on which the coherent unfolding of the masterpieces of the western novel ultimately depends.

CLASSIFICATION OF NOVELS

One possible classification of novels is based on a similarity to some other mode of writing. Beginning with Defoe, who presented his fictions in the guise of historical, travel, religious or criminal memoirs, the novel has taken over the techniques of many other literary kinds. Less specifically, the more defined and stylized ways of looking at life which are the basis of some of the other literary genres find their spiritual, and to some extent their formal, parallels in certain kinds of novel: Jane Austen's novels are very close to the comedy of manners, while Thomas Hardy's *The Return of the Native* has many of the characteristics of tragedy.

Of even greater critical importance is the tendency of novels to group themselves together according to their own intrinsic similarities to each other in manner and matter: a novel's plot, structure and style are inevitably affected by such elements as its setting in place and time, the kind of character it portrays and the role allotted him, and the nature of the author's larger intentions.

Structural Categories.—Percy Lubbock in *The Craft of Fiction* (1921) and Edwin Muir in *The Structure of the Novel* (1929) suggested certain fairly similar basic structural categories. In the "dramatic" or "scenic" novel such as Henry James's *The Ambassadors*, the narrative mainly proceeds in a fairly small number of important scenes which are presented rather completely, as in a play; and this concentrated focus necessarily involves a restriction of the time and space dimensions. At the other extreme is the "panoramic" novel, such as Thackeray's *Vanity Fair*, where the point of view of the novelist ranges over rather wide expanses of time and space; here the narrative is more like a running commentary than a play. Sometimes, as in Tolstoi's *War and Peace*, the narrative ranges equally widely in space and time, but there is more often a greater emphasis on one or the other. Where the essential emphasis is spatial, we have the adventure novel, such as Stevenson's *Treasure Island*, or the picaresque novel, such as Smollett's *Roderick Random*: we are very conscious in both of the wide variety of places to which the action takes us. In another and more recent kind of novel, we are much more aware of the temporal dimension, of the flow of time; such works as Arnold Bennett's *The Old Wives' Tale* or John Galsworthy's *Forsyte Saga* belong to this category, and may be called chronicle novels.

The time setting in another sense provides the basis for a different kind of classification: the historical or period novel. It has at least three fairly distinct kinds. In one, where actual historical persons and actions are the basis of the novel, the work is really fictionalized history: Robert Graves's brilliant Roman reconstructions such as *I, Claudius* for example. At the opposite extreme is the historical romance or period novel in which the past is used merely as an exciting and exotic background for adventures—quasi-military in Dumas' *The Three Musketeers*, sentimental in Margaret Mitchell's *Gone With the Wind*. Between the

two extremes of antiquarianism and romantic fantasy is the historical novel proper, where there is an authentic historical background but where the chief characters and actions are fictional: Sir Walter Scott's novels are the classic models of the genre, and his example suggests that the success of the historical novel tends to be proportional to its closeness to the author's own time: *Waverley, or 'Tis Sixty Years Since* (1814) dealt with times that were just within living memory.

The particular setting of a novel in place affords an even greater variety of classification according to content. The spatial equivalent of the historical romance is the exotic novel, where the background is treated in a spirit not of topographical accuracy but of romantic escape. The regional novel as a serious genre has been developed in many directions since Maria Edgeworth's studies of Irish provincial life and Balzac's category of "Scenes of Provincial Life" in *La Comédie Humaine*. There are, for example, the American novels of the south, and the many great fictional studies of rural, urban and metropolitan communities—George Eliot's *Middlemarch*, Sinclair Lewis' *Main Street* and Balzac's *Le Père Goriot*, for example.

Kinds of Characters.—The kind of character in a novel and the role allotted him provides the basis of several important fictional traditions, which may or may not coincide with classifications based on the treatment of time and place. The oldest, and perhaps the commonest, kind of novel is that which bases whatever narrative unity it possesses on the dominance of a single character. Where the character is, in Aristotle's phrase, "less good than ourselves," we have the picaresque novel. The term is often employed as if it were the equivalent of "highly spiced" in cooking, but its derivation—from *picaro*, Spanish for "a rogue"—indicates that it strictly applies only to novels where the chief character, like Thomas Mann's Felix Krull, is a conspicuous dissenter from established moral and social codes. Where there is one chief character, neither a hero nor a villain but somewhere within the ordinary moral range, we get the ordinary biographical novel which is perhaps the largest of all classes. It, in turn, has many different species. Formally, the main one is probably the autobiographical, where the chief character is the speaker and relates the whole course of his life, as in Defoe's *Robinson Crusoe;* but another important species is the one which covers only that part of the hero's biography which concerns his social and moral initiation into adulthood. Here, Goethe's *Wilhelm Meisters Wanderjahre* is the classical example, and the German term *bildungsroman*, meaning "novel of educational formation," is the most convenient name. It, in turn, has an important subspecies, the *kunstler-roman*, or "novel about the artist's life," of which James Joyce's *Portrait of the Artist as a Young Man* is a supreme example.

All these kinds of biographical novels, except perhaps the last, tend to be panoramic in narrative structure; but as regards characterization, the picaresque novel is like the adventure story in that it mainly employs what Forster has called "flat characters," who are not seen "all round" and who do not develop, whereas the biographical novel proper usually contains at least one fully presented and developing, or "round," character—the hero.

Novels where several characters have equal or at least considerable prominence, as in Jane Austen's, for example, are often dramatic in structure; and their cast is mainly composed of "round" characters. It should, however, be remembered that the majority of minor characters are "flat" in every kind of novel; that the terms themselves are both relative and to some extent subjective; and that, as the example of Mr. Micawber reminds us, "flat characters" may be just as memorable and successful as "round ones"—in characterization much depends on the particular needs and opportunities of the novel's basic structure.

The picaresque novel and the *kunstler-roman* may be regarded as examples of categories based on the class or occupation of the main character; but the same sort of categorizing can be applied to novels which are based on a group of characters rather than on one individual. There is, for example, the political novel, the novel of high life and the novel of peasant life. In some cases this mode of classification determines the essential literary nature of the work: thus the cowboy novel has developed the very strict conventions of plot, character, background and theme which characterize the modern American "western"; but in other cases, the question of the class or occupation of the characters may be quite incidental.

The Author's Intention.—One could, no doubt, establish a large subspecies of novels dealing with marine fishermen; but it would hardly enable us to gut the secrets of Melville's *Moby Dick* or Hemingway's *The Old Man and the Sea*. It is always to the larger emphases that we must attend; and in *Moby Dick*, for example, in spite of the vast amount of information on whales and whaling, the author's main intention is not the study of a particular occupation. Intention is most obvious in the didactic or propagandist novel, of which Harriet Beecher Stowe's *Uncle Tom's Cabin* is the classic example; it has somehow survived, but most didactic or propagandist novels have proved to be as ephemeral as the causes they espoused. Of greater importance in the novel as literature are the intentions which the author may not declare openly, but which may nevertheless be the essence of his novel's meaning. This condition is especially so in many modern novels, where the author rarely confides his views to the audience in the way that Fielding and Trollope did. He may have an attitude to the narrative which is quite different from that of the fictional narrator; an example of this ironic discrepancy between the apparent tenor of the narrative and the very different intention of the author is in Anita Loos's *Gentlemen Prefer Blondes*, where we are not intended to share the narrator's self-complacency but to laugh at it.

More generally, there are many novels where there is an ironic interplay between the meanings that the characters themselves see in their situation and the very different implications intended by the author; perhaps the extreme development of this ironic indirection is in the later novels of Henry James, but all novels probably benefit to some extent if we read them not with an uncritical subjective identification with the characters, but with a degree of dispassionate distance and objectivity.

There are at least two other large categories of fiction which need to be read with an awareness that they are not primarily intended as direct and literal representations of reality: the romance and the fable. Both of them are much older than the novel, but in their modern forms both of them may nevertheless be clothed in sufficient apparent likeness to ordinary life to fall within the category of the novel. In the romance, to which we shall return later, we are given something which may at times look like life in the real world, but which is really idealized in some way; whereas in the fable, it is not so much that the fictional world is an ideal one, but that the essential interest of the narrative lies in some more or less overt general moral lesson which it illustrates, rather than in the narrative for its own sake. Sometimes, as with Christian, the protagonist of Bunyan's *Pilgrim's Progress*, the fact that the characters have allegorical names gives us a clear guide to the author's special intentions; and sometimes, as in Johnson's *Rasselas* or Voltaire's *Candide*, the author's aim is so obviously the discussion and illustration of general ideas that we feel compelled to withhold the name of novel; but in the novels of Hawthorne, for example, it is only a certain consistent lack of density in the narrative line, and a pervasive tendency to generality in the psychological presentation, which tells us that we are in a rather special domain where larger metaphysical issues are the main forces in conflict.

Some critics, such as F. R. Leavis and Richard Chase, have used the term "fable" in a rather wider sense, and have applied it, not merely to novels where the writer's gaze is manifestly directed off stage in the direction of cosmic contradictions and eternal verities, but more widely to all novels where, though we read through them with the sense of their presenting complete and real fictional worlds, we later discover that a definite moral pattern was worked out in the narrative: Jane Austen's novels, for example, can usually be reduced to such an underlying moral fable. This extension of the term has its dangers, but we must recognize that it is impossible to classify and name all the infinite gradations by which different novels range from the total particularity of documentary

realism through the various indirections of allegory and fable and symbolism to the supreme generality of myth.

EARLY MODES OF NARRATIVE AND THE NOVEL

Novel and Epic.—Because of the priority of the epic among the established forms of narrative and the enormous prestige given it by the genius of Homer, theorists of the novel have been much concerned about the relation of the new form to the epic. Fielding, for example, claimed as much as he could of its protecting authority for his new kind of prose fiction, in the preface to *Joseph Andrews* (1742), which was, he announced, "a comic epic in prose." Many later novelists have been inspired by similar ambitions, but it is probable that the analogy has proved too general and abstract to be very helpful.

Epic belongs, essentially, to a more primitive stage of civilization, where large, but not vast, communities have learned the arts of farming and metalworking but still spend much of their time in fighting and raiding each other. Later stages of civilization, of course, imitated primitive epic, as Virgil and many later writers imitated Homer. But in the 18th century critics became aware that epic poetry belonged to a particular kind of civilization; and they eventually saw that this had implications for the emerging form of the novel. Especially was this true in Germany. C. F. Blankenburg's important *Essay on the Novel* led the way in 1774, and later Goethe and Schiller drew a similar but more comprehensive socio-literary contrast: on the one hand there was the ideal harmony between man, nature and the gods which had existed in the golden age of Greece and which was reflected in epic poetry; on the other hand there was modern society, with its urban and bourgeois life, and with the influence of Christianity's self-conscious individualism and its pressing sense of the conflict between divine and secular interests: it was obviously impossible for the novel to reflect anything like the coherence and serenity of the Homeric world. Later, Hegel took the contrast a step further: since modern civilization was inexorably "prosaic," the novel's typical theme had to be the division between the poetic and spiritual aspirations of the individual and the prosaic realities of his existence.

The epic and the novel reflect different societies, and therefore present different kinds of people. As Aristotle pointed out, Greek literature had no literary form which represented people who were neither "better than ourselves," like those of epic or tragedy, nor "worse than ourselves," like those of comedy, but merely "like ourselves"—as the characters of novels usually are. Actually, the only items in our opening definition which the novel shares with the epic are those of size: both are narratives "of considerable length" and both have "plots of more or less complexity"; common usage, indeed, has made "epic" into a mere superlative of scale. As for subject matter, we can only say that the more a novel gives a vast panorama of a whole society, especially one engaged in war, the more it approaches epic. But when we consider how the ultimate power in Conrad's *Nostromo* is capitalism, or how the whole trend of Tolstoi's thought in *War and Peace* is antiheroic, we see how deeply and essentially different the two forms are.

Novel and Romance.—The particular historical and social background of romance tends to confirm the view that the three main forms of narrative correspond to three different phases of civilization. The Greek romances or novels arose long after epic and are associated with the cosmopolitan and commercial cities of the Hellenistic period. Some of the Greek romances related fantastic adventures, like the interplanetary journeys in Lucian's *True History;* but the largest class, of which Heliodorus' *Aethiopica,* in the 3rd century A.D., is the best surviving example, depicted the endless misadventures of a pair of lovers until they were finally reunited.

The rebirth of literature in medieval Europe exhibited the same sequence: heroic literature was succeeded by romantic. The *chansons de geste* of the 11th and 12th centuries dealt largely with fighting; but the more settled and sophisticated life of the later feudal period, with its development of courtly love, produced the chivalric romance, first in poetry and later in prose.

Medieval romance had two new cultural features which were both essentially Christian: the moral idealism of chivalry, and the erotic idealism of courtly or romantic love. Both of these values, of course, were passed on to the modern world, and they provided an important element in its fiction. The medieval romances were so called because they were narrated, not in Latin, but in the romance vernaculars; and the term has persisted in the French, Italian, German and Russian words for a novel; only English makes a linguistic distinction between the fanciful "romance" and the realistic "novel."

For good and for ill, however, the tendencies cannot be wholly separated. For two reasons. As regards content, the spirit of romance, the aspiration for a world of knightly values and romantic loves, is a genuine part, though perhaps a regrettably small one, of the real world. As regards literary form, many novelists have thought that they could better represent the essential truths of life if they dramatized them even at the cost of complete plausibility, or brought them into higher relief by omitting circumstantial details.

Another combination of the novel and the romance, however, merely exploits the confusion of fiction and reality; for what is often called a romance is a form of popular fiction which makes a business of purveying romantic wish fulfillments of the most unreal kind through the apparently realistic medium of the novel.

Realistic Traditions of Fiction.—Convincing reference to the details of ordinary life occurs in early literature, but it is usually casual and sporadic. The major exception to this in classical literature is the largest extant portion of the *Satyricon* of Petronius—Trimalchio's feast. Its masterly picture of the vulgar inanity and ostentation of the life of the *nouveaux riches* in the days of Nero gives us our most complete and intimate knowledge of daily life in classical times—its houses and manners and speech and ultimate social values. As a whole, however, the *Satyricon* is not a unified realistic narrative but a curious miscellany of prose essays dealing with social and literary criticism, of picaresque narrative, incidental bawdy stories and interpolated poems. It belongs to the tradition of Menippean satire which has its modern equivalent in that somewhat marginal kind of novel, of which the classic example is Sterne's *Tristram Shandy,* where the narrative is essentially a pretext for incidental and miscellaneous disquisitions.

The two medieval narrative forms closest to the daily life of the people were primarily for the entertainment of the growing urban middle class. The fabliau, a fairly short verse story, usually concerned with amorous adventures in low life, developed in France during the 12th and 13th centuries: the most famous English example is Chaucer's *Miller's Tale.* But it was for the richer and more cultivated merchant society of 14th-century Florence that the first momentous step toward the modern novel was taken. Giovanni Boccaccio's famous collection of *novelle,* the *Decameron,* established the basis of the modern short story; and something of their narrative skill and psychological veracity is also found in Boccaccio's long prose works, the *Ameto,* the *Fiammetta* and the much longer *Filocolo.*

Both the fabliau and the *novella* tended to take a cynical view of life, which was diametrically opposed to the high-strained idealism of the chivalric romances; even closer to the modern novel are some of the 16th-century works in this antiromance tradition which reflect the ending of the heroic chivalric ideals of feudalism. The picaresque novel was initiated by the anonymous *Vida de Lazarillo de Tormes* in 1554, an autobiographical account of a poor boy's attempts to keep alive by tricking his employers; the form typically offers wonderful opportunities for taking the reader into the most varied social environments and for describing the life there with vivid and often seamy detail.

The full development of the novel, however, required a narrative mode that was less episodic and more rooted in character—the *picaro* himself tends to be merely the sum of his escapades; the novel also had to be able to present the whole of reality, not merely the comic and sordid scenes typical of the picaresque. The first major resolution of these two problems is found in *Don Quixote* (1605, 1615), where Cervantes combined burlesque of

the chivalric romances with certain picaresque elements.

In its formal structure *Don Quixote* is almost as episodic a succession of adventures as the romances it parodied, such as *Amadís de Gaula* (1508); and its predominantly comic mode inhibited a fully realistic treatment of the actions of the hero. Yet when Cervantes juxtaposed the romantic idealism of Don Quixote against both the meagre possibilities of realizing them in the world of contemporary actuality, and the earthy empiricism of Sancho Panza, he resoundingly initiated the novel's endless exploration of the conflict between the ideal and the real as it occurs in the individual's dealings with his environment and his fellow human beings. Nor is this all. The characterization of the two protagonists is not only remarkable in itself, but it is the basis of a progressive psychological interaction which is worked out in narrative terms, and thus foreshadows what is perhaps the novel's richest and most characteristic resources—basing a unified narrative development on the working out of a personal relationship.

So much for the definition of the novel, its classifications and its fictional predecessors; we must now turn to a historical survey of the genre as it developed in Great Britain and the United States. For its development in other countries, *see* the national literature articles—CANADIAN LITERATURE; FRENCH LITERATURE; GERMAN LITERATURE; etc.

THE ENGLISH NOVEL TO 1900

That there is a deeply realistic strain in the English national temper is suggested by its early literature. Chaucer's portraits of the pilgrims and their interplay in *The Canterbury Tales* reveal a genius for the vividly concrete; the same tendency is active in the telling detail and mordant observation found in much other medieval poetry; while Sir Thomas Malory's *Le Morte Darthur*, printed by Caxton in 1485, gives a compelling sense of physical actuality to the legendary material of the Arthurian romances.

Elizabethan Period.—In the 16th century the greatest achievements of English literature were in poetry and drama, but there was considerable activity in many kinds of prose fiction. John Lyly's *Euphues* (1578) is a romantic intrigue told in elegant letters, which are interspersed with general discussions on such topics as religion, love and epistolary style; Lyly's main interest is not narrative or psychological but educational, as is suggested by his hero's name (Euphues is Greek for "well cultivated"), and the very considerable influence of *Euphues* was therefore on literary style rather than on the development of fiction. A similarly rhetorical emphasis marks the most widely admired work of Elizabethan fiction, Sir Philip Sidney's *Arcadia* (1590). Combining elements from three kinds of romance—the Greek, the chivalric and the pastoral—Sidney tells a very long and complicated story composed of separated noble lovers, disguises, oracles, love philtres and hairbreadth escapes, which are set in a conventionalized but beautifully described pastoral landscape.

The same emphasis on complicated adventures is found in many of the less aristocratic prose narratives. Chivalric romances, both translated and original, such as Emanuel Forde's *Parismus, the Renowned Prince of Bohemia* (1598–99), were very widely read, and so were the shorter and more stylish pastoral romances of such writers as Thomas Lodge, whose *Rosalynde* (1590) gave Shakespeare the plot of *As You Like It*, and Robert Greene. But if one wants to catch the note of life as it was lived by the Elizabethans, one must turn elsewhere.

To warn people against the methods of real criminals there arose a literature of roguery; and some of this popular journalistic reporting, notably Greene's "cony-catching" pamphlets, vividly describes the life of the London streets. The picaresque tradition also produced one highly original masterpiece, Thomas Nashe's *The Unfortunate Traveller* (1594), in which the often scabrous adventures of Jack Wilton, an unscrupulous page traveling through the continent, are brilliantly and racily described. But it is the silk weaver and popular balladist Thomas Deloney who gives the most detailed pictures of ordinary domestic life in his three narratives about tradesmen, *Jack of Newbury* (1597), *The Gentle Craft* (i.e., shoemaking; 1597–98) and *Thomas of Reading* (1599). Deloney, however, sets his tale in earlier days; his clothiers and shoemakers, though convincing as characters, are not really developed, and his novels are essentially miscellaneous collections of anecdotes with only a minimal connecting thread. Delony is therefore no exception to the generalization that the Elizabethans, like earlier English writers, were not primarily interested in the kind of faithful representation of ordinary life which is typical of the novel.

The 17th Century.—Under the Stuarts prose fiction continued mainly along the established traditions of the picaresque novel, the romance and the *novella*. The enormously long French heroic romances of the time were much translated and imitated, while Mrs. Aphra Behn wrote some readable "novels"—longish short stories of intrigue, of which the most famous is *Oroonoko* (1688), telling the tragic love of a gallant Negro slave.

Apart from another masterpiece in the same genre, William Congreve's graceful *Incognita* (1692), there is little else in 17th-century prose fiction of note, with the giant exception of John Bunyan. *Grace Abounding to the Chief of Sinners* (1666) is in the established Puritan form of the autobiographical confession, which relates the sinner's life until he finds "the miracle of precious Grace"; the subject of *Pilgrim's Progress* (1678) is similar, but it is cast in the allegorical form of a journey from the City of Destruction to the Gates of Heaven; while *The Life and Death of Mr. Badman* (1680) reveals the ampler opportunities for graphic realism afforded by the exemplarily negative case.

Bunyan's prose style shows the force of popular Puritan preaching combined with the eloquence of the Authorized Version of the Bible; it can accommodate the homely and the sublime, and range with equal conviction from domestic trivialities to the visions of burning faith. Bunyan is thus an excellent example of one of the main arguments of Erich Auerbach's brilliant *Mimesis: the Representation of Reality in Western Literature* (1946; English translation, 1953). Auerbach shows how Christianity's strong egalitarian belief that the souls of all sorts and conditions of men are potentially of equal value produced a narrative tradition quite different from the classical literary theory of the separation of styles, whereby serious treatment was restricted to "noble" subject matter, while everyday reality and humble people were considered appropriate only for comic or satiric treatment. Bunyan presents his humble protagonists with utterly serious realism; on the other hand his allegorical method, the narrative equivalent of the traditional Christian way of interpreting realities in otherworldly terms, is obviously not typical of the novel, which presents secular life for its own sake.

The 18th Century.—Bunyan was a village tinker, and his works were a direct expression of the connection between narrative realism and the increasing articulateness of the tradesmen and shopkeepers who had already shown their power in the Civil War. In 1688, the year of Bunyan's death, the Glorious Revolution finally destroyed the feudal pretensions of the Stuarts and inaugurated the political and social dominance of middle-class commercial interests, of which Daniel Defoe was the foremost spokesman. Though born a Puritan like Bunyan, Defoe reflects the strong secularizing tendency of his time; his pretendedly genuine autobiographical memoirs *Robinson Crusoe* (1719), *Moll Flanders* (1722), *The History of Colonel Jack* (1722) and *Roxana* (1724) are vivid and comprehensive expressions of the social and economic individualism of the Protestant ethic. In form they are loosely episodic biographies of heroes or heroines for whom the quest for middle-class security is the most compelling reality, although it is occasionally in uneasy conflict with other values, notably those of religion and of personal feeling. Helped by his journalistic training, Defoe, much more thoroughly than any previous writer, tried to make his fiction literally convincing; and he also introduced into the tradition of the novel one of its most enduring themes—the struggle of the individual both with the external world and with his own conscience.

Another bourgeois Puritan, Samuel Richardson, has often been credited with the novel's paternity—and probably deservedly, if by this is meant that his works are the first which fit completely into the main fictional patterns of the centuries to come. Defoe had no significant successors but Richardson had many, both in

England and abroad. His *Pamela: or, Virtue Rewarded* (1740) tells in a series of letters how a virtuous servant girl finally constrains her amorous master to marry her: and it is thus the archetype of the commonest kind of novel, that based on the mating process. Richardson's exhaustive treatment of his heroine's psychological states had led him to construct a unified novel out of what would previously have been material only for a short story: and this great extension in psychological depth, continued in *Clarissa: or, the History of a Young Lady* (1747–48), showed how a single personal relationship could be developed to mobilize a rich complexity of larger ethical and social conflicts: *Clarissa* is the first, and one of the greatest, of tragic novels. Finally, in the *History of Sir Charles Grandison* (1753–54), Richardson used the epistolary method for a less intense kind of social and moral analysis.

Henry Fielding was provoked by the sanctimonious moralism of *Pamela* into writing *Joseph Andrews* (1742), a lively comic story about the travels, misadventures and final marriage of Pamela's virtuous brother. *Tom Jones* (1749) is a panoramic novel in which Fielding exhibited his ethical and social views in a large and complex plot; while *Amelia* (1751) is a more sombre treatment of the consequences of marital infidelity and weakness. Fielding is in many ways the antithesis of Richardson: equally serious as a moral and social thinker, his method was essentially humorous, expansive, eclectic and illustrative; it incorporated many elements from the fable, the comic drama and the essay.

The chief immediate successors of Richardson and Fielding were Tobias Smollett and Laurence Sterne. Smollett in *Roderick Random* (1748), *The Adventures of Peregrine Pickle* (1751) and other novels, of which the best is *Humphry Clinker* (1771), developed the primarily comic and satiric novel along picaresque lines: he is most successful, perhaps, in the presentation of eccentrics and grotesques, a characteristic tendency since then in the English novel. Sterne, perhaps the most gifted and certainly the most original of the 18th-century novelists, wrote *The Life and Opinions of Tristram Shandy* (1759–67), a witty, indecent and brilliantly prolonged demonstration of how to entertain the reader without ever giving him the novelistic development he expects.

In the later part of the 18th century the reading public expanded and the number of novels produced increased steadily. Few of them, however, were of much importance apart from Oliver Goldsmith's popular and influential *The Vicar of Wakefield* (1766) and Fanny Burney's *Evelina, or a Young Lady's Entrance Into the World* (1778) and *Cecilia: or, Memoirs of an Heiress* (1782), which showed the natural advantages of feminine novelists for delicate social comedy. The sentimental novels of Henry Mackenzie and the Gothic tales of Horace Walpole, William Beckford, Ann Radcliffe and M. G. ("Monk") Lewis revealed the growing taste of writers and readers alike for strong appeals to the emotions; while toward the end of the century the novel began to be extensively used by Robert Bage, William Godwin and other radicals for overt social and political propaganda.

The Romantic Period.—English romanticism found its main expression in poetry, but Sir Walter Scott's romantic interest in the past brought about the historical novel which soon became extremely popular all over Europe. The first of the series, *Waverley* (1814), shows the clash of the old feudal order of the Scottish Highlands with the rising bourgeois culture of the Lowlands; and Scottish themes inspired the best of his other novels, *Old Mortality* (1816), *Rob Roy* (1818) and *The Heart of Midlothian* (1818).

Jane Austen described her own times and scenes. *Pride and Prejudice* (1813), *Mansfield Park* (1814), *Emma* (1815) and *Persuasion* (1818) are beautifully poised studies of "three or four families in a country village." Combining Richardson's psychological minuteness with Fielding's broader comic method, and basing her plots on courtship and marriage, she initiated one of the greatest and most characteristic traditions of the English novel, that of familiar domestic comedy used to present larger conflicts of moral and social values: George Meredith and E. M. Forster are perhaps her most illustrious successors.

Two other lesser fictional traditions were developed during the romantic period. Mary Shelley's *Frankenstein* (1818) inaugurates the tradition of science fiction on its horrific side; while Thomas Love Peacock's clever and delightful satires, such as *Headlong Hall* (1815) and *Crotchet Castle* (1831), show the capacity of the novel for miscellaneous topical comment.

The Victorians.—During the reign of Queen Victoria the novel became unquestionably the dominant literary genre. The growth of the reading public and the further consolidation of the political, social and literary power of the middle class enabled the great Victorian novelists to command a public of unprecedented size. Largely because readers had much leisure and because the main outlets for fiction were serial publication or sales to the circulating libraries, the Victorian novel was typically very long; many were published in three volumes, and were called "three-deckers." The novel also became family reading, and this made it rather reticent about many subjects, especially sex; more generally, it tended to a comfortably affirmative tone, which often became mawkish and sentimental about the pieties of family life. Nevertheless now that the Victorian age is beginning to exchange the ignominy of being out-of-date for the prestige of being antique, we can begin to appreciate more justly how its fiction had a broad humanity which remained faithful to the real proportions of experience; never more so, perhaps, than in the humour which is so characteristic a feature of the fiction of the period.

Nor can the major Victorian novelists be fairly accused of complacency. Charles Dickens, for example, was a reformer in everything he wrote, attacking a multitude of social, political, administration and economic evils. There are many things in his novels which modern criticism finds it difficult to defend: the melodramatic oversimplification of goodness and badness in *Nicholas Nickleby* (1838–39), the sentimentalism of *The Old Curiosity Shop* (1840–41), the insular and unhistorical bias of *A Tale of Two Cities* (1859); the rambling and often overcomplicated plots. Yet the intensity and the variety of Dickens' imagination and his unique rhetorical gifts make light of these defects; *Martin Chuzzlewit* (1843–44), *David Copperfield* (1849–50), *Bleak House* (1852–53) and *Great Expectations* (1860–61) give what only the greatest literature can give, a comprehensive, personal and enduring vision of the world.

If Dickens is the greatest novelist of the age, George Eliot's *Middlemarch* (1871–72) is probably its greatest novel. Her great gifts of heart and head united with her supreme insight into individual moral development to produce a vast panorama of a Midland community in transition under her impact of the political, social and economic changes produced by the Industrial Revolution; while at the individual level we see the tragic attrition which time and circumstance bring to the generous enthusiasms of those who, like Dorothea Brooke and Lydgate, and like so many Victorians in real life, wish to devote their lives to bettering the lot of their fellows.

William Makepeace Thackeray was Dickens' chief rival; although his more polished but less intensely committed novels have not worn so well, *Vanity Fair* (1847–48) remains a great and permanent achievement. Anthony Trollope, on the other hand, turned his very lack of emotional or imaginative intensity into an advantage for performing one of the main functions of the novel: a balanced and detailed chronicling of many areas of social life, most notably in the six *Barchester* novels (1855–67). Of the four novels of Charlotte Brontë, *Jane Eyre* (1847) maintains its peculiarly powerful spell despite its melodramatic sentimentality; while her sister, Emily Brontë achieved in *Wuthering Heights* (1847) an intensely tragic confrontation of the passions of love, jealousy and hatred.

At a somewhat lower literary level are many other Victorian novelists of real interest and importance. Among the countless novels of social and political enlightenment one should at least mention Disraeli's *Sybil: or The Two Nations* (1845), Charles Kingsley's *Yeast* (1851), Elizabeth Gaskell's *North and South* (1854–55) and Charles Reade's *It Is Never Too Late to Mend* (1856). There is even an element of social reform in the novels of W. Wilkie Collins, whose *The Woman in White* (1860) and *The Moonstone* (1868) are outstanding examples of the story of mystery and detection, just as Robert Louis Stevenson's later *Treasure Island*

(1883) and *Kidnapped* (1886) are classics of the boy's adventure story.

Later in the century, George Meredith's great reputation was based on wit, intelligence and a marked poetic gift; but although *The Ordeal of Richard Feverel* (1859), *The Egoist* (1879) and *Diana of the Crossways* (1885) reveal considerable psychological acuteness and a brilliantly ironic command of the social scene, they now seem to have an almost disabling affectation of manner. The other great novelist of the later part of the century is Thomas Hardy, also a poet and a master of landscape; intensely direct and honest, his tragic novels *The Return of the Native* (1878), *Tess of the D'Urbervilles* (1891) and *Jude the Obscure* (1896), despite the use of somewhat obtrusive coincidences to underline the malignity of fate, give a harrowingly veracious picture of the consequences of sexual frustration and social deprivation.

THE AMERICAN NOVEL TO 1880

General Characteristics.—It was in the novel that American literature first developed its individuality and independence. Lacking intrinsic formal conventions, the novel is immediately and directly responsive to its historical and social environment; and that of the United States until after the Civil War could hardly have been more different from Victorian England. The comparative absence of either a rich cultural heritage, or of complex and long-rooted class distinctions, together with the endless differences of habit, speech and attitude which they entail, meant that the immediate social horizon offered the American novelist less opportunity to develop the kind of realistic notation of the social scene which was the basis of the English (and European) novel of manners. Americans had no "manners" in this sense of the word; but that is not the only reason they did not produce the kind of novel written by Fanny Burney and Jane Austen, Thackeray and Trollope. For, in the last analysis, the novel of manners assumes that the essential values of life emerge from the processes of society; the American novelist, on the other hand, typically felt himself to be alone and quite unable to share the basic assumptions of the people around him: partly because he had no large and cultivated reading public like that in England; partly because his historical past offered him little besides the intransigent moral individualism of Puritanism.

The isolated artist, then, was left with the need to discover his own new world of moral and social values, and he typically attempted the task with a total abandonment to his own personal insight and a very free handling of the traditions of the novel. In an open and endlessly shifting society, of which the life of the frontier was only an extreme example, the loose framework of the romance could suffice, with its picturesque and uninhibiting settings, simplified characterization and episodic plots. For the more speculative and introverted writer the romance could serve equally well, or melodrama's even more simplified rendering of moral and psychological conflict. In either case the novel was stripped of most of its realistically representational baggage—the lonely explorer travels light.

The Early American Novel.—Despite the Puritan objection to fiction as frivolous and worldly, the 18th-century English novels were imported surprisingly quickly after publication. But it was not until 1789 that the first American novel appeared—William Hill Brown's *The Power of Sympathy*. Its epistolary method and its combination of melodrama and sentimentalism reflect the legacy of Richardson. So do the novels of Susanna Rowson (*c.* 1762–1824) and Hannah Webster Foster (1759–1840); but other influences—Fielding, Smollett and Fanny Burney—appear in many other early novels, such as Gilbert Imlay's *The Emigrants* (1793), Hugh Henry Brackenridge's *Modern Chivalry* (1792–1815), and Royall Tyler's *The Algerine Captive* (1797).

The first original talent is usually considered to be that of Charles Brockden Brown, who was inspired by William Godwin's *Caleb Williams* to write several sentimental and Gothic novels. The best is *Wieland* (1798), where the hero, a cultivated Rousseauist, lives in happy domestic retirement until he is transformed into the murderer of his family and an eventual suicide under the combined spells of a family doom, religious mania and a fascinating Godwinian villain who pursues his fell designs on Wieland's peace of mind (and his sister's honour) by means of his skill as a ventriloquist.

James Fenimore Cooper began with an unsuccessful attempt at the novel of domestic manners, *Precaution* (1820). Later he wrote many historical and political novels in addition to the famous "Leatherstocking Tales." Though neither planned as a unit nor written in chronological order, these romances show a coherent and significant development in their hero's life. *The Deerslayer* (1841) and *The Last of the Mohicans* (1826) show Natty Bumppo learning the arts of the hunter and woodsman, and becoming the companion of Chingachgook and other heroic Indians; older in *The Pathfinder* (1840) and *The Pioneers* (1823), he is forced westward before the advancing frontier, and dies in *The Prairie* (1827): progress, represented by mercenary squatters, has made impossible an independent life in harmony with wild nature and primitive but noble Indians. Despite Cooper's many faults of construction, style and characterization, he created one of the great American myths—Natty Bumppo, lonely seeker of a truer way of life which endlessly eludes him.

During Cooper's long literary career—from 1820 to 1851—the number of novels written greatly increased. Many regional novelists appeared, especially in New England, Virginia, the Carolinas; the best of them, and the most prolific, was William Gilmore Simms (1806–70), who wrote of the Revolutionary War and the life of the southern frontier settlements.

The Mid-19th Century.—Subject and attitude were original in Cooper, but the essential structure of the novel remained derivative, mainly from Richardson, the Gothic novel and Walter Scott. With Nathaniel Hawthorne came a highly idiosyncratic adaptation of romance to the exploration of timeless moral perplexities. In his greatest work, *The Scarlet Letter* (1850) the early New England background is not presented with profuse historical details; and even the laws for the punishment of adultery, on which the plot is based, are used mainly as symbols of how in the light of eternal standards, the Puritan code, like human laws in general, is a crude form of ethical justice which takes little account of the complex and problematic nature of psychological reality. These complex realities are suggested in many ways. Hester Prynne's later serene dedication to good works seems the result of openly acknowledging her sin, but she remains unrepentantly ready to elope with her seducer: while her vengeful old husband, though legally guiltless, has apparently committed a more deadly spiritual sin which is symbolically punished by the mysterious growth of a perverted attraction toward his wife's lover, Arthur Dimmesdale.

Essentially the same method, sparing of concrete incident and detail but rich in suggestion of larger issues, is found in the satire on Brook Farm idealism in *The Blithedale Romance* (1852) and in the slow Gothic drama of the ancestral Puritan curse in *The House of the Seven Gables* (1851).

Herman Melville began with a series of successful narratives of his early adventures in the Pacific—*Typee* (1846), *Omoo* (1847), *Redburn* (1849), *White-Jacket* (1850). Melville's subsequent attempt to transcend the phenomenal world—to give "more reality than real life itself can show"—was begun in *Mardi* (1849), and developed more fully in *Moby Dick* (1851) and *Pierre* (1852). It was only after 1920 that the greatness of *Moby Dick* was widely appreciated. Its apparent subject is absorbing enough: the ill-fated hunt of a whaling captain, Ahab, for the white whale which made him lose a leg; but, in addition to this narrative interest, and the extraordinary farrago of miscellaneous information about whales and whaling, we soon become aware that we are on a quest for something even more slippery and deeply submerged than Moby Dick. For what, exactly, has been much debated; Melville was probably attempting to symbolize the impious and fatal attempt of Puritan monomania (Ahab) to extirpate what it sees as evil (the whale) even though it is part of God's creation. D. H. Lawrence in *Studies in Classic American Literature* (1923) defined the essential theme of Melville, and of much other American fiction, as the conflict of passion and morality, and the "evil" whale would stand well enough for the mysterious power and beauty of the instinctive elements in man which are under continual attack

from the organized repression of Puritanism.

Melville's later works, such as *The Confidence Man* (1857) and the novelette *Billy Budd* (published posthumously in 1924), suggest a deepening disillusion with American society and a melancholy resignation to the fated victimization of natural innocence (Billy Budd) by senseless evil and corruption (Claggart).

Melville and Hawthorne are the giants of mid-19th-century American fiction; but the most influential novel of the period was undoubtedly *Uncle Tom's Cabin* (1852). Its author, Harriet Beecher Stowe, also wrote pleasing studies of New England life such as *The Minister's Wooing* (1859); and this preoccupation with the local scene, which has remained very strong in the tradition of American fiction, was continued by such writers as George Washington Cable (1844–1925) in his portrayal of Creole life in Louisiana.

THE MODERN NOVEL

The modern English and American novel, though still distinct in many ways, have been affected by many of the same historical and social influences, while their literary development has been influenced by the fiction of many other countries, notably of France.

Historical Influences.—Many of the differences between the two societies tended to diminish as industrialism and urbanization coloured the whole of American life and as economic expansion and World Wars I and II increased American contact with the rest of the world. In both countries the exploitation of a vastly enlarged reading public by the mass mediums greatly increased the separation between "highbrow" and "lowbrow." This separation, combined with the increasing political and social dominance of a vulgarly philistine class of financiers and industrialists, widened the gap between writers and society almost as much in England as America. No writer since Dickens has been both the best and the most popular; the greatest modern novelists bear on both sides of the Atlantic the same stigmata of alienation and dissent: Henry James, Joseph Conrad, James Joyce and D. H. Lawrence were alike exiles and expatriates.

Literary Influences: Realism and Naturalism.—The increasing separation of the modern novelist from the values and attitudes of his society is reflected not only in the subjects but in the structures of his fiction and in its modes of representing reality. Scott had given the novelist the dignity of the historian; Stendhal aspired to be the chronicler of his century; Balzac, in his *La Comédie Humaine*, set out to be the scientific naturalist of the human species; but it was not until Gustave Flaubert's *Madame Bovary* in 1857 that the novel was given a pattern of conscious technical expertness. The name of realism was soon, and rather unhelpfully, given to the school of Flaubert; it rejected any idealization of "reality" or any concession, in plot and character, to the romantic wishes of the reader or the writer; instead, the novelist was to be a wholly objective recorder of "reality." Realism was thus the logical systematization of the novel's inherent formal assumption—its pretense at the literal, historical truth of what it presents in terms of positivist science.

With Naturalism the process went further. In his *Le roman expérimental* (1880) Émile Zola codified the analogy of the novelist and the scientist: neither of them selects or creates; they merely study and report. Actually, however, the biological determinism of the Naturalists led them to cut off their "slices of life" so as to show characters and environments which reduced life to the most elementary struggles to survive in a social environment whose irresistible power condemned man's efforts to an untragic futility.

Impressionism and the Stream of Consciousness.—As regards narrative structure, Naturalism tended toward the sprawling and the diffuse. But another literary tendency, and one in appearance quite opposed to it, soon appeared, which was sometimes described as Impressionist by Ford Madox Ford and others. Impressionism follows from Flaubert's concern with objective methods of narration, but its quasi-scientific and epistemological bias also relates it to Realism and Naturalism, although its relativist, empirical and subjective doctrine was one which had arisen in opposition to Positivism. The doctrine was clearest in the Impressionist painters, who theorized that the "real" pictorial reality was not the object as it was known to be, but the object as it appeared to the observer under special conditions of atmosphere and illumination; similarly the literary Impressionists made "point of view" the basis of a technique whereby their novels might be not only more shapely than those of the Naturalists, but truer to the individual's actual experience of life.

This general viewpoint received classical critical expression in the essays of Henry James, especially in the prefaces which he wrote to the New York edition of his novels (1907–09). According to James, a novel should be a "direct impression of life"; since the author himself must not appear, an adequately sensitive recording intelligence was needed within the novel; the novelist must also organize his narrative so that virtually the whole novel could be rendered "scenically" and made to happen under the reader's eyes. Modern critical theory of the novel as a form with modes of operation as complex and precise as those of any other literary genre was thus established by James, and criticism of the novel is still mainly operating within his concepts; among his 20th-century disciples are Percy Lubbock in England and R. P. Blackmur in the United States.

James's notion of narrative point of view as an optically accurate reflection of how individuals actually receive their impressions of life was capable of much further extension; and Virginia Woolf both in her later novels and in such critical essays as "Modern Fiction" (1919), took the extreme individualist and relativist direction which is often described as "stream of consciousness" or "interior monologue." Essentially, this attempts to give the reader a series of verbal stimuli which are literal quotations of the flux of impressions passing through the minds of the protagonists. Like any other representational technique this is, in the last analysis, a mere pretense on the part of the writer; but there is no doubt that in James Joyce, for example, or in William Faulkner it is an innovation which has had many triumphs and has now to some extent been absorbed into the narrative idiom of most modern fiction. *See* also CRITICISM.

ENGLAND AFTER 1900

The Edwardian Period.—The influence of the French and later of the Russian novelists began to be felt in England toward the end of the 19th century. George Moore started in the Naturalist tradition, in his Zolaesque *A Modern Lover* (1883), for example, while George Gissing wrote many sombre studies of the darker side of contemporary life, as in *The Nether World* (1889) and *New Grub Street* (1891). Few of the English novelists were much concerned with the problems of technique, however, and their originality came mainly from their content.

This description is on the whole true of the most successful novelists of the Edwardian period—H. G. Wells, Arnold Bennett and John Galsworthy—although Bennett was at first a conscious adherent of the French Realist tradition. In *The Old Wives' Tale* (1908) and *Clayhanger* (1910), he showed his great capacities as a shrewd observer of social and economic life, capacities which he soon turned to making his own fortune by his pen. H. G. Wells wrote novels of many kinds; but his principal aim, in *Tono-Bungay* (1909) for example, was to use fiction as a sounding board for his own radical views of social, political and sexual reform. John Galsworthy began his classic exposure of the Victorian upper middle class in *The Man of Property* (1906), which developed into *The Forsyte Saga* (collected in 1922).

In her essay "Mr. Bennett and Mrs. Brown" (1924) Virginia Woolf suggested that all these Edwardian novelists had been much too busy with the material phenomena of life and their notions about changing the world to concern themselves sufficiently with the truth of individual experience. One of their contemporaries, however, was exempted from this charge—Joseph Conrad, a transitional figure whose deeply personal art combined the old and the new: his plots employed the resources of the adventure story and of melodrama and his essential moral themes were fairly traditional, but in such a novel as *Lord Jim* (1900) the method of indirect narration through Marlow exemplified both the Impressionist technique and the relativist and skeptical attitude to life which it ultimately implies. *Nostromo* (1904), *The Secret Agent* (1907

Under Western Eyes (1911) and *Victory* (1915) were his other greatest novels.

E. M. Forster, another transitional figure, wrote all his novels except *A Passage to India* (1924) before 1914. He used the comedy of domestic manners as his form, but extended its range and added other more modern devices such as the repeated symbol or leitmotiv, as in *Howard's End* (1910); in the liberal humanist tradition, Forster's novels all explored the possibilities of harmony between countries, classes and persons through intelligence, sensitivity and love.

After World War I.—It would be difficult to exaggerate the extent to which this calamity reshaped the ways in which people looked at life: after 1914 it seemed that brutality and increasing social dissolution were the deepest truths about the world, not peace and progress; as for fiction, history had certainly destroyed the leisure and social stability needed for the kind of large-scale development of family and personal relationships on which the Victorian novel had been based.

The two most revolutionary voices among the novelists were those of James Joyce and D. H. Lawrence. They had little in common except the absolute individualism of their lives and their art, which led them both to unprecedentedly frank explorations of private experience, including the animal functions; this in turn brought them both into conflict with the law, and thus converted them into notorious public symbols of literary and moral subversiveness.

D. H. Lawrence began with realistic and fairly traditional novels about the mining towns and countrysides of his native Nottinghamshire, such as *Sons and Lovers* (1913), which recorded with harrowing sincerity the conscious and unconscious results of the hero's emotional attachment to his mother. Later Lawrence became impatient with the careful working out of plot and background in the traditional novel and his fiction became a bolder and freer effort to express the instinctive, inarticulate elements in character and personal relationships; *Women in Love* (1921) and *Lady Chatterley's Lover* (1928) are works of great power, insight and truth.

James Joyce began in the aesthetic tradition, with its cult of the lonely, Godlike creator. *A Portrait of the Artist as a Young Man* (1916) is a brilliantly composed picture of its hero's emergence from the restrictions of family, religion and country into the freedom of the artist. *Ulysses* (1922), probably the most influential and original novel of the period, mainly deals with an advertising-canvasser, Leopold Bloom; there are many intentional parallels with Homer's *Odyssey*, whose main function is as an ironical measure of the degradations of modern life; but what gives *Ulysses* its greatest power is the use of interior monologue to reveal the inmost minds and feelings of the characters as they live, hour by hour, through a Dublin day. Joyce's last work, *Finnegans Wake* (1939), attempts, through a new language and a new mythic mode of narrative, to cover the whole of the recurring cycles of world history in the form of a dream by a Dublin public-house keeper, H. C. Earwicker: Joyce's phenomenal powers as a humorist and a master of language are not in question but the merits of his final effort to revolutionize the novel are.

Virginia Woolf was almost as famous an innovator as Lawrence and Joyce. She developed the consistent stream-of-consciousness method of Dorothy M. Richardson (*Pilgrimage*, 1915–38) in *Mrs. Dalloway* (1925), *To the Lighthouse* (1927) and *The Waves* (1931) in a way which revealed a genius for poetic description of mood and atmosphere. Among the other English writers of the 1920s Aldous Huxley was perhaps the most famous for his intellectual, witty and cynical novels of discussion such as *Crome Yellow* (1921), *Antic Hay* (1923), and his larger scale *Point Counter Point* (1928).

Time will perhaps decide that Ford Madox Ford and Wyndham Lewis were underrated in their day. Certainly Ford's *The Good Soldier* (1915) and his Tietjens series (1924–28) are memorable both for their Impressionist method and for their picture of the decay of the English ruling class during the Edwardian period and World War I; while Wyndham Lewis in *Tarr* (1918), *The Apes of God* (1930) and other fictions remained an uncompromising and powerful critic of the life and literature of his times. On the other hand it may be that the great popular successes of W. Somerset Maugham blinded the critics to the enduring qualities of his novels *Of Human Bondage* (1915) and *Cakes and Ale* (1930).

After the 1920s.—In the novel, as in poetry, the great innovations of the modern period began just before World War I and came to the forefront very soon after it. The subsequent picture was more confused, and no figure with the authority of Joyce or Lawrence established himself. The fiction of the 1930s was much influenced by the atmosphere of political crisis—unemployment at home, fascism and the menace of war abroad. Its most permanent additions to the traditions of the novel were probably those of George Orwell (1903–50) and of the Hungarian-born Arthur Koestler (1905–), whose greatness depended less on their literary qualities than on their political insight.

After World War II the tendency was toward fiction on a smaller scale and in more traditional forms, modified by the technical procedures of such pioneers as James, Conrad and Joyce. Graham Greene (1904–) continued to write melodramas with moral and religious overtones; and Ivy Compton-Burnett (1892–) and Henry Green (pseudonym of Henry Vincent Yorke; 1905–) further developed their sophisticated virtuosity. Among the younger novelists William Golding (1911–), Angus Wilson (1913–) and Kingsley Amis (1922–) established their reputations.

THE UNITED STATES AFTER 1880

To World War I.—In the United States the greatest successors of Hawthorne and Melville were the very different figures of Mark Twain and Henry James, who came to maturity after the Civil War.

Mark Twain (Samuel L. Clemens) began by turning toward the idyllic past, to boyhood, to the west and to the vernacular riches of folk culture. All these are combined in *The Adventures of Huckleberry Finn* (1884) where, in the kinship of young Huck and Jim the old Negro slave, two innocents aboard a raft floating down the Mississippi, one may see a parable of the beauty and the unreality of "the American dream": to them codes, cultures, institutions, history are only interferences with the real things of life; happiness must be sought in the harmony which outcasts can achieve with nature and with themselves, but with nothing else; certainly not with what goes on in the settlements along the river banks. The narrative voice—Huck's vernacular—catches the predestined note of such a theme: its naïve simplicities are equally eloquent in their affirmations of happiness and in their ironic rejections of what man has made of man. This style was to be, as Ernest Hemingway later noted and personally demonstrated, the necessary speech of the naïve, the pastoral, the masculine and the primitivist strains in 20th-century American fiction.

Twain later became the obsessed spectator of the gilded age (which he named); and in such works as *A Connecticut Yankee in King Arthur's Court* (1889), "The Man That Corrupted Hadleyburg" (1899) and *The Mysterious Stranger* (published posthumously 1916), he revealed an uncontrolled revulsion from his increasingly commercialized society. Henry James lived most of his life in the genteel and cultivated Europe which Twain had begun his career by mocking in *The Innocents Abroad* (1869); but James's most persistent subject was nevertheless a sophisticated version of Twain's idealization of American innocence in its perilous exposure to the traditional charms and the infinitely varied corruptions of the society of London and Paris and Rome. Such, in essence, is the story of *The American* (1877) and *The Portrait of a Lady* (1881); while in later works, including *The Ambassadors* (1903), *The Wings of the Dove* (1902) and *The Golden Bowl* (1904), the same contrast is part of a much more complicated moral pattern.

But the international theme is not, of course, James's only subject, as *The Awkward Age* (1899), *What Maisie Knew* (1897) and *The Princess Casamassima* (1886) attest. What his works have in common is that in all of them James managed to be, very intensely, both a passionately involved moralist and a meticulously detached artist; and his novels consequently invite a strenuousness of attention to the complexities both of their fictional organization and of their ethical implication, which many readers have found too much

to give, and to which others have perhaps given too much.

James's friend William Dean Howells was the chief spokesman of the realistic direction which most U.S. fiction began to take after the Civil War. Having realized itself as a country, the United States had to face its problems; they were not unlike those of any advanced capitalist society, and they had already been described by the French Realists and Naturalists. For example, Howells' *The Rise of Silas Lapham* (1885), a study of the attempt of a self-made paint manufacturer to push his family into the Brahmin society of Boston, could well have been treated by Flaubert or Maupassant. After Howells, Stephen Crane's short career produced, most notably, *Maggie: a Girl of the Streets* (1893), a Naturalist study of the degradation produced by the tenement environment of New York; *The Red Badge of Courage* (1895), his famous masterpiece about the Civil War; and many short stories, such as the impressionistic "The Open Boat."

The chief tendency of the first decade of the new century was an angry Naturalism. Frank Norris planned a vast Naturalist trilogy to be called "The Epic of the Wheat": *The Octopus: a Story of California* (1901), dealt with production; *The Pit: a Story of Chicago* (published posthumously in 1903), concerned distribution; the third part, to be called "The Wolf: a Story of Europe," would have dealt with consumption. Norris' writing was sometimes banal and forced, but he was a writer of great power, perhaps because his belief in the determining effect of the environment was accompanied by an equally marked romantic identification with the sheer vigour of man's struggles—a dualism which also vitalizes his novel *McTeague* (1899).

Much of Norris' Naturalism and his note of violent social protest was echoed by Jack London; but Norris' most important successor was Theodore Dreiser. The realism of Dreiser's *Sister Carrie* (1900) caused it to be withheld from publication until 1912; *The Financier* (1912), *The Titan* (1914) and *The "Genius"* (1915) are massive and vigorous studies of a successful tycoon, Frank Cowperwood, and show a progressive identification with the values of wealth and power. Less powerful but more prolific, Upton Sinclair's works included Norrislike studies of particular industries; the Chicago stockyards in *The Jungle* (1906), *King Coal* (1917) and *Oil!* (1927).

After World War I.—Edith Wharton, friend and successor of Henry James, developed the well-made novel of manners. As Howells had already showed, U.S. society was now richly provided with differences of class and habit and tradition; Mrs. Wharton took brilliant satirical advantage of this in such novels as *The House of Mirth* (1905) and *The Custom of the Country* (1913). Many other writers who had begun before the war made or increased their reputations afterward, notably Willa Cather, Ellen Glasgow (1873–1945), James Branch Cabell and Booth Tarkington; but the most distinctive note of the postwar years was struck by writers who had just come to manhood; the war and the America of Coolidge turned them away from interest in political and social reform and toward the exploration of themselves, and above all of the small groups of like-minded, world-weary yet very convivial dissenters which are a characteristic feature of the life and the fiction of the 1920s.

F. Scott Fitzgerald is the legendary symbol of what Gertrude Stein dubbed "a lost generation," and the most representative voice of the jazz age, whose fortunes are suggested by the arc of Fitzgerald's own literary development, from *This Side of Paradise* (1920), *The Beautiful and Damned* (1922) to *The Great Gatsby* (1925), *Tender Is the Night* (1934) and the unfinished *The Last Tycoon* (1941). The complex economy of *The Great Gatsby* embodies a great theme of the American novel—the corruption and defeat of a naïvely romantic midwestern emigrant against a setting of the squalors of society both high and low.

Ernest Hemingway's *The Sun Also Rises* (1926; published as *Fiesta* in England) dealt with the American expatriates of Fitzgerald's generation; but in *A Farewell to Arms* (1929), *For Whom the Bell Tolls* (1940) and many other novels and short stories Hemingway's heroes and their idiom—an artfully laconic understatement—exhibit a brutal and increasing alienation from civilization, and form a connecting link between the earlier American primitivism of Cooper and Twain and the "tough guys" of modern popular fiction.

The chief contemporaries of Fitzgerald and Hemingway were Sinclair Lewis and William Faulkner, both, like Hemingway, winners of the Nobel prize. Lewis wrote realistic and satiric exposures of midwestern life in *Main Street* (1920) and *Babbitt* (1922), of medicine in *Arrowsmith* (1925), and of religion in *Elmer Gantry* (1927). William Faulkner, on the other hand, was a much more original and powerful writer especially in *Sartoris* (1929), *The Sound and the Fury* (1929), *As I Lay Dying* (1930), *Sanctuary* (1931), *Light in August* (1932) and *Absalom, Absalom!* (1936). Many of his later works, such as the trilogy on the rise of the Snopeses—*The Hamlet* (1940), *The Town* (1957) and *The Mansion* (1959)—continued his study of Yoknapatawpha county, while *A Fable* (1954) is a parable of Christ's Passion.

The depression of the 1930s reinforced the radical and naturalist traditions. John Dos Passos produced a vigorous and original panorama of American life through the first three decades of the century in *U.S.A.* (1930–36). James Farrell wrote the *Studs Lonigan* trilogy (1932–35), an impressive study of the impact of the Chicago environment on a young man. John Steinbeck's *The Grapes of Wrath* (1939) is a memorable picture of the struggles of migrant farm workers in California.

Among the other important writers of the 1930s, Thomas Wolfe, with his sprawling autobiographical narratives, demands notice; while it is ironical to observe that the tendency toward the radical proletarian novel had some influence on Erskine Caldwell, whose *Tobacco Road* (1932) and *God's Little Acre* (1933) were to become the world's all-time best-sellers among works of fiction.

After World War II the general level of technical narrative skill was remarkably high, and Thornton Wilder (1897–   ), James Gould Cozzens (1903–   ), Robert Penn Warren (1905–   ), and Walter Van Tilburg Clark (1909–   ) added to their considerable reputations. Among the many distinguished novelists who established themselves in the 1950s the following should certainly be mentioned: Ralph Ellison (1914–   ), Bernard Malamud (1914–   ), Saul Bellow (1915–   ), J. D. Salinger (1919–   ), Norman Mailer (1923–   ) and James Baldwin (1924–   ).

See also **Romance**; **American Literature**; **English Literature**; the articles on national literature—**French Literature**; **German Literature**, etc.; and the biographies of the various authors.

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NOVELLO, the name of an English musical family of Italian origin.

VINCENT NOVELLO (1781–1861), composer and publisher, was born in London on Sept. 6, 1781. From 1797 to 1822 he was organist at the Portuguese embassy chapel, where he directed the first English performances of Masses by Haydn and Mozart; from 1840 to 1843 he was organist at the Roman Catholic chapel at Moorfields. An original member of the Philharmonic society, he had a distinguished circle of friends, including the Lambs, Leigh Hunt, Shelley and Keats. Novello was a prolific composer, but his work as editor and publisher forms his chief title to fame. His *Collection of Sacred Music*, in two folio volumes, appeared in 1811 and marks the founding of the publishing house of Novello. In 1849 he went to live at Nice, where he died on Aug. 9, 1861.

JOSEPH ALFRED NOVELLO (1810–1896), eldest son of the above, was born in London on Aug. 12, 1810, and died at Genoa on July 16, 1896. He began his career as a bass singer but in 1829 he became active in music publishing, his first important work being *Purcell's Sacred Music*, begun by his father in the previous year. It was he who developed the house of Novello and who introduced inexpensive editions of large-scale choral works to England. In 1857 he retired to Italy, leaving the business to be managed by Henry Littleton, formerly his assistant, who subsequently bought it and expanded it with marked success. After Littleton's death in 1888 his descendants carried on the business.

CLARA ANASTASIA NOVELLO (1818–1908), fourth daughter of Vincent Novello, was born in London on June 10, 1818. One of the most famous sopranos of her time, she received high praise from Mendelssohn, Schumann and Rossini. In 1843 she married Count Gigliucci and retired for a time to Italy, resuming her professional career in 1850. She died in Rome on March 12, 1908. (H. Ru.)

NOVEMBER, the 11th month of the modern calendar, with 30 days. It was the ninth month (Lat. *novem* "nine") in the early Roman calendar, which began with March. The attempt of the Roman senate to rename it in honour of Tiberius provoked his reply, "And what will you do if you have thirteen Caesars?" In the churches of western Christendom Nov. 1 and 2 are celebrated as All Saints' and All Souls' day, respectively, perhaps replacing an old Celtic feast of the dead. (*See* HALLOWEEN.) The end of World War I is commemorated on Nov. 11. In the United States the fourth Thursday of the month is a national holiday, Thanksgiving day (*q.v.*). *See* also CALENDAR. (F. R. Wn.)

NOVENA, in Roman antiquity (Lat. *novendial*), a nine-day festival solemnized on the occasion of a prodigy announcing misfortune (especially a shower of stones); also, more commonly, the nine days' mourning following the death of the emperor or other personages. In Christian usage the term designates a spiritual devotion consisting in the recitation of a set form of prayer for nine consecutive days, in petition for a divine favour or in preparation for a liturgical feast or other important event; *e.g.*, a jubilee. The nine days recall the similar time spent by the apostles in prayer, "with the women and Mary," in preparation for the gift of the Holy Spirit (Acts i, 13–14). Novenas were known in the middle ages, but their popularity dates from the 17th century; especially popular was the novena before the feast of the Immaculate Conception (Dec. 8). Today the Novena of Grace, so called (March 4–12, in honour of St. Francis Xavier), is perhaps the best known. Recent proliferation of novenas in honour of the saints is deprecated by those engaged in the liturgical movement. (J. C. My.)

NOVERRE, JEAN GEORGES (1727–1810), was a distinguished French choreographer, whose revolutionary *Lettres sur la danse et sur les ballets* (1760) crystallized 18th-century ideas on the need for important reforms in ballet production. Noverre stressed the importance of dramatic motivation, and decried overemphasis on technical virtuosity. Born in Paris, April 29, 1727, Noverre studied under Louis Dupré, made his debut at Fontainebleau in 1743 and danced in Berlin and Lyons. His first notable choreographic success was *Fêtes Chinoises* (Paris, 1754). This production attracted the attention of David Garrick, who presented it at Drury Lane, London, in 1755.

Noverre was court ballet master at Stuttgart from 1760 to 1767, producing such masterpieces as *Medée et Jason* and *Psyché et l'Amour*. He was summoned next to Vienna where his powerful dramatic ballets *Adele de Ponthieu, Les Horaces* and *Apelles et Campaspe* effectively incorporated his theories. In 1776, on the recommendation of Marie Antoinette, his former pupil, he was appointed ballet master at the Paris Opéra, fulfilling a life-long ambition. He died at St. Germain, Oct. 19, 1810.

Noverre's *Lettres* have been translated into many languages, including English, German, Czech and Korean. His ideas are still valid and constitute an eloquent plea for dramatic expressiveness in the dance.

See Derek Lynham, *The Chevalier Noverre, the Father of Modern Ballet* (1950). (Ln. Me.)

NOVGOROD, a town and administrative centre of Novgorod *oblast* in the Russian Soviet Federated Socialist Republic, U.S.S.R., stands on the Volkhov river, about two miles below its outfall from Lake Ilmen and about 110 mi. S.E. of Leningrad. Pop. (1959) 60,669. It is one of the most ancient and historically important towns of Russia.

The main feature is the kremlin (originally known as *detinets*) on the Sofiskaya Storona, the west (left) bank of the Volkhov. First mentioned in 1044, it was extended in 1116. In the 14th century the first stone wall was built. The present walls, with a circumference of more than 1,500 yd., have nine towers. Within the kremlin is the cathedral of St. Sophia, first built of wood in 989. The present building dates from 1045–50 and, although restoration was carried out in the 19th century, it remains one of the finest examples of early Russian architecture. Of special note are the great bronze doors, dating from the 12th century and probably of Byzantine workmanship. Also in the kremlin is the Granovitaya palace (1433), the bell tower (1443) and the little chapel of St. Sergius, also of the 15th century. Another chapel, that of St. Andrew Stratilata, dates from the 17th century as do several other minor buildings. A park has been laid out, surrounding the kremlin.

On the opposite bank of the Volkhov, the Torgovaya Storona, stands the cathedral of St. Nicholas, dating from 1113 and decorated by exterior frescoes. Also of the 12th century are the cathedral of the Nativity of Our Lady, located in the former Antoniev monastery, downstream on the Volkhov; the cathedral of St. George, on the shores of Lake Ilmen in the former Yuriev monastery; the church of St. John (1127); and the church of the Assumption (1135–44). In and around Novgorod, despite damage in World War II, there still survive many other old churches. Of particular note are the church of St. Theodore Stratilata (1360–61), the church of the Transfiguration (1374) and the Znamenski cathedral of the 17th century. From the 18th century dates the Putevoi palace. In 1862 a monument designed by M. O. Mikeshin was raised in the kremlin to commemorate the 1,000th anniversary of Russia. The town has a pedagogic institute.

Novgorod's industries are relatively small and include timber working (furniture and match making), the manufacture of clothing, knitwear and chinaware, fish canning and the repair of river craft. Communications are good, with rail connections to Leningrad, to Luga on the Leningrad-Riga line and to Chudovo on the Moscow-Leningrad line. Novgorod stands on the main Moscow-Leningrad highway, where a road branches to Pskov. The Volkhov is navigable for small craft.

History.—Novgorod is first mentioned in chronicles for the year 862, but its origins are obscure. Archaeological discoveries show the existence of a fortress in the 9th–10th centuries and testify to the growth of Novgorod's trade district (*Torgovaya Storona*) in the 10th century, but there appears to have been an earlier fort-settlement, or *gorodische*, on the shores of Lake Ilmen. The first recorded ruler of Novgorod was Rurik, who was a Varangian, or Norseman, invited by the people of Novgorod to be their prince. In 882 his successor, Oleg, captured Kiev and moved his capital there. Again in 980 the prince of Novgorod captured Kiev, but in general the supremacy of the Kievan princes

was recognized. In 989, under Vladimir, the inhabitants of Novgorod were forcibly baptized. In 1019 the Kievan grand prince Yaroslav granted the town a charter, the Russian law (*Russkaya pravda*), which gave it self-government. The assembly of the townspeople, known as the *veche*, elected their prince. His function was little more than that of military commander and he could be, and often was, removed by the vote of the *veche*. After the death of Vladimir II Monomakh (1125), when the political and economic power of Kiev began to disintegrate and when Suzdal in the northeast had not yet grown strong enough actively to interfere with its western neighbour, Novgorod began to liberate itself from the control of Kiev and work out the pattern of its freedom. From 1270 on, the *veche* elected only a magistrate or burgomaster as its ruler. Sovereignty resided in the town itself, which was quaintly styled *Gospodin Veliki Novgorod* ("Lord Novgorod the Great").

During that period Novgorod flourished as a great trading centre on the "water road," the route from the Baltic to Byzantium, via the Volkhov, Lovat and Dnieper. Trade also went across the portages of the Valdai hills to the Volga and down that river to the Caspian sea and central Asia. The great staple of Novgorod trade was furs, but amber from the Baltic, honey, wax and slaves were also sent south. Return cargoes were mostly luxury goods, gold and silverware and silks. In their search for furs, the town's traders penetrated far into northern Russia and into the basin of the Northern Dvina, then known as Zavolochie, the "land beyond the portage." They even crossed the northern end of the Urals into the northwestern corner of Siberia. Later, in the 12th century, "daughter" towns, Vologda and Vyatka, were founded in these northeastern regions and in time they became independent. The trade of Novgorod was carried on by organized guilds of merchants, each living in its own section of the town. There was a close link with the Hanseatic league and the town derived no little importance from its position as the farthest point to which the Hanse merchants could trade into Russia.

With the decline in power of the Kievan princes, Novgorod was frequently engaged in struggles with the other towns of Russia. In the 12th century there was a prolonged struggle with Suzdal, the main source of grain for Novgorod. In 1169 and again in 1216 the Novgorodians defeated the forces of Suzdal. Meanwhile the growing power of Sweden and the Teutonic Order began to threaten Novgorod from the west. To aid the town against them, the people of Novgorod called on Alexander (*q.v.*) (Nevski), prince of Vladimir, and under his leadership defeated the Swedes on the Neva in 1240 and the Teutonic Order on the ice of Lake Peipus in 1242. Thereafter the town, although still electing its own magistrate, acknowledged the authority of the princes of Vladimir. In the great Tatar invasion of 1238–40, the Tatar armies under Batu Khan came within 60 mi. of Novgorod, but the onset of the thaw on the marshes around the town deterred them and the town was saved from the destruction which overwhelmed most other Russian towns. In the 14th century Novgorod began a long struggle for supremacy with the rising power of Moscow. To the southwest, Lithuania was the new power and Novgorod enlisted its aid against Moscow. In 1332 and again in 1386, under Dimitri Donskoi, Moscow launched attacks on Novgorod. Despite the constant wars and the natural disasters of fire in 1340, 1385 and 1388 and plague in 1390, it is said that the population of Novgorod in the 14th century numbered 400,000 and that there were more than 200 churches.

During the first three-quarters of the 15th century Novgorod was one of the main bones of contention between Lithuania (united with Poland in 1385) and Moscow. In the first three decades the Lithuanian prince Vytautas repeatedly tried to annex Novgorod; but after his death (1430) Novgorod was peacefully wooed by Casimir IV Jagiello, king of Poland and grand prince of Lithuania. Because it harboured his enemies during the civil war and accepted Lithuanian princes, Basil (Vasili) II, grand prince of Moscow, declared war on Novgorod and defeated its forces in 1456; the republic then lost its right to carry on independent diplomatic relations with foreign powers. The first eight years of Tsar Ivan III's reign were marked by acts of open insubordination toward Moscow and illicit relations with Lithuania. At the end of the 1460s the pro-Lithuanian party under Marta Boretskaya asked Casimir IV to annex the city and to submit the archbishop to the jurisdiction of the pro-Uniate metropolitan of Kiev; but before Casimir could offer effective aid, Ivan, in order to "save" his so-called patrimony from the enemies of Orthodoxy, marched on the city, defeated the Novgorodians (1471) and forced them to renounce all dealings with Lithuania and to cede large portions of their northern colonies. Yet Novgorod still remained technically a "free city." In 1477 the *veche*, now under control of the still vigorous anti-Muscovite faction, refused to recognize Ivan's sovereignty. Ivan mobilized his army, surrounded Novgorod and forced it to accept his terms (Jan. 1478). He removed the *veche* bell, the symbol of freedom, confiscated large areas of church land and established his full sovereignty over the city. Even so, opposition to Moscow still continued, until in 1570 Ivan IV "the Terrible" crushed the city, massacring many thousands and deporting the survivors.

In 1611 Novgorod was captured by the Swedes, but in 1617 it was returned to Russia by the treaty of Stolbovo. In 1701 Peter I the Great had Novgorod fortified, but his founding of St. Petersburg replaced its function as a link with the Baltic and the town declined to a minor regional centre. In 1727 it was made seat of a *gubernia* (province). During World War II, from Aug. 1941 to Jan. 9, 1944, Novgorod was occupied by the Germans, and the greater part of the town was reduced to ruins. After the war, not only was the town rebuilt but also the many architectural relics of its long past were carefully restored.

Novgorod Oblast covers an area of 55,299 sq.km. (21,351 sq.mi.) and was formed in 1944 from Leningrad *oblast*. Across it from north to south are the Valdai hills, the line of terminal moraines of the last glaciation, which reach a height of 1,053 ft. in Mt. Kamennik in the extreme south. West of the Valdai hills is the extensive basin of Lake Ilmen, into which a large number of rivers flow, notably the Msta from the east, the Lovat from the south and the Shelon from the west. The outlet for the lake the Volkhov, flows north to Lake Ladoga. A high proportion of the basin is covered by swamp of grass marsh or peat bog. East of the Valdai hills is another swampy lowland in the upper basin of the Volga and drained by the Kobozha and Mologa. There are innumerable small lakes on the Valdai hills. The whole area is covered by glacial deposits, giving an alternation of low, often sandy, mounds and swampy boulder clay hollows. The climate is continental, modified by maritime influences from the west, with January average temperatures about −5° C. (23° F.) and July averages about 17° C. (63° F.). Rainfall is about 20–24 in. a year. The natural vegetation, apart from the swamp areas, is mixed forest of spruce, oak, pine (especially on sands), birch, maple and lime. Along the rivers are extensive floodplain meadows. Soils are usually podsols, often acidic and of low fertility.

The *oblast* population in 1959 numbered 736,529, of whom 251,399 (38%) were urban. The 8 towns and 17 urban districts are all small, the more notable, after Novgorod, being Staraya Russa and Borovichi. Industry is chiefly concerned with timber exploitation, producing sawtimber, paper, pulp and matches, and with primary flax processing. Some cotton cloth is made at Borovichi and cotton thread at Kulatin. Glass and china are also made. Near Borovichi a little lignite is mined. Agriculture, because of the extensive swamps and infertile soils, is weakly developed. Less than 9% of the surface is under the plow. Oats, rye, flax and potatoes are the main crops. Dairying is far more important, especially to supply Leningrad. Since 1870 considerable areas of swamp have been drained, chiefly for pasture or improved forest.

The *oblast*'s chief traffic arteries, rail and road, run northwest-southeast across it between Leningrad and Moscow. The Tallinn-Pskov line to Bologoye (on the Moscow line) crosses it from west to east. *See* also references under "Novgorod" in the Index.

(R. A. F.; X.)

NOVI PAZAR, a town in Dezevski *srez* (district), of the Socialist Republic of Serbia, Yugos., lies at the head of the fertile

valley of the upper Raska on the site of the ancient Serbian city of Rascia (Ras), 115 mi. S. of Belgrade. Pop. (1961) 20,712. There are Roman baths in the vicinity. The 9th-century church of St. Peter, one of the oldest religious buildings in Yugoslavia, is an interesting example of early medieval Slav architecture. Nearby is the famous monastery of Sopoćani (dating from 1285) with vast frescoes portraying the Gospels. Agriculture is the main economic activity and there is a trade in fruit and timber. The town was captured by the Turks in the 15th century and became the seat of a sanjak. It was taken by the Serbs and Montenegrins during the Balkan Wars (1912–13) and was assigned to Serbia by the treaty of Bucharest (1913). Novi Pazar has road links with the valley of Ibar. (V. De.)

NOVI SAD (German Neusatz; Hungarian Újvidék), administrative centre of the Autonomous Province of Vojvodina and of Novi Sad *srez* (district), Yugos., is situated on the left bank of the Danube opposite the historic fortress of Petrovaradin about 47 mi. N.W. of Belgrade. Pop. (1961) 102,385. Novi Sad originated in 1690 as a fortress settlement and became a fishing village. In 1748 it attained city status and was named Novi Sad. During the Hungarian Revolution (1848–49), the town was partly destroyed. After World War I, it was incorporated with the province into Yugoslavia and during World War II it was occupied by Hungarian troops. It was for long the focus of Serbian culture, especially after the foundation in 1826 of the Matica Srbska (Serbian Literary society), and has a university (established 1960), a pedagogical college, an opera house, an art gallery and several museums and archives. It has excellent communications with central Europe via the Danube canal system and by road and railway. The city developed as the economic centre for agricultural products of the fertile Backa plain, but there has also been considerable industrial growth, *e.g.*, the manufacture of porcelain, textiles, electrochemical equipment and agricultural machinery. (V. De.)

NOVOCAIN: *see* Procaine Hydrochloride.

NOVOCHERKASSK, a town in the Rostov *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., stands at the confluence of the Tuzlov river with the Aksai, a distributary of the Don, 33 mi. N.E. of Rostov-on-Don. It is on the Rostov-Shakhty-Voronezh railway and the main highway between Rostov and the Donets basin (*q.v.*). Pop. (1959) 95,453. The original town, Starocherkasski, stood on the Don, but it was frequently inundated and moved to its present site in 1805, becoming the capital of the Don Cossack region. It was a centre of the anti-Bolshevik movement (1917–20) and during World War II was occupied by the Germans (1942–43). Its industries produce electric locomotives for main-line and factory use, machine tools, iron castings, butter and fats, flour and alcohol. There are polytechnic and agricultural teaching institutes and research institutes of hydrochemistry, hydrotechnology, reclamation and vine growing. (R. A. F.)

NOVOKUZNETSK (formerly Stalinsk), a town in Kemerovo *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., stands on both banks of the Tom river, just below its confluence with the Kondoma, in the Kuznetsk basin (*q.v.*) industrial area. Pop. (1959) 376,730. Originally the small village of Kuznetsk, founded in 1617, stood on the right bank, with about 4,000 inhabitants in 1926. In 1929, under the first five-year plan, an iron and steel works was founded on the opposite bank. Round the works a new town, Novo (New)-Kuznetsk grew up, which was renamed Stalinsk in 1932. Development was extremely rapid and the fully integrated plant became one of the largest in the U.S.S.R. The town is now the largest in the Kuznetsk basin; in 1961 its name reverted to Novokuznetsk. As well as iron and steel it produces aluminum, using bauxite from the nearby Salair deposit.

Large-scale coal mining is carried on round the town and supplies coking coal for the blast furnaces. There is a chemical industry, using by-products, while slag is used in making cement. The main heavy-engineering manufactures are mining machinery and bridge girders. Novokuznetsk has metallurgical and pedagogic institutes. (R. A. F.)

NOVOMOSKOVSK (formerly Stalinogorsk), a town of Tula *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., lies 40 km. (25 mi.) S.E. of Tula, on the shores of (Lake) Ivan-Ozero on the upper Don. Pop. (1959) 106,738. Originally the small settlement of Bobriki, the town was founded in 1930 and developed rapidly as a major centre of the chemical industry. In 1934 it was renamed Stalinogorsk. In 1961 the name was changed again to Novomoskovsk. It lies in the Podmoskovny coal basin, and lignite is mined there, which is used in a large thermal power station. Natural gas, brought by pipeline from the north Caucasus mountains, is used in the chemical industry, which produces fertilizers. There is a mining-machinery factory. (R. A. F.)

NOVOROSSISK, a town in Krasnodar *krai* of the Russian Soviet Federated Socialist Republic, U.S.S.R., stands on the Black sea coast, at the head of Tsemes bay (Tsemesskaya Bukhta) and at the foot of the western extremity of the Caucasus mountains, 60 mi. W.S.W. of Krasnodar town. Pop. (1959) 93,461. In 1838 the Russians founded a fortress there, but its importance as a port grew steadily, especially after the coming of the railway in 1888. Before the Revolution, Novorossisk was the largest grain-exporting port of Russia after Odessa. It is still a major port with a naval base, shipbuilding yards, refrigeration plant and grain elevators. Cementmaking is important, with four large factories producing 12% of the Soviet output. Other industries are flour milling, fish processing and light engineering. It was occupied by the Germans (1942–43) during World War II and suffered severe damage. (R. A. F.)

NOVOSHAKHTINSK, a town in Rostov *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., stands on the small Maly Nesvetai river, 57 km. (38 mi.) N.N.W. of Rostov-on-Don on the Rostov-Donets basin highway, and is also connected by a branch line to the main Rostov-Donets basin railway. Its population (103,566 in 1959) had more than doubled since 1939. It is one of the chief mining centres of the eastern end of the Donbass coalfield which is particularly rich in anthracite. Novoshakhtinsk has also an important chemical industry, and there are production of sewn goods, brewing, flour milling and the processing of dairy products. (R. A. F.)

NOVOSIBIRSK, an *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., was formed in 1937. It lies in western Siberia and until 1943–44 included large areas that now comprise Kemerovo and Tomsk *oblasts*. Present area 68,803 sq.mi. Pop. (1959) 2,298,481. The eastern part of the *oblast* lies in the basin of the Ob, which crosses it from south to north, but the greater part is drained toward the west by the Om and Tara to the Irtysh. The large Lake Chany is a basin of inland drainage, receiving two rivers of some size, the Kargat and Chulym. Almost the whole *oblast* is an extremely level plain, known in the north as the Baraba steppe (Barabinskaya Step) and in the south as the Kulunda steppe (Kulundinskaya Step). It is exceptionally swampy and there are innumerable lakes. Only on the Ob plateau, east of the Ob, does the land rise slightly. The climate is severely continental, with summer temperatures averaging about 21° C. (70° F.) and rising to maxima of 35°–41° C. (95°–105° F.); winter averages are about −18° to −20° C. (0° to −4° F.). Vegetation and soils range from taiga on podsol soils in the north, through forest steppe, with groves of birch on gray forest soils, to true steppe on chernozem.

Fifty-five percent of the population (1,275,539) are urban, living in 12 towns and 10 urban districts. Nearly three-quarters of these live in the administrative centre of Novosibirsk, where all the important industry is concentrated. Other towns are small, local agricultural centres, mostly concerned with food processing. The main agricultural area is the Kulunda steppe, of which a high proportion is under cultivation. Spring wheat is by far the most important crop, occupying half the arable land. Other crops are oats, barley and sunflowers. In the Baraba steppe, with its extensive natural pasture, dairying is dominant. Some of the swamp was reclaimed between 1895 and 1917, and part of this work has been reconditioned. In the north, arable farming is again significant, with wheat, rye and flax the most important crops. Fishing is important in the Lake Chany region. (R. A. F.)

NOVOSIBIRSK, a town and *oblast* administrative centre of the Russian Soviet Federated Socialist Republic, U.S.S.R., stands on the right bank of the Ob, at the confluence of the Inya. With a population (1959) of 886,470, it is the largest town in Siberia. It developed after the village of Krivoshchekovo on the left bank was chosen as the crossing point of the Ob for the Trans-Siberian railway in 1893. In 1895 the new settlement, Aleksandrovski, was renamed Novonikolayevsk, which it was called until 1925. In 1897, when the rail bridge was completed, the population was 7,832. In 1904 it was made a town. By 1911 the population was 63,000 and by 1939 it had increased to 405,000. Industry has grown with the town and was especially stimulated in World War II, when many factories were evacuated to this area. Engineering takes first place, producing heavy machinery, hydraulic presses, mining equipment, instruments, agricultural machinery, turbines and electrothermal equipment. There are ship and locomotive repair works. Metal for these factories is partly supplied by a rolled-steel mill and large tin works in Novosibirsk. There is an important chemical industry, producing plastics and pharmaceutical goods. Consumer products include cotton cloth, knitwear, footwear, leather goods and furniture, as well as a range of foodstuffs. There are two thermal power stations and, just above the town, the great Novosibirsk barrage and hydroelectric station, with a capacity of 400,000 kw. Novosibirsk is a major communications centre, with railways to the Kuznetsk basin and Barnaul, as well as the Trans-Siberian. The Ob is navigable and there is a large airport. The town is rapidly developing as the cultural focus of Siberia, especially since the founding of its university in 1959 and of the Siberian branch of the Academy of Sciences. There are institutes of railway engineers, water transport, electrotechnology and communications. (R. A. F.)

NOWELL, ALEXANDER (*c.* 1507–1602), dean of St. Paul's cathedral, London, who incurred the royal disfavour for his tactless preaching, was educated at Brasenose college, Oxford, where he may have shared rooms with John Foxe, the martyrologist. He became master of Westminster school (1543) and prebendary of Westminster (1551). In Mary's reign he was deprived of his prebend and sought refuge at Strasbourg and Frankfurt, where he developed extreme puritan views. He accepted the Elizabethan religious settlement, however, and was rewarded in 1560 with the deanery of St. Paul's, where he remained until his death on Feb. 13, 1602. His relations with Elizabeth I were on several occasions unfortunate. Once (1562) she took objection to a prayer book which he had put for her use, because it contained pictures of saints. Another time (1564), when he preached against the crucifix with obvious allusion to the one she kept in the royal chapel, the queen interrupted his sermon. He is generally regarded as the author of the catechism inserted before the order of confirmation in the Prayer Book of 1549—his "small" catechism—which, supplemented in 1604, is still the official catechism of the Church of England. Early in Elizabeth's reign he wrote a "larger" catechism which was printed in 1570, and in the same year appeared his "middle" catechism, designed for use in schools.

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NOWGONG, a town and district of Assam, India. The town, headquarters of the district, is on the Kalang river, 74 mi. E.N.E. of Gauhati by rail. Pop. (1961) 38,600. There are two colleges affiliated to Gauhati university, a technical school and a nursing and midwifery training centre. Nowgong is a large producer of jute.

NOWGONG DISTRICT (area 2,167 sq.mi.; pop. [1961] 1,210,761) is largely a plain, encircled by thick forest with the Brahmaputra river on the north. It is intersected by the Kalang river and its tributaries, and is much affected by floods. Numerous marshes and small lakes occur, some notable for fisheries. Teak, sal and lac are valuable forest products. Shifting cultivation in the hills is practised by the Mikir and Kachari tribes (*qq.v.*). Jute and some silk are produced. The chief crops include rice, tea and mustard seeds. Bordowa is a holy place for Assamese Vishnuites (Vaishnavites), being the birthplace of Sri Sri Shankardeva; Silghat on the Brahmaputra is a river port and the rail terminus of a branch line. Raha village is well known for brassware. Lumding in the south is an important junction of the North East Frontier railway. (M. BA.)

NOWY SACZ, a town in Cracow *wojewodstwo* (province) southern Poland, lies on the Dunajec, a tributary of the Vistula, about 115 km. (71 mi.) S.E. of Cracow by road. Pop. (1960) 34,000. It is in a Carpathian valley (Kotlina Sadecka) famed for its apples. Nowy Sacz was founded in 1292, as a result of a privilege granted by Waclaw II, who moved the town of Sacz to a new and more defensible site at the crossing of two old routes, along the Carpathians, and from the north to Hungary (now used by the railway lines), and this helped its development. It developed as an administrative and regional cultural centre and has a metal industry. It is also a tourist centre because of its fine old buildings and the attractive surrounding district. (T. K. W.)

NOYES, ALFRED (1880–1958), English poet, a traditionalist in his literary tastes and remembered chiefly for his lyrical verse, was born at Wolverhampton, Staffordshire, on Sept. 16, 1880, and educated at Exeter college, Oxford. While still an undergraduate he published his first book of poems, *The Loom of Years*, in 1902. Encouraged by George Meredith and others he produced further volumes such as *Forty Singing Seamen* (1907) and *Drake* (1908), which showed patriotic fervour and a love for the sea. In 1913 he went to the United States on a lecture tour and in the following year was elected to a professorship of modern English literature at Princeton university, which he resigned in 1923.

Noyes's most considerable achievement was the epic trilogy, *The Torch-Bearers* (three volumes, 1922–30), which took as its theme the progress of science through the ages. In addition to several volumes of poetry—his *Collected Poems* appeared in 1910, 1920, 1927 and 1950—he wrote critical essays, biographies and novels. After his conversion to Roman Catholicism in 1927 his religious beliefs tended to colour his work, in particular *The Unknown God* (1934) and *Voltaire* (1936). Among his later publications were *Two Worlds for Memory* (1953), an autobiography, and *The Accusing Ghost* (1957), a defense of Roger Casement. Noyes died at Ryde, Isle of Wight, on June 28, 1958.

NOYON, a city of northern France in the *département* of Oise, is built at the foot and on the slopes of a hill 67 mi. (109 km.) N.N.E. of Paris by rail. Pop. (1962) 9,019. Its beautiful transitional Romanesque-Gothic cathedral (12th–13th century) and the old *hôtel de ville* were burned during World War I and later restored. The cathedral treasures include a Carolingian manuscript and a rare musical incunabulum. The town has good trade in livestock and grain and contains chemical and artificial manure works and iron foundries.

Noyon, the ancient Noviomagus Veromanduorum, was Christianized by St. Quentin at the end of the 3rd century, and about 530 the seat of the bishop was transferred there from St. Quentin. St. Eligius was bishop in the 7th century. Charlemagne was crowned there in 768 and Hugh Capet crowned in 987. Till the French Revolution the bishopric was one of the ecclesiastical peerages of the kingdom. At the beginning of the 12th century Noyon obtained a communal charter through the favour of its bishops. It was ravaged by the English and the Burgundians during the Hundred Years' War. It was captured by the Spaniards in 1552, and then by the Leaguers, who were expelled in 1594 by Henry IV. John Calvin was born there in 1509 and the house in which he lived as a boy is now a museum. Noyon was occupied by the German army in 1914 and was abandoned, bombarded and reduced to ruins, 1917–18. In World War II the town was again occupied by the Germans (June 1940) and was severely damaged.

NSAW, a West African people known also as Banso, numbering about 52,000 (1960s), the largest of the Tikar groups in Bamenda district of Cameroon Republic. Their kingdom, with its capital at Kimbaw (or Kumbo), is ruled by the *Fon* ("king," pl. *Afon*), whose position is hereditary within one of their exogamous patrilineal lineages. The queen mother (*Ya*, pl. *Aya*) assists in the government and in the hearing of court cases.

The Nsaw practise sedentary farming with fallowing. Maize is the principal crop, supplemented by taro, yams, a white carrot (*Coleus*), white and sweet potatoes, cassava, Guinea corn (*Sorghum*), finger millet (*Eleusine*), plantains, beans, peas and other fruits and vegetables. Farming is done largely by women, with a short-handled hoe as the main tool. Men clear the high bush, help in harvesting grain crops, hunt, gather honey, raise plantains, tobacco, chickens and goats, provide fire wood and are responsible for house building and thatching. Women trade in local produce, and men make long trading journeys. Some men do wood carving, make baskets or raffia hats, tap palm wine and engage in new crafts such as carpentry, tailoring and brickmaking. Pottery and iron tools are obtained in trade from neighbouring peoples, and cotton cloth from the Hausa of northern Nigeria. European clothing has been adopted by a few, but men generally wear loincloths woven by the Hausa, and women wear string fringes. Islam has been introduced through the Hausa and Fulani (*qq.v.*), but it is estimated that over 80% of the Nsaw follow their traditional religion. They believe in a supreme god who created human beings and is associated with the earth and its fertility. Ancestors are worshiped as intermediaries between god and the living. Diviners consult the black spider (*ngam*), as among the Bamum.

See P. M. Kaberry, *Women of the Grassfields* (1952). (Wi. B.)

NUBA, the name commonly used to describe the Negroid inhabitants of the Nuba hills in the southern half of Kordofan (*q.v.*) province, Republic of the Sudan. This region (approximately 30,000 sq.mi.) is studded with rugged granite hills which rise sharply from a wide clay plain and vary considerably in size and extent.

The Nuba peoples (numbering more than 500,000 in the 1960s) live on or near the hills (the plains being mainly occupied by Baggara Arabs) in many tribal groups that differ in physical type, language and culture. They are vigorous, independent hill folk of good physique, strong in traditions and fighting qualities. The number of language groups (ten) is fewer than formerly supposed: Tegali-Tagoi; Koalib-Moro; Talodi-Masakin; Lafofa; Kadugli-Krongo; Katla; Temein; Nyimang; Daju; "Hill" Nubian (Dilling, Ghulfan, etc.) Researches indicate possibilities of reducing these. The first four have sometimes been termed Bantoid, as they share a noun-class system reminiscent of Bantu. The speakers of Daju and "Hill" Nubian are incomers from the west and north respectively.

S. F. Nadel gives a fourfold cultural grouping based on kinship structure, type of clan organization and the presence or absence of a spirit-possession cult practised by mediums (*kujurs*). Kinship descent is, broadly speaking, matrilineal in the south, patrilineal elsewhere. The Nuba are agriculturalists (using spade-type hoes), with hill terraces and, now, larger cultivations on the plains. The main crops are millet, sesame, maize, peanuts, beans, onions, cotton and tobacco. They also keep cattle, sheep, goats, donkeys, fowl and (except in Islamized areas) pigs. Religious practices are much linked with agricultural rituals, animal sacrifices are made to ancestral spirits and priestly experts and rainmakers have an important position.

Tribal units are under government-appointed *meks* or chiefs and patterns of homestead vary. Marriage payments are in livestock, weapons and other objects, and by agricultural service. In the remoter hills, men still go naked and women wear beads and lip-plugs, but clothes are increasingly worn. In some parts the lower incisors are removed in both sexes; male circumcision is now more widely practised. Wrestling and stick fighting are the principal sports. Varying degrees of Islamization may be observed and Arabic is used as the *lingua franca*.

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NUBAR PASHA (Nubar Pasha Nubarian) (1825–1899) was one of the outstanding Egyptian statesmen of the 19th century. Born at Smyrna (Izmir), Turk., in Jan. 1825 of an Armenian Orthodox family originally from Shikakhokh in the southeast of Russian Armenia, he was educated at Geneva, Switz., and Sorèze, France. In 1842 he went to Egypt as secretary to his uncle, Boghos Bey Yusufian, Mohammed Ali Pasha's director of foreign affairs. On Boghos Bey's death in 1844 Nubar became secretary-translator to Mohammed Ali and later joined the staff of Ibrahim Pasha whom he accompanied to Paris in 1846 and 1847. Abbas I who succeeded as viceroy in 1848, made Nubar his first secretary. In 1853 he was appointed viceroy's agent in Europe, returning to Egypt after the accession of Said Pasha with whom he traveled to the Sudan in the winter of 1856–57.

Nubar's promotion was now rapid. A member of the railway board, and from 1858 director of railways, he took a leading part in the arrangements between Said and Ferdinand de Lesseps for the construction of the Suez canal, and when Ismail Pasha became viceroy, he went to Paris in 1863–64 to negotiate with the French government and the Suez Canal company a revision of the original contract. In 1865 he was minister of public works and from 1866 minister of foreign affairs. Nubar's ability as a negotiator is nowhere better shown than in his eight years of bargaining with the powers and the Porte which ended in 1876 in the reform of the consular courts and the institution of mixed tribunals. (*See* Capitulations.) Ismail's debts were bringing him to the verge of bankruptcy and in Aug. 1878, under pressure from Britain and France acting on behalf of Ismail's creditors, the khedive reluctantly appointed a mixed Egyptian and European ministry led by Nubar, who also retained the portfolios of foreign affairs and justice.

Nubar vainly tried to induce Ismail to adopt the role of constitutional ruler and was criticized in Egypt for his apparent sympathy with the bondholders. In defiance of the powers, Ismail dismissed his ministry in April 1879 and within three months was himself deposed. His successor, Mohammed Tewfik Pasha, recalled Nubar to the presidency of the council of ministers in 1884 on the resignation of the ministry of Mohammed Sharif Pasha. Nubar remained in office until 1888 when he resigned after a clash with Sir Evelyn Baring, the future earl of Cromer, British representative in Egypt. In 1894 Nubar became prime minister for the third and last time, but ill health coupled with impatience under British tutelage soon caused his resignation (1895). He retired to Paris where he died on Jan. 14, 1899.

Two of his relatives achieved distinction in the khedivial service; his brother, Arakel Bey al-Armani, governor of Khartoum (d. 1858), and his nephew, Arakel Bey Abro, governor of Massawa, killed in 1875 in the Egyptian-Ethiopian war.

Nubar's brilliant, if somewhat doctrinaire, mind fitted him preeminently for international negotiation rather than for practical administration. Combining Ottoman with European culture and sharing the Turkish-speaking Egyptian ruling families' contemptuous ignorance of Arabic, he had little in common with Egyptian nationalists whom he regarded as provincials, while they, notwithstanding his great services for Egypt, regarded him as a foreigner.

See also Egypt: *History*.

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NUBIA, an ancient region of northeastern Africa, extending approximately from the Nile valley at Aswan, near the First cataract in upper Egypt, eastward to the Red sea, westward to the Libyan desert and southward to about Khartoum, in the Republic of the Sudan. Its north-south extent is about 560 mi. between latitudes 16° and 24° N., and most of it lies in the Sudan. It has no strictly defined limits, however, and is little more than a geographical expression. It was originally called Cush (Kush) under the Pharaohs and the Greeks called it Ethiopia (*see* Ethiopia, Ancient); the present name is derived from *nob* (slave) in the Mahass dialect of the Nubian language, of which four different dialects are spoken between Aswan in Egypt and Dongola in the Sudan.

The country consists mainly of sandy desert and rugged plateaus

of the Nubian sandstone through which the Nile flows in a gorge. The river in this section is narrow with little or no flood plain, but a continuous series of slight falls and rapids occurs, coincident with outcrops of harder crystalline rock. Between Khartoum and Philae, Egypt, the Nile makes a great S-shaped bend; the region west and south of the Nile within the first bend is the Bayuda desert (Sahra' Bayyudah) and that east of the Nile the Nubian desert, corresponding roughly with the conventional division of upper and lower Nubia. Most of Nubia is within the almost rainless zone.

The construction of the Aswan high dam in Egypt, and the consequent ponding back of the Nile creates a narrow lake extending about 350 mi. south, submerging not only Wadi Halfa, the only settlement of any size in the region, but also a number of discontinuous patches of cultivated land. This necessitated the resettlement of about 60,000 peasant cultivators. For the measures taken to preserve ancient monuments *see* section below, *Excavation and Preservation of Nubia's Sites and Monuments*. The communications between Egypt and the Sudan also needed replanning; they were formerly maintained by steamer service between Ash Shallal (near Aswan), the terminus of the Egyptian railway, and Wadi Halfa, the northern terminus of the Sudanese railways.

(A. B. M.)

ARCHAEOLOGY AND EARLY HISTORY

In Nubia the early Stone Age ran its usual course. Pre-Abbevillian tools occur at Wadi Halfa and at Nuri below the Fourth cataract. Abbevillian tools were found at Wadi Halfa, between the Second and Third cataracts at Sai Island (Jazirat Say) and Wawa, in Wadi al Hudi near the mouth of the Atbara river and near Omdurman. Acheulean tools occur near Wadi Halfa, at Laqiyah in the Wadi al Qa'b and at Omdurman. Early Levallois occurs near Tangasi between the Third and Fourth cataracts; and Acheulean-Levallois hybrid cultures near Wadi Halfa, at Salimah oasis, north of 'Abri and, in the Sangoan (Tumbian) form, at Omdurman.

The Levalloisian technique lasted long. It is seen in the Sebilian culture from Kom Ombo (Kawm Umbu) and in surface finds all over Nubia; and it still affected cultures at the beginning of the historic period.

Fossils have been found associated with the Sebilian at Wadi Halfa. In the Upper Sebilian, microliths become dominant, suggesting the Capsian culture from north Africa with its backed-blade technique. Similar microliths are widely found on the surface; and at Khartoum a culture with Capsian connections and indistinguishable from the Wilton of southern Africa occurs with bone harpoons with four or more barbs, barbed bone arrowheads and redware pottery bowls decorated with wavy-line impressions made by a catfish spine. The makers were Negroes who lived by hunting and fishing. They had no domestic animals and did not cultivate. This culture has been found as far north as the Fourth cataract and between Wadi Howar in the west and Kassala in the east.

It was followed between Jabal al Awliya and the Second cataract by one in which gouges, celts and amazon stone beads, all typical of the Fayyum Neolithic, occur with pottery, most of which is burnished and the most typical of which is a hard redware decorated with triangular impressions in a pattern imitating basketwork. This pattern developed out of the wavy-line pottery of Early Khartoum. Early forms of black and black-topped redware occur; and shards burnished after combing or incision show how easily rippled ware could have developed. With this Khartoum Neolithic culture occur zeolite lip plugs, notched fish-hooks of shell and bone harpoons, most of which have four or more barbs and a perforated butt. The next culture so far known is one with ripples made by pebble-burnishing over combing. One such pot found at Omdurman is identical in all but size with one from the A-group cemetery at Faras near Wadi Halfa, which has been dated to the reigns of Zer and Zet (about 3000 B.C.) by pottery and copper tools imported from Egypt. At Omdurman about 18 pots were buried in each grave. Gourd shapes and small deep bowls were common. Large deep bowls of coarse redware decorated with squares alternately plain or hatched by impressions made by catfish spines show connections with both Early Khartoum and the Gerzean periods of Egypt.

Egyptian Influence.—Rock pictures are frequent along the Nile between the First and Third cataracts, and while no doubt a few representing wild animals date from the prehistoric period, all historic periods are represented. Sites of the earlier Egyptian predynastic have not been found south of Ad Dakkah. There is on a rock near the Second cataract a reference to the conquest of lower Nubia by Zer, third king of the 1st dynasty, and Egyptian imports dating from his and the succeeding reign were found in the neighbouring A-group cemetery of Faras. Lack of sites in Nubia associated with the Old Kingdom may be because of the activities of those Pharaohs: the earliest historic reference to Nubia is to a raid by Sneferu (*c.* 2613 B.C.) who built ships and "hacked up" the land of the Nehesi or Nehsui (*cf.* modern Al Mahas) and brought back many prisoners and cattle; it is probable that such raids devastated a land in which civilization had flourished during the Neolithic and predynastic periods. Under the 5th and 6th dynasties (*c.* 2494–*c.* 2181 B.C.) Egypt's contact with the south became rather more peaceful. Although under Pepi I military expeditions had been led by Uni to the Nehes lands of Irthet (Irtjet), Medju (Medjai, *cf.* modern Beja), Yam, Wawat, Kau and the land of Temeh, nevertheless Harkhuf of Elephantine made four trading expeditions during the reigns of Merenre and Pepi II, as far as Yam (Darfur?), returning with donkeys laden with incense, ebony, leopard skins and ivory.

After the fall of the Old Kingdom a cattle-owning people (the C-group) came into the area between the First and Second cataracts and survived until the beginning of the 18th dynasty. They lived on the riverbank in settlements of round huts of wood and grass and buried their dead beneath mounds of earth protected by circular walls of dry stone. They wore leather clothing, and bowls of black or brown ware, decorated with elaborate incised patterns often filled with white and later with coloured pigments, are characteristic of their pottery. Under the 11th dynasty Egypt turned its attention to the south again. An inscription near Aswan records the dispatch of ships to Wawat.

The first Pharaohs of the 12th dynasty, Amenemhet I and Sesostris (Senusret) I, occupied Nubia as far as Semna, about 50 mi. S. of the Second cataract. Communications with Egypt were protected by massive mud-brick forts, a fine example of which at Buhen opposite Wadi Halfa was excavated by W. B. Emery in the 1960s. A trading post was built probably in the reign of Amenemhet II (1929–1895 B.C.) at Karmah (Kerma) at the downstream end of the Dongola reach and 150 mi. S. of Semna. Karmah was probably the home of the chief of Cush: in graves excavated locally the principal occupant was laid in native fashion on a bed in a large low tumulus, while women and retainers, sometimes numbering hundreds, were buried alive with him. It is in any case most unlikely that G. A. Reisner, the Egyptologist, was correct in thinking that it was the headquarters of successive Egyptian governors. The Egyptian statues found in these graves were presumably traded to the princes of Cush by Egyptian merchants during the Second Intermediate period (*c.* 1720–1567 B.C.). They At Karmah Egyptian craftsmen developed local industries. They made exquisitely fine burnished black-topped red pottery never again equaled, objects in faience and quartz decorated with blue glaze and short copper swords with ivory hilts.

The southern group of Egyptian forts (Mirgissah, Shalfak, Uronarti and Semna) were probably built by Sesostris III (1878–43 B.C.) after a local rising. Until the 13th dynasty the level of the Nile flood was recorded at the Semna forts. These levels show that the Nile was 26 ft. higher in flood than it now is, and the rainfall must have been correspondingly greater to provide grazing for the C-group cattle and to allow tribes to live on the west bank in what is now desert.

At some period subsequent to this, and probably connected with the expulsion of the Hyksos from Egypt, these forts were all destroyed by fire. Shards of C-group and Pan-grave pottery and stone axes copying bronze axes typical of the 17th dynasty have been found as far east as Agordat in Eritrea.

Ahmose I, the founder of the 18th dynasty, began the reoccupation of Nubia and built a temple at Buhen; and his successor Thutmose (Tuthmosis) I occupied the whole of Cush at least as far as 50 mi. S. of Abu Hamad, where he set up a boundary inscription. Cush was then incorporated in Egypt under a viceroy, whose first duty was to dispatch the tribute of Nubia to Egypt. Informative representations of the arrival of this tribute in Egypt may be seen in tomb and temple at Luxor. Almost every Pharaoh founded a town or built one or more temples in Nubia from the local sandstone. The most splendid was that at Sulb (Soleb) dedicated to Amon and himself by Amenhotep III, who also built a smaller one at Seddenga for the worship of his queen Tiy. Other temples include those built by Queen Hatshepsut at Buhen, Thutmose IV at Barkal, Amenhotep IV (Ikhnaton) at Sesibi and Tutankhamen at Faras and Ḳawa.

The construction of temples was continued under the 19th dynasty. Ramses II (1304–1237 B.C.) built two great rock-hewn temples to himself and his queen, Nefertari, at Abu Simbel, and also temples or shrines at Gerf Husein (Jurf Husayn), Bayt al Wali, Wadi Sabu'a, Dirr (Dayr al Bahri), Ibrim, Faras and 'Akasha in lower Nubia; and his name occurs at Amarah West, Sais, Kawa and Jabal Barkal in upper Nubia. In places, as at Kawa, he was not above erasing the name of the original builder and substituting his own. Seti I built the town wall at Amarah West and probably built the original temple, to which various kings up to Ramses IX made additions. The known antiquities of Nubia under the New Kingdom or Empire are entirely Egyptian. They include at Anibah tombs built with pyramidal roofs like those at Dayr al Madinah; and farther south inscriptions at Tangur (Shuqayq), Dosha, Nauri, Tumbus and Kurgus.

Napata and Meroe.—From the period between 1100 and 750 B.C. nothing is known. Napata (*q.v.*) seems to have been still Egyptianized when in 750 B.C. Kashta set himself up there as king of Cush and conquered upper Egypt, founding the 25th dynasty, known as the Cushite dynasty. Piankhi (*c.* 730 B.C.) included the rest of Egypt in his empire, and Shabaka, his successor, transferred the capital to Thebes and was known as king of Cush and Egypt. Piankhi built the great temple of Amon at Napata. The only monuments of Shabaka and Shebitku (Shabataka) in Nubia were their pyramids at Kurru. All the pyramids in this cemetery are now ruined, but the painted chambers of Tanutamon and his sister Kalhata are preserved. The burial chamber was excavated in rock below ground level, approached from the east by a stairway cut in the rock. The pyramid was built on ground level above the chamber and had a small mortuary chapel on its eastern face. (These chapels have all disappeared at Kurru and Nuri, but some of those at Meroe remain, and the designs with which they are decorated are of considerable interest and importance.) Taharqa built more than one temple at Napata, carved four colossal figures out of the face of Jabal Barkal and built the largest pyramid of a new cemetery at Nuri. A disastrous clash with the Assyrians, who were armed with iron weapons and had recently included Palestine in their empire, led to the evacuation of Egypt by Taharqa. His successor, Tanutamon, temporarily reoccupied upper Egypt, but was soon forced to abandon it (661 B.C.). The dynasty, however, continued to reign, first at Napata and subsequently at Meroe (*q.v.*), for about 1,000 years. The immediate successors of Tanutamon (Atlanersa, Senkamanisken, Anlaman, Aspelta, Amtalka and Malenakan, *c.* 653–538 B.C.) were able to construct pyramids and temples in the pure Egyptian style. A temple at Jabal Barkal was begun by Atlanersa and finished by Senkamanisken. The sun temple at Meroe (mentioned by Herodotus) was built by Aspelta; and the temple of Amon at Meroe was apparently built by Aspelta, Amtalka and Malenakan.

The kingdom no doubt stretched as far as Sennar, where a scarab of Shabaka has been found, and Jabal Mayyah, where objects dating from Taharqa to Aspelta and later periods were discovered; and it is reasonable to suppose that from Sennar it extended to the gold country of Beni Shangul (Ethiopia), and from Jabal Mayyah to the Shilluk country on the upper White Nile.

Napata was sacked *c.* 590 B.C. by an expedition sent by the Saite Psamtik II to forestall a Cushite threat to reestablish their dominion over Egypt. Greek and Carian mercenaries, who took part, left graffiti at Abu Simbel and Buhen. This sack of Napata led to the transfer of the political capital to Meroe, although kings were buried at Napata as the old religious capital up to the time of Nastasen (*c.* 315 B.C.). The Persians are said to have invaded Nubia under Cambyses in 522 B.C., but of this there is no evidence, although Nubians with carnelian-tipped arrows served in the army of Xerxes.

From his study of the royal cemeteries of Napata and Meroe, Reisner constructed a king list covering this period. Twenty kings and some of their queens were buried at Nuri, and all their names have been recovered. Forty-one rulers, who succeeded them, of whom 23 have been identified (4 or 5 were queens), were buried from *c.* 300 B.C. in pyramids at Meroe. Reisner thought that during this later period there were two occasions when Napata was for a time independent of Meroe and its rulers buried in the two groups of pyramids at Jabal Barkal. But there is some doubt about this, although the names of four kings did turn up at Kawa that were not found at Meroe. Ergamenes (248–220 B.C.) built the temple of Dakkah and imported an Egyptian scribe to decorate his tomb chapel. He and his successors (who built six large pyramids) represent the most prosperous period of Meroe, when relations with Ptolemaic Egypt were friendly. But, cut off from Egypt, the Egyptian culture of the kingdom naturally degenerated. The Meroitic cursive script was invented before 200 B.C. When it was in general use, the knowledge of Egyptian and Egyptian scripts was quickly lost. Soon after 150 B.C. the Meroitic hieroglyphic script was invented for decorative inscriptions. The traditional offering scenes, which occur on the older pyramids, were then varied, giving them a distinctive Meroitic tinge. Degeneration was continuous until 45 B.C., when Queen Amanishakhete came to the throne. In 23 B.C. Gaius Petronius had invaded Napata with a Roman army as a result of frontier trouble in lower Nubia, when the statue of Augustus had been looted from Syene (modern Aswan). He destroyed Napata and, retiring, left a garrison at Ibrim. Queen Amanishakhete is buried in the second largest pyramid, in which Giuseppe Ferlini found a hoard of treasure. Her successors, King Natakamani and Queen Amanitere (15 B.C.–A.D. 15), repaired the temple of Amon at Meroe, built two temples at Naqah, a temple at Wad Ban Naqah and one at 'Amara East—the last two disappeared during the 19th century—and restored the great temple of Amon at Napata. The colossal royal statues on the temple site on Argo Island probably belong to this period. From that date degeneration was unchecked. The pyramids gradually became smaller and red brick eventually replaced stone in their construction. Red brick was much used for building in the latter centuries at Meroe, and in the last palace it was used in a crude imitation of a Roman bath.

Nubia entered the Iron Age during the Meroitic period. A few manufactured iron objects were imported in the 6th century B.C., but by 480 B.C. Nubia was still practically without iron. Pyramid foundation deposits first include iron about 360 B.C., when it probably began to be smelted at Meroe, although remaining a royal monopoly for several centuries. Meroitic pottery at Faras was predominantly wheel-made with some elaborate painted designs in the 2nd century A.D. To the same date belong fine ware, with repeated impressions of small stamps with designs such as the ankh, and imported barbotine cups. Handmade pottery including black ware with impressed designs filled with red or yellow pigment also occurred and was probably more frequent in the south. Artificial reservoirs in the island of Meroe, some of them associated with small temples (as at Al Musawwarat, as Safra, Naqah, Hardan, Awateib, Basa, Duanib and Umm Usuda), and in the Gezira were a feature of the Meroitic period and suggest decreasing rainfall.

The last record of the kings of Meroe is a demotic inscription from Philae recording an embassy of King Tekerideamani in A.D. 253. The knowledge of writing died out. There are no inscriptions on the walled group of temples at Al Musawwarat. The Blemmyes of the Eastern or Arabian desert (Beja) destroyed the Meroitic culture in lower Nubia; and Meroe itself was destroyed between A.D. 320 and 350 by an expedition dispatched by Aeizanes,

king of Aksum, to crush a trade rival or by one of his predecessors.

The Nobatae.—The Meroitic culture is followed in Nubia by one attributed by Reisner to the X-group. These may have been the Nobatae, a name possibly derived from confusion between Nuba and Napata (the "Red Nuba" of Aeizanes). They replace the northern kingdom of Napata, which had twice made itself independent of Meroe. The X-group tumulus is a direct descendant of the Meroitic pyramid, and X-group pottery is in the Meroitic tradition. X-group cemeteries occur at Napata (Az Zumah and Tangasi) and at Wawa, Sai Island, Firqah, Attiri, Gemai, Adindan, Ballanah, Kustul, Ibrim and Kalabsha (Kalabisheh). The royal cemeteries at Ballanah and Kustul covered two centuries. The kings were buried with Meroitic insignia, and human beings and animals were sacrificed to accompany them. Grave goods included imported Byzantine objects; but no evidence of a written language was found. In the Meroe area, graves contemporary with the X-group contain many large handmade mat-impressed pots and smaller bowls burnished and decorated with incisions near the rim. Large mound graves of this period are common as far south as Khartoum. The X-group have also been identified with the Blemmyes, who from the 3rd century had continually troubled Egypt and by the 5th century were established at Talmis (Kalabsha), combining with the Nobatae to raid upper Egypt. They were compelled by Florus in A.D. 452 to keep the peace but were allowed to visit the temple of Philae and to borrow the statue of Isis.

About A.D. 540 the Nobatae were converted to Christianity, and shortly after that, at Kalabsha, their king Silko, then a Christian, records his defeat of the Blemmyes and of the upper Nobatae (of Napata?). After this the capital of the Nobatae seems to have been at Pachoras (Faras), until they were amalgamated with Mukurra (Muqarra) in the single Christian kingdom of Dongola (*q.v.*). South of that was the kingdom of Alwa or Alodia (Aloa) with its capital at Soba (Sawba) near Khartoum. Alwa had become Christian in A.D. 580.

Muslim Conquest.—In A.D. 652 a Muslim army from Egypt captured Dongola and compelled the kingdom to pay tribute to Egypt. Arab historians often mention relations between Egypt and Nubia; but the kingdom of Dongola remained Christian until the 14th century, when it was overrun by Mameluke armies from Egypt. The stone castles of Nubia (Sai, Khandaq, Bakhit, etc.), which show crusader influence, date from the unsettled period before the final fall of Dongola. Soba survived for another two centuries, and then gave place to the Muslim Fung (Funj) kingdom of Sennar.

Christian Influence.—The churches of Nubia were small when not adaptations of heathen temples. Some were built of stone masonry, but brickwork was commoner. In the north there were two principal types, basilican and domed, and mud brick was usual; whereas in Dongola a typical church had red brick walls with a roof supported by four granite monolith columns with separate granite capitals. Mural paintings covered the walls. Little now remains of any of these churches except one or two small mud-brick buildings in out-of-the-way places (*e.g.*, the church of Abdelgadir near Wadi Halfa), and the ugly atypical fortified church at Old Dongola, which owes its preservation to its conversion to a mosque in the 14th century. In Dongola during the Christian period, graves frequently had a rectangular stone superstructure with tombstones inscribed with Greek letters and either Greek or Coptic inscriptions; and circular stone cairn graves of the same period also occur as far south as Khartoum and west across northern Kordofan. Rare inscriptions of Old Nubian in Greek characters have also been found. Pottery in the Meroitic tradition continued in the Christian period, the best being a thin ware coated with a white slip and decorated with designs in sepia. For the later history of Nubia *see* the history sections of EGYPT and SUDAN, REPUBLIC OF THE. (A. J. AL.)

Excavation and Preservation of Nubia's Sites and Monuments.—At the beginning of 1960 the governments of the United Arab Republic (U.A.R.) and the Sudan turned to the United Nations Educational, Scientific and Cultural organization for help in salvaging the ancient sites and monuments of Nubia threatened with destruction by the great lake which would build up behind Egypt's new dam at Aswan. UNESCO responded by launching what subsequently grew into the biggest archaeological rescue operation of all time.

Field Expeditions.—About 300 mi. of Nubia along the banks of the Nile in Egypt and the Sudan became the scene of intense activity of some 24 expeditions from as many countries. Before 1960 that part of Nubia inside the Sudan was virtually terra incognita and its archaeological richness may be measured by the number of hitherto unknown sites later revealed—more than 200 along a 25-mi.-stretch of the river's banks. They ranged from prehistoric, through A-group and C-group to Pharaonic, Meroitic, X-group and Christian, apart from rock inscriptions.

Necessary preliminaries to operations were the aerial archaeological surveys carried out by UNESCO in collaboration with the governments of the U.A.R. and the Sudan in 1960. The UNESCO mission in Sudanese Nubia continued to assist the national expeditions by making available survey data and a well-equipped photographic laboratory at Wadi Halfa. The mission in addition made a ground survey of the west bank and the many islands of the Second cataract and dug a large number of sites. An important discovery by one of the national expeditions was that of an Egyptian Old Kingdom town devoted to copper smelting, at Buhen, evidence of much earlier Egyptian penetration of Cush than was previously believed.

The 12th-dynasty fortresses of the Second cataract received well-merited attention. Built of mud brick, they could not be salvaged. That at Buhen, including the town of the same period, was completely cleared and much valuable data on early Egyptian military architecture was gathered. Mirgissah fortress was also the scene of remarkable finds. In the sandy plain below the fortress was found a large complex of fortifications enclosing buildings well preserved; all dated from the 12th dynasty. Nearby was uncovered a necropolis of the Kerma (Karmah) culture and an important cache of Middle Kingdom execration texts.

Several expeditions uncovered rich remains of the C-group people, in the shape of many cemeteries and even houses, and much was added to the somewhat scanty knowledge of this historically significant culture. Cemeteries of the A-group were located and prehistorians found ample evidence that Nubia was well populated in Paleolithic times. Other teams recorded the many rock drawings and inscriptions discovered in Nubia. X-group cemeteries were dug by most of the expeditions, the outstanding find being at Kasr Ibrim. There two large tomb magazines, unrobbed, yielded a splendid array of bronze vessels, glassware, ornaments and iron weapons.

Evidence of the early Christian occupation of Nubia was found in profusion. Settlements, each with its church, were uncovered on 13 islands of the Second cataract alone. On the surrounding mainland, every slope and promontory bore signs of once thriving communities. A spectacular find was made in the great basilica hidden beneath the mound at Faras West (Pachoras) where the excavators removed over 100 magnificent frescoes in a remarkable state of preservation. The walls of the church bore not only religious paintings but inscriptions in Greek and Coptic, including a valuable list of the bishops of Pachoras, some of whose tombs and funerary stelae were found.

Temples.—To save the temples of Nubia was a financial problem and the raising of funds was the main concern of UNESCO's International Campaign Executive committee. Several states co-operated fully by undertaking to defray the cost of transferring certain temples out of reach of the rising waters. As examples, the Federal Republic of Germany completed the removal of the large Egypto-Roman temple of Kalabsha to a point about 30 mi. away; the U.S. government undertook to conserve the group of Ptolemaic Roman temples on the island of Philae, which, being located below the new dam, fortunately did not have to be removed; the French government undertook the transfer of the temple of 'Amada, while several other temples of Egyptian Nubia, namely Qertassi (Kertassi), Taffeh, Dakkah, Muharraqah and Debod (Debot) were dismantled by the U.A.R. for later re-erection. In all, about [illegible] temples and shrines were to be preserved.

In Sudanese Nubia, Hatshepsut's temple at Buhen was dismantled by the Egypt Exploration society of the United Kingdom. The removal of this temple exposed for the first time in 3,500 years the original Middle Kingdom temple beneath. The two New Kingdom temples at Semna were also to be removed.

Much more difficult problems were posed in the salvaging of the two rock-cut temples of Ramses II and Queen Nefertari at Abu Simbel (*q.v.*). The plan (evolved by Swedish experts) was to remove the top of the sandstone cliff above them, dissect the temples in the interior and reassemble them on prepared sites on the plateau above. A temporary coffer-dam would hold back the rising waters while the work was in progress. It was a stupendous task and the estimated cost was high. Nevertheless there did seem to be a good prospect that these two superb reminders of a great civilization would be saved for posterity.

Meanwhile, not only Abu Simbel but all the temples and shrines in Egyptian Nubia were recorded by epigraphists and by photogrammetric photography undertaken by teams from the Documentation and Study Centre for the History of the Art and Civilisation of Ancient Egypt, established at Cairo by UNESCO and the government of the United Arab Republic. (RE. K.)

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NUBIAN DESERT, covering about 90,000 sq.mi. in northeastern Sudan, is the eastern extension of the Western or Baiyuda desert (Sahra' Bayyudah) and Libyan desert (*q.v.*) beyond the Nile valley and the southern extension of the Arabian desert (*q.v.*). It occupies the area west of the Red sea between the Itbay ('Atbay) mountains and the Nile in its course from the Sixth cataract (above Atbara) to the Second cataract (near Wadi Halfa). Generally the desert is without water, vegetation or people, though limited settlement occurs along some of the eastern wadis, notably the Ibib. (R. W. SL.)

NUBIAN LANGUAGE AND WRITING. Nubian is the name given to the language of the Barabra or Nubians in the Nile valley, between Merawi, a few miles below the ancient Napata, and the First cataract at Aswan. It has two principal dialects: the Mahass-Fadija being spoken in the central portion, from a little south of the Third cataract, and the Dongola-Kenuzi at both ends of the region.

Languages related rather closely to Nubian of the Nile valley are spoken in the hills of Kordofan and as far westward as eastern Darfur. This entire area is considerably south and west of the portion of the Nile valley in which Nubian is spoken and probably represents the point of origin of Nile Nubian. The entire Nubian group belongs to the Macro-Sudanic family of languages spoken in east and central Africa. (*See* AFRICAN LANGUAGES.)

The speakers of Nile Nubian are at present Muslims and their language is penetrated with Arabic borrowings. During the medieval period, however, they were Christians and the Nubian Church was affiliated with the Coptic Church of Egypt with its patriarch in Alexandria. These Nubians adapted the alphabet of the Egyptian Copts, in turn derived from the Greek alphabet, to their own language. The documents, which are generally of a religious character and translated from the Greek, are of great linguistic interest as representing the only language at present spoken by Negroes from which indigenous records antedating the modern period are to be found. The language appears to be directly ancestral to the modern dialect of Mahass-Fadija. The writings date from the end of the 8th century to the beginning of the 14th century.

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ÑUBLE, a province of central Chile, includes segments of coastal range, central valley and cordillera. Area 5,387 sq.mi., pop. (1960) 284,516. Ñuble, formed in 1848, was altered significantly in area in 1927 when Itata department was transferred from Maule province (*q.v.*). Chillán, founded in 1580, is the provincial capital; pop. (1960) 66,771. Together with San Carlos (13,598), Bulnes (5,831), Yungay (2,116) and Quirihue (10,203), it is a departmental seat.

The provincial economy is stimulated by the Chillán plan, a comprehensive rural improvement program operated by Chilean and U.S. agronomists. The vine, wheat, edible legumes, fruit and livestock are important. Industry, chiefly in Chillán, is concerned with food processing, milling (grain and lumber), tanning and shoe manufacturing. The city's recovery from the catastrophic 1939 earthquake is advanced; new public buildings and the cathedral are striking. Chillán's open-air market is perhaps the most colourful in Chile. The state railway, which traverses the centre of the province, has branches that lead to Tomé and Concepción and into the cordillera. Minor beach resorts, the cordilleran spa of Termas de Chillán and ski lodges near Chillán volcano are recreation areas. Chillán Viejo (6,058) is the birthplace of Bernardo O'Higgins and Ninhue is the birthplace of Arturo Prat, Chile's most celebrated naval hero. (J. T.)

NUCLEAR ENGINEERING is concerned primarily with the design, construction and operation of nuclear reactors. It became clear during the 1950s that substantial numbers of specially trained engineers are needed for the development of nuclear power and its associated industries. The working methods of nuclear engineering are derived from physics and the older engineering fields, but special techniques have had to be developed to solve the unique problems encountered in dealing with nuclear fission, and many of these are surveyed in this article.

Nuclear reactors based on the fusion of light elements are envisaged, but they are not considered here because many problems in the field of physics must be solved before such reactors can become practical power producers.

The physical principles of nuclear fission are discussed in the articles ATOM; ATOMIC ENERGY; and NUCLEUS. This article consists of the following sections:

VII. Fuels and Fuel Recovery
VIII. Economics of Nuclear Power Production
IX. Other Industrial Applications

I. INTRODUCTION

Nuclear reactors are devices which yield large amounts of heat and radiation and whose existence depends upon the availability of isotopes of heavy elements which undergo fission when struck by a neutron. The only isotope occurring in nature which is fissionable by slow neutrons is one particular isotope of uranium known as U^{235}. This is a rare isotope, since in natural uranium it is outnumbered approximately 140 to 1 by another isotope, U^{238}. When a single slow-moving neutron collides with an atom of U^{235}, the atom becomes suddenly so unstable that it may split violently into two major fragments accompanied on the average by two or three extra neutrons. There is a large release of energy, contained mostly in the kinetic energy of the fragments, which is quickly dissipated as heat. The energy release is so large by ordinary standards that the heat from the fissioning of all of the atoms of 1 lb. of U^{235} is as much as from burning 1,500 tons of coal.

Since neutrons are expelled in the fissioning process, it is possible for one fission to initiate another, and this another, and so on, thus creating a chain reaction. Basically, therefore, a nuclear reactor is designed to permit a self-sustaining and controlled nuclear chain reaction and to remove safely the heat which is generated.

Of the two to three neutrons that are released in each fission, at least one must be successful in producing another fission if the chain reaction is to persist. There are two main reasons why this is difficult to accomplish with natural or with only slightly enriched uranium. Instead of colliding with another of the widely spaced U^{235} atoms, the neutrons may escape from the uranium altogether, or they may strike and be absorbed by one of the U^{238} atoms. Although a fast neutron will occasionally cause fission of U^{238}, a chain reaction in natural uranium is impossible. This may be overcome either by increasing the proportion of U^{235} or by slowing down the neutrons. Uranium containing higher proportions of U^{235} is artificially produced in large gaseous diffusion plants. A gaseous compound of uranium is pumped through barriers containing very small openings, and since the lighter atoms of U^{235} have, on the average, slightly higher velocities than those of U^{238}, they slip through the barrier a bit more easily, thus increasing their concentration. Repeated often enough, the process yields uranium with almost any desired degree of enrichment in U^{235}. A reactor using such fuel and little other material is said to be a fast reactor because most neutrons are absorbed before they slow down. If the neutrons are slowed to a tiny fraction of their initial speed, they are much more likely to cause fissions of U^{235}, and it is then possible to sustain a chain reaction in natural uranium. The device for slowing the neutrons is called a moderator. The reactor in this instance is called a thermal reactor because most neutrons are slowed down to near thermal equilibrium with the moderator before absorption.

The moderator is either mixed with the uranium or, if the uranium is in the form of a latticework of solid fuel elements, the moderator occupies most of the intervening space. It must meet two primary requirements: first, it must be a very poor absorber of neutrons so that, when neutrons collide with its atoms, they are not lost; second, its atoms must be as small as possible—in other words, as near to the weight of the neutron as possible—so that the rapidly moving neutrons, through a series of "billiard ball" collisions, will lose almost all of their speed. The neutrons are then moving with small energies nearly in equilibrium with the average kinetic energy of the molecules of the moderator, and they are referred to as thermal neutrons.

A chain reaction, therefore, occurs if the neutrons released from any single fission bounce around often enough among the moderator atoms, without escaping or without being absorbed, and are slowed enough so that eventually at least one collides with another atom of U^{235} and causes it to undergo fission. When the number of neutrons moving in this manner in the reactor remains constant from one generation of fissions to the next, the reactor is said to be "critical." If, on the average, neutrons are being lost, the system is "subcritical," and the chain reaction will not sustain itself. If the density of neutrons is increasing, the system is "supercritical," and the rate of energy release will increase. Control of the reactor is accomplished by introducing materials which readily absorb neutrons, such as cadmium or boron. These may be in the form of control rods which can be withdrawn sufficiently for the reactor to become "critical."

The fission products (the fragments which result from fission in a reactor are a nuisance. There are about 40 different ways in which U^{235} may split, so that as the chain reaction proceeds, a variety of elements accumulate in the remaining uranium, most of them intensely radioactive—many of them strong absorbers of neutrons. To protect against this radiation and the radiation arising directly from fission, the reactor must be surrounded by thick, heavy shields. The gradual increase within the reactor in the amount of this neutron-absorbing material must be taken into account in the design of the control system.

Although U^{235} is the only easily fissionable material found in nature, it is fortunately possible to produce others. If nuclear energy depended solely on U^{235} fissions, it would be far less interesting as a new source of fuel for power generation. The more abundant atoms of U^{238} may become easily fissionable by converting them to isotopes of plutonium, Pu^{239}. This conversion may take place over a period of several days through a series of nuclear transformations when U^{238} absorbs a neutron. A nuclear reactor in which a chain reaction is being sustained may therefore, at the same time be producing new fissionable material. In fact, when it is possible for a second neutron from each fission to find its way into an atom of U^{238} and convert it to plutonium, thus renewing the supply of fissionable material at the same rate that it is being consumed, the energy available from natural uranium is multiplied theoretically by a factor of approximately 140. A reactor which accomplishes this is called a breeder the U^{238} in this instance is referred to as fertile material.

The production of plutonium, without attempting to utilize the energy release, was the specific purpose of the first big reactors ever built, located at Hanford Works, Wash. When these reactors were first put into operation their success seemed doubtful because the chain reaction tended to cease when the power level was increased. This was determined to result from the buildup of one particular fission product, an isotope of xenon, having an affinity for neutrons. The solution to this problem and the subsequent successful operation of the reactors was one of the exciting accomplishments of World War II.

Th^{232}, the predominant isotope of thorium found in nature, is also a fertile material, since a neutron absorbed in Th^{232} gives rise to a conversion to still another isotope of uranium, U^{233}, also easily fissionable. Thus, a reactor containing enough U^{235} to support a chain reaction and Th^{232} as a fertile material may also become a breeder.

In summary, therefore, a reactor will ordinarily consist of fissionable material, a moderator, control rods, shielding and fertile material. In addition, there must be structural materials and mechanisms for removing the heat which is produced.

II. NUCLEAR REACTOR PRINCIPLES

1. Multiplication Factor.—The "effective" multiplication factor is a useful concept for studying reactor behaviour. It is sometimes called the criticality factor and may be defined as the ratio of the number of neutrons present following any one generation of fissions to the number present following the immediately preceding generation. If the effective multiplication factor, represented by k_{eff}, is unity, the reactor is critical, and the chain reaction is self-sustaining. If k_{eff} is greater than 1, the neutron density will increase; and if k_{eff} is less than 1, the neutron density will decrease.

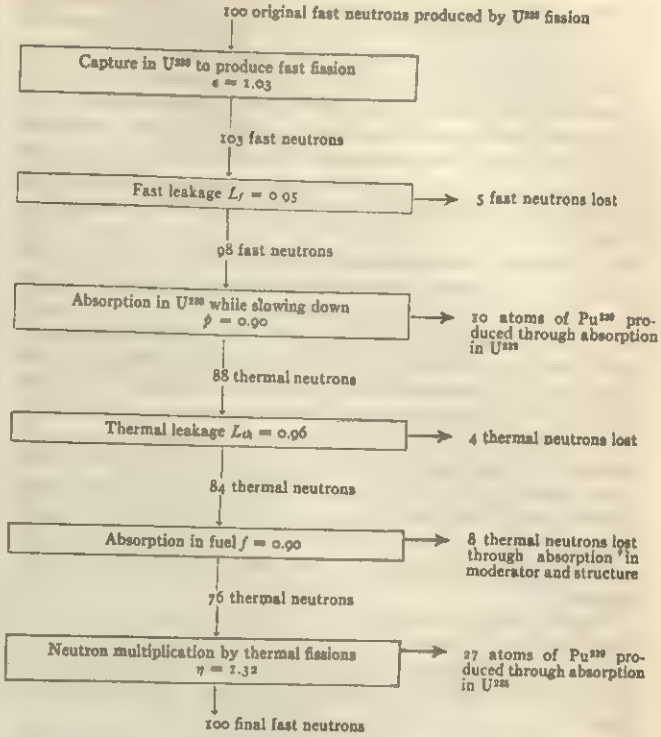
Since neutrons are always lost at the boundaries of a reactor it is convenient to study first a reactor of infinite dimensions, thus making it possible to ignore temporarily the leakages of neutrons through the boundaries. In this case the multiplication

factor is called k_∞, and the determination of its value is a major part of nuclear reactor design.

As shown by the equation $k_\infty = \eta\epsilon p f$, its value may be expressed as the product of four factors: η is the number of neutrons produced per thermal neutron absorption in fuel (this number is smaller than the neutrons released per fission because some of the neutrons are absorbed in fuel without causing fission); ϵ is the fast fission factor, defined as the ratio of the total number of neutrons produced, including the additional production of neutrons by a small number of U^{238} fissions caused by fast neutrons, to the number caused by thermal neutrons alone; p is the resonance escape probability, the fraction of neutrons that are not absorbed while being slowed; and f is the thermal utilization, the fraction of thermal neutrons that are absorbed in fuel.

The factor k_∞ depends only upon the material in the reactor and must be corrected for leakage in any actual reactor design. Neutrons which have collisions near the edges of a reactor have large probabilities of escaping. It is convenient to separate the leakage factor which applies while the neutrons are slowing down from that which applies while the neutrons are thermal. The "effective" multiplication factor for a finite reactor is then written as $k_{eff} = k_\infty L_f L_{th}$ where L_f is the fraction of fast neutrons that do not escape before becoming thermal and L_{th} is the fraction of thermal neutrons that do not escape before being absorbed. The combination of effects in the formula for k_∞ and due to the leakages are shown for a typical case in the accompanying diagram. The chain is applied to 100 neutrons to make the calculation come out in whole numbers.

Typical Nuclear Chain Reaction



2. Slowing of Neutrons.—In the slowing or moderation process, neutrons generally lose energy at each collision. Since the neutrons slow down in a discontinuous manner, considerable effort has been devoted to finding some smooth mathematical step functions which will describe their over-all behaviour accurately. One such method is the "continuous-slowing-down model" which assumes that the neutrons slow down continuously until they reach thermal energy, at which time they diffuse until they are absorbed or leak from the reactor. This model gives good calculated results for a large range of reactors.

3. Neutron Spatial Distribution.—The neutron density (the number of neutrons found in a unit volume) and the neutron flux (ϕ, the density multiplied by the typical velocity) are not uniform throughout a reactor because of the leakage losses through the outermost surface and because of nonuniformities in fuel arrangement and in neutron-absorbing materials.

The fundamental equation which describes the energy, spatial and time dependence of the neutrons in a reactor is so complicated for most practical applications that approximations must be made. The most elementary approximation is to assume that all neutrons have the same energy and that their spatial distribution may be described by the same rules as those applying to diffusion of gases, or to the diffusion of heat in a conducting material. This one velocity (or energy) model is reasonably accurate for large thermal reactors in which almost all fissions occur at thermal energies. For reactors with fissions occurring at energies above thermal this simple model is not accurate enough. The usual method used is to break the full neutron energy range into discrete blocks and assume that the neutrons have "group average" characteristics while in this energy range. The diffusion equations relating to each separate group are solved simultaneously to give the neutron flux as a function of energy and space. One major limitation to this method is the difficulty of obtaining for high energies the necessary "group constants" with which to solve the equations. This leads to the paradox that the simpler one- or two-group method with empirical constants may give more accurate results than the theoretically more elegant multigroup methods.

For simple geometries, the diffusion equations may be solved analytically, but in practice the reactor design is so complicated that high-speed electronic computing machines are needed to obtain approximate solutions. The digital computer is utilized by all reactor designers as a useful tool by means of which designs can be tried without the expense of building critical experiments. The calculations are complex, some data are uncertain and small errors may be very significant. For a new reactor it may be prudent to carry out preliminary low-cost experiments on a low-energy reactor of the same type or on a subcritical assembly of reactor materials, in order to check the calculations.

4. Reactor Transient Behaviour.—Care must be taken during the operation of a reactor that k_{eff} never be allowed to exceed by much the critical value of unity. Applying a very simple analysis, since k_{eff} is the number of neutrons left after one neutron has completed its cycle, then $k_{eff} - 1$ or Δk is the number of extra neutrons per cycle per starting neutron. Thus the gain each cycle for n neutrons is $n\Delta k$, and if the cycle time is l seconds, the gain in neutrons each second is $n\Delta k/l$. This relationship leads to the exponential expression $n/n_0 = e^{\Delta k t/l}$, where n_0 is the original neutron density; n is the time-dependent neutron density; t is the time after Δk appears; and l is the neutron cycle time which would appear to be of the order of the lifetime of a free neutron, which is 10^{-5} to 10^{-2} sec. Since this is so short, it would appear that very small values of Δk would cause the neutron density (and consequently, the power level) to rise exponentially at a very rapid rate. This is unacceptable since uncontrolled power increases can damage the reactor and perhaps create a serious hazard. Therefore, this analysis seems to indicate that safe operation of a reactor is virtually impossible, because it demands an impracticably accurate control of k_{eff}.

However, in this simplified analysis it has been assumed that all neutrons are produced at the instant of fission, whereas in fact some of them are delayed. These are emitted a short time later from some of the fission products, and they constitute about 0.75% of all neutrons. They introduce a sluggishness into the response of the reactor to changes in k_{eff}. The sluggishness is roughly equivalent to a neutron cycle time, l, of 0.1 seconds under normal conditions. Safe operation of reactors is therefore practicable because the control of k_{eff} need not be so accurate as at first indicated. Nevertheless, if Δk should become larger than this delayed neutron fraction, the chain reaction is then no longer dependent upon the delayed neutrons, and it becomes "prompt critical," a dangerous situation since the rate of power level increase can become extremely fast.

5. Reactor Control and Instrumentation.—The primary control of the reactor is through measurements of the neutron flux. This is not only because the neutron flux increases in proportion to

the power level, but also because neutron-sensitive instruments inherently have very quick responses. The wide range of neutron flux, varying by factors of as much as 10^{10} from start-up to full-power operation, requires the use of a variety of instruments with overlapping ranges since no single instrument could cover this whole range. These instruments are used to activate the control system, consisting of the addition or removal of neutron-absorbing material. A large number of auxiliary control and alarm devices may be used in addition to the nuclear instrumentation for adequate understanding and control of operating conditions at all times.

The control system must be devised so as to provide for immediate shutdown in the event of any emergency. In addition it must take account of changes in k_{eff} which occur during routine operation. For example, k_{eff} may have a "temperature coefficient"; *i.e.*, its value may be affected by the temperature of the fuel or moderator. If the coefficient is negative, it tends to be self-correcting from a safety standpoint because an increase in temperature reduces the reactivity. With a positive temperature coefficient a much greater burden is placed on the control system.

The control system must also offset the changes in time caused by the burnup of the fuel and due to the accumulation of fission products. The latter is referred to as fission-product poisoning because of the strong tendency of some of the products to absorb neutrons.

To offset all of these changes, the control system must contain large amounts of excess k_{eff} to be used only as needed. To avoid premature use of this excess reactivity is one of the prime safety problems in the design of a reactor. (*See* also NUCLEAR INSTRUMENTS.)

6. Heat Production.—A characteristic feature of a nuclear reactor is that heat can be produced at almost any desired rate. The upper limit on the rate at which the fissions may be allowed to occur depends not upon the fission process or upon the chain reaction, but simply upon ability to safely remove the heat which is generated. The fission energy appears almost immediately as heat, and if it is not removed fast enough, the temperature of the reactor will rise until the materials of construction begin to melt or are damaged in some other manner.

A major problem of reactor design is, therefore, to devise schemes for transferring large amounts of heat quickly. Power densities of several thousand kilowatts per litre of core volume may be considered, and it is necessary to use materials of construction and coolants which not only have good heat transfer characteristics but which can withstand very high temperatures.

III. REACTOR MATERIALS AND CONSTRUCTION

Development of reactors is greatly dependent on the selection and development of suitable materials. These must carry out their particular functions while not impeding the chain reaction and not interacting. The environment is hostile, as the unusual radiation and other conditions are liable to impair function and cause interactions.

Materials which may serve as moderators include ordinary water, heavy water, beryllium and graphite. Each of these meets the requirement of containing elements of low atomic weight which are poor neutron absorbers.

Ordinary water has the advantage of containing hydrogen atoms, which are small, but an important disadvantage is that these hydrogen nuclei occasionally absorb neutrons. The oxygen atoms contained in the water are poor absorbers but they are fairly heavy, thus contributing little to the slowing down process.

Heavy water has the advantage of containing atoms of deuterium which, although not quite as small as the hydrogen atoms, are much less likely to absorb neutrons. Heavy water is expensive, however, and both light and heavy water have the disadvantage of requiring high pressure for containment at high temperature.

Beryllium is an excellent moderator from the standpoints of the size of its atoms, of its neutron-absorption power and of its ability to withstand high temperature, but again it is expensive and it is difficult to machine and fabricate.

Finally, graphite has been used extensively. Its atoms are not ideally small, but they are also poor neutron absorbers, and the temperature properties of graphite are excellent. However, it has the disadvantage of being adversely affected by continued exposure to neutron and gamma irradiation.

When used to surround the entire core of the fuel-bearing region of the reactor to retard the escape of neutrons, the moderating material is called a reflector. It does not reflect neutrons as a mirror reflects light, but random collisions occur in it and some neutrons which would otherwise be lost are returned to the reactor core. By conserving neutrons, a good reflector always reduces the fuel requirement for a reactor.

The coolant for a reactor is usually a fluid, either gaseous or liquid. Desirable coolants have good heat transfer properties, the ability to withstand high temperatures, low neutron-absorbing properties and, of course, low cost. Both light and heavy water have been used, as well as liquid organic materials, fused salts, liquid metals such as sodium, and air and carbon dioxide. Helium and nitrogen are also possibilities.

As a coolant, water again has the disadvantage of having to be pressurized at higher temperatures, whereas both the liquid organic materials and liquid sodium may go to much higher temperatures without pressurizing equipment. It is found, however, that the organic materials tend to deteriorate chemically under radiation exposure, and liquid sodium is difficult to handle because of its chemical properties and because of the intense radioactivity which it develops under neutron bombardment. Air and carbon dioxide have desirable temperature and heat transfer properties, but both absorb neutrons and acquire undesirable radioactivity. Helium has excellent heat transfer characteristics and it does not become radioactive, but it is extremely difficult to contain, thereby giving rise to special pumping problems.

Structural materials are required to hold the reactor together to channel the coolant, to form control rods and to clad and protect the fuel. These materials must perform satisfactorily under prolonged and intensive neutron and gamma irradiation. Also, they must be poor neutron absorbers.

The gross physical properties of most materials will eventually change under intense irradiation. Coolant molecules are broken up into smaller molecules or into their constituent atoms. Crystalline lattices, characteristic of metals and ceramics, are distorted or strained through a shifting or removal of constituent atoms. Furthermore, the atoms may be transmuted into different elements altogether.

Radiation damage may also be due to the thermal "spike" caused when the kinetic energy from a single fast neutron, for example, is absorbed in a very small region. The highly localized peak temperatures, perhaps exceeding 5,000° C., may cause alterations in the properties of the material. From a macroscopic point of view these effects are manifested as hardening and embrittlement in metals, discoloration and hardening or softening in plastics and decomposition in water and in organic materials. Some forms of radiation damage can be annealed, and the annealing may occur at working temperature.

In addition to radiation damage, corrosion problems tend to be accentuated within a reactor because of high temperature and more uniquely, because of the particle bombardment which is believed to alter chemical reactivity by causing ionization.

Induced radioactivity due to neutron exposure is another complication. Aluminum, for example, becomes radioactive with a half life of 2.3 min. In other words, the activity decreases to half of its value during this short period. Iron, on the other hand, contains a particular isotope which becomes radioactive with a half life of three years. If it is necessary to remove the material from the reactor for any reason, the aluminum obviously is preferable from the standpoint of dangers in handling.

Materials which have been widely used in structural elements within the reactor include stainless steel, aluminum and zirconium. The chief disadvantage of stainless steel is high neutron absorption by iron; the melting point of aluminum is low; and zirconium is expensive and difficult to fabricate.

Consideration must be given to the internal heat generation which takes place due to the absorption and scattering of radi-

tion. As a result, excessive internal stresses may develop in materials within and adjacent to an operating reactor unless adequate heat removal methods are provided.

The different combinations and arrangements of materials for coolant, moderator and structure provide a large variety of reactor concepts for consideration. *See* also METALLURGY: *Metallurgy in Nuclear Engineering*.

IV. RADIATION HAZARDS AND SHIELDING

Although it is occasionally necessary to shield certain reactor system components from the radiation in order to minimize radiation damage, the protection of operators and other personnel in the vicinity is the major purpose of reactor shielding. For example, for a high-power reactor without any shielding, personnel would have to remain at a distance of at least five miles in order not to be harmed by the radiation.

The unit of radiation dosage applied to humans is called the rem (the rem is that dosage of radiation having the same biological effect as 1 rad of X-radiation; the rad, in turn, is defined for any radiation as the amount that releases an energy of 100 ergs per gram of matter). A person being X-rayed for some diagnostic purpose may receive a dosage of about 1 rem. A dose of 25 rem is commonly applied for the removal of local growths. Dosages of 450 rem or above are likely to be lethal. The recommendation of the International Commission on Radiological Protection is that no individual should receive more than 5 rem per year, with a maximum exposure in any period of 13 weeks of not more than 3 rem. The dosages to which human beings are continuously exposed from cosmic rays and from radioactive materials in the earth and atmosphere are much smaller than this amount.

In the vicinity of a typical power reactor core the radiation intensity must be reduced by a factor of 10^{10} to 10^{12} if human beings are to enter the area. Since the gamma rays and neutrons are highly penetrating, large masses of material are required to reduce the intensity of these radiations to tolerance level.

The mechanism for absorbing fast neutrons is somewhat different from that for gamma rays. They must be slowed down and then captured. The shielding material, therefore, should contain a combination of light atoms and atoms, such as cadmium, boron and hafnium, with high absorbing power for slow neutrons.

The attenuation of gamma rays, on the other hand, depends upon the density of the material. The heavier the atoms, the smaller the thickness required. In practice, therefore, to shield for both neutrons and gamma rays a combination of the two types of material is used. Because of its high hydrogen content and its availability, water is the most commonly used neutron shield. In applications where there is no premium on keeping the shield small, water may also be used effectively as a shield for gamma rays.

For stationary power reactors a homogeneous mixture, such as concrete, is normally used. This has the advantage of being relatively inexpensive, of containing hydrogen atoms to aid in slowing down and capturing neutrons and of having a relatively high density to promote absorption of gamma radiation.

For mobile reactors, such as those for nuclear propulsion of an aircraft, the weight of the shield is of overriding importance, and its cost is secondary. In this instance laminated layers are almost always used because of their reduced weight. One of the laminations will consist of materials of low mass number for the neutron attenuation, and the other lamination will consist of a high mass number to attenuate the gamma rays. Also, for this particular application full advantage is taken of the attenuating effect of distance and of shadow shielding; *i.e.*, the shielding of a small area such as the crew compartment is accomplished by interposing a small shield between the compartment and the reactor instead of completely around the reactor.

V. RADIOACTIVE WASTES AND DISPOSAL PROBLEMS

The accumulation of radioactive waste materials is one of the major problems confronting nuclear engineers. With the ever-increasing amounts of material which give off alpha, beta and gamma radiation, it becomes more and more difficult to make certain that human beings are never exposed to anything more than very tiny radiation levels.

The alpha and beta rays have very low penetrating power and are usually not harmful unless the waste material emitting these radiations is taken internally. In this case there may be direct exposure, perhaps over extended periods of time, of vital parts of the human body. Therefore it is necessary to make certain that contamination of water and air by such materials is kept below tolerable limits.

Radioactive wastes may exist as liquids, solids or gases, and they are usually classified, by the intensity of the emitted radiations, as either high-level or low-level wastes. When the emitted radiation intensity is sufficient to reduce the time a human being can remain near the material, it is considered high-level. On the other hand, if the waste material can be handled directly without undue consideration being given to the time of contact (radiation intensities up to 0.05 rem per hour), it is considered low-level.

The major source of radioactive waste materials is from the fission process itself. Almost all of the fragments are intensely radioactive, with half lifes varying from a few seconds up to thousands of years. In time the radiation level of these materials decreases, but on the average this radioactive decay is so slow that it alleviates the waste disposal problem only slightly.

Radioactive materials are also induced by radiation within a nuclear reactor. Certain radioisotopes are deliberately manufactured in this manner and others are necessarily produced in connection with operation of the reactor. For example, if air is used as a coolant, radioactive isotopes of oxygen, nitrogen and argon will be produced as well as radioactive materials from particles of dust and other impurities found in the air.

One method of reducing the radiation level of radioactive waste materials to tolerable levels is simply by dilution and dispersion. The aim is generally to reduce the concentration of the offending isotope to less than $\frac{1}{10}$ of the limits considered tolerable. Care must be taken, however, to make sure that there is no reverse process which will reconcentrate these materials; for example, involvement in the life cycle of some organism found in the sea where the waste material may be dumped.

Gases and most low-level aqueous wastes are disposed of by dilution and dispersion. The gases—for example, those used for reactor cooling—are usually diluted with large volumes of air and discharged to the atmosphere through high stacks. If the gas contains particular matter, it is passed through filters and electrostatic precipitators before being discharged.

Dilution is also used extensively in disposal of reactor cooling water and relatively low-level aqueous wastes. But most such wastes are stored for a short period prior to release to allow isotopes with short half lifes to decay. After dilution and dispersion in a river, lake or the sea, the concentration of the active isotopes must be low enough to be below drinking water tolerances—approximately 10^{-11} curies per litre. The total volume of low-level liquid wastes disposed of in the United States by this technique in 1956, for example, was nearly 9,000,000,000 gal.; the cost of disposal was more than $1,500,000; both figures increased in succeeding years.

The highest-level wastes are the fission products taken directly from nuclear fuel. For reactors with liquid fuel, the fission products may be continuously removed as a part of the process of operating the reactor. But for fuel in solid form, the fuel elements must be taken from the reactor from time to time and processed separately, not only to remove the fission products but also to separate the unused fuel to make it available for manufacture of new fuel elements. In either event, high-level radioactive wastes accumulate in abundance, and their level is far too high to consider dilution and dispersion. The only other method of waste disposal is to concentrate and store the material. Its bulk may be reduced by evaporation, and the condensate then can be treated, if possible, as low-level waste. Large amounts of the high-level concentrate have been stored in underground tanks. Another method of storage is to fix the fission products into an inert solid carrier, such as blocks of concrete, so that they cannot escape. These blocks are then buried or stored indefinitely in a

remote area. Still another procedure is to remove those particular isotopes which have long half-life periods and high radio toxicity, such as strontium-89 and cesium-137. This reduces substantially the radioactivity level of the remaining material and facilitates its disposal. It is also possible to store high-level wastes in underground geologic formations, such as salt beds, salt domes and deep basins with no connection to potable waters or other natural resources.

VI. NUCLEAR REACTOR TYPES

Nuclear reactors may be classified according to design in several different ways depending on the types of fuel, moderator and coolant used, on the arrangement of these compounds and on the velocity of the neutrons sustaining the chain reaction.

In addition, reactors may be classified according to their purpose. Research and test reactors are built primarily to supply neutrons for physical and biological research, for testing of materials and for manufacture of radioisotopes. Production reactors are built to manufacture fissionable materials by converting fertile materials. Reactors capable of producing heat in sufficient quantity and at temperatures high enough to have practical use are known as power reactors. Sometimes more than one of these purposes are served simultaneously by a single reactor.

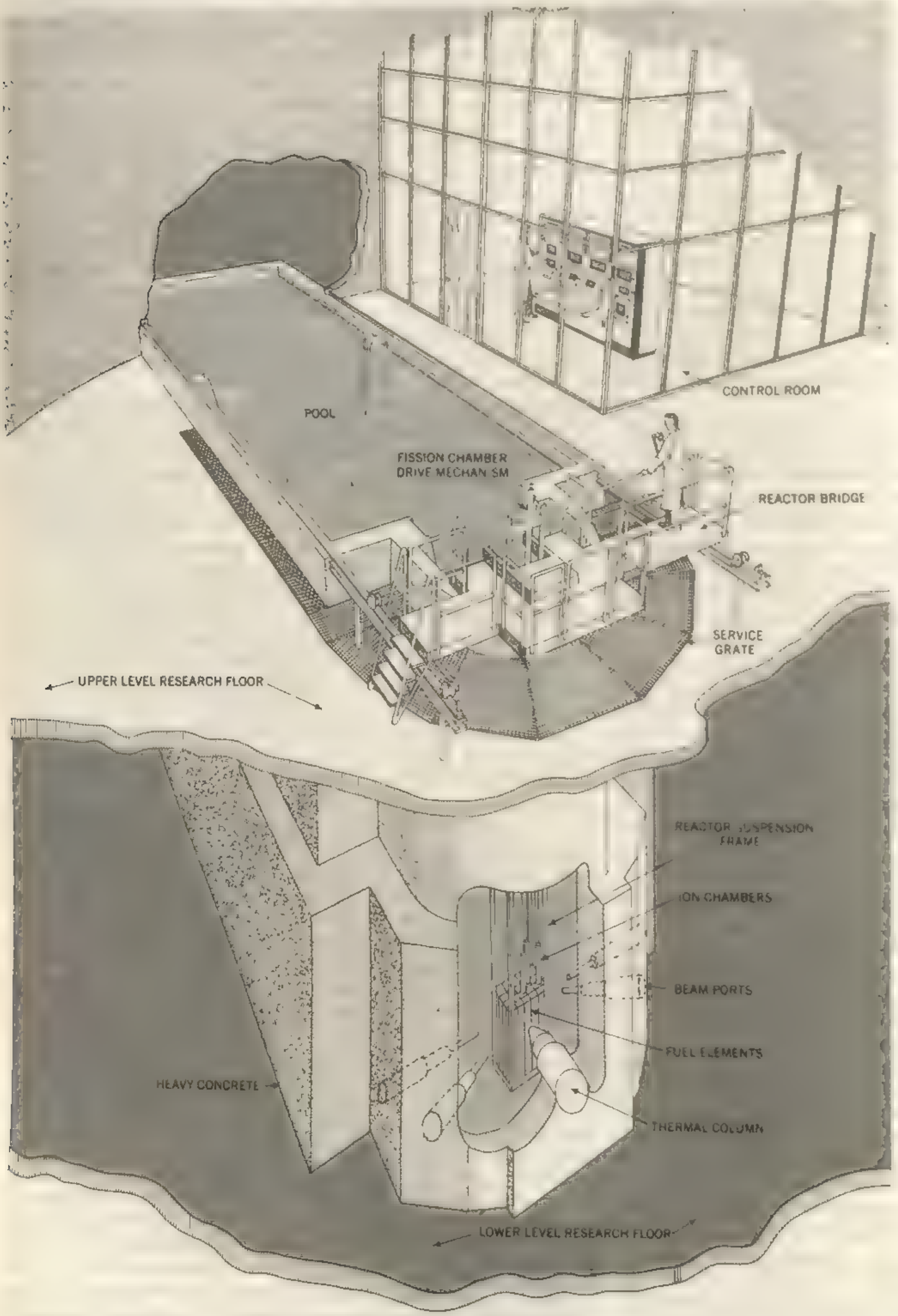
To classify reactor types solely on the basis of design, or solely on the basis of purpose, fails to emphasize those types which are of greatest interest because of past experience or because of their promise for advancement of the technology. Instead it is customary to group reactors primarily on the basis of their chronological development.

1. Heterogeneous Natural-Uranium Reactors.—The world's first self-sustaining nuclear chain reaction was achieved in an experiment at The University of Chicago on Dec. 2, 1942. Natural uranium metal rods were placed between alternate blocks of graphite, which served as moderator. In such a design, where the fuel is distributed in a fairly definite geometrical pattern or lattice within the mass of the moderator, the reactor is referred to as heterogeneous.

The large plutonium production reactors built originally at Hanford Works are of the heterogeneous type, using natural uranium and graphite, and cooled by ordinary water. The research reactor at the Oak Ridge (Tenn.) National laboratory, commonly referred to as X-10, is also graphite-moderated and uses natural uranium. The graphite cube in this reactor measures about 25 ft. along each edge and is traversed by several hundred equally spaced, cylindrical channels. These channels are loaded with 1.1-in.-diameter aluminum-clad cylinders of metallic uranium; the aluminum is to keep the fission products within the fuel. Cooling is achieved by air flow through these channels.

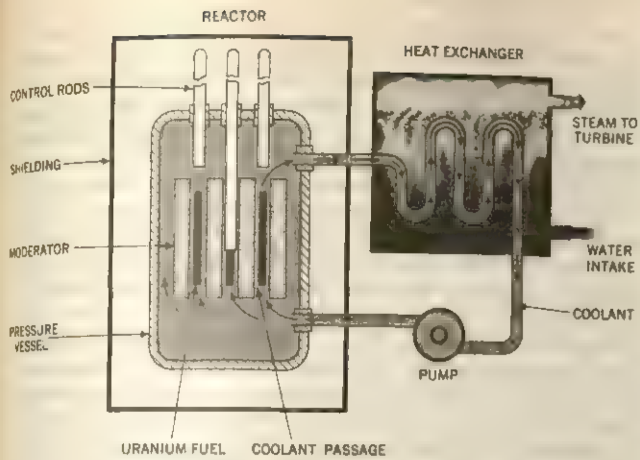
Another example of a heterogeneous natural uranium reactor was the Calder Hall type built in Great Britain, the first reactor to produce electric power on a commercial scale. The moderator is graphite, and the heat is removed from finned fuel elements by carbon dioxide, which is pumped through the fuel element channels under pressure.

Heavy water can also be used as a moderator with natural uranium. The NRX, completed in



BY COURTESY OF AGRICULTURAL & MECHANICAL UNIVERSITY OF TEXAS

FIG. 1.—PHANTOM DRAWING OF "SWIMMING POOL" RESEARCH REACTOR AT THE AGRICULTURAL AND MECHANICAL UNIVERSITY OF TEXAS



BY COURTESY OF U.S. ATOMIC ENERGY COMMISSION

FIG. 2.—SCHEMATIC DRAWING OF A URANIUM-FUEL NUCLEAR REACTOR

Aug. 1947 at Chalk River, Ont., is an early example. Aluminum is used to clad the fuel elements, and ordinary water is pumped through the fuel element channels as a cooling fluid.

Heavy water also shows promise for use in large power reactors fueled with natural or perhaps slightly enriched uranium.

2. Heterogeneous Enriched-Uranium Reactors.—With the use of enriched uranium, the size of the core required to sustain the chain reaction may be greatly reduced. For example, the material testing reactor, located at Arco, Ida., has a core with over-all dimensions of about 9 × 27 × 24 in. The uranium is enriched to more than 90%, then alloyed and clad with aluminum in the form of curved plates. The reactor is water cooled and operates at a relatively high power level (40 megawatts) to produce high neutron fluxes for research and test purposes.

The pressurized water reactor at Shippingport, Pa., was the first in the United States to produce substantial amounts of electric power for commercial use. In it, the water serves both as moderator and coolant. The fuel elements are of two types: most of them are tubes of zircaloy (an alloy of zirconium) containing natural uranium oxide pellets; to permit attaining the critical state, the core is "seeded" with a smaller number of plate-type fuel elements, also clad with zircaloy but containing uranium enriched to 93% and alloyed with zirconium.

Heterogeneous reactors containing organic materials as coolants also showed promise because of the lower operating pressures which are possible. Slight enrichment is necessary for reactors of this type, except perhaps when heavy water is used as a moderator.

3. Boiling Water Reactors.—There are some advantages to generating steam within the reactor core. It has been found that a water-moderated reactor can be made to operate stably while the water is boiling in the core. The steam produced may be used directly to drive a turbine or passed through an intermediate heat exchanger to generate steam in a secondary turbine loop.

The experimental boiling water reactor at Argonne National Laboratory, Lemont, Ill., has a cylindrical core, approximately four feet in each dimension, containing interchangeable natural and enriched uranium plate-type fuel elements. Either natural or forced circulation of the water is possible. The reactor is constructed to permit operation with heavy water as the reactor coolant and moderator.

4. Fast Breeder Reactor.—The fissions in this type of reactor occur at high neutron energies since no moderator is provided to slow the neutrons. Attainment of the critical level necessitates relatively high enrichment and large fuel mass. The Enrico Fermi reactor, Detroit, Mich., consists of zirconium-clad fuel pins enriched to 27% in U^{235} and cooled by liquid sodium. Surrounding the core is a "blanket" of uranium, consisting primarily of U^{238}. Conversion to plutonium occurs more easily with the faster neutrons, and it was anticipated that plutonium would be produced in this blanket at a rate equal to or exceeding that at which the U^{235} was consumed.

5. Homogeneous Reactors.—A reactor in which the fuel material is more or less evenly dispersed throughout the moderator is known as a homogeneous reactor. One type utilizes a uranium salt, such as uranyl sulfate, which is dissolved in ordinary or heavy water and is contained in a corrosion-resistant metal vessel. As energy from the chain reaction heats this fluid, power may be obtained by circulating it to an external heat exchanger. An advantage of this reactor is that it permits continuous removal of fission fragments and continuous refueling. The problem of reactor "poisoning" is therefore minimized, and the costly fabrication and processing of fuel elements necessary with heterogeneous reactors is eliminated.

The homogeneous reactor test facility at Oak Ridge, Tenn., had a 32-in.-diameter zirconium alloy core tank which contained a uranyl sulfate-heavy water solution having a concentration of approximately 10 g. of U^{235} per litre. Plutonium could be produced either from U^{238} in the solution or in a blanket. One of the major problems connected with this type of reactor has been the highly corrosive character of the solution.

6. Research, Test and Training Reactors.—The earlier research reactors used natural uranium, but with the availability of enriched uranium for fuel it has been possible to effect substantial reductions in cost for reactors of more recent design.

One of the more popular types, providing moderate neutron fluxes (10^{12} to 10^{13} neutrons per square centimetre per second) is called the "swimming pool" reactor. This has a reactor core suspended in an open pool of water. The water serves as coolant, moderator, radiation shield and neutron reflector. Plate-type fuel elements, highly enriched in U^{235}, are ordinarily used.

For higher neutron fluxes (10^{13} to 10^{14}) a better cooling system is needed if ordinary water is retained as the moderator; therefore a closed cooling system with a tank reactor is generally used. In a tank reactor the core is located within a closely fitting tank through which water is pumped to carry away the heat. This type lacks the simplicity of the swimming pool reactor, and the core is not so easily accessible for research purposes. Even though the core is small in order to obtain a high power density, the tank is designed in such a way that materials to be irradiated for research and test purposes may be inserted directly into the core. In addition there are openings for test purposes, also yielding high fluxes, in the blanket of these reactors.

The first research reactors using enriched uranium were of the homogeneous type, commonly called "water boilers," even though boiling was not permitted. The core consisted of a stainless steel spherical shell, about one foot in diameter, which contained the aqueous fuel solution. The heat was removed by a cooling coil wound through the inside of the sphere. This design, which is characterized by low fuel inventory and a relatively high neutron flux in relation to its low power level, has a high degree of inherent safety.

A heavy water research reactor has a lower mass of fissionable material and a higher thermal neutron flux than a comparable light water reactor designed for the same power. The thermal neutron flux distribution across the core is relatively flat, and consequently this reactor type provides a large experimental volume at a comparatively high flux level.

VII. FUELS AND FUEL RECOVERY

Three nuclides, U^{235}, U^{233} and Pu^{239}, undergo fission with thermal neutrons and therefore have received major consideration as nuclear fuels for industrial purposes. Relatively large quantities of Pu^{239} have been produced, but this nuclide has found its major use in weapons production. Commercial power reactors will in due course produce surplus Pu^{239}. U^{233} has also been produced, but in considerably smaller quantities, and it has been used principally for experimental purposes. U^{235} remains, therefore, of primary interest for industrial applications.

Since nuclear reactors are inherently incapable of consuming all the fuel they contain, the fuel elements taken from heterogeneous reactors will always contain substantial amounts of fuel. The recovery of this unused fuel from solid fuel elements so that it may be reused generally reduces the total fuel cost.

There are many different kinds of solid fuel elements. The

major considerations involved in their design include not only nuclear characteristics but also heat transfer and coolant flow, radiation damage, corrosion, mechanical strength and the containment of fission products.

In order to minimize the cost of reprocessing the fuel and of refabricating the new fuel elements, it is desirable to leave the fuel in the reactor as long as possible. Pure uranium metal makes a poor fuel element because it is susceptible to radiation damage, it is very reactive chemically, and it undergoes three solid-phase transitions below its melting point. Thermal cycling causes severe and permanent distortion in shape and volume. Substantial improvements are made by alloying the metal with appropriate diluent metals and by use of chemical compounds of uranium, such as uranium oxide and uranium carbide.

The basic materials for most reactor fuel elements are of three types: metallic fuels contain uranium metal or uranium metal alloys; ceramic fuels are sintered compacts of uranium compounds; and cermets are dispersions of uranium compounds in a metal matrix.

These materials are ordinarily formed into flat or curved plates, rods or hollow tubes, and then are clad completely with a thin metal sheath that protects the fuel material from corrosive attack by the coolant and prevents fission products from contaminating the coolant. Geometric arrays or clusters of the individual plates, rods or tubes of the clad fuel material form the active portion of a fuel element. End boxes of inert materials are often attached to both ends of the active portion to hold the fuel element in place in the reactor core and frequently to direct the flow of coolant through a particular section of the core. Thus, the finished fuel element generally contains a rather high ratio of inert to active material.

Fuel recovery is the technology of separating fission products and diluent materials from irradiated fuels and converting the purified fuel to a reusable form. Chemical processing of used fuel has been the only method utilized on an industrial scale.

Basically, chemical processing consists of two steps: fuel dissolution and solvent extraction. However, several ancillary steps are required in a complete fuel processing plant.

Used fuel elements are first stored temporarily, then transferred to a fuel stripping facility where all easily separated inert material, such as end boxes, side plates or cladding, are stripped from the basic fuel material by chemical or mechanical processes, or both. The stripped fuel is dissolved in a suitable acid solution, which is then adjusted with reagents to produce an appropriate feed solution for the solvent extraction step.

Solvent extraction is the heart of the process because it accomplishes the separation of fuel from the fission products (decontamination) and from all other diluents not previously removed. This is accomplished by intimately mixing the feed solution with an organic solvent that selectively entraps the uranium or plutonium in the feed. The organic solvent, being less dense than and immiscible with the feed solution, is easily separated from it, and the fuel-depleted aqueous feed solution becomes the highly radioactive aqueous raffinate (waste). The fuel-rich organic solvent is then contacted with a stripping solution having a different acid concentration than the feed solution, and the fuel is transferred from the organic solvent to the aqueous strip solution. The fuel-depleted organic solvent now becomes organic raffinate and must be purified in a solvent recovery step before it is reused. If sufficient decontamination has occurred in the first cycle of solvent extraction, the fuel-rich strip solution is concentrated and becomes the product of the chemical processing plant, an aqueous solution of uranyl or plutonium nitrate. If not, the fuel-rich solution may be processed through a second and perhaps a third cycle of solvent extraction to achieve the desired degree of decontamination.

If the feed to the solvent extraction cycle contains a mixture of uranium and plutonium, a partitioning cycle, wherein the plutonium is separated from the uranium, is generally interposed between the first and second extraction cycles. Partitioning is accomplished by adding to the first cycle strip solution a reagent that will readily reduce the plutonium from the +VI valence state to the +IV valence state but will not alter the valence of uranium. When this solution is contacted with organic solvent, the uranium is readily extracted while the reduced plutonium remains in the aqueous phase. Thereafter the uranium and plutonium streams are treated separately if further decontamination is required.

Radioactive aqueous raffinates from the solvent extraction, solvent recovery and fuel stripping processes are treated in a liquid waste treatment step to reduce the volume of radioactive wastes that must be stored permanently. The storage of the radioactive wastes is one of the major cost factors in the chemical recovery of used fuel.

The fuel stripping, dissolution, feed treatment and waste treatment steps of chemical processing may be either batch or continuous processes, but the solvent extraction and solvent recovery steps are inherently continuous processes. Continuous processing methods throughout a plant are more economical than a combination of batch and continuous methods; however, the wide variety of fuel enrichments, compositions and geometries encountered are not readily adaptable to continuous processing methods.

Highly enriched fuel must be processed in "critically safe" equipment or be "batch controlled" in order to prevent the inadvertent assembly of a critical mass. The geometry of critically safe equipment is such that it is impossible to achieve a critical state. Batch control limits to less than a critical amount the quantity of fuel that may be admitted to any given vessel.

The kind and quantity of diluent in the fuel mixture has its greatest effect on the dissolution step. Highly corrosion-resistant diluents require chemically sophisticated acids for their dissolution and even more specialized materials of construction in the dissolver. Fuel materials having high diluent-to-fuel ratios result in inefficient dissolver and solvent extraction operation and large waste volumes per unit of fuel processed.

VIII. ECONOMICS OF NUCLEAR POWER PRODUCTION

From an economic standpoint the great potential of nuclear energy for producing electrical energy or motive power lies in the enormous amount of energy released from a relatively small amount of fissionable material. In spite of this, however, the cost of producing power with nuclear fuels has remained high in comparison to the cost with conventional fuels. Present developments indicate that this comparison may be reversed for some applications during the 1960s.

The capital costs of a nuclear power reactor tend to be high because of the complexity of the plant and the large inventory of nuclear fuel. Surrounded by thick concrete shielding power reactors may range from 30 to 60 ft. in diameter, and some require 1,500–3,000 tons of high-purity graphite or 50–100 tons of costly heavy water. While the size of the reactor can be reduced by enriching the fuel, the reduction in capital cost tends to be offset by higher fuel cycle costs. In addition, elaborate and complex mechanisms are required for control. Large storage facilities for coal and oil are not needed, but instead rather elaborate facilities are required for transferring and storing the highly radioactive fuel discharged from the reactor.

The operating costs, in particular the cost of the fuel cycle, remain higher than the conventional counterpart, but with the advance of reactor technology substantial reduction in these costs can be expected. The cost items for uranium fuel include its mining, refinement from ores, enrichment and conversion to a form suitable for use in the reactor. If in solid form, it must further be clad in a protective jacket to prevent the escape of the fission products.

When the highly radioactive fuel elements are discharged from the reactor, they must be stored in shielded pits until the activity has decayed to a sufficiently low level to permit their transportation to chemical processing plants. Even after a period of 100 days or more, the fuel is still radioactive enough to require heavy lead shielding during transportation. Thus, every ton of fuel shipped to the reactor plant must be accompanied by [illegible] tons of shielding when reshipped to the fuel reprocessing plant.

The recovered fuel is recycled back into new fuel elements with additional makeup material to account for the fuel burned. Since the enrichment of the fuel is reduced by fissioning of the U^{235}, the recovered fuel may have to be recycled through a gaseous diffusion plant or blended with a higher enrichment uranium in order to achieve the required enrichment.

Because of the great expense of fuel processing and fabrication, it is clear that substantial savings in the cost of fuel can be achieved by increasing the fuel burnup—in other words, by reducing the frequency with which the reactor has to be recharged with new fuel elements. The obstacles to high burnup are primarily: (1) the accumulation of fission products which "poison" the reactor by absorbing neutrons; (2) the damage to the fuel elements resulting from the effects of radiation; (3) the buildup of contained fission products in gaseous form; and (4) thermal cycling. To offset the poisoning, increased enrichment can be used, but this in turn adds expense because of the cost of compensating for the excess reactivity during the early life of the fuel element when the increased enrichment is not needed, and because of the extra cost of the fuel itself.

An extensive development effort is directed toward means of increasing the burn up of reactor fuel before replacement is necessary. Besides improvements in the physical soundness of the fuel elements, there are under development schemes which involve intentional poisoning of the fresh fuel elements, use of two or more fuel regions of different enrichment and other plans to prolong reactor core life.

Homogeneous reactors also show promise for reduction in fuel costs. With fuel in a fluid form, the expensive and complicated fabrication step is eliminated and continuous chemical processing of the fuel becomes an integral part of the reactor operation. Fission products are continuously removed, providing more efficient utilization of the fuel, and the other obstacles to high burnup found in solid fuel elements are nonexistent.

A reactor which breeds new fissionable material has the important economic advantage of accumulating new fuel at least as fast as it is burned, but the large inventories of fuel and fertile material required at the outset are a strong offsetting cost factor.

IX. OTHER INDUSTRIAL APPLICATIONS

Experience with several experimental vessels clearly demonstrated the technical feasibility of nuclear energy for ship propulsion. The cost remains high in comparison with conventional fuels, but nuclear propulsion has certain inherent advantages which tend to offset these high costs. These include increased cruising range, elimination of the need for carrying liquid fuel except for emergency purposes and for the generation of electricity while in port, and elimination of the need for an air supply or an exhaust system for the power unit. Exploitation of these advantages suggests that ships may be designed for greater earning capacity even if propulsion costs remain about the same.

In general, the types of reactors which appear to be suitable for central station generation of electricity may also be considered for ship propulsion. Greater emphasis in marine service is placed, however, on compactness, reduced weight and operation at the higher temperatures which permit higher thermal efficiency. The design must also allow for the motion of the ship and for the possibility of collision.

The process heat requirements of industry are large in comparison with their requirements for electric power. In certain types of industry where large amounts of heat are needed on a relatively continuous basis, nuclear fuel may prove interesting as a source of energy. The industries having such heat requirements include certain types of food processing, pulp and paper, and chemicals.

Neutrons from nuclear reactors have been used extensively to manufacture radioisotopes with wide industrial and research applications. Large gamma-ray sources may be used for the preservation and perhaps sterilization of certain types of food. In the chemical industry the effects of radiation on materials may in some cases be turned to an advantage through promoting or initiating certain desirable chemical changes. *See* also ATOMIC ENERGY: *Peacetime Applications.*

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NUCLEAR INSTRUMENTS. Radiations from atomic nuclei, rather than the nucleus itself, are the usual object of measurement in nuclear instruments. This article therefore deals with devices for measuring numbers and energies of α-rays, β-rays, γ-rays and neutrons. Basic scientific concepts are presented elsewhere. (*See* ATOM; ELECTRON; ISOTOPE; NEUTRON; NUCLEUS; RADIOACTIVITY.)

Because γ-rays and X-rays are so nearly identical, much of γ-ray instrumentation is applicable also to X-rays. (*See* X-RAYS.) Radioactivity and X-rays have similar applications to medical diagnosis and therapy. (*See* RADIOLOGY; RADIATION: BIOLOGICAL EFFECTS.) Detection of protons, deuterons, tritons and heavier ions is similar to α-ray measurement.

CLASSIFICATION AND DESCRIPTION

Physical Basis of Measurement.—All nuclear instruments depend on an interaction of the measured radiation with some matter, contained in the instrument, which may be called the reacting medium. Since each kind of radiation may have a variety of interactions with each form of matter, there is no simple way of summarizing the myriad possibilities. In the table an attempt is made to organize the art according to seven main groups of basic effects. This classification emphasizes the way in which the information about the radiation originates; the way in which it is organized and presented in the instrument reading is treated below, under *Information Obtained.*

Of the classes of instruments represented in this tabulation, the four of greatest general interest (gas-filled instruments, scintillators, photographic methods and neutron counters) are discussed in some detail in the following sections. References on others are given in footnotes to the table.

Gas-Filled Instruments.—When radiation particles (except neutrons) or photons pass through a gas, interaction occurs with the electrons of the gas molecules. Probability of interaction is high for doubly charged α-particles, less for β-rays and very small for γ-ray photons. If the interaction is such that an electron is completely removed from the molecule, an ion pair is formed (the negative electron and the positive molecular ion). This is the simplest and, for nuclear instruments, the most important ionizing process; there are other possibilities, such as attachment of electrons to molecules to form negative ions and dissociation of polyatomic molecules.

Electrical charges available in the gas must be separated, positive from negative, and made to give some visible indication. The simplest means of accomplishing this is by the use of electroscopes

Classification of Nuclear Instruments

Physical basis	Name of instrument or method	Reacting medium
Production of heat	radiation calorimeter, bolometer	solid
Production of light	scintillation and Cerenkov* counters	solid or liquid
Change of electrical property	electrometer, ionization chamber, proportional counter, Geiger counter, spark† counter, spark chamber‡	gas
	crystal counter§, solid-state ionization chamber	solid crystal
	electron multiplier	solid metal surface
Change of chemical property	photographic method	photographic emulsion
	chemical dosimeter¶	solid or liquid
Change of physical state (phase)	cloud chamber♀	supersaturated vapour
	bubble chamberδ	superheated liquid
Nuclear reaction	fission chamber, neutron counter	solid or liquid
Lethal effect	microbial monitor☐	living organism

*J. V. Jelley, "Cerenkov Radiation," *Progress in Nuclear Physics*, vol. 3 (1954). †S. C. Curran and J. D. Craggs, *Counting Tubes* (1950). ‡A. Roberts *et al.*, "Spark Chamber Symposium," *Review of Scientific Instruments*, vol. 32 (1961). §F. C. Champion, "Solid Conduction Counters," *Progress in Nuclear Physics*, vol. 3. ‖S. S. Friedland *et al.*, "The Solid-State Ionization Chamber," *Institute of Radio Engineers Transactions in Nuclear Science, NS-7* (1960). ¶F. S. Dainton, "Radiation Chemistry," *Annual Reviews of Nuclear Science*, vol. 5 (1955). ♀*See* CLOUD CHAMBERS. δD. V. Bugg, "The Bubble Chamber," *Progress in Nuclear Physics*, vol. 7 (1959). ☐"Measuring Large Radiation Doses," special editorial report in *Nucleonics*, vol. 17 (1959).

and electrometers. These are devices which give a visible deflection proportional to the charge stored on their electrodes. When the gas between two oppositely charged electrodes is ionized by radiation, electric current flows through the gas to reduce the stored charge and the deflection. The chamber containing the gas to be ionized (the ionization chamber) may be more or less integral with the device (electrometer) for measuring the ionization current but functionally, at least, one can always think of them as separate.

In applying electron-tube amplification to ionization chambers, the ionization current is made to flow through a large resistance (hundreds or thousands of megohms) and the voltage across this resistance, when ionization current flows, activates the control grid of the amplifier (fig. 1). Special requirements on this first amplifier tube (electrometer tube) are low grid currents and high insulation of the control grid.

The ionization chamber may be used either to indicate average ionization current (current type) or to indicate individual ionizing events (pulse type). In the current type sufficient capacitance C must be parallel with R of fig. 1 to provide a time constant RC large compared with the average interval between ionizing events, whereas in the pulse type this time constant must be small.

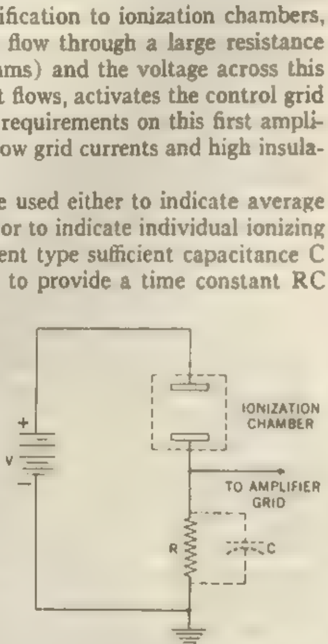

FIG. 1.—IONIZATION CHAMBER CIRCUIT

The amount of battery voltage V supplied to the chamber and the nature of the gas with which the chamber is filled are factors of importance. In principle, neither the battery nor the gas is necessary for charged-particle radiation such as α- and β-rays. In fact, strong α- and β-ray sources can be measured in a vacuum simply by exposing the source to an electrode which intercepts a small fraction of the emitted particles, giving rise to a current in the circuit of fig. 1, even though V is zero. Thus it is clear that the battery voltage and ionizing gas provide a kind of charge amplification, whereby, instead of only one or two electronic charges being collected per incident particle or photon, a large number of ion pairs (hundreds or thousands per centimetre of path) may be formed and collected. (A different avenue of amplification is exploited in the electron multipliers, where the surface on which the primary particle impinges releases several secondary electrons. *See* ELECTRON TUBE: *Photoelectric Devices.*)

An electron released in a primary ionizing event will be accelerated along the voltage gradient existing in the chamber volume. Depending on the nature of the gas, the gas pressure, the distance to the electrode and the voltage gradient, the electron may (1) reach the anode and make its contribution to the ionization current; (2) become attached to a neutral molecule to form a negative ion, which will move much more slowly toward the anode; (3) recombine with a positive ion and be totally lost; or (4), and this is the most interesting possibility, have one or more collisions with neutral gas molecules as a result of which new ion pairs are formed. This secondary increase in number of ion pairs, called gas amplification, is defined in terms of the average number of ion pairs formed by an electron per centimetre of its path along the voltage gradient; it is unity for an ionization chamber (which by definition is understood to be an instrument operated with voltages small enough for this statement to be essentially true).

The voltage on an ionization chamber should be large enough, however, to ensure that substantially all primary ion pairs escape recombination and are collected. Once this "saturation" voltage is reached, a somewhat higher voltage is equally satisfactory, so that a closely regulated voltage is not required. If the voltage is raised to the point where gas amplification becomes noticeably greater than one, there will then be a range of voltage such that at any point in this range the magnitude of current pulse furnished by a given type of particle will be proportional to the particle's energy. An instrument operated in this range is called a proportional counter. The distinction between a proportional counter and a pulse-type ionization chamber is rather subtle since both instruments can be made to furnish output pulses proportional to the ionizing particle's energy. In the ionization chamber the voltage is low (typically, a few hundred volts) and the exact value is not at all critical; there is no gas amplification, so the primary ions must be sufficient in number to drive the electronic amplifier, and therefore only heavily ionizing radiation such as α-rays can be measured. In proportional counters, the voltage is higher (perhaps 1,000 v.) and there is gas amplification possibly as large as 10,000; so, although the output pulse magnitude is proportional to particle energy, the exact value of the large proportionality factor is markedly dependent on voltage. Thus, the ability of the proportional counter to measure energy of weaker radiation, such as β-rays, necessitates a well-regulated voltage supply.

Gas amplification is naturally limited by the fact that the individual multiplying processes, or "avalanches," will, as they become larger, eventually interfere with each other. As voltage is raised above the proportional range, therefore, one finds this interference developing and causing transition to a new mode of counter operation. In this voltage range (typically centred at about 1,400 v.) the instrument is known as a Geiger or Geiger-Müller counter. These G-M tubes give pulses of a size not depending on the energy of the ionizing particle, which simply serves to trigger the discharge in an all-or-none way. Thus the G-M counter serves only for counting but is nevertheless extremely useful, since it may respond to a single primary ion pair. The Geiger discharge is characterized by its rapid spread along the full length of the anode. Once a given discharge pulse is initiated, the entire counter volume becomes insensitive and remains so until the pulse of positive ions is cleared. (The more mobile electrons are very rapidly collected on the anode.) For this reason Geiger counters cannot be made to operate as fast as proportional counters, in which the pulse of positive ions moving toward the cathode is more localized.

The size of pulse from a Geiger counter is more or less proportional to the voltage, and quantitative use of these counters therefore requires a well regulated high-voltage supply. The voltage must be kept below the point at which the electrical discharge becomes continuous. Even below this limit, the G-M counter will give a continuous succession of discharges unless provision is made for quenching. The necessity for quenching follows principally from the emission of secondary electrons at the cathode upon arrival there of the positive ions released in the first discharge. Occurrence of single discharges may be ensured by admixture to the main filling gas of a quenching gas, which suppresses the secondary electron emission.

The choice of gas with which to fill the ionizing volume is important, particularly for proportional and Geiger counters. Current-type ionization chambers generally are filled with air or with the noble gases. In high-quality pulse-type ion chambers and proportional counters it is important to avoid all possible traces of electronegative gases, such as oxygen. Argon is extensively used for all three groups of gas-filled counters, with the addition of one part in ten of ethyl alcohol for quenching in Geiger tubes. Endless varieties of pure and mixed gases have been tried, most with some degree of success. Behaviour of a supposedly pure gas may be radically modified by a trace of another.

Range of gas pressures is also quite wide—from many atmospheres in high-efficiency ionization chambers to small fractions (*e.g.*, one-tenth) of an atmosphere in Geiger counters. Construction is rather standardized for proportional and Geiger counters, viz., a cylindrical cathode, of diameter one inch or less, with a fine-wire anode, a few thousandths of an inch in diameter, mounted along the axis of the cylinder. The large voltage gradient near the fine wire is an essential feature of these instruments. Ionization chamber design is more flexible. Choice of electrode material is important, particularly for γ-ray Geiger counters, which are activated by electrons ejected from the cathode rather than by ionization of the filling gas.

Gas-filled nuclear instruments are an application of one of the most complicated branches of physics. (*See* ELECTRICITY, Con-

DUCTION OF: *Conduction in Gases*.) Crudely contrived devices may work after a fashion, but a precisely quantitative instrument involves careful combination of design factors.

Scintillation Counters.—Visible light plays a minor role in gas-filled instruments, except Geiger counters, where photons are an important ingredient of the discharge mechanism. There are solid materials, such as zinc sulfide, which as early as 1908 were observed under α-particle bombardment to emit tiny flashes of light, visible through a microscope to the dark-adapted eye. By counting the number of flashes, or scintillations, seen on a zinc-sulfide screen a direct measure of the number of incident α-particles is obtained. The only comparably direct observation of nuclear particles is to see their tracks in a cloud chamber or bubble chamber.

The important role of visual scintillation counting in the first quarter of the 20th century was ended by developments in gas-filled tubes and associated electronics. Nevertheless, it was an electronic development which, after World War II, revived interest in scintillators. This was the electron multiplier, mentioned above. If the cathode of such a tube is designed to eject electrons in response to incidence of visible light, the tube is called a photomultiplier. It is an extremely sensitive means for detecting photons. By using a photomultiplier in place of visual observation, scintillation counting becomes competitive with and in some respects superior to gas-tube techniques.

The scintillation counter consists of three essential parts: scintillating phosphor, photomultiplier tube and any optical coupling required between these two. The ability of such an instrument to measure incident radiation properly depends on (1) whether some of the energy of the incident particle or photon is absorbed by the phosphor; (2) whether any of the absorbed energy appears as emitted visible photons; (3) whether any of the emitted photons reach the photocathode; (4) whether the photons cause emission of photoelectrons; and (5) whether the electron multiplication proceeds properly. Each of the three structural elements must be evaluated against these five points.

There are three main classes of phosphor (*see* LUMINESCENCE): inorganic crystals, organic crystals and organic plastics and solutions. In general, fluorescence occurs more rapidly than phosphorescence, so that fluorescence is preferred for fast counters. There is one principal difference between organic and inorganic scintillators. The luminescence process is characteristic of the organic molecules themselves and can occur whether the phosphor molecules make up pure crystals or are dispersed in plastic or liquid solutions. By contrast, the luminescence of inorganic phosphors is essentially related to the crystalline structure, either by way of lattice defects in a pure crystal or, more commonly, by way of impurities deliberately introduced to "activate" the crystal.

Important inorganic phosphors are sulfides of zinc and cadmium, activated with copper or silver; alkali halides (notably sodium iodide), activated with thallium; and tungstates of calcium and cadmium. The first-used organic crystal, naphthalene ($C_{10}H_8$), has been largely superseded by the more efficient anthracene ($C_{14}H_{10}$). Other organic crystalline phosphors include stilbene, terphenyl, diphenylacetylene and quaterphenyl. Plastic phosphors are solid solutions of an organic phosphor in a transparent plastic—for example, 2% of anthracene in polystyrene. An efficient liquid scintillator (about half as good as solid anthracene) is a solution of 0.5% *p*-terphenyl in xylene; numerous other organic solvents and solutes also give good results. The total domain of all phosphor types is seen to be very complex and rich in possibilities.

For the second element of the scintillation counter, the photomultiplier tube, there are available ever-increasing numbers of specially developed types. The spectral response of the photocathode must match to a reasonable extent the colour of light in the scintillations. High luminous sensitivity, large current gain and low "dark current" (noise due to thermionic emission, leakage current, etc.) combine to give a good signal-to-noise ratio. For fast coincidence counting it is important that there be small spread in transit time (the interval between appearance of light pulse at cathode and appearance of current pulse at anode). Transit time and spread in transit time have both been reduced to the order of a millimicrosecond (1/1,000,000,000 of a second).

The nature of the optical coupling of phosphor to photomultiplier depends on the situation. If the efficiency of light collection is unimportant, the phosphor may be at some distance from the phototube, with air intervening. This is wasteful of light for two reasons: the photocathode subtends only a small fraction of the total solid angle into which light is radiated; and no attempt is made to eliminate reflection from the glass surface of the phototube. The first wastage may be minimized by "persuading" the light to leave the phosphor principally in the direction of the tube by giving attention to such optical details as geometrical shape and surface finish. The second wastage is reduced by providing a complete optical path with no large discontinuities in refractive index. By "light piping" through plastic rods, this can be done even over long distances and over curved paths.

Photographic Methods.—Nuclear science and technology have from their beginning made use of photographic materials, for a photographic plate was the means whereby radioactivity was discovered. In addition to the general practices of picture taking (*e.g.*, photographing particle tracks in a cloud chamber) and radiography (*e.g.*, using γ-radiation, like X-rays, to reveal flaws in an iron casting), there are three specifically nuclear applications of photographic emulsions: exposure measurement, autoradiography and high-energy particle studies. In all of these the emulsion is treated in the usual sequence of exposure, development, fixing and washing. (*See* PHOTOGRAPHY.)

Photographic emulsions are dispersions of fine grains of silver bromide (sometimes with a bit of silver iodide for greater sensitivity) in gelatin. Exposure to light or to particle radiation causes some grains of the bromide (those constituting the latent image) to become developable. This means that in the development process spots on these particular grains are first and most rapidly reduced to pure silver. (In physical development, the sensitive specks receive deposits of silver from the developer.) As the silver particles are opaque, the most exposed portions of emulsion are darkest.

Presumably this basic process is essentially the same in all photographic and nuclear emulsions. The primary mechanism, by which some grains become developable, is not fully understood either for light or for nuclear radiations.

Measurement of exposure to radiation usually depends on degree of blackening of a piece of film, although in special cases particle tracks in the film may be counted. This general blackening is similar to radiographic applications, except that here no picture is involved and hence contrast and resolution are unimportant. Various film types have been developed, differing chiefly in the variety of radiation to which they are sensitive and in the total exposure for which they are suitable. Energy dependence of a film can be modified by covering all or part of the film sample with an absorbing coating or shield.

Autoradiography (or radioautography) is a peculiarly nuclear method of studying material structure. A small number of radioactive atoms are introduced into the chemical build-up of the structure. Under the assumption that the radioactive isotope (the tracer) behaves chemically just as would its nonradioactive twin—an assumption which is not always justified, particularly with light elements—one obtains the desired structure, normal except for the fact that some of the atoms eventually betray their locations by radioactivity. A photographic emulsion placed near these atoms will record their positions.

Close proximity of a thin layer of emulsion to the specimen under study is desirable for greatest accuracy, resolution and sensitivity. Special ways of getting emulsion as close as possible include emulsion stripped from its main supporting base, liquid emulsion painted on the specimen, the wet-process method of forming a single-grain layer of crystals directly on the specimen and floating the emulsion on water as a means of applying it directly to the specimen. Resolution down to the region of one micron has been obtained, which is about the limit with visible light. Techniques include both optical density measurement of the developed

image and study of individual particle tracks. For the latter purpose special emulsions have been developed.

Nuclear track emulsions are used a great deal also in high-energy physics to record the passage or transformation of nuclear and cosmic-ray radiations. In ordinary optical emulsions the proportions by weight of halide grain and gelatin are about equal; in nuclear track emulsions, the grain proportion is about six times as large. Nuclear track preparations are also characterized by narrow grain-size distribution and by large thickness of emulsion.

Neutron Counters.—Measurement of neutrons is distinguished from other radiation measurement by the negligible interaction of neutrons with electrons. Hence the process of ionization, so important in most nuclear instruments, is not directly useful for neutron detection. Neutrons do, however, react with atomic nuclei. (*See* NEUTRON: *Detection of Neutrons.*)

Neutron-nucleus interactions are more complex than the relatively simple ionizing action of other varieties of radiation. The complexity is threefold: (1) the large number of nuclear species; (2) the different reactions that may occur between a neutron and any given nucleus; and (3) the strong dependence of cross section (probability) for any one reaction on the energy of the neutron. Besides making neutron instrumentation rich in possibilities, this complexity has the more sinister effect of leading to unexpected troubles caused by interaction of neutrons with the materials of which the instrument is constructed. This is especially important in high-flux measurements, such as are made on nuclear reactors.

Boron is perhaps the most-used material: in ion chambers and proportional counters filled with BF_3 gas or with boron coatings or foils; as a loading for photographic emulsion; and in the boron thermopile, which indicates by thermocouple the heat derived from large neutron flux. Scintillators are being used with increasing success. For example, an anthracene crystal scintillator will detect neutrons quite well via the recoil of its own hydrogen nuclei. Lithium iodide crystal phosphors have proved quite effective because of the large probability of thermal neutron interaction with the lithium-6 nucleus. Scintillators also are used to respond to the γ-radiation emitted when neutrons are captured in cadmium or boron. Since neutrons are often accompanied by γ-rays, which most scintillators detect efficiently, the problem of discriminating between neutrons and γ-rays is important. There is also continued development of fission chambers. The isotopes uranium-238, neptunium-237 and plutonium-239 have fission cross sections that make them especially useful, in the range from 10 kev to 2.5 Mev, for measurement of neutron energy spectra. A combination of three fission chambers, each utilizing one of these isotopes, permits good coverage of the range mentioned. The slow neutrons, for which the plutonium has a large fission cross section, must be screened from the plutonium counter by shields of boron. The 2.5-Mev threshold of the reaction of neutrons on sulfur-32 is also useful.

EVALUATION AND USE

Nuclear instruments are used in a wide variety of situations to obtain many different kinds of information. It is therefore important to evaluate these instruments as to information obtained, as to factors affecting accuracy and as to the best choice of instrument for a particular purpose.

Information Obtained.—Nuclear instruments furnish answers to two kinds of questions: quantitative (how much radiation?) and qualitative (what kind of radiation?).

Taking first the quantitative approach, it is convenient to distinguish information about the source of radiation from information about the radiation traversing space. In either case one may also distinguish the measurement of a total, integrated number of radiation events from measurement of the rate at which events are occurring. This leads to a fourfold classification depicted in fig. 2. In each of the four cells a single word is chosen to characterize the quantity measured. Irradiation instruments give a quantitative indication of how much total radiation has entered a certain space over a certain interval of time. Intensity meters indicate the rate at which radiation is entering a certain space. Activity instruments show the rate at which radiation is leaving a

	integrated action	rate of action
space effect	irradiation	intensity
source strength	depletion	activity

FIG. 2.—QUANTITATIVE CLASSIFICATION OF INSTRUMENT INDICATION

certain source. Depletion instruments show how much radiation has left a certain source over a certain interval of time. For charged-particle radiation, depletion may be measured by the charge built up on the source. Source depletion may also be inferred from other observations, but it is seldom directly measured. So the important categories are irradiation, intensity and activity.

The question "how much?" may be taken to mean "how many?" This is pure counting: irradiation is measured in counts by a counter; and intensity in counts per time unit by a counting rate meter or rate meter. Counter scales usually consist of a combination of high-speed electronic registers (many operate with small neon bulbs) and a lower-speed mechanical register. Typical rate meters indicate by a pointer on a scale marked in counts per minute. Source activity is rated in curies (1 curie = 3.700×10^{10} disintegrations per second) or in rutherfords (1 rutherford = 10^6 disintegrations per second). Choice of a good unit for activity involves an awkward dilemma. Disintegration rate is not a straightforward measure of activity, for it does not specify number and kind of radiations per disintegration—a given source may for example, simultaneously emit β- and γ-rays. Nevertheless, this choice is doubtless better than trying to specify the total radiation, which could hardly be measured by a single instrument in the mixed cases.

For many applications, especially those of a biological nature, an answer to the question "how many?" is not enough. What is needed is an indication of the effect the radiation might have on matter occupying the space in question. A highly available form of matter, air, is made the basis of such a unit. The roentgen (abbreviated r; mr for milliroentgen) is the quantity of X- or γ-radiation such that the associated corpuscular emission (electrons released from air molecules by the photons) in 0.001293 g. of air produces, in air, ions carrying one electrostatic unit of electricity of either sign. The mass is that of 1 c.c. of dry air at 0° C. and 760 mm. pressure. Assuming an average of 32.5 ev of energy required to form an ion pair in air, 1 r corresponds to the expenditure of about 83 ergs in each gram of air. This number may need revision, as more recent measurements suggest that 32.5 ev is about 10% too small. Irradiation instruments calibrated in roentgens are commonly called dosage meters or dosimeters. Intensity meters are called dosage-rate meters and are generally calibrated in r/hr or mr/hr. Source activity can be similarly expressed in a unit abbreviated rhm, which stands for roentgen per hour at one meter.

For nonphoton radiation, such as α-rays, β-rays and neutrons, the roentgen is not available. A similar unit, the rad, is defined for any radiation as that amount which releases energy of 100 ergs per gram of matter. But the biological effects of radiation are not solely dependent on the amount of energy released; it is also a question of how highly localized the energy is. Such considerations have led to another unit, the rem, supposed to be that dose of radiation which has the same biological effect as 1 rad of X-radiation. These rad and rem units, though poorly defined, help to emphasize the variation of biological effectiveness and to ensure careful setting of proper exposure tolerances.

Calibration requires the availability of standards against which the instrument response may be checked. For calibration of the counting mechanism of counters and rate meters there are available electronic pulse generators of various kinds. But for over-all calibration of counters a standard source of radiation must be used. The preparation and use of standard α-, β- and γ-sources is a complicated and difficult art, involving all the considerations discussed below under accuracy. Carefully prepared sources are available commercially.

The situation is simpler for instruments calibrated in roentgens. It is relatively easy to build a standard instrument measuring ionization of air. But when biological effectiveness is brought in, as it

rem units, the requirement of "standard biological tissue" is clearly impossible of fulfillment in any absolute sense.

Turning from the quantitative "how much?" to the qualitative "what kind?" the first question concerns the variety of radiation —whether it is α, β, γ or neutron. Of these four varieties, α-rays are least able to penetrate matter, γ-rays and neutrons are the most capable and β-rays are intermediate. One way, therefore, of distinguishing varieties of radiation is to vary the thickness of absorbing material in front of the counter. In standard air, for example, α-rays are unable to travel more than a few inches, whereas γ-rays and neutrons can penetrate 100 ft. or more. This range of penetration, however, of any given variety of radiation is also a function of the radiation's energy. So the use of absorbers does not always unambiguously identify variety. Some instruments by their very nature will respond only to one variety. This is essentially true of the fission counter for neutrons, because only the neutron has an appreciable chance of causing fission. But instrument response, like absorption, is in general energy dependent as well as variety dependent.

A measurement which helps in identifying variety and is also interesting in itself is the determination of half life (more generally, of time dependence) of radiation intensity. Radiation of a given variety, originating in a given mass of a single species of radioactive nucleus, decays exponentially with a characteristic time constant. Thus the half life, the time for the observed intensity to decrease to half its original (first-observed) value, is characteristic of the nuclear species. These three factors—nuclear species, half life and variety of radiation—are connected; and in cases where the connections are known from previous work, knowledge of any two determines the third (*see* RADIOCARBON DATING).

Energy dependence of absorption and of instrument response has been mentioned above. These two techniques, therefore, give a start on the measurement of radiation energy. Actually, the study of energy distribution, often called spectroscopy in analogy with the similar study of light, is a large and important part of nuclear science. Highly precise instruments have been developed. For charged particles, they may sort out different energies by means of electric and magnetic fields. Crystal diffraction methods are useful for γ-rays and neutrons (*see* ELECTRON DIFFRACTION).

With proper care, the size of pulse obtained from a pulse-type ion chamber, a proportional counter or a scintillation counter will be a measure of the particle or photon energy. These instruments are particularly effective when used with electronic devices, called multichannel differential pulse-height analyzers, which automatically sort out pulses according to size and display the distribution. Nuclear reactions having a well-defined energy threshold are useful, as mentioned above in connection with neutron counters.

An important class of measurement, somewhat related to energy measurement, is coincidence counting, recording the counts from two (or more) counters only when they occur simultaneously. The definition of simultaneity is limited by the counters, especially by the deviations in their time lags.

Examples of coincidence counting would be detection of annihilation radiation—a pair of γ-rays formed when a positron and a negative electron meet and annihilate each other; or detection of β- and γ-rays emitted simultaneously by some radioactive nuclei. The term anticoincidence counting is applied to those cases in which all counts from the two channels are recorded except those occurring simultaneously.

A typical nuclear physics problem is to determine the disintegration scheme of a particular nucleus. Boron-10, for example, has been found to decay after neutron bombardment to lithium-7 by two processes. In about 7% of the disintegrations, an α-particle is emitted with the full 2.79 Mev of energy; in the other 93%, the α-particle carries only 2.31 Mev and the remaining 0.48 Mev appears in a promptly emitted γ-ray. Elucidation of such a disintegration plan requires measurement of variety of radiation, of energy (of each particle or photon) and of activity or intensity (number of particles and photons).

The information obtained from nuclear instruments is usually presented visually by pointer-scale combinations, oscilloscope traces or patterns of lights; qualitative applications of counters make good use of headphones or loud-speakers, in which the rate of clicking is an indication of intensity.

Nuclear instruments are applied to many industrial measurements, yielding information on pressure, liquid level, thickness of strips and coatings, wear, fluid flow, etc. But these devices are beyond the scope of this article.

Factors Affecting Accuracy.—Information from nuclear instruments is limited in accuracy by the fact that radiation and radioactivity are universal. Cosmic rays and radioactivity of the earth and air provide a background count which sets a lower limit to the useful range of instrument indication. To these outside sources of background may of course be added spurious counts from the instrument itself; leakage of charge across insulators and radioactive impurities in materials of construction are sources of this trouble. Fission counters are least subject to background error, since for some fissionable elements so-called spontaneous fission occurs only at the rate of once in several hours. Alpha-counting may be pushed down to about 1 count per minute, but unshielded proportional and G-M counters have a background rate of about 30 counts per minute, which with an inch or so of lead shielding may be reduced below 15 counts per minute. In scintillation counters background is about 1 count per minute per cubic centimetre of crystal. Similar limitations apply to photographic methods, under the general label of fog. In autoradiography the word artifact is sometimes used to denote spurious evidence of radiation. If N radiation counts are recorded in time t, the standard deviation or error, neglecting background, is $\sqrt{N}$ in the count and $\sqrt{n/t}$ in the counting rate, $n = N/t$. If the background alone is counted for time t_b to establish a background rate b, and then in the presence of this background a source is observed for time t_2 to give a total counting rate n_2, the net rate of the source is $n_1 = n_2 - b$, and the standard deviation in n_1 is

$$\sqrt{\frac{n_2}{t_2} + \frac{b}{t_b}}$$

Sometimes a radiation variety giving strong counter pulses is to be measured against a high background of a weaker pulse variety. Examples are fissions against α-particles and α-particles against β-particles. The numerous weaker variety pulses may accidentally bunch together closely enough at some instant to build up in the amplifier what looks like a strong pulse. Much the same problem occurs in counting weak radiation pulses over crests in grid current noise of the first amplifier tube.

Accuracy in measuring a single variety requires discrimination against other varieties which may also be present. In current-type chambers this may be achieved by subtracting currents; thus the γ-compensated neutron chamber has a three-electrode system, one pair of electrodes collecting current from a volume affected both by neutrons on boron coatings and by γ's, the other pair collecting from a volume in which only γ's are effective. The difference of the currents is a good measure of neutrons, provided equal γ-efficiencies are obtained in the two regions between the electrode pairs, as by adjustment of volumes.

Another limitation on counters, especially serious for the full-volume breakdown of G-M tubes, is imposed by dead time, the period during which, after one count has been initiated, the instrument is incapable of detecting another event. Furthermore, even if the counter can generate a very rapid succession of pulses, the electronic indicating system may be unable to resolve them. Electronic pulse shaping, emphasizing the rapidly changing portions of the pulse wave form, can bring great improvement in resolution.

Efficiency of counting means the ratio of counts observed to the total one would like to observe or could observe from the given sources. This involves first the question whether a given particle or photon ever enters the counter; and then the question whether, if it does enter, it will be counted. In the first place, the counter must have some or all of its walls thin enough for the radiation to penetrate; for the soft β-radiation measured in carbon-14 dating, for instance, thin-window counters must be used, or else the sample must be inside the counter.

Other considerations are geometrical—for example, a point source of radiation in free space could register on a counter no more than the fraction F of its emission, where F is the ratio of the effective solid angle, subtended by the counter relative to the point source, to the maximum possible solid angle, 4π steradians. If the counter can be made to surround the source completely, as when a small source is embedded within a scintillator, total (or 4π) counting becomes possible. Shape and dimensions of the source have an effect not only on counting geometry but also on scattering and absorption.

Scattering is pronounced for electrons, and the backscattering from a reflector may be used to increase by 50% the count from a β-source. Absolute counting refers to the effort to assign an accurate value, based on the observed count, to the total number of radioactive atoms in the sample. Scattering, absorption and efficiency are all of great significance to absolute counting.

Evaluation for Various Applications.—In addition to basic technical factors discussed above, there are practical matters such as cost, size, reliability and portability to be considered in making the best choice of instrument for a particular application. Simple, open-to-the-atmosphere, air-ionization chambers are admirably suited to moderate-accuracy rate-meter applications at medium to high levels, as for military and civil defense needs. In dosimetry the fountain-pen-size condenser r-meter and the film badge are most useful for monitoring personnel. The condenser r-meter is a roentgen meter, or dosimeter, consisting of an electrometer chamber giving an initial electric charge, worn by the user and then measured for charge lost, which indicates the total ionizing radiation received. Chemical dosimeters have the advantage over film badges of being easily and quickly read.

Geiger counters combine sensitivity at low counting rates with relative simplicity. An example of an inexpensive assembly would be a Victoreen-type 1B86 counter tube, a 1-megohm resistor, a miniature 300-v. battery, a pair of high-impedance magnetic headphones and an on-off switch—all connected in series. G-M counters are sensitive, reliable and portable enough to be very useful in prospecting for radioactive ores. For this purpose the more sensitive but more expensive scintillation counters are also in wide use. For prospecting (*see* GEOPHYSICAL PROSPECTING), an upper limit on scale range of 5 to 20 mr/hr. suffices, as background at earth's surface averages 0.02 to 0.05 mr/hr., and a count of several times background is encouraging (but not conclusive!) evidence of mineral radioactivity. The scintillator method is extremely flexible as to counter volume. For a medical dosimeter probe a tiny crystal may be used on the end of a light-piping plastic rod; at the other extreme, large volumes of liquid scintillator surround a counting chamber large enough to receive a human body. Liquid scintillators of large volume also played a key role in detection of the neutrino, most elusive of fundamental particles (*see* PARTICLES, ELEMENTARY).

Accurate nuclear measurement can be achieved only if a good instrument is used with good auxiliary equipment. For example, medical dosimetry of γ-emitters such as radioiodine may be wrong by a factor of two because of scattered radiation, but this error may be largely eliminated by using with the counter a collimator that will accept only rays coming from a highly limited direction, and by feeding the counter output to a pulse analyzer which permits counting only peak, unscattered pulses. Other auxiliary items useful on occasion include automatic counting timers and sample changers; flow controls for liquid or gaseous samples; shielding and absorbing materials; and devices for remote handling of dangerously strong sources.

See also BUBBLE CHAMBER; BOLOMETER; CERENKOV RADIATION; PHOTOELECTRICITY.

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(J. D. T.)

NUCLEAR MAGNETIC RESONANCE, a technique for observing the magnetic character of atomic nuclei through a resonant response to a high frequency magnetic field when the nucleus is placed in a static magnetic field.

Approximately two-thirds of the stable and almost all of the unstable atomic nuclear species possess angular momentum, called nuclear spin. As required by quantum mechanics, the magnitude of the angular momentum is a half-integral multiple of $h/2\pi$ where h is Planck's constant, 6.625×10^{-27} erg-seconds. Accompanying the spin is a magnetic dipole moment, as if electric charge were circulating around the axis of the spin (*see* NUCLEUS: *Further Properties of Nuclei*). The convenient unit for the specification of the magnitude of nuclear magnetic moments is the nuclear magneton.

A particle with the charge and mass of a proton, the simplest nucleus and a constituent of all others, would have a magnetic moment of one nuclear magneton, if it rotated as a rigid body with one unit $h/2\pi$ of angular momentum. The proton actually has a spin of one-half $h/2\pi$ and a magnetic moment of 2.7899 nuclear magnetons.

In a static magnetic field, the torque acting on a nucleus through its magnetic moment gives rise to a characteristic frequency of precession about the direction of the field, resembling the precession of a spinning top. A relatively weak oscillating or rotating magnetic field lying in the plane perpendicular to the static field can, when in synchronism with the precession, radically change the nuclear orientation; this phenomenon is called nuclear magnetic resonance. Such a technique was applied by I. I. Rabi and collaborators to molecular and atomic beams to improve their precision for measuring nuclear magnetic moments and spins. Magnetic resonance can be detected purely electromagnetically, provided the nuclear spins and moments are in some degree preferentially oriented, as they are in normal matter in thermal equilibrium in a static field. As an example one may consider the radio-frequency impedance of a coil of wire wound around a small bottle of ordinary water. If a suitably weak radio-frequency current at 20 megacycles per second is used to measure the impedance, while a strong uniform magnetic field of about 5,000 gauss in the direction perpendicular to the axis of the coil is slowly varied, a measurable increase in resistance will be observed as the field moves through the region of 4,673 gauss. This increase in circuit loss is the result of the magnetic resonance of the hydrogen nuclei in the water. Such effects were first observed by E. M. Purcell and collaborators and, independently, by F. Bloch and collaborators. In this way it has been found possible to study the paramagnetism due to the nuclear moments in matter, a phenomenon that is very difficult to detect statically. Nuclear magnetic resonance has other uses than the precise measurement of the magnetic moments of nuclei. Properties of solids and liquids can be studied because the shapes, widths, splitting and transient responses of the resonances depend upon such properties. Data relating to crystalline structure, thermally induced internal motions, electronic band structures, antiferromagnetism, diamagnetism, electronic paramagnetism, ferroelectricity, self-diffusion in solids and liquids, viscosity in liquids and chemical exchange rates are among the subjects included in the results of experiments on nuclear magnetic resonance. Chemists find the study of the resonance of hydrogen in liquids especially useful because of the presence of small shifts and splittings originating in molecular structure. Nuclei having more than one-half unit of angular moment have magnetic resonances that are profoundly influenced in some materials through torques originating in the electric fields of the atoms and molecules which couple with the nonspherical distribution of electric charge in the nuclei, as characterized by its electric quadrupole moment. It is, for example, possible to have magnetic resonance of such nuclei in some solids at very high frequencies even without a static magnetic field. Studies of such resonances provide further information about electrostatic aspects of solid and nuclear structures. *See* also ATOMIC AND MOLECULAR BEAMS; ELECTRON PARAMAGNETIC RESONANCE.

(R. V. P.)

See E. R. Andrew, *Nuclear Magnetic Resonance* (1955); N. F. Ramsey, *Nuclear Moments* (1953).

NUCLEAR MOMENTS are mechanical, electrical and magnetic quantities related to the rotation of the atomic nucleus and to its shape or configuration. If the nucleus is subjected to electric or magnetic forces arising from nearby atomic electrons, from other nuclei or externally applied fields, the behaviour of the nucleus will depend upon its shape. Since the nucleus is a complicated structure, its electric and magnetic configurations need to be considered separately. By breaking it down into a series of moments of successively decreasing value the complex nuclear shape may be conveniently described as an approximate sum of several simpler structures mutually superimposed. These quantities are of primary importance in understanding the nucleus and the forces that hold the nuclear particles (protons and neutrons) together. Any successful theory of nuclear structure must permit calculations of nuclear moments that agree with experiment. Nuclear electric and magnetic moments have been used extensively to explore the force fields in atoms, molecules, crystals, liquids and laboratory electromagnets.

In the 1920s the existence of nuclear mechanical and magnetic moments was postulated by W. Pauli (and independently by S. A. Goudsmit and E. Back) to explain a very fine splitting (hyperfine structure) of lines in the optical spectra of some atoms. During the early 1930s the development of high-resolution optical spectroscopy and the atomic-beam method made possible rapid advances in this field. Late in the 1930s the introduction of the magnetic-resonance atomic-beam experiment permitted a new order of precision in such investigations. In the years following World War II the techniques of radio-frequency and microwave electronics were applied to magnetic and quadrupole resonance in atoms and molecules. (*See* ATOMIC AND MOLECULAR BEAMS.)

Precision control of radio-frequency radiation as evolved in the 1960s permitted atomic-beam experiments that determine atomic hyperfine interactions to an accuracy exceeding that of any frequency measurement based on time as defined astronomically. The working definition of time, therefore, has been revised in terms of these interactions; such measurements can be made to a precision of 1 part in 1,000,000,000,000.

Definitions.—In physics the term moment refers to the distribution of a quantity with respect to some convenient point or line such as a centre of gravity or an axis of rotation.

The term electric monopole is sometimes used to refer to a point (or uniform spherical) charge distribution. Isolated magnetic monopoles have been sought and, although discussed in the literature, they had not been observed up to the 1960s.

An electric dipole is a combination of a point positive charge and an equal negative charge separated by some distance. The electric dipole moment of such a system is given as charge separation distance multiplied by the charge magnitude (*see* DIPOLE MOMENTS).

A magnetic dipole is exemplified by a magnetic compass needle in which north and south magnetic poles are concentrated at the ends as in fig. 1(A). The magnetic dipole moment of such a system is given as the pole strength multiplied by the needle length. The properties of a magnetic dipole can be approximated by a

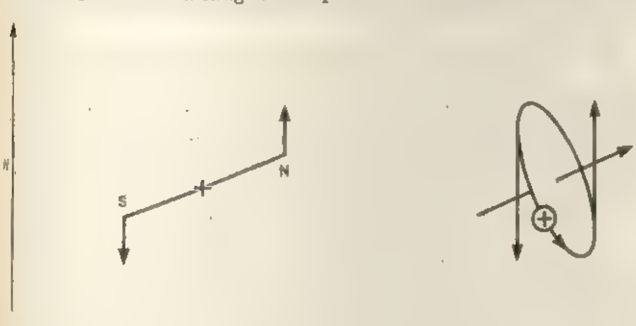


FIG. 1.—MAGNETIC DIPOLE PROPERTIES: (A) MAGNETIC NEEDLE IN THE PRESENCE OF A MAGNETIC FIELD H UNDERGOES FORCES TENDING TO TWIST IT INTO ALIGNMENT WITH THE FIELD; (B) CIRCULAR LOOP OF MOVING POSITIVE CHARGE UNDERGOES SIMILAR FORCES TENDING TO ALIGN THE AXIS PARALLEL TO H

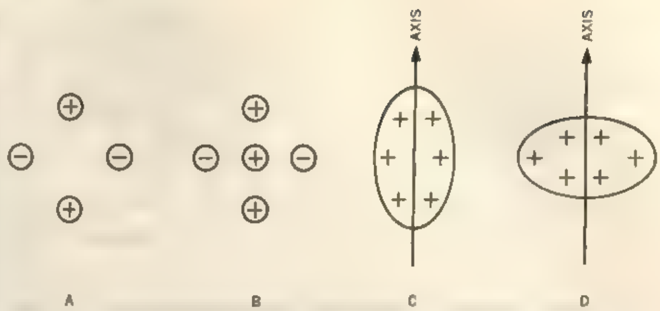


FIG. 2.—ELECTRIC QUADRUPOLE CONFIGURATIONS: (A) IDEALIZED QUADRUPOLE OF TWO OPPOSITELY ORIENTED DIPOLES; (B) SIMILAR QUADRUPOLE WITH AN ADDED MONOPOLE; (C) CONTINUOUS VOLUME OF CHARGE CONSISTING OF A CHARGED PROLATE SPHEROID WITH A POSITIVE MONOPOLE AND A POSITIVE QUADRUPOLE MOMENT; (D) CHARGE DISTRIBUTION CONSISTING OF AN OBLATE SPHEROID AND HAVING A POSITIVE MONOPOLE MOMENT AND A NEGATIVE QUADRUPOLE MOMENT

ring of circulating electric charge as in fig. 1(B) where a disk with a current ring around its circumference is shown. This is equivalent to a magnetic dipole oriented along the axis. In a magnetic field both the magnetic needle and the disk will undergo a twisting force, tending to align their axes parallel to the field.

The nuclear electric quadrupole moment Q is rigorously defined for a nuclear volume τ as $Q = \frac{1}{e} \int_\tau \rho(3z^2 - r^2)d\tau$ where ρ is the charge density, z is the co-ordinate along the axis of reference, r is the radius vector to the volume element $d\tau$ and e is the electronic charge.

It is possible to build up charge or current distributions which will have a quadrupole (four-pole) moment that can be formed as shown in fig. 2(A). Such a configuration could have zero mono-

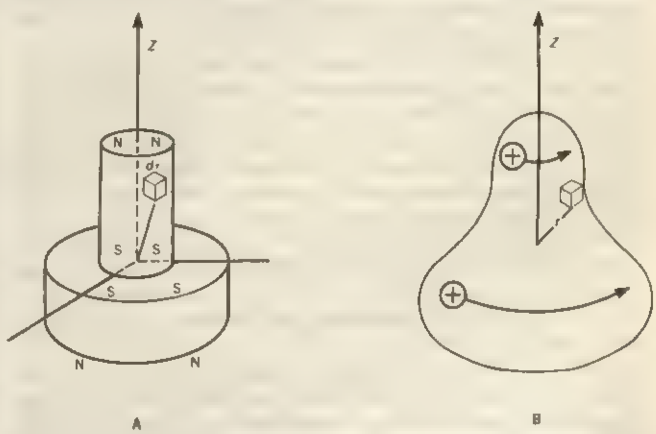


FIG. 3.—MAGNETIC OCTUPOLE CONFIGURATIONS: (A) ARRAY OF DIPOLES OVER A VOLUME WHICH COULD HAVE A TOTAL DIPOLE MOMENT OF ZERO AND AN APPRECIABLE OCTUPOLE MOMENT; (B) CONTINUOUS DISTRIBUTION OF CIRCULATING POSITIVE CHARGE WHICH COULD HAVE POSITIVE DIPOLE AND OCTUPOLE MOMENTS

pole and dipole moments but a positive quadrupole moment. Other examples of charge distributions with quadrupole moments are illustrated in the figure.

A nuclear magnetic octupole moment Ω may be defined mathematically as $\Omega = \int_\tau \frac{1}{2}(5z^3 - 3zr^2)\ \nabla \cdot M d\tau$ where z, r and τ are defined as for the quadrupole moment and $\nabla \cdot M$ is the divergence of the nuclear magnetization. The quantity $\nabla \cdot M$ may be imagined as the equivalent pole density at the ends of a dipole. Thus an array of magnetic dipoles as illustrated in fig. 3(A) might have zero dipole moment but an octupole moment greater than zero. A distribution of circulating positive charge illustrated in fig. 3(B) would have both magnetic dipole and octupole moments. There is no a priori reason for excluding electric 16-pole moments from atomic nuclei but none had been observed up to the 1960s.

The spin (moment of momentum, or angular momentum) of a particle with mass m as in fig. 4(A), moving at velocity v with respect to a centre O is given as mvr where r is the distance from m to the line of motion (*see* MECHANICS).

FIG. 4.—SPIN (MOMENT OF MOMENTUM, ANGULAR MOMENTUM): (A) THE SPIN WITH RESPECT TO CENTRE O OF A PARTICLE OF MASS m WITH VELOCITY v IS GIVEN AS mvr; (B) A ROTATING RIGID BODY CAN BE IMAGINED AS COMPOSED OF MANY PARTICLES. THE TOTAL SPIN IS THE SUM $m_1v_1r_1 + m_2v_2r_2 + \ldots$

A rigid body, as in fig. 4(B) may be considered as composed of many particles $m_1, m_2, m_3, \ldots$ Such a body can be viewed at any instant as though each particle were moving at right angles to its radius from 0. The sum of angular momenta of all mass particles is termed the angular momentum (or spin) of the entire rigid body. Since angular momentum refers to a particular direction and sense of rotation it is a vector quantity, and can be represented by a line (in the direction of the axis of rotation) with length proportional to the magnitude of the quantity. A positive sense to the line is arbitrarily taken such that when one looks in that direction the rotation appears clockwise.

Since the rotation of the nuclear particles in their orbits is rapid compared to the time taken for most experimental observations the nuclear shape appears to be symmetrical about the axis of rotation. As a consequence of this and of certain other symmetry properties of forces between particles in the nucleus, nuclei are not expected to have electric dipole or octupole moments, or magnetic monopole, quadrupole or 16-pole moments.

Quantum Effects.—The laws of mechanics (*see* QUANTUM MECHANICS) that describe the motions of atomic or nuclear particles are somewhat different from those of classical mechanics. For example, in classical mechanics a rotating body can have any given amount of angular momentum. An atomic system of a particle in orbit, according to the simplified quantum mechanics, can have only some whole number of units or quanta, equal to $h/2\pi$, where h is Planck's constant (6.625×10^{-27} erg sec.). In addition to its orbital motion each proton and neutron spins about its own axis, just as the earth does while at the same time revolving about the sun. The angular momentum associated with each particle spin is always $\frac{1}{2}$ unit.

An additional aspect of angular momentum in quantum mechanics is that the axis of rotation cannot be randomly oriented. In space there must be at least some small magnetic field present at all times. With respect to this field, the angular momentum vector can be oriented only in those directions such that its possible projections along the field differ by whole units of $h/2\pi$. For example, if the total angular momentum is 3 units, then the possible projections along the field can be 3, 2, 1, 0, −1, −2 and −3 (*see* fig. 5). These values of the projections are designated by the symbol m and are termed the magnetic quantum numbers. (More accurately the discrete values of orbital angular momentum are $\sqrt{l(l+1)}$ where the quantum number $l = 1, 2, 3, \ldots$ Similarly, the spin quantum number s determines the magnitude of spin equal to $\sqrt{s(s+1)}$. These quantities approximate the simplified integral values for large quantum numbers. The statements regarding integral values of m are still exact.)

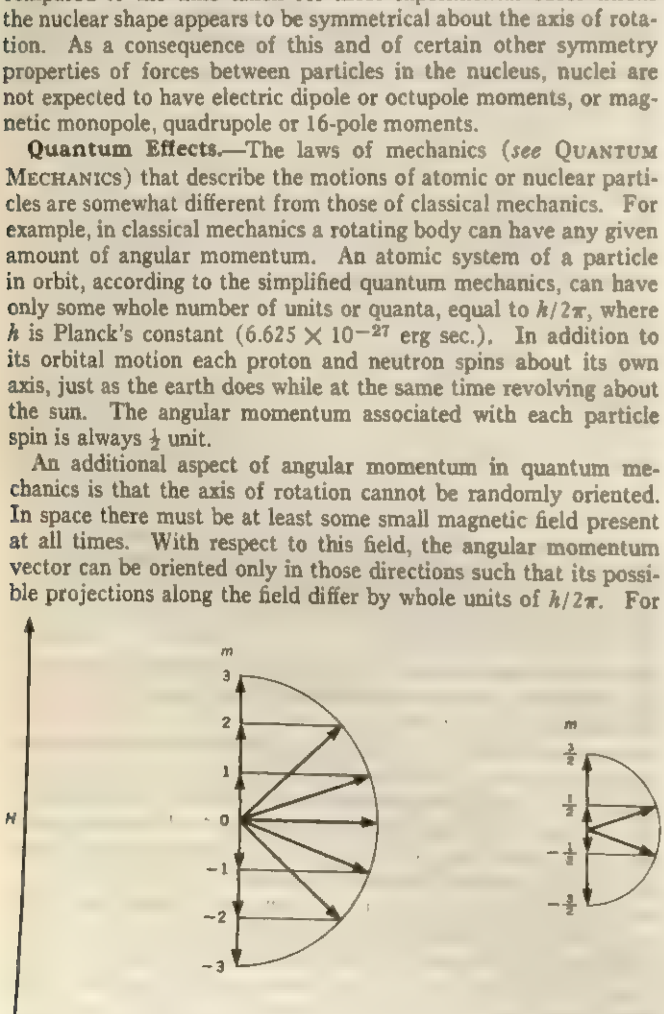


FIG. 5.—POSSIBLE ORIENTATIONS OF ANGULAR MOMENTUM VECTOR: (A) IN THE PRESENCE OF A MAGNETIC FIELD H A VECTOR OF 3 UNITS HAS POSSIBLE PROJECTIONS m OF VALUE 3, 2, 1, 0, −1, −2 AND −3; (B) A VECTOR OF $\frac{3}{2}$ UNITS HAS POSSIBLE PROJECTIONS OF $\frac{3}{2}$, $\frac{1}{2}$, $-\frac{1}{2}$ AND $-\frac{3}{2}$

One consequence of the orientation aspect of angular momentum is that the total angular momentum of the nucleus is a vector sum of the components (orbital plus particle spin) giving an integral number of units if there are an even number of particles or an integral number plus $\frac{1}{2}$ unit if there are an odd number of particles.

Interactions Involving Moments.—Consider first the magnetic dipole interaction. Since a uniform field exerts a force on a dipole tending to align it with the field, any other orientation will represent a state of higher potential energy. This difference in energy will be expressed by $\Delta W_m = \frac{\mu}{I} mH$ where I is the total angular momentum, μ is the magnetic dipole moment, H is the applied magnetic field, and m is the magnetic quantum number; ΔW_m represents the work done to orient the system from the lowest m-state to that of next higher energy. It is a primary concept in quantum mechanics that an atomic system can generally exist only in discrete energy states, and to jump from one to the other it must emit or absorb radiant energy depending on whether the initial state E_1 is higher or lower than the final state E_2. The radiant energy will have a frequency ν given by $E_1 - E_2 = h\nu$ where h is Planck's constant.

Suppose a system of nuclei is given in which the nuclear spins are all oriented in the m-state of lowest energy. If these nuclei are subjected to electromagnetic radiation with a frequency of exactly ν the radiant energy will be absorbed and the system will jump to the next higher m-state. Under appropriate conditions this energy absorption can be detected electronically and the frequency ν measured with extreme precision; thus the energy difference can be determined with great accuracy. These principles form the basis of the techniques of magnetic resonance and may be applied to solids, liquids, gases in bulk, and to free atoms in an atomic beam (*see* NUCLEAR MAGNETIC RESONANCE).

If the atomic electrons have a combined angular momentum of one or more units they will produce an electric field at the nucleus which can interact with a nuclear electric quadrupole moment. If the electronic angular momentum is $\frac{3}{2}$ units or more, there will be a magnetic field that can interact with a nuclear magnetic octupole moment.

In general the quadrupole effects are small compared with those of the dipoles, serving to produce a slight shift in the position of the energy levels as expected from dipoles alone. Magnetic octupole moments produce extremely small additional shifts that require extremely high precision in measurement and have been observed in only a few cases.

An atom with a magnetic dipole moment exposed to a nonuniform magnetic field undergoes a linear force in addition to its tendency toward orientation. The various m substates of fig. 5 are acted upon by different forces. The use of an atomic beam makes possible the physical separation of these states and an observation of an induced transition between them. In this way the energy difference between substates is observed directly.

The atomic- or molecular-beam technique has been applied to many problems involving nuclear moment interactions and has given results that are among the most precise physical measurements ever made. The method has permitted verification of the basic ideas involved in understanding the properties of nuclear moments. This method has also permitted the measurement of more than 150 nuclear spins.

Other principal techniques for measuring nuclear moments are magnetic resonance, optical spectroscopy, microwave spectroscopy,

electron paramagnetic resonance and pure electric quadrupole resonance (*see* SPECTROSCOPY: *Applications*; ELECTRON PARAMAGNETIC RESONANCE; RESONANCE ENERGIES).

Empirical Results of Measurements.—As a result of the measurement of spin for more than 150 different nuclei in their most stable state the following empirical rules have been found to hold: (1) nuclei with an odd number of particles have spins of $(m+\frac{1}{2})$ units of $h/2\pi$ where m is an integer; (2) nuclei with an even number of particles have spins of m units of $h/2\pi$; (3) nuclei with an even number of protons and an even number of neutrons have zero spins.

These regularities form the starting point of the shell model theory of nuclear structure which has been so fruitful in predicting nuclear properties that M. G. Mayer and J. H. D. Jensen (*qq.v.*) were awarded Nobel prizes in 1963 for their role in its development (*see* NUCLEUS: *Nuclear Structure and Nuclear Forces*). The values of nuclear spin range from 0 to 12 units of $h/2\pi$. Measured values of nuclear magnetic dipole moments range from 0.002 in thallium-198 to more than 6 nuclear magneton units in neptunium-237. (The nuclear magneton is defined as $eh/4\pi Mc = 0.505038 \times 10^{-23}$ erg/gauss where e is the electronic charge, M is the mass of the proton, h is Planck's constant and c is the velocity of light.) Values of nuclear moments are given in some of the references cited below, but most extensively in the nuclear data tables published by the National Research council of the U.S. National Academy of Sciences.

As a result of the nature of nuclear forces one would expect the following relationship between nuclear spin and highest electric or magnetic moment associated with the nucleus:

spin 0	electric monopole
spin $\frac{1}{2}$	magnetic dipole
spin 1	electric quadrupole
spin $\frac{3}{2}$	magnetic octupole
spin 2	electric 16-pole, etc.

There appears to be no evidence in conflict with these predictions.

BIBLIOGRAPHY.—V. W. Cohen, "Comparison of Methods for the Determination of Nuclear Spin as Applied to Radioactive Nuclei," in I. Estermann (ed.), *Recent Research in Molecular Beams* (1959); H. Kopfermann, *Nuclear Moments* (1958); K. F. Smith, *Molecular Beams* (1955); N. F. Ramsey, *Nuclear Moments* (1953); A. de Shalit and I. Talmi, *Nuclear Shell Theory* (1963). (V. W. C.)

NUCLEAR PHYSICS: *see* ACCELERATORS, PARTICLE; ATOM; ATOMIC ENERGY; NUCLEUS; PARTICLES, ELEMENTARY.

NUCLEIC ACIDS, a group of large, complex compounds of high molecular weight that occur in all plant and animal cells and viruses and are of great importance since they control the formation of proteins in the cells and also take part in the transmission of heredity information (the genetic code). Upon mild hydrolysis nucleic acids yield (1) the ortho (trihydrate) form of phosphoric acid; (2) a pentose (five-carbon) sugar or a deoxypentose (a pentose with one oxygen atom removed) sugar; and (3) a mixture of nitrogenous bases (*see* fig. 1) of the pyrimidine and purine types. Pyrimidines, also called 1,3-diazines, are six-membered rings that contain nitrogen atoms in the 1 and 3 positions. Purines (*q.v.*) contain two rings, one a pyrimidine and the other an imidazole (*i.e.*, a five-membered ring with nitrogen atoms in the 7 and 9 positions).

Structure.—Nucleic acids fall into two chemically distinct classes:

1. In ribonucleic acids (commonly abbreviated to RNAs) the sugar is a pentose and the principal bases are the purines adenine and guanine and the pyrimidines cytosine and uracil. Small amounts of thymine and of methylated adenine, guanine and cytosine have also been reported, especially in the "soluble RNA" (sRNA) of the cell cytoplasm (*see* below).

2. In deoxyribonucleic acids (commonly abbreviated to DNAs) the sugar is a deoxypentose and the principal bases are the purines adenine and guanine and the pyrimidines cytosine and thymine. In the DNA of certain bacterial viruses cytosine is absent and its place is taken by 5-hydroxymethylcytosine, which is frequently substituted in the 5-hydroxymethyl group with one or two glucose residues. Small quantities of 5-methylcytosine have also been found, especially in the DNA of wheat germ.

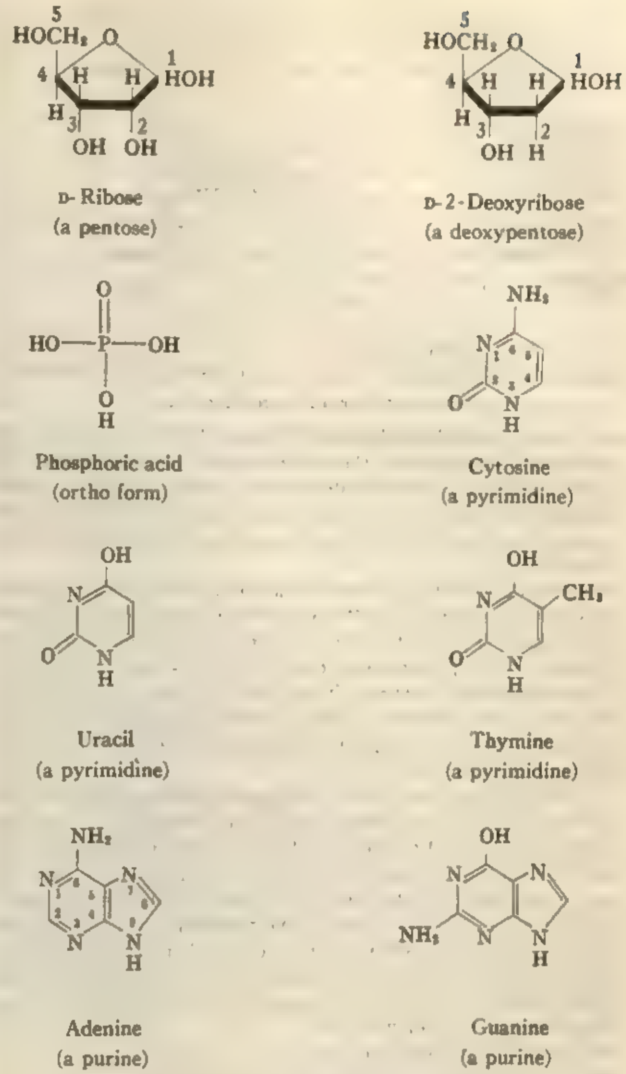
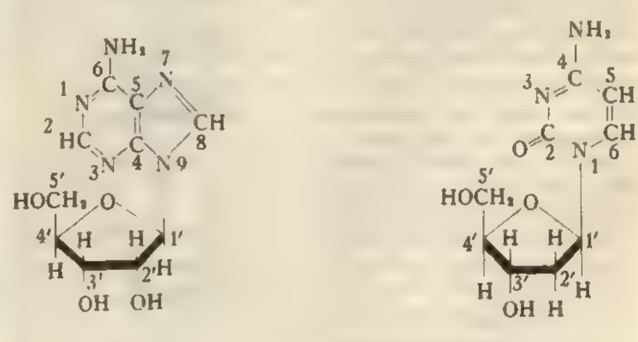


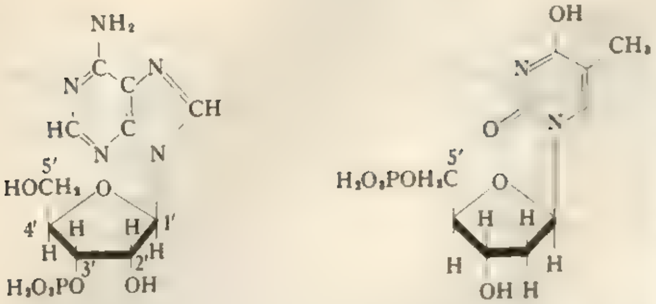
FIG. 1.—MAJOR COMPONENTS OF NUCLEIC ACIDS

In all cases in which the question has been investigated the pentose of RNA has been identified as D-ribose and the deoxypentose of DNA as D-2-deoxyribose. In both RNA and DNA the fundamental structural unit is the nucleotide, in which a purine or pyrimidine base is linked to a sugar molecule, which in turn is esterified with orthophosphate. Normally the nitrogen atom at position 9 of the purine or position 1 of the pyrimidine is linked to the carbon at position 1 of the sugar. The base-sugar subunit compound is termed a nucleoside and is named after the base. Thus the ribonucleosides of adenine, guanine, cytosine and uracil are called adenosine (*see* fig. 2), guanosine, cytidine and uridine, respectively. The deoxyribonucleoside of thymine is called thymi-



Adenosine Deoxycytidine

FIG. 2.—EXAMPLES OF NUCLEOSIDES



3'-Adenylic acid (Adenosine-3'-phosphate)

5'-Thymidylic acid (Thymidine-5'-phosphate)

FIG. 3.—EXAMPLES OF NUCLEOTIDES

dine; other deoxyribonucleosides are named by adding the prefix "deoxy-" to the names of the corresponding ribonucleosides. In pseudo-uridine, a ribonucleoside found in small quantities in RNA (especially sRNA, *see* below), the base-sugar linkage involves the carbon at position 5 of the uracil instead of the nitrogen at position 1.

Nucleotides (*see* fig. 3) may be named as acids or as phosphate esters of nucleosides (*e.g.*, 3'-adenylic acid, or adenosine-3'-phosphate; and 5'-thymidylic acid, or thymidine-5'-phosphate). In naturally occurring nucleotides the phosphate is usually at position 5 of the sugar but sometimes it occurs at position 3 and occasionally is attached cyclically to both. Free mononucleotides of this sort form an important part of the chemical machinery of the cells, especially as coenzymes.

Nucleic acid molecules can be regarded as polynucleotides that are built up from 5'-nucleotide units, the phosphate of each nucleotide being linked to the 3' hydroxyl of the succeeding nucleotide. The resulting molecule consists of a long chain in which sugar and phosphate alternate and in which a base is attached to each sugar (*see* fig. 4). The relative proportions of the different bases vary from one RNA or DNA to another depending on the sources from which they are isolated. But as a general rule the number of bases with a 6-amino group (*i.e.*, adenine and cytosine) is equal to the number with a 6-keto group (*i.e.*, guanine and thymine or uracil). It was not possible in the early 1960s to determine the sequence of bases throughout the length of an RNA or DNA molecule, but the available evidence made it highly unlikely that they were arranged in any regular repeating pattern.

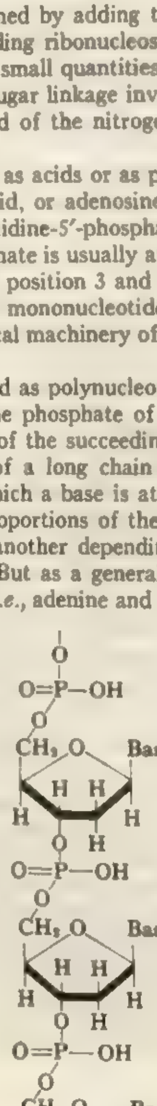


FIG. 4.—STRUCTURE OF THE POLYNUCLEOTIDE CHAIN IN DNA

Molecular Weight.—The molecular weight of DNA or RNA depends on the source from which it is obtained and the method by which it is isolated. The values obtained for DNA in the early 1960s fell mostly in the range 1,000,000–10,000,000, but there was some evidence that in vivo the true molecular weight might be of the order of 100,000,000 and that the mechanical shearing forces to which such an enormous molecule was subjected during even the mildest isolation procedure might degrade it. Estimates of the molecular weight of ribosomal RNA (*see* below) were of the order of 1,000,000. On the other hand, sRNA (*see* below) had a molecular weight of only about 25,000.

Occurrence.—All nucleated plant and animal cells and all microorganisms other than viruses contain both types of nucleic acid. In general, plant viruses contain RNA and most bacterial viruses DNA. Animal viruses may contain either RNA (*e.g.*, poliomyelitis virus) or DNA (*e.g.*, vaccinia virus).

As their name implies, nucleic acids were originally isolated from cell nuclei, and for many years it was assumed that they were not found elsewhere. This view was not seriously challenged until about 1940, when two new techniques were devised for investigating the structural elements of the cell.

The first of these was histochemical. Because of their content of purines and pyrimidines, nucleic acids absorb ultraviolet light very intensely at a wave length of about 260 mμ. Consequently if a histological tissue section is photographed in ultraviolet light of about this wave length (using a microscope with quartz lenses) the parts of the section that have a high concentration of nucleic acids can be identified as dark areas in the photograph. This method does not distinguish between DNA and RNA but this distinction can be made by using specific histochemical reactions.

The results obtained by these methods may be summarized as follows: All cell nuclei contain DNA and except in a few special cases DNA is not found outside the nucleus. During cell division DNA is found only in the chromosomes. Most of the RNA of the cell is found in the cytoplasm but a small proportion can be demonstrated in the nucleus, especially in the nucleolus.

The second main technique for elucidating the chemistry of cell structure has been the isolation of cell components such as nuclei and mitochondria in sufficiently large amounts to allow them to be subjected to chemical analysis. The principle of the method is to break up cells mechanically (or by ultrasonic vibration) in an aqueous or (more rarely) an organic solvent. The resulting suspension of cell debris is then sedimented in the centrifuge. By varying such conditions as the density of the medium and the speed of the centrifuge it is possible not only to isolate the cell nuclei in bulk but also to separate the cytoplasmic debris into several fractions that can, by electron microscopy, be identified with particular structures in the intact cell. This technique has been applied successfully to a variety of plant and animal tissues and to microorganisms. Analysis of fractions isolated in bulk in this manner has confirmed that DNA is found only in the nuclei, which also contain a small amount of RNA. The bulk of the RNA (80%–90%) is found combined with protein in the ribosomes. The ribosomes, which are granules dense to electrons and measuring 10 to 20 mμ in diameter, are found attached to the endoplasmic reticulum in the intact cell. A lesser amount of RNA (the so-called sRNA) is found free in solution in the cell sap. The RNA content of the mitochondria is almost negligible.

Biochemical Functions of Nucleic Acids.—*Genetic.*—The universal distribution of the nucleic acids suggests that they must play some essential role in biochemistry. Since DNA is invariably a constituent of the chromosomes and since it is so seldom detected anywhere else in the cell, it seems reasonable to suppose that it may be involved in the mechanism of inheritance (*see also* GENE; GENETICS, HUMAN). The first direct evidence on this question was obtained from studies on bacteria. It has been known for many years that the pneumococci may be classified into a number of strains or types, each characterized by the production of a serologically and chemically specific capsular polysaccharide. The type to which an individual cell belongs appears to be determined by its genetic constitution; the type does not change spontaneously during the life of the cell and at cell division it is passed on to the daughter cells. If, however, a culture of, say, type II pneumococci is treated with an aqueous extract prepared from pneumococci of, say, type III under suitable conditions, some of the cells will lose their capacity to synthesize type II polysaccharide and will acquire the capacity to synthesize type III polysaccharide. By this means pneumococci of any given type may be transformed to any other type by treatment with an aqueous extract of cells of the second type. Such transformed cells show no tendency to revert spontaneously to their original

type, nor do their descendants. It appears, therefore, that transformation involves a change in the genotype of the cells. For this reason transformation has been termed a directed mutation. The active principle of the aqueous extracts that bring about such transformations in pneumococci has been shown to be DNA of high molecular weight. Similar transformations have been demonstrated in a variety of bacterial species, notably *Haemophilus influenzae* and *Escherichia coli*. These alterations have not been limited to changes in cell type or serological character but have included changes in resistance to drugs and capacity to synthesize specific enzymes. In each case the new characteristic acquired by the transformed cell is induced by DNA obtained from a strain of cells of the same species that already possess the characteristic. It would appear, therefore, that the hereditary chemical characteristics of one bacterial cell can be transferred to a second cell of the same species in the form of DNA. This generalization has led to the conclusion that the hereditary characteristics not only of bacterial cells but of cells in general are determined by the DNA they contain; in other words, that DNA is the biologically active material of the gene.

Control of Cell Activities.—Evidence that DNA can profoundly influence the activities of the cell in a specific direction has also been obtained from the study of the DNA-containing viruses, in particular the bacteriophage T2, which infects *E. coli*. Each particle of this virus appears to consist of a DNA core completely surrounded by protein. In the process of infection the particle adheres by means of its protein to the surface of the bacterial cell. The phage DNA then enters the cell, in which it initiates the synthesis of new phage particles. This synthesis is accompanied by rapid and extensive changes in the metabolism of the host cell. The normal synthesis of respiratory and adaptive enzymes, and of RNA, ceases. DNA synthesis continues, but the DNA formed is typical not of the host but of the infecting phage and is characterized by its content of hydroxymethylcytosine, a pyrimidine never found in the DNA of normal *E. coli*. An even more remarkable phenomenon is that a strain of *E. coli* normally incapable of thymine synthesis will begin to produce this pyrimidine as soon as it is infected with phage. All these changes appear to be brought about only by the DNA of the phage. The phage protein appears to take no part in the changes and throughout them remains attached to the exterior of the host cell. If the phage protein is removed from the cell wall after the DNA enters the cell, the production of new phage particles and the concomitant changes in the metabolism of the host continue unaffected. The process of phage infection seems to consist essentially in the transfer of control of the cell from its own DNA to the DNA of the phage. The protein of the phage seems to serve only the quite subsidiary role of protecting the phage DNA and injecting it into the host cell in an active form. A capacity for directing the activities of the cell seems to be characteristic of RNA as well as DNA. Free RNA isolated from tobacco mosaic virus is capable by itself of infecting tobacco plants with mosaic disease and causing the plant cells to support the production of complete virus particles. Here again the protein of the virus seems to serve a completely subsidiary role, perhaps simply as a protective coat to preserve the nucleic acid from inactivation. Similar infective properties have been demonstrated in purified RNA from a wide variety of RNA viruses (*e.g.*, poliomyelitis virus) and in purified DNA from the bacterial DNA virus ϕX 174.

The evidence from viruses therefore indicates that in spite of their chemical differences DNA and RNA are equally capable of assuming control of the activities of the cell. In the normal, uninfected cell, however, this control seems to be vested entirely in DNA.

Certain other characteristics of DNA metabolism seem consistent with this conclusion. In general the amount of DNA per set of chromosomes is remarkably constant for all the cells of any given species, regardless of tissue. This is what one would expect since each set of chromosomes contains the same amount of genetic instructions or information. Again the DNA of the cell, unlike most other cell constituents, is not continually being broken down and replaced. Within the limits of the techniques available, it appears that DNA synthesis takes place only in preparation for chromosome reduplication (*e.g.*, at mitosis) and that once DNA is synthesized it does not break down during the life of the cell.

Structural Basis of Control and Duplication.—At first sight DNA might seem an unlikely candidate for the role of controlling the activities of the cell since it is built up from only four different kinds of deoxynucleotide unit and since these are always linked together in the same way to give a long unbranched polynucleotide chain. Clearly one such chain can differ from another only in the number of each type of nucleotide it contains and in the sequence in which the nucleotides are arranged. It follows therefore that whatever instructions the DNA molecule may contain about the activities and capacities of the cell must be recorded in some sort of "code" expressed in the sequence of bases along its length. Moreover, by definition this set of instructions must be duplicated precisely and completely every time a cell divides in order that the daughter cells may inherit the characteristics of the parent. In other terms, there must be some mechanism by which the order of bases in an existing DNA chain is exactly copied in a new DNA chain.

The probable mechanism by which this is brought about was elucidated from a study of the structure of the DNA molecule. On the basis of nucleotide composition, physical properties and, in particular, X-ray crystallography (M. H. F. Wilkins), the DNA molecule is believed to consist of two deoxypolynucleotide chains running parallel to one another but in opposite directions. The bases in each chain are so arranged that an adenine in one chain is always opposite a thymine in the other and vice versa; and a guanine in one chain is always opposite a cytosine in the other and vice versa (*see* fig. 5). The two chains are held together by hydrogen bonding between these base pairs. The chains are not straight but are twisted into a regular double helix (*see* fig. 6) and the pairs of bases lie at right angles to the helix, like the steps of a spiral staircase (J. D. Watson and F. H. C. Crick).

Duplication.—A molecule of this sort, in which each strand is the exact complement of the other, could be duplicated in the manner shown in fig. 7. For convenience only a very short length of the molecule is shown and the representation is purely diagrammatic; nucleotides are indicated by their initial letters. It is necessary to suppose as a first step that the relatively weak hydrogen bonds linking the two strands can be broken and that somehow the strands can be separated (fig. 7[b]). In the second step (fig. 7[c]) each base in either strand must be supposed to bind to itself the complementary free deoxymononucleotide by the same pattern of hydrogen bonds that existed in the original intact molecule. The third step would be the polymerization of these attached deoxymononucleotides to give two new polynucleotide strands, each strand exactly complementary to the old one on which it was formed (fig. 7[d]). The result of the entire process is that the original DNA molecule is replaced by two molecules, both identical with their progenitor and both containing one strand derived from it and one strand newly synthesized (*see* fig. 7[a and d]).

The actual process of DNA formation can be demonstrated in the test tube using an enzyme prepared from microorganisms or from animal tissues. The deoxymononucleotides to be converted into DNA must be in the form of the nucleoside triphosphates instead of the monophosphates and the reaction can be represented as follows (Arthur Kornberg):

$$\text{nucleoside triphosphates} \rightarrow \text{DNA} + \text{inorganic pyrophosphate}$$

Since the synthesis in vitro will take place only in the presence of an existing DNA molecule acting as primer, and since the synthetic DNA formed in the reaction has a nucleotide composition similar to that of the primer, it seems reasonable to conclude that the latter is acting as a template for the synthesis in the manner postulated above. Moreover, DNA in which the double helix arrangement has been broken up by heating in solution to a temperature sufficient to rupture the hydrogen bonds seems to be particularly effective as a primer.

In vivo also, DNA synthesis seems to follow the sort of mecha-

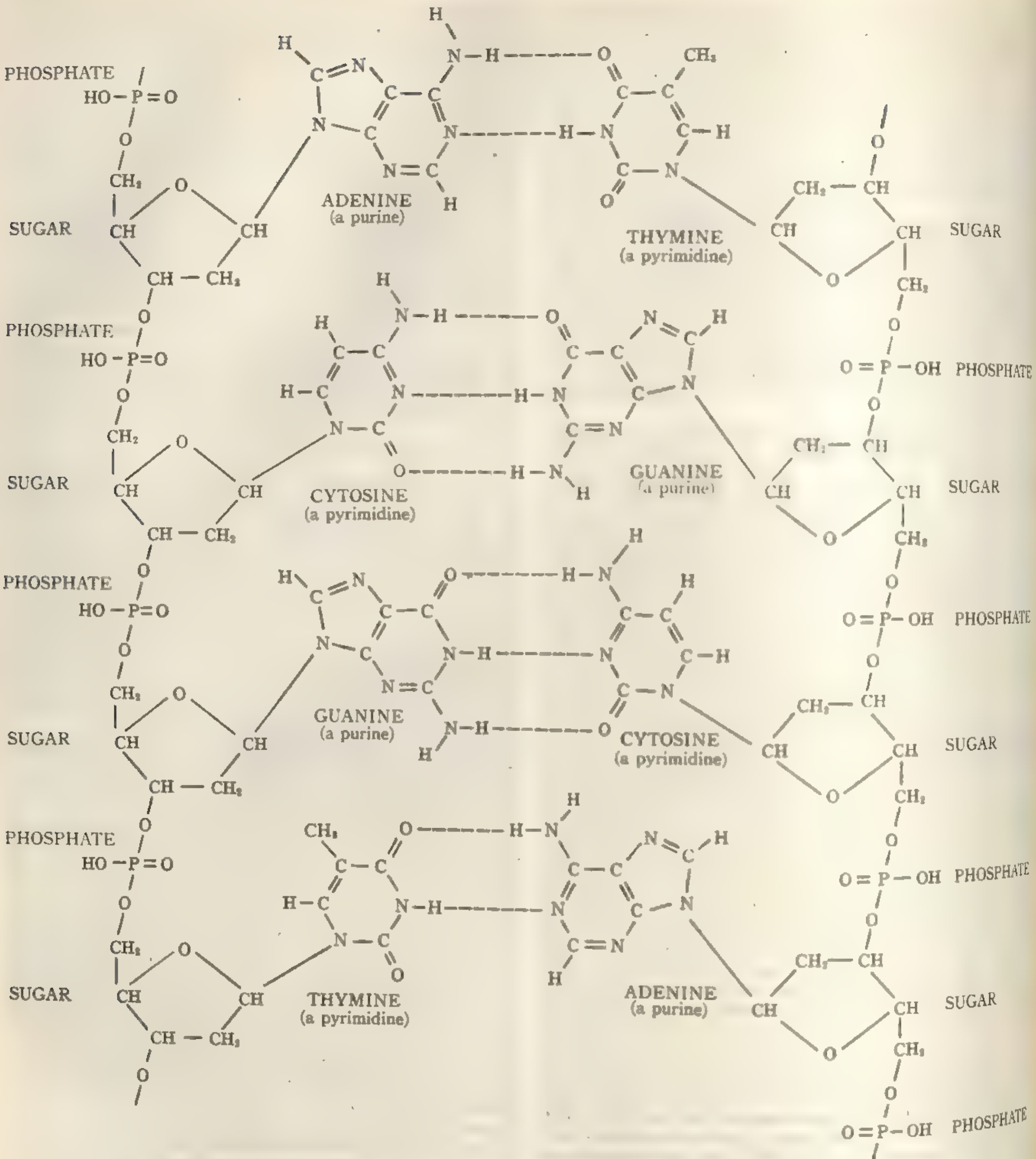


FIG. 5.—DIAGRAM OF SECTION OF DNA MOLECULE SHOWING PAIRING OF BASES ON PARALLEL POLYNUCLEOTIDE CHAINS

nism described above, since it can be shown by isotope methods that when new DNA molecules are formed they consist of two subunits, one derived from an existing DNA molecule and the other newly synthesized.

Determination of Protein.—The biological role postulated for DNA implies not only that it must be capable of exact reproduction but also that it must have an effective mechanism for determining the activities of the cell. Studies of the biochemistry of genetics have indicated that in the first instance this control is probably achieved by determining the nature of the proteins, particularly the enzymes, that the cell can synthesize. Proteins are exceedingly complex in structure. Not only are they built up from an average of 200 units of at least 20 different types of amino acid but the polypeptide chains in which these are arranged are twisted into precise and elaborate geometrical arrangements.

As a first approximation, however, it seems reasonable to suppose that the most important feature of protein structure is the number of different types of amino acid in the polypeptide chain and the order in which they are arranged (*see* PROTEINS: *Structure of Protein*). The fact that this arrangement is under detailed genetic control has been strikingly demonstrated by the study of the occurrence of certain abnormal hemoglobins in man. The ability to synthesize these is genetically determined in accordance with the classical Mendelian principles, yet by chemical analysis it has been shown that the abnormal hemoglobins may differ from normal hemoglobin in only one of the approximately 300 amino acids of the molecule. Presumably, therefore, the sequence of amino acids in the polypeptide chain of a protein synthesized by a cell depends ultimately on the sequence of nucleotides in the DNA of one of the cell's chromosomes.

A crude and admittedly tentative picture of how the sequence of amino acids is determined can be put forward. Since about 1940 it has been known that cells that synthesize a great deal of protein either for their own growth (*e.g.*, in embryonic tissues) or for secretion (*e.g.*, in the pancreas) have a high content of RNA. The tissue fractionation technique described above has shown that most of the RNA is in the ribosomes but that some of the remainder, the sRNA, is in solution in the cell sap. This sRNA has the remarkably low molecular weight of about 25,000, which is equivalent to about 80 nucleotides. These are apparently arranged in a single chain looped back on itself to give a short two-stranded structure. Under appropriate conditions an amino acid molecule can be attached to the ribose of the last nucleotide of the chain. The amino acid is first activated so that it forms its acyl anhydride in combination with the mononucleotide adenosine monophosphate thus:

amino acid + adenosine triphosphate
$\rightarrow$ amino acyl adenosine monophosphate + inorganic pyrophosphate

The adenosine monophosphate is then replaced by sRNA:

amino acyl adenosine monophosphate + sRNA
$\rightarrow$ amino acyl sRNA + adenosine monophosphate

These reactions are catalyzed by the same enzyme. There appears to be a separate activating enzyme and a separate species of RNA for each of the 20 amino acids involved in protein synthesis. The sRNA molecules, each with its attached amino acid, are then taken up by the ribosomes and it is there that the actual process of protein synthesis takes place. It is thought that the amino acids are aligned in the correct order because of some correspondence between the small sRNA molecules (transfer RNA) to which they are attached and the RNA (messenger RNA) of the much larger ribosome particle. Possibly the individual sRNA molecules may be complementary in their sequence of bases to particular sites in the ribosomal RNA and may be capable of specific combination with these sites, perhaps by the same sort of hydrogen bonding as holds the two strands of the DNA molecule together.

A mechanism of this sort implies that the type of protein synthesized depends on the nature of the RNA of the ribosomes; *i.e.*, on its base sequence. It follows, therefore, that the control of protein synthesis by DNA must be exerted by the DNA determining the base sequence in at least part of the ribosome. There is evidence that this may be brought about by the so-called messenger RNA. This is a relatively small fraction of the RNA of the cell that is rapidly synthesized and equally rapidly destroyed.

In the synthesis of RNA, DNA (in single stranded form) is thought to act as primer and the mechanism of synthesis is believed to be analogous to that of DNA so that the nucleotide sequence of the newly synthesized RNA corresponds to that of the DNA primer. Using purified enzymes it can be shown in the test tube that RNA synthesis can be "primed" by DNA and that the product of the synthesis has a nucleotide composition corresponding to that of the DNA primer (the uracil of the RNA being taken as equivalent to the thymine of the DNA). Again there is evidence that when a bacterial cell is infected by a DNA virus one of the first consequences is the synthesis of a new messenger RNA corresponding in base composition to the DNA of the virus and that this new messenger RNA is taken up by the ribosomes and it determines the nature of the proteins that are to be synthesized. It seems reasonable to assume that in the normal cell the DNA controls protein synthesis by a similar sort of mechanism.

FIG. 6.—DIAGRAM INDICATING DOUBLE HELICAL STRUCTURE OF NUCLEIC ACIDS

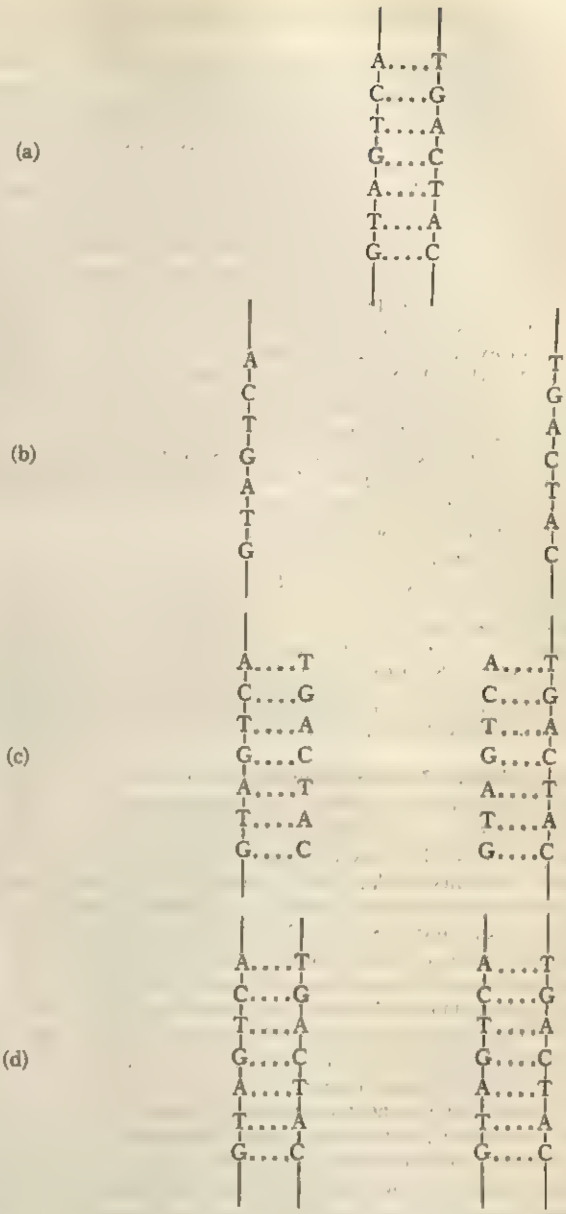


FIG. 7.—SKETCH SHOWING POSSIBLE DUPLICATION METHOD

Proteins and the Genetic Code.—If protein synthesis is accomplished by a mechanism of this sort, there must be some sort of relationship between the sequence of bases in the DNA (and messenger RNA) and the sequence of amino acids in the protein produced. Since DNA and RNA are built up from only four different types of nucleotide whereas proteins are built up from about 20 different types of amino acid, it follows that each amino acid in the protein chain must be represented in the nucleic acid chain not by a single nucleotide but by a group of nucleotides. The nature of this code by which amino acids are represented is still the subject of speculation. It seems likely, however, that if each amino acid is represented by a specific group of nucleotides

there must be three nucleotides or a small multiple of three in each such group.

Some information about the code has been obtained by making use of synthetic polynucleotides (Severo Ochoa) as messenger RNA. Such synthetic polynucleotides can be added in the test tube to a system containing ribosomes, sRNA and the enzymes and cofactors necessary for protein synthesis. By comparing the composition of the synthetic polynucleotides with the relative proportions of the different amino acids taken up by the ribosomes it is possible to deduce a tentative relationship between the nucleotides of the messenger RNA and the protein synthesized. For example, if a synthetic polynucleotide consisting solely of uridine nucleotides is tested in this way it is found that the ribosomes take up an exceptionally large amount of the amino acid phenylalanine (Marshall W. Nirenberg and J. Heinrich Matthaei). From this it is concluded that phenylalanine must be represented in the code by a group of uridine nucleotides (presumably three). By similar arguments groups of nucleotides have been provisionally assigned to all 20 amino acids. These details were speculative and controversial in the early 1960s but the general correctness of the scheme seemed to be well established.

See also references under "Nucleic Acids" in the Index.

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(J. N. D.; R. Y. T.)

NUCLEUS. In animals and higher plants a nucleus is that portion of the cell containing the hereditary materials (chromosomes, genes) and a nucleolus. It is discussed in the article Cell. This article deals with the nucleus of the atom, a particle of very small radius and exceedingly great density located at the centre of the atom. All but a negligible fraction of the atomic mass is concentrated in the nucleus. At the same time the size of the nucleus is more than 100,000 times smaller than the size of the atom. The approximate size of the atom, in turn, is a few 1,000,000,000ths of an inch (*i.e.*, one, two or three times 10^{-8} cm.). The nucleus carries a positive electric charge that is an integral multiple of the elementary charge (whose magnitude is 4.8×10^{-10} electrostatic units).

By the mid-1960s understanding of the nature of atomic nuclei had reached the point where radical changes were being felt in the personal, social, economic and political lives of people throughout the world. In medicine, diagnostic and therapeutic methods employing particles derived from atomic nuclei increasingly were being used; improved new varieties of food plants and animals were being produced with nuclear techniques (*see* Radiation: Biological Effects).

Ancient aims of alchemy (*q.v.*) to achieve transmutation of chemical elements finally were being realized as methods for manipulating the constituents of atomic nuclei developed. Enormous energies that bind these constituents together were being released to revolutionize methods of warfare, and were being controlled to fuel ships and illuminate cities. The dominance of any nation in international politics was beginning to hinge on the skill of its scientists and technicians in dealing with the atomic nucleus. The discussion that follows summarizes the principles and discoveries of nuclear physics that underlie these world-wide changes.

The discussion of the atomic nucleus to follow is organized as follows:

I. Description and History
II. Detection of Nuclear Processes
III. Constituents of the Nucleus
IV. Nuclear Energy
V. Further Properties of Nuclei
VI. Beta Decay
VII. Alpha Decay and Spontaneous Fission
VIII. Metastable Nuclei
IX. Nuclear Reactions
X. Summary of Nuclear Properties
XI. Nuclear Structure and Nuclear Forces
XII. Energy Production in Stars
XIII. Utilization of Nuclear Energy
XIV. High-Energy Experiments on Nuclei

I. DESCRIPTION AND HISTORY

The first clear evidence about the internal structure of the atom was obtained by E. Rutherford in 1911. He was led by his experiments to assume that atoms consist of a nucleus, as described above, and a number of electrons. These electrons carry a negative elementary charge (of magnitude 4.8×10^{-10} electrostatic units) and they have a mass which is a small fraction of the atomic mass. (The fraction representing the total weight of the electrons in the atom to the atomic weight is $\frac{1}{1,840}$ in the case of hydrogen, the lightest element, or $\frac{1}{4,700}$ for uranium, a typical heavy element.) The number of electrons in the atom is equal to the number of positive charges the nucleus carries so that the atom as a whole is neutral. The atomic number and the designation Z are used for either of these quantities. All chemical and most physical properties of atoms are determined, apart from exceedingly small variations, by the atomic number Z. Atoms having a given Z value form an atomic species. For example, if the nucleus has one unit of charge and one electron is present we have a hydrogen atom. As further examples, nuclei with 2, 6, 26, 79 and 92 charges may be mentioned; the corresponding atoms have 2, 6, 26, 79 and 92 electrons and the atomic species are helium, carbon, iron, gold and uranium, respectively. The chemical transformations, the appearance and common behaviour of materials built from the atoms depend only on the configuration of the electrons. This is influenced, in turn, only by the nuclear charge and is practically independent of other properties of the nucleus. The atomic properties are discussed in detail in Atom. In the following the interest is in the central particle; *i.e.*, the nucleus.

Formerly it was believed that atoms were immutable entities. This statement did not imply that the configuration of the electrons in the atoms could not change. It was, indeed, soon recognized that chemical changes are caused by the rearrangement of the electrons. As long as the charge of the nucleus has remained the same, however, the atom is considered unchanged. No matter what deformation occurs in the electron arrangement, it will always return to the normal configuration as soon as the disturbing force is removed.

In 1896 A. H. Becquerel noticed that uranium emits unusual radiations, designated as radioactivity. In the next few years the work of Marie and Pierre Curie, E. Rutherford, F. Soddy and others led to the recognition that the phenomenon had to be explained by a spontaneous, permanent and intrinsic change of the atomic species (*see* Radioactivity). In uranium this is brought about by the emission of a particle from the nucleus which carries away two units of positive charge and which is called an α-particle (alpha particle). Thus the uranium nucleus, originally containing 92 units of charge, disintegrates into a nucleus containing 90 units of charge. This nuclear charge characterizes a different atomic species, thorium. These phenomena will be discussed later in the section on α-decay. The emitted particle has a very high velocity, as much as the 20th part of the greatest possible velocity, that of light. Thus a much larger kinetic energy is concentrated on the α-particle than was ever before found on a body of comparable mass. Actually the α-particle is the nucleus of the helium atom (*see* Alpha Particles).

In the hands of Rutherford these α-particles became powerful tools in exploring the interior of the atoms. In experiments published in 1911 Rutherford showed that the majority of particles pass through thin (of the order of $\frac{1}{10,000}$ in.) but solid foils without being deflected. A few α-particles were scattered through quite large angles. These observations could be explained by assuming that the α-particles had collided with heavy, charged particles, the atomic nuclei. The greater number of small deviations were the result of distant collisions; *i.e.*, of forces acting between two particles which did not approach closely. The large deflections were caused by the larger force of two charged particles more nearly in contact. In order to account for the large number

of undeviated particles, the nucleus had to be given a radius small compared with that of the atom. Rutherford assumed that the charge of the nucleus is positive and that the remainder of the atom consists of the light negatively charged electrons.

Collisions between the α-particles and the electrons are much more frequent than the noticeable collisions between α-particles and nuclei, but because of the small mass of the electron these collisions do not result in an observable deflection of the α-particles. Rather they cause a gradual loss of energy of the α-particles. The distance through which the particle travels before it loses all of its available energy is called the range of the particle. The range depends, in general, on the initial energy of the particle, on its charge, its mass and on the density of the electrons with which it can collide. The hypotheses which Rutherford made to explain his experiments have been fully verified by the experimental and theoretical studies of atomic and nuclear physics.

In 1919 Rutherford observed that nitrogen bombarded by α-particles emitted a new product. This turned out to be a nucleus of the hydrogen atom, which is called a proton, carries a single unit of positive charge and is the simplest of all atomic nuclei. The reaction was produced by a close collision of the α-particle and the nucleus of the nitrogen atom, which carries seven positive charge units. The α-particle attached itself to the nitrogen nucleus, producing a so-called compound nucleus of high internal energy. From this structure the fast proton is subsequently emitted. The actual time for the emission is an exceedingly small fraction of a second (*see* PROTON).

The result of this nuclear reaction is that the nitrogen nucleus, having absorbed the α-particle with two positive charges and having emitted a proton carrying only one positive charge, has now turned into an oxygen nucleus. In this way Rutherford's experiments accomplished the transmutation of nitrogen atoms into oxygen atoms. At the same time the bombarding helium nuclei were transformed into hydrogen nuclei. In the process the kinetic energy of the system had also changed. The final particles contained less energy than the original helium nuclei.

Rutherford's experiments also explained why the transmutation of elements could not be accomplished by the previously used methods of chemistry and physics. Artificial change of nuclear charge requires a nuclear reaction induced by the close contact of two atomic nuclei. Because of the strong electrostatic repulsion of the positively charged nuclei, sufficiently close contacts can occur only if the nuclei approach each other with a high initial velocity. The required high velocities do not occur in chemical processes and thus the endeavour of the alchemists to transmute elements by chemical means was doomed to failure. As soon as methods and techniques specialized in the production and observation of high-velocity particles were developed, transmutation of atoms could be observed.

The study of atomic nuclei remained a field sharply separated from the investigation of atoms and from other branches of chemistry and physics. The reason for this is twofold. First, the details of nuclear structure influence the properties of the atom as a whole and the properties of matter in bulk to an exceedingly small extent.

Thus the study of the structure of matter could proceed without detailed knowledge of the atomic nucleus. Second, the internal behaviour of nuclei can be influenced only when energy is present in very high concentrations. The required high energies are carried by α-particles such as were used in Rutherford's experiments. In chemical and most physical processes, however, the concentration of energy is not high enough to influence the behaviour of nuclei to a noticeable extent. Thus, nuclear processes occur, so to speak, in a world of their own and unusual special methods must be devised to penetrate into this world.

For several years following the publication of these first experiments on nuclear transmutations, radioactive materials occurring in nature remained the only source of high-energy particles. The study of nuclear processes was handicapped by the relatively small number of particles these sources made available to the experimenter. Observations had to be made over quite long periods of time and results had to be based on the observations of relatively few processes. Nuclear scientists therefore made every effort to produce similarly fast particles by artificial means. The first machine to do this was the cascade transformer of C. C. Lauritsen, H. Crane and others which was completed in 1928. This was followed by the machine of J. D. Cockcroft and E. T. S. Walton in 1929 and the electrostatic generator of R. J. Van de Graaff in 1931. These machines are called linear accelerators, a term derived from their common fundamental principle. The charged particles, such as protons or α-particles, are introduced at one end of a cylinder containing a very strong and extended electric field. As the particles move through the field they are continuously accelerated. In order that no energy should be lost by collisions with atoms, the cylinder is evacuated. The fundamental principle of these machines is the method by which the necessary electric fields are obtained.

Another principle was used in the cyclotron (E. O. Lawrence, 1932, *see* ACCELERATORS, PARTICLE). In this machine particles are confined by a magnetic field to a spiral-shaped orbit and accelerating electric fields are repeatedly applied while the particles are moving along this orbit.

The betatron (D. W. Kerst, 1940) is similar to the cyclotron in that the particles are confined by a variable magnetic field. The acceleration, however, is accomplished by the principle of induction. According to this principle, increase of current in one coil induces an opposite current in a coaxial coil. In the betatron a change of current in a coil causes an acceleration of electrons which do not move in a second coil but rather in free space. An important practical difference between the cyclotron and the betatron is that the former is used to accelerate atomic nuclei while the latter accelerates electrons.

After 1945 improvements in all these machines became possible through closer control of the electromagnetic fields which are used to confine and accelerate the particles. In some of these, electrons or nuclei are accelerated in straight lines (L. W. Alvarez, acceleration of protons, 1946; H. H. Hansen, acceleration of electrons, 1948). Acceleration is achieved by the continuous action of an accelerating field which moves along with the accelerated particle. A machine of the cyclotron type is the synchrotron (E. M. McMillan and V. I. Veksler, 1945) for the acceleration of electrons. In this machine electrons are kept in a circular orbit by a changing magnetic field and the acceleration is accomplished by repeated application of an electric field near a certain point in the orbit of the electrons. By a close correlation between the changing magnetic field and the period in which repeated accelerations are applied (synchrocyclotron), it became possible to accelerate nuclei to very high energies; the highest energy reached in the early 1960s was in the proton accelerator at Brookhaven National laboratory, Upton, N.Y. The energy obtained was approximately 8,000 times higher than the energy of the α-particles of uranium.

These high-voltage machines were capable of producing a considerable number of nuclear reactions which were, in principle, analogous to the reaction studied by Rutherford in 1919. In some of these reactions energy was released, in others energy was absorbed, but in all cases the energy changes were great compared with the energy changes involved in chemical reactions.

In 1932 Irène Curie and F. Joliot discovered that by nuclear reactions radioactive nuclei can be produced. In their experiments they used, like Rutherford, α-particles. With these they bombarded boron atoms, whose nuclei carry five elementary charges. The resultant nucleus contained two more charges and was therefore a sevenfold charged nucleus, or a nitrogen nucleus. This nitrogen nucleus differed from all nitrogen nuclei found in nature in that it emitted a particle called the positron. This particle is similar in all respects to the electron discussed above except that it carries a positive rather than a negative charge. In the following years a great number of radioactive nuclei were produced. Many of these emit positive electrons like the nitrogen nucleus just described, others emit the more common negative electrons. Radioactivities of this type are called β-activities, and the positive or negative particles emitted by the nuclei are called β-rays. (*See* RADIOACTIVITY.) Actually β-radioactivity was discovered practically simultaneously with α-activity, but up to 1932 only

a few naturally occurring β-activities were known. All elements can be obtained in a radioactive form.

Considering the great energy release which was frequently encountered in nuclear reactions, the question arose whether it would be possible to utilize this energy. This was not possible for the following reason: in order to release nuclear energy one had to start with highly energetic particles. Most of these particles, if they impinge on a piece of matter, will not get close to nuclei and will not produce reactions but will instead squander their energy by making collisions with light electrons. In this way the originally concentrated energy of the particles will ultimately be transformed into heat. Only a small fraction, less than $\frac{1}{100}$ of 1%, of the originally fast particles get close enough to an atomic nucleus to produce a nuclear reaction. In these rare instances the nuclear energy may be greater, sometimes even 10 or 100 times greater, than the energy of the impinging particle but since these processes occur only rarely, the net gain in energy is small. The bombardment of a piece of material by a stream of energetic, charged particles will thus produce a heating of the bombarded sample which is only slightly increased by the reactions occurring in the sample. Considering the exceedingly high cost of the original source of energy, the actual slight energy production could not be considered as a practical source of power.

A great number of additional nuclear transformations became possible in 1932 when J. Chadwick discovered the neutron (*q.v.*). This particle has a mass which is very slightly in excess of the mass of the hydrogen nucleus, or proton. In contrast to the proton, however, it carries no charge and is the only known nuclear particle that is neutral. Consequently the neutron does not attract any electrons and does not have the property of other nuclei of surrounding itself with an extended electron configuration. Thus one of the striking properties of the neutron is that it may penetrate almost freely through several inches of solid materials, being influenced in its path only whenever it touches an atomic nucleus.

The fact that neutrons are not charged gives rise to a second important consequence. This is that neutrons can approach any nucleus without being repelled by the charge on the nucleus. Therefore a neutron need not have a high velocity, or a high energy, in order to cause a nuclear reaction. Unlike the charged particles the neutrons can approach with equal ease such nuclei of small charge as those of nitrogen or such nuclei of high charge as those of gold or uranium. This fact was utilized by many investigators following 1932 to explore a great number of nuclear reactions. E. Fermi and his collaborators in Rome, Italy, were by far the most active and successful workers in the field.

The fact that a neutron need not have high energy for it to approach a nucleus reopens the question of whether nuclear reactions can be used to produce useful power. Unfortunately neutrons could be produced only in reactions in which fast particles were involved. A typical example is the reaction described above in which a fast α-particle impinges on a boron nucleus and forms a radioactive nitrogen nucleus. In this reaction a neutron is also ejected. In the final analysis this neutron represents as costly an investment of energy as the fast particle itself and practical power production by this means seems to remain unattainable.

Actual utilization of nuclear energy on a large scale became a concrete possibility at the end of 1938 when O. Hahn and F. Strassmann in Berlin, Ger., discovered uranium fission. These investigators made a careful study of the artificial radioactive substances that were obtained when neutrons impinged on the uranium nucleus. Fermi and his collaborators had noticed several years earlier that when a uranium nucleus is hit by a neutron, a variety of radioactive substances are produced. At that time the reaction was not understood. Hahn and Strassmann specifically identified barium in the bombarded uranium target they were studying. To explain the presence of this much lighter element a very violent reaction must have occurred in the uranium nucleus. It was concluded that the nucleus of uranium, because of its large size and the repulsion of its many positive charges, is on the verge of disintegration. The additional energy brought into the nucleus by the neutron is sufficient to make the nucleus break apart. The process is called the fission of the nucleus. The electrostatic repulsion of the product nuclei at the instant of fission makes them fly apart with great velocity and an amount of energy unusually large even in the scale of nuclear energies. This splitting of the uranium nucleus can occur in a number of ways, giving a variety of pairs of disintegration products. These nuclei, which are unstable and disintegrate by β-particle emission, add to the energy liberated by the reaction. The above conclusion was reached and verified experimentally by several scientists. The first of these were O. Frisch and L. Meitner in Copenhagen, Den.

It was further guessed that neutrons are liberated in fission making possible a chain reaction. If, for instance, 2 neutrons were emitted, these could react with uranium nuclei producing 4 neutrons. These would multiply to 8, then to 16 and so on. In a few steps the number of neutrons will become extremely large, the reaction is accelerated and energy is liberated at an ultimately explosive rate. Later in 1939 L. Szilard, F. Joliot and others experimentally verified the liberation of a sufficient number of neutrons. This was the necessary proof of the feasibility of a chain reaction and work was begun on producing such a reaction. To control the chain reaction means, first, to allow neutrons to multiply and, subsequently, to strike a balance of neutron production and neutron absorption so that the number of neutrons just maintains itself and does not grow to explosive proportions. This was first achieved under the guidance of E. Fermi on Dec. 2, 1942, at The University of Chicago. Subsequently, many additional nuclear reactors were built, all based on the principle explained above. Some of these reactors liberate considerable amounts of energy and progress has been made toward transforming this energy into useful power.

In 1942 the development of the explosive aspects of the nuclear chain reaction was undertaken by a group headed by J. R. Oppenheimer. On July 16, 1945, the first so-called atomic bomb was exploded in the desert near Alamogordo, N.M. Afterward, two atomic bombs were exploded over Japan. In the following years numerous tests of atomic bombs were carried out by U.S. scientists in the Pacific and Nevada, by Soviet workers; and by a British group in Australia. In later tests (in particular the U.S.S.R. test of 1953 and the U.S. tests of 1951 and 1952), the explosion was based in part on the building up of light nuclei. The nuclear reaction involved in that case is the fusion of small nuclei into larger units rather than the fission of the heaviest nuclei into two parts. The fusion reaction is most easy if hydrogen nuclei are involved which carry only a single unit of charge and if the temperature in the reaction is extremely high so that charged particles can approach each other. The designations hydrogen bomb and thermonuclear bomb refer to the facts just mentioned. *See* ATOMIC ENERGY.

II. DETECTION OF NUCLEAR PROCESSES

When a nuclear reactor produces energy, and particularly when an atomic bomb explodes, the effects of nuclear processes are very noticeable, even without elaborate detecting devices. The energy released appears in the form of heat or, in the case of the atomic bomb, partly in the form of motion of air masses, light and other radiations. Some of these radiations are capable of ionizing and rearranging individual molecules. If that happens extensively in living tissue, radioactive burns result and the tissue may suffer serious damage (*see* RADIATION: BIOLOGICAL EFFECTS).

In the development of nuclear science, both past and future observations of an individual process are more important than the observation of the impressive phenomena that accompany the large-scale release of nuclear energy. Individual nuclear processes are observable, in fact, for two reasons. One is that particles participating in nuclear reactions as a rule have exceptionally high energy and are, for that reason alone, noticeable among the myriads of atoms of comparable size but much lower energy through which these nuclear fragments move. Another reason is that the effects of these fast particles can be amplified. Thus they can easily be detected by the use of suitable apparatus (*see* NUCLEAR INSTRUMENTS).

Any of the charged particles or electromagnetic radiations connected with nuclear reactions can produce an effect in a photographic plate similar to that of light. This effect essentially consists of producing disturbed grains in the photographic plate. These disturbed grains then are developed in subsequent chemical processes so that a deposition of metal big enough to be visible to the naked eye or under the microscope is formed at the position of the disturbed grain. The process of developing plays in this special instance the role of amplifying the original effect of the nuclear radiation. The characteristic property of nuclear fragments is their high energy by which they can activate a number of grains lying along a straight line. Use of photographic plates of various sensitivities and detailed study of the density of the excited grain and of the length of the track make it possible to recognize the kind and energy of the particles that cause the track. It is interesting to note that the blackening of a photographic plate by the faintly radioactive pitchblende started A. H. Becquerel in 1896 on the first investigation of a nuclear process. Half a century later the finer methods of observation described above made photographic plates most valuable tools of research in nuclear physics.

The Wilson cloud chamber, devised by C. T. R. Wilson in 1912, is a piece of apparatus especially designed for the detection of charged nuclear fragments (*see* CLOUD CHAMBERS). In its general principle of action it is similar to the photographic plate. In the latter nuclear radiations give rise to disturbed centres in the photographic emulsion. In the cloud chamber, α-rays or other fast charged particles form ions (*i.e.*, charged atoms or molecules) along their paths. The process of developing is replaced in the cloud chamber by a process of condensation. The cloud chamber contains a vapour, usually water vapour, which is maintained at a temperature just above the condensation temperature. Following the passage of nuclear particles, the cloud chamber is expanded and by this process the vapour contained in it is cooled so that condensation sets in. The water molecules are attracted to the ions which mark the trail of the fast particle. Thus a set of droplets is formed making the path of the particle visible. The process of amplification in this case is the growth of the droplets around the ions.

There is one method of observing nuclear particles without the use of an amplifying mechanism. This is the method of observing fluorescence or scintillations. Along the path of the fast particles atoms and molecules are not only ionized but also disturbed to various degrees. These atoms and molecules return to their normal states and in doing so emit light. The light effects produced in a suitable fluorescing material by a single α-particle are actually visible to the naked eye. These individual processes are called scintillations. It is remarkable that in a scintillation the effects of a single nuclear process can be seen directly without the use of intervening equipment. This is possible because of the great amount of energy of the α-particle and the extremely great sensitivity of the human eye. As a practical means of studying nuclear reactions the observations of scintillations were of great importance about 1920. The scintillation method, combined with sensitive apparatus for the detection and amplification of light, again proved of great usefulness.

Electrical apparatus may also be used to detect nuclear particles. In these detecting devices the ions produced by the nuclear particles are set in motion by electric fields. This can be done in a variety of ways. The field may be chosen relatively small and its effect may be merely to collect the ions on an electrode. In this case the resulting current is always so small that in order to observe it one has to amplify the current. This is done by equipment similar to the common radio receiving sets. If stronger fields are used to move the original ions, these ions may acquire enough energy to knock electrons out of other atoms or molecules, thereby producing more ions. In this way some amplification takes place immediately. This initial amplification might become so considerable as to develop into an actual discharge, as happens in the Geiger-Müller counter.

Electric detecting devices are particularly useful because of their great flexibility. They can be set in a way to become selectively sensitive to a specific particle. When arranged and coupled in an appropriate manner these electric devices can count particles of a specified energy. They can be used to study the coincidence in time of two processes. Therefore they can furnish the important information that two nuclear particles have been released in the same process. Finally, by automatic recording the number of various kinds of particles that have passed through a counter may be found.

While electric fields are most frequently used in collecting the ionized atoms along the path of a nuclear fragment, magnetic fields are frequently used to determine the exact speed and energy of the fragments. Simultaneous use of electric and magnetic fields gives important information to indicate the mass of the particle under study. This latter piece of equipment, the mass spectrograph, is not, properly speaking, an instrument of detection, but a precision instrument designed to measure one of the basic properties of nuclei (*see* MASS SPECTROSCOPY).

Among the nuclear fragments there is one which cannot be observed directly by any of the methods described above. This particle is the neutron. The detection of neutrons proceeds as a rule in an indirect way. The collisions of the neutron with atomic nuclei of various kinds produce fast, charged particles or electromagnetic radiation and either of these may be detected by one of the many methods that have been described.

III. CONSTITUENTS OF THE NUCLEUS

According to ideas in the 1960s the nuclei are built from two simpler particles, the neutrons and the protons. These two particles, which are considered the building blocks of nuclei, are also called nucleons. As has been mentioned above the protons carry the elementary charge (4.8×10^{-10} electrostatic units), whereas the neutrons do not carry a charge. Physicists introduce a special atomic mass unit (amu) that has $\frac{1}{12}$ the mass of carbon-12; 1 amu $= 1.6604 \times 10^{-24}$ g. Atomic weight tables based on carbon-12 show the following weights in amu: hydrogen 1.00797, the proton 1.00728, and the neutron 1.00867. These values can be expressed in grams if multiplied by the amu mass above.

In general a nucleus contains Z protons and N neutrons, where Z and N are integer numbers. The charge of the nucleus is Z times the elementary charge. It was pointed out in the first section that the atomic species is determined by Z alone. Nuclei of the same atomic species may, however, contain various numbers of neutrons. It is found, for instance, that hydrogen with Z equal to one may have N equal to zero, one or two. Such members of the same atomic species with different N values are called isotopes. It is customary to differentiate isotopes by a superscript equal to $Z + N$ following the chemical symbol of an atomic species. Thus the isotopes of hydrogen are H^1, H^2 and H^3. Frequently the Z value is indicated by a leading subscript (*e.g.*, ${}_1H^2$) but this subscript may be omitted since the chemical symbol also indicates the Z value. As further examples, the isotopes of oxygen may be mentioned, where Z equals 8 and N may be 6, 7, 8, 9, 10 or 11, and isotopes of uranium, in which Z is equal to 92 and N may have any value from 135 to 148.

Because isotopes have the same Z value and hence the same chemical behaviour, it is extremely difficult to separate them. Methods depending on the difference in mass, or N value, have been developed (*see* ISOTOPE) but these are much more expensive and less efficient than chemical processes.

The total number $(Z + N)$ of particles in the nucleus is called the mass number and is designated by A. The actual mass of a nucleus differs by a small amount from the sum of the masses of its protons and neutrons. It should be noticed that while the charge of the nucleus is exactly Z times the elementary charge, the mass of the nucleus is not obtainable in a similarly simple manner. A more detailed discussion of this remarkable fact will be given in the next section.

Among nuclei which contain few particles it is often found that the values of Z and N are nearly the same. Some of the most abundant isotopes found in nature such as ${}_2He^4$, ${}_6C^{12}$, ${}_7N^{14}$ and ${}_8O^{16}$ exhibit this phenomenon. As one goes to heavier nuclei the number of neutrons increases faster than the number of protons

in the nucleus. In uranium, for instance, the most abundant isotope has 54 more neutrons than protons.

In the 1960s there was no consistent theory to account for the forces which hold neutrons and protons together in the nucleus. To assure stability it must be assumed that these forces are in the main attractive. In the following there will be occasion to discuss some properties of these forces. Here it is sufficient to mention that these forces have extremely short range. The forces between neutrons and protons become negligible if the distance exceeds the order of magnitude of the nuclear diameter.

In addition to nucleons, that is, protons or neutrons, other particles are known to be emitted in nuclear transformations. Among these the α-particles and β-particles should be mentioned. These occur in the great majority of spontaneous nuclear disintegrations (spontaneous radioactivity) and historically they were the first to be observed. Nevertheless they are not considered to be primary constituents. In fact the α-particle may be considered to consist in turn of two protons and two neutrons, having a charge of two and a mass of approximately four units. The fact that α-particles so often occur as the product of nuclear disintegrations arises from the extraordinary stability of this particular arrangement of protons and neutrons.

The reason β-particles, which are either negative or positive electrons, are not considered regular constituents of the nucleus is more involved. According to the basic theory of atomic physics one cannot confine a particle of small mass, such as the electron, in a region as small as the nuclear radius without giving it an energy greater than the nuclear energy. In other words, the paradox occurs that the electron, if thus confined, must have an energy great enough to permit the particle to escape (*see* ELECTRON).

Nuclear theory describes the emission of negative or positive electrons as a process in which the negative or positive electron is created at the moment of emission. This concept becomes plausible when it is added that both the creation and annihilation of pairs of positive and negative electrons have been observed outside of nuclei. Thus these electrons cannot be considered immutable. Any attempt to assume the presence of these electron pairs in the nucleus leads to a complicated picture where any number of positive and negative pairs may be assumed to be present. In the accepted theory and for the following discussion, the presence of positive and negative electrons is ignored. Attention is confined to a model composed of neutrons and protons.

IV. NUCLEAR ENERGY

Observations of natural and artificial nuclear transmutations verify that the energies involved in nuclear reactions are of great magnitude. In fact, these energies are larger by a factor of 1,000,000 than the energies involved in chemical reactions. The neutrons and protons are bound together in nuclei about 1,000,000 times more strongly than atoms are bound together in chemical compounds or in the most stable crystals known. This great energy is closely associated with a general law of atomic physics according to which the binding or localization of a particle in a smaller region necessarily requires a greater binding energy.

The most direct way to measure nuclear binding energies is the study of nuclear reactions. Thus if one nucleus of the lithium isotope Li^6 is bombarded by a deuteron (the nucleus of heavy hydrogen H^2) two nuclei of helium are obtained. The reaction may be written similarly to an equation in chemistry:

$$Li^6 + H^2 \rightarrow 2He^4$$

To produce the reaction the bombarding deuterons must have enough kinetic energy to approach the lithium nucleus in spite of the electrostatic or coulomb repulsion of the two particles. The required energy is a few hundred thousand electron volts. (The electron volt, abbreviated ev, is the usual unit of energy in atomic and nuclear physics. It is the energy an elementary charge gains when it falls through a potential of one volt. One electron volt equals 1.6×10^{-12} ergs or approximately 1.5×10^{-18} of the work done in lifting a pound weight to a height of one inch.) The energy of the two resulting α-particles is equal to the energy of the deuteron plus an additional 22.17 million electron volts (Mev); *i.e.,* 22,170,000 ev. This difference in energy arises from the stronger binding of the neutrons and protons when combined in two helium nuclei, rather than in a lithium nucleus and a deuteron. The total binding energy of the helium nucleus compared with four free particles is 28 Mev or 7 Mev per particle. This is close to the largest binding energy per particle in any nucleus. The binding energy is a negative energy in the sense that one has to add energy to decompose a helium nucleus into neutrons and protons.

A determination of nuclear binding energies is often complicated because the reaction products have an excess internal energy, or excitation. The energy of excitation is retained by the nucleus for a very short time and then is emitted as γ-rays. These γ-rays are electromagnetic waves and are similar to light. There are, however, significant differences: γ-rays are emitted by nuclei, light is emitted by atoms; γ-rays carry away in a single process about 1,000,000 times more energy than light does; considered as a wave process, γ-rays have approximately 1,000,000 times shorter wave length than light. The most striking difference is that γ-rays are invisible though they produce physiological changes throughout the body, including the eye.

These γ-rays can enter actively into nuclear reactions. The absorption of γ-rays may excite a nucleus and furnish enough energy to disintegrate the nucleus. The most common result of such a disintegration is the splitting off of a neutron. If a nucleus of deuterium is bombarded by γ-rays with an energy of 2.2 Mev or more, the nucleus may distintegrate into a neutron and a proton, $H^2 + \gamma \rightarrow n^1 + H^1$. Since the energy of the γ-rays can be measured independently, this type of reaction furnishes an additional method for measuring binding energies. The reaction just described indicates a binding energy of 2.2 Mev for the deuteron.

The great amount of energy liberated in nuclear reactions makes it possible to use a method of energy measurement for nuclei which in other cases is impractical. The method of energy determination is based on a law obtained from theoretical arguments by Albert Einstein in 1905: whenever the energy of a system is changed, the mass is changed by a corresponding amount.

Energy changes in familiar objects are accompanied by exceedingly small changes in mass and, thus, the mass change postulated by Einstein was beyond observation. As an example consider a large spring weighing, say, 5 lb. and suppose a force of 3,000 lb. compresses the spring 6 in. The change of mass is 10^{-12}% of the mass of the spring. In chemical reactions the change in mass is a few orders of magnitude larger, but still too small for observation. Let us suppose a gram molecular weight (87.9 g.) of pyrite (FeS) is formed from iron and sulfur. The change in mass calculated from the heat energy released in the reaction, is 10.7×10^{-10} g. This corresponds to $\frac{1}{1,000,000,000}$ of 1% change in mass.

If now a neutron and a proton are considered as combining to form a deuteron, the energy liberated is 2.18 Mev per deuteron. This represents a difference in mass between the two particles when free and when combined in a deuteron of about a tenth of 1%. This difference is large enough to be measured accurately. Therefore, by reversing this procedure and measuring the difference in mass of separated and combined particles, the binding energy of the particles can be calculated. Thus the statement of the previous section, that the mass of a nucleus is not equal to the mass of the constituent particles, is explained by the mass change accompanying the energy change.

The relationship between mass and energy changes stated by Einstein may be written:

$$\Delta E = \Delta mc^2$$

where ΔE is the energy change expressed in ergs, Δm is the accompanying change of mass given in grams and c is light velocity, equal to 3×10^{10} cm. per second. If the energy is measured in million electron volts (Mev) and the mass is measured in the usual nuclear mass units ($\frac{1}{12}$ of the mass of the carbon atom) then the above relation gives a change of 1/931 nuclear mass units for every Mev change in energy.

As an example, consider the mass of deuterium or heavy hy-

drogen H^2 which is composed of a proton H^1 and a neutron n. In nuclear mass units

$$\text{mass of } H^2 = 2.01412$$
$$\text{mass of } H^1 = 1.00797$$
$$\text{mass of } n \;\; = 1.00867$$

Δm = mass of H^1 + mass of n − mass of H^2 = 0.00237. To convert this mass difference into a binding energy, multiply by 931 to give 2.2 Mev.

The choice of the unit of mass as $\frac{1}{12}$ of C^{12} can now be clarified. On this basis, the masses of other atoms are nearly whole numbers because in C^{12} the binding energy of the nucleons is similar to the binding energy in most other nuclei. Thus the mass of the nucleons in C^{12} is similar to the mass of the nucleons in other nuclei and if the total mass of C^{12} is set equal to the total number of nucleons contained in that nucleus, that is to 12, masses of other nuclei will be close to whole numbers.

V. FURTHER PROPERTIES OF NUCLEI

The particles that compose the nuclei (*i.e.*, the protons and neutrons) have a property which in a subtle way influences nuclear structure. These particles behave as though they were rotating around their own axes. There is no reason to believe that the statement just made can be taken in a literal sense. A picture as detailed as a definite axis localized in the particle is misleading. Nevertheless, neutrons and protons behave in many respects like rotating tops. The protons and neutrons carry an angular momentum which is half the unit of angular momentum in atomic physics. (The magnitude of unit angular momentum is 1.0544×10^{-27} erg-seconds and is usually called $\hbar$. This quantity is $\frac{1}{2\pi}$ times h, the quantum of action. *See* QUANTUM MECHANICS.) The angular momentum or spin of neutrons and protons behaves according to a certain set of rules. If the spinning motion around a given direction in space is investigated, it will always be found that the magnitude of the proton and neutron spin is one half of a spin unit, but that the sign of the spinning motion may have one of two opposite values. In other words the rotation may be clockwise or counterclockwise. The spin of nuclei may be considered as composed of the spins of the neutrons and protons in the nucleus. In the deuteron, which consists of a neutron and a proton, the spins of the neutron and proton seem simply to add, giving a total spin of one unit of angular momentum. The spin of the α-particle, which contains two protons and two neutrons, is equal to zero. In this case the spins of the constituent particles may be considered as partly clockwise and partly counterclockwise, so that the effects of the individual spins cancel. Indeed the spin was found equal to zero in all nuclei containing an even number of neutrons and an even number of protons (*see* NUCLEAR MOMENTS).

To the angular momentum caused by the spins of neutrons and protons there must be added the effect of the motion of these particles along their orbits within the nucleus. Consider the nucleus of the lead isotope containing 208 particles. The spin of this lead isotope has been found equal to zero. Now if a proton, which carries one half unit of spin, is added to the nucleus, the result is a nucleus of bismuth (Bi^{209}) and it might be expected that this nucleus had a spin of one half (zero, caused by Pb^{208} plus one half, caused by the proton). Actually the nuclear spin of Bi^{209} is nine halves. Therefore an additional spin or angular momentum is present which is caused by the motion of the proton in its orbit.

Spin values of nuclei show a few simple regularities. If the system contains an even number of particles of spin one half, the total spin is zero or an integral multiple of the atomic unit of angular momentum. If the system contains an odd number of particles of spin one half, then the system has a spin which is $n+\frac{1}{2}$ atomic units, where n is any positive integer or zero. This rule follows from the basic facts of atomic physics and from this rule was derived a strong argument against the presence of electrons in nuclei. According to earlier ideas the deuteron was considered as composed of two protons and an electron. Now the electron, like the proton, possesses a spin which is one half unit of angular momentum. This would give the deuteron an odd number of particles, each with one half unit of spin and, according to the statement made above, the deuteron would be expected to have $n+\frac{1}{2}$ spin units. Actually it has a spin of one unit. If, on the other hand, the deuteron is assumed to consist of a proton and a neutron, the observed spin value agrees with the rule given above.

The spin of neutrons and protons suggests the idea of an internal rotation. Whenever a charged particle like the proton rotates, one expects to find that the particle behaves like a magnet. Furthermore, from the charge and the spin may be predicted the strength of the magnet associated with the proton. The proton, indeed, behaves like a magnet, but the strength of the magnet is 2.79 times the predicted value. This has been considered as an indication that the proton is not quite a simple particle but can undergo some internal change.

According to the simplest ideas the neutron, not carrying a charge, should have no magnetic effects. This again turns out to be incorrect. The neutron carries a magnetic moment whose strength is 1.935 times the predicted strength for the proton and whose sign is opposite to that of the proton. This means that the magnetic properties of the neutron are those of a rotating negative charge. The discrepancies just mentioned do not contradict any rigorous predictions of atomic theory but only those conclusions based on the idea that neutrons and protons are particles of a very simple kind.

The magnetic moment of the deuteron is almost but not quite the sum of the magnetic moments of the proton and neutron. The fact that there is a slight deviation does not constitute a real difficulty if one considers the effect of the orbits of these two particles within the deuteron. In general all nuclei which have a spin have a magnetic moment. Detailed predictions are not possible because knowledge of the internal structure of nuclei is meagre.

Neutrons and protons have a further peculiarity in that two particles of the same kind are never found to occupy the same state. This rule bears the name of the Pauli exclusion principle. Within a nucleus orbits may be assigned to the nucleons (neutrons or protons). This assignment has to be made in such a manner that no more than two neutrons (or protons) shall be found in one orbit. Further, if there are two neutrons (or protons) in one orbit then these two particles must differ in spin; *i.e.*, one spin must be clockwise and one must be counterclockwise. It is possible for these two particles to be in the same orbit only because they differ in another one of their properties. The rule that two particles cannot be in the same state is thus satisfied. We see that the spin is significant for the details of nuclear structure. The possibility of two spin orientations allows the presence of two neutrons (or protons) in the same orbit of the nucleus.

The configuration of two neutrons or two protons in the same orbit seems to be stable so that, in general, a somewhat greater binding energy is found if the number of neutrons and the number of protons in the nucleus are both even; less if one or the other number is odd. The smallest binding energies are found for odd numbers of both neutrons and protons. In fact, only four stable isotopes are known with odd Z values and odd N values: H^2, Li^6, B^{10} and N^{14}. All others in this category are radioactive, indicating that the nucleus possesses sufficient energy to cause a transformation. Atomic species with even mass numbers are more abundant in the earth's crust and atmosphere than atomic species with odd mass numbers. The most abundant elements, Fe^{56}, Si^{28} and O^{16}, for instance, have even charges as well as even mass numbers. This is further evidence for the stability of the nuclei in question.

The simplest example of a very stable nucleus is helium He^4. As many particles as possible are put into the lowest orbit which can hold two protons and two neutrons. As mentioned before, the packing fraction of helium is large. Any additional particles, either protons or neutrons, must go into new orbits in which the binding energy per particle is less.

Atomic nuclei behave differently according to whether A is even or odd. If the mass number is odd, then two identical nuclei cannot occupy the same state. If the mass number is even, two identical nuclei can be placed in the same state. In the former

case we say that the nuclei obey Fermi-Dirac statistics; in the latter case we say that Einstein-Bose statistics apply. The two kinds of behaviour may be more exactly described by a statement concerning a function, the wave function (*see* QUANTUM MECHANICS), which describes the behaviour of particles, in particular the behaviour of pairs of identical particles. In the case of Einstein-Bose statistics this wave function remains unchanged if the positions of the identical particles are interchanged. In the case of Fermi-Dirac statistics a similar change leads to a change in sign of the function. Which of the two rules applies can be found experimentally by studying the rotation of a diatomic molecule containing the two identical nuclei. In this case the rotation actually brings about the interchange of the nuclei.

The application of these rules gives further evidence that neutrons and protons, rather than protons and electrons, are the proper constituents of nuclei. For example, take a nucleus of nitrogen $_7N^{14}$ which experimentally has been shown to obey Bose statistics. Assuming electrons and protons in the nucleus there would be present a total of 14 protons and 7 electrons. According to knowledge concerning protons and electrons, the interchange of two electrons or of two protons changes the sign of the function characteristic of the system. Thus the interchange of 14 protons and 7 electrons will invert the sign 21 times which amounts to a simple reversal of sign. This contradicts Einstein-Bose statistics which imply that interchange does not change the wave function. If on the other hand, $_7N^{14}$ is considered an assembly of 7 protons and 7 neutrons the interchange of the nuclei inverts the sign 14 times, which is equivalent to saying that the interchange leaves the sign unchanged.

It is seen, therefore, that a detailed consideration of finer nuclear properties like spins and wave functions gives the same final results as were obtained by more crude arguments: nuclei are built from neutrons and protons. To assume electrons in the interior of the nuclei would lead to a whole series of difficulties.

VI. BETA DECAY

A great number of nuclei are known to emit β-particles; *i.e.*, electrons or positrons. The emission of such a particle is accompanied by the transmutation of the nucleus. The resultant nucleus has the same mass number as the original one. If an electron has been emitted the nucleus in the final state will have one more positive charge than the original nucleus. If a positron is emitted the nuclear charge decreases by one unit. C^{11} is an example of a positron emitter, transforming into B^{11}, a boron isotope. C^{14}, another isotope of carbon, emits an electron and decays into nitrogen, N^{14}. An isotope of potassium K^{40} is capable of emitting either an electron or a positron and of transforming into calcium or argon, respectively.

The radioactive decay may be considered as a single act which takes an exceedingly short time, about 10^{-22} seconds. This is not, however, the time in which radioactive substances disappear. These elements have lifetimes which have been observed to vary from less than one-tenth of a second to more than 1,000,000,000 years. If there is an assembly of radioactive nuclei of a certain kind, then one half of these nuclei will have undergone radioactive decay in this lifetime, which is more specifically called the half life.

Each radioactive nucleus has a probability of undergoing the radioactive process per unit time and this probability is independent of the previous history. In particular, this probability does not depend on the length of time the radioactive nucleus has existed. Thus is obtained the law for a radioactive population according to which the radioactive population is halved in each lifetime.

One may assume that each β-decay is caused by one of two basic processes. These are the transformation of a neutron into a proton accompanied by the emission of an electron and the transformation of a proton into a neutron with the simultaneous emission of a positron. These processes are intrinsically slow but the reasons causing the transition or determining its rate are not yet known.

The transition of a free proton into a neutron cannot be observed. This transformation could be written:

$$H^1 \rightarrow n + e^+$$

where n stands for a neutron and e^+ is the symbol for a positron. The neutron is known to be heavier than the proton by 0.00[illegible] mass units and the total reaction products are heavier than the proton by 0.0019 mass units. The mass difference corresponds to an increase of energy during the reaction amounting to 1.77 Mev. If the neutron and positron gained kinetic energy during the reaction, the energy needed would be greater still. Thus at least 1.77 Mev must be supplied if the proton is to disintegrate into a neutron and a positron. Thus the reaction does not occur and the free proton is stable.

On the other hand a neutron can decay giving rise to a proton and an electron

$$n \rightarrow H^1 + e^-$$

The proton and electron together are 0.00081 mass units lighter than the neutron. According to the equivalence of mass change and energy change 0.754 Mev of energy are set free. The reaction described here is the simplest of all possible β-decays. It has been actually observed and its lifetime is approximately a quarter of an hour. Neutrons usually disappear much more quickly by reacting with other nuclei.

A β-decay process in a complex nucleus is described as one of the neutrons in the nucleus turning into a proton or one of the protons changing into a neutron, emitting an electron or positron respectively. This picture correctly describes the fact that the mass number of the nucleus remains unchanged while the charge of the nucleus changes by plus or minus one in the two cases mentioned. In complex nuclei it often does pay to convert a proton into a neutron plus a positron. One may consider, for instance, the decay

$$C^{11} \rightarrow B^{11} + e^+$$

While the sum of the masses of the neutron and positron is greater than the mass of the proton, the sum of the masses of B^{11} and e^+ is actually less than C^{11}. In the

$$C^{11} \rightarrow B^{11} + e^+$$

process a proton is turned into a neutron and a positron. The necessary energy is supplied by the greater binding energy of the resultant neutron. Thus the question of whether or not a nucleus can emit an electron or a positron depends on whether or not the transformation of a proton into a neutron or the transformation of a neutron into a proton can lower the energy of the system. In the energy balance must be included: the mass difference between the neutron and proton, the binding energy of these particles in the nucleus and the mass of the positron or electron which is to be ejected.

It may occur that there is not enough energy available to transform a proton within a nucleus into a neutron and to eject a positron at the same time. A nuclear transformation may nevertheless proceed. Instead of the emission of a positron the nucleus may absorb one of the electrons which are always to be found in the vicinity of the nucleus. In this way instead of having to supply an energy equal to the mass of the positron, one gains the energy corresponding to the similar mass of the electron. For instance, the isotope of manganese containing 54 mass units in its nucleus decays by capturing an electron and one obtains an isotope of chromium.

Consider two nuclei: one shall contain N neutrons and Z protons, the other $N-1$ neutrons and $Z+1$ protons. Add to the latter an electron. Of the two systems now considered, one or the other will have a higher energy and whichever one this is will not be stable but will transform into the other system. Nuclei of the same mass number are called isobars. Two isobars, differing by one charge unit, are called neighbouring isobars. The argument shows that of neighbouring pairs of isobars, one must be unstable.

There are a few known cases of neighbouring isobars where both nuclei seem to be stable. The reason for this apparent stability is the small energy difference between the isobars. It will be seen later that β-transformations in which little energy is released may have long lifetimes. In these cases β-processes may be so rare as to escape observation.

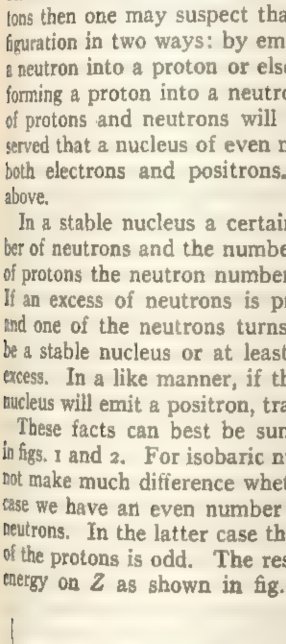
Now consider two isobars which differ by two charge units

There are many examples of such isobars. If all other isobars have higher energies than these two, then both of these isobars may be stable. In fact, a single transition will lead to a system of higher energy. A lowering of the energy could occur only if two β-transitions (*i.e.*, the ejection of two electrons or two positrons) occurred simultaneously. It has been mentioned above that the lifetime of radioactive nuclei is very long compared with the time an electron needs to cross the nucleus. This fact can be expressed by saying that the β-process is an improbable one. A process in which two electrons or two positrons undergo this improbable transition simultaneously is unlikely, and no direct measurement had detected it by the 1960s.

In the previous section it was stated that nuclei containing an even number of neutrons or an even number of protons have lower energies and are more stable than nuclei containing an odd number of neutrons or an odd number of protons. If a nucleus contains an odd number of neutrons and an odd number of protons then one may suspect that it can assume a more stable configuration in two ways: by emitting an electron and transforming a neutron into a proton or else by emitting a positron and transforming a proton into a neutron. In either case an even number of protons and neutrons will be obtained. It is frequently observed that a nucleus of even mass number and odd Z value emits both electrons and positrons. One example is K^{40} mentioned above.

In a stable nucleus a certain balance exists between the number of neutrons and the number of protons. For a given number of protons the neutron number may vary between narrow limits. If an excess of neutrons is present an electron will be emitted and one of the neutrons turns into a proton. The product will be a stable nucleus or at least one which has a smaller neutron excess. In a like manner, if the nucleus has a proton excess, the nucleus will emit a positron, transforming a proton into a neutron.

These facts can best be summarized in two curves, as shown in figs. 1 and 2. For isobaric nuclei with odd mass number it does not make much difference whether Z is even or odd. In the first case we have an even number of protons but an odd number of neutrons. In the latter case the number of neutrons is even; that of the protons is odd. The result is a smooth dependence of the energy on Z as shown in fig. 1. The arrows indicate possible transitions. For isobaric nuclei with even mass number nuclei with even Z values have a lower energy than nuclei with odd Z values. The former contain an even number of protons and an even number of neutrons, the latter an odd number of protons and an odd number of neutrons. The resulting energies are shown by the curves in fig. 2. The transitions are again indicated by arrows. The figures illustrate that for even mass number one may expect more than one stable isobar, while for odd mass number only one isobar is likely to be stable.

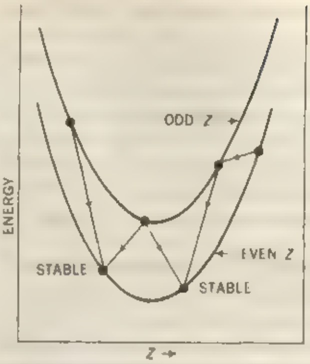


ADAPTED FROM A FIGURE BY H. BETHE IN "REVIEWS OF MODERN PHYSICS," APRIL 1936, V. 8, NO. 2

FIG. 1.—SCHEMATIC REPRESENTATION OF THE ENERGY OF ISOBARS AS A FUNCTION OF ATOMIC NUMBER: ODD MASS NUMBER

It would be expected that when a β-ray is emitted from a nucleus it should carry away with itself in the form of kinetic energy the difference in energy between the original and the resulting nuclei. This is not so. The β-particles emitted from one definite nuclear species have various energies: some carry very little energy, most of them about one-half or one-third of the expected energy and a few nearly all of that energy. None are found to carry an energy in excess of the expected amount.

The fact that β-rays of a definite decay process have varying energies is surprising. It has not been possible to explain the varying energies of β-rays by the assumption that β-rays come from nuclei differing to a certain extent in their properties. Neither did it prove possible to assume that β-rays of varying energy leave the nucleus with correspondingly varying residual energy. On the other hand, the law of conservation of energy requires that the energy difference between the expected and the actual amount should appear in some other form (*see* ENERGY).



ADAPTED FROM A FIGURE BY H. BETHE IN "REVIEWS OF MODERN PHYSICS," APRIL 1936, V. 8, NO. 2

FIG. 2.—SCHEMATIC REPRESENTATION OF THE ENERGY OF ISOBARS AS A FUNCTION OF ATOMIC NUMBER: EVEN MASS NUMBER

The simplest explanation of the facts described above is the following: in the decay process not one but two particles are emitted from the nucleus. One of them, the β-ray, is an electron carrying a positive or negative charge. The other one is called the neutrino. It carries no charge and has no intrinsic mass, but it carries away the missing amount of energy from the nucleus in the form of kinetic energy (*see* PARTICLES, ELEMENTARY).

The assumption that a neutrino is emitted together with the β-ray has helped to explain a number of peculiarities of the β-process. First, the neutrino hypothesis does not merely explain that β-rays from the same decay process have various energies, but it is also capable of accounting for the frequencies with which various β-energies occur.

On the basis of the neutrino theory it was also possible to predict that the probability of β-decay increases with the fifth power of the energy released in the decay. In other words, the lifetime of the radioactive nucleus is inversely proportional to the fifth power of the maximum energy of the β-particle. This law is an approximate one and holds only for the simplest type of β-decay, for sufficiently high energies and for similar nuclei. The more complex β-disintegrations seem to have a decay probability which differs from the probability predicted by the simple theory. These anomalous β-decay processes have smaller decay probabilities and considerably longer half lives than the normal processes.

There is a further group of phenomena which can be explained with the help of the neutrino hypothesis. These are the changes of nuclear spin and nuclear statistics during a β-decay. It has been stated previously that a nucleus or, more generally, an association of particles will have a spin which is an even or odd multiple of one-half the elementary unit of spin according to whether the system contains an even or odd number of particles, each carrying one-half unit of spin. Now a β-ray carries one-half of a spin unit and so do the neutrons and protons of which the nucleus is built. If it is assumed that in a β-process the β-ray is emitted by itself, then the number of particles carrying one-half unit of spin would have increased by one during the process. It would be necessary to assume that the total spin of the system changes. It is, however, a very general rule that the spin of a system left to itself, like a nucleus undergoing a β-decay, must not change. The rule of conservation of spin is indeed almost as strongly supported by experience as the rule of conservation of energy. The emission of a single electron would violate spin conservation as well as energy conservation. If it is assumed that together with the electron a second particle, the neutrino, is emitted and, if it is also assumed that the neutrino carries a half unit of spin, the difficulty disappears.

An analogous argument can be put forward for nuclear statistics. It has been mentioned that a nucleus or system of particles has Einstein-Bose statistics or Fermi-Dirac statistics, respectively, if it contains an even or odd number of particles which themselves obey Fermi-Dirac statistics. Protons, neutrons and electrons do behave according to Fermi-Dirac statistics. If the β-process consisted of the emission of an electron only, the total number of particles would change by one and during the process the system would change from Einstein-Bose statistics to Fermi-Dirac statistics or vice versa.

Such a change in statistics is completely alien to our notions about the composition of matter. For instance, two systems obeying Fermi-Dirac statistics cannot be in the same state, but two

systems obeying Einstein-Bose statistics tend to be in the same state. The transformation of a system from one statistics to another would imply a changed behaviour of similar systems. This change would be so peculiar that we find ourselves unable to incorporate it in the mathematical laws which describe physics in the atom. If it is assumed, however, that together with an electron a neutrino is emitted and that the neutrino obeys Fermi-Dirac statistics, the difficulty is resolved. Two particles obeying Fermi-Dirac statistics are emitted in the process and therefore a change in statistics is not expected.

In addition to carrying energy a neutrino also carries away a momentum which can be calculated from the energy which it possesses. If a nucleus which was originally at rest suffers a β-decay, the momenta carried by the decay products must add up to zero. Since the neutrino is invisible, the momenta of the observable particles do not cancel. By measuring these momenta, one can obtain the momentum which the neutrino must have carried. This difficult experiment has been performed and indicates that the neutrino carries the expected momentum.

Finally, since neutrinos are emitted in β-decays, one can show that they in turn stimulate β-disintegration when they impinge on otherwise stable nuclei. Since the β-disintegration is an exceedingly improbable process, this stimulating effect of the neutrinos is very weak. By using the large neutrino fluxes which are emitted by big nuclear reactors, it has been possible to obtain some indication of this stimulating influence of the neutrino. The evidence for the existence of neutrinos is thus partly indirect and partly based on extraordinarily difficult experiments. Nevertheless, the existence of neutrinos can hardly be questioned.

VII. ALPHA DECAY AND SPONTANEOUS FISSION

In the β-decay a nucleus emits particles which, according to our model, the nucleus does not actually contain. The electron and neutrino emitted in the process may be considered as born at the moment of emission. In other radioactive processes, which are discussed now, particles are ejected from the nucleus which were present in a different configuration before the decay took place.

In another respect all radioactivities are similar: the half-life of a radioactive nucleus is always exceedingly long as compared with times in which nuclear rearrangements could be expected to take place. The ratio of these times is in most cases larger than 10^{20} and sometimes even much greater than that. The reason for such long lifetimes is unknown in the case of β-processes. The reason must, it is thought, lie in the nature of the birth process of electron-neutrino pairs. In the case of other radioactive processes, such as α-decays and spontaneous fission, G. Gamow, E. U. Condon and R. W. Gurney have satisfactorily explained the long lifetimes.

In an α-disintegration a nucleus emits an α-particle, which is itself a very stable nucleus containing two neutrons and two protons. α-active nuclei are encountered among the nuclei which carry the highest charges. In these nuclei the repulsion between the α-particle and the rest of the nucleus results in an energy release which is not only sufficient to overcome the short-range attraction between the α-particle and the rest of the nucleus, but also gives the α-particle a kinetic energy of a few million electron volts.

The spontaneous fission process is also observed in the most heavily charged nuclei. In this process a nucleus divides into two approximately equal fragments which, under their mutual coulomb repulsion, fly apart with a kinetic energy close to 200 Mev.

Both in the α-decay process and in the spontaneous fission process there is an important obstacle to the disintegration. The initial part of the disintegration, instead of releasing energy, actually would require some added energy which is not available in the cases considered. Thus an α-particle at a large distance from the nucleus has a lower potential energy than when it is inside the nucleus. However, an α-particle outside the nucleus but close to it (*i.e.*, when it is in an intermediate state of the disintegration process) has a higher potential energy than when either in the *initial* state inside the nucleus or in the final state when it is far away. This is, indeed, not surprising. In order to bring the α-particle from the initial state to the intermediate state it is necessary to do work against the short-range forces holding the α-particle in the nucleus. Again, if it is desired to bring the nucleus from the final state into the intermediate state it is necessary to do work against the coulomb repulsion. It is seen that the α-particle has to overcome a potential barrier in order to get from the initial state to the final state. Since there is not enough energy available to do this the process should be impossible from the point of view of classical mechanics. In the mechanics which is valid for particles of atomic and subatomic size it is not possible to localize sharply any particle without giving it a large amount of energy at the same time. Applying this kind of mechanics to the motion of the α-particle it is found that the α-particle, instead of staying in the nucleus, will leak through the potential barrier. While this statement is in conflict with our intuition concerning the behaviour of particles, it must be accepted on the basis of extensive experience of atomic and subatomic physics. The penetration of the potential barrier by these particles is closely related to the fact that these small particles, as long as they have a well-defined energy, cannot be sharply located on one side of the barrier.

The necessity of penetrating a potential barrier in the process of disintegration explains the long life and small disintegration probability of the α-active substances. This surprising penetration of a potential barrier becomes extremely improbable as the height or the breadth of the barrier or else the mass of the particle in question becomes bigger. The result is that an α-particle may approach the surface of the nucleus 10^{20} times or more often before it actually succeeds in leaving the nucleus. A further consequence is that relatively small differences between α-active substances cause great changes in the decay probability. The most important factor influencing the decay probability is the energy released in the α-process. If the decay energy is high, that energy will approach more closely the top of the barrier. The result is a greatly increased penetration probability and a greatly increased rate of decay. In fig. 3 the half-lives of the α-active nuclei are plotted against the energy released in the α-decay. While the range of energies for which observations exist extends only from 3.5 to 9 Mev, the corresponding lifetimes are of quite different orders of magnitude. They range from 10^{-7} seconds to 10^{10} years, a time longer than the age of the earth. In order to plot all of these different times in a single graph a logarithmic scale is used. This means that each unit on the vertical scale stands for a factor ten in the lifetime. Next to the ordinate the half-life values are entered in units of seconds and also in units of years. The dots in the figure represent observations for various α-active nuclei. The curve was obtained by applying the theory of barrier penetration to the α-decay process. While this theory disregards all finer details of nuclear structure it is still in excellent agreement with the general trend of the observed points.

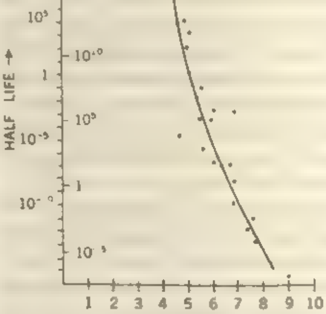


FIG. 3.—HALF-LIFE FOR α-DECAY AS A FUNCTION OF α-RAY ENERGY. (SOLID CURVE IS THEORETICAL)

An entirely similar situation is encountered in the theory of spontaneous fission. Here the nuclear division must be considered as the end result of a process in which an originally spherical nucleus first takes on the form of an ellipsoid, then that of a dumbbell, then that of two smaller and nearly spherical pieces close to each other which finally fly apart to form the fission fragments. The initial distortion in this process requires an energy which, as in the case of α-decay, is actually not available. A potential barrier must be overcome if the fission is to proceed. This potential barrier is probably less high than the one encountered in α-decay. The particles to be moved through this barrier, however, are

fission fragments, containing about 100 neutrons and protons instead of the 4 nuclear units contained in an α-particle. The fact that a much bigger mass must be moved through a potential barrier decreases the disintegration probability. The uranium isotope U^{238} is among the α-active nuclei of longest life with a half-life of 4.5×10^9 years. Yet this nucleus will have more than 1,000,000 times greater probability to decay by an α-process than to undergo spontaneous fission.

VIII. METASTABLE NUCLEI

If a nucleus is not in its lowest state of energy, it is said to be in an excited state. Lifetimes of such excited states, as a rule, are short and the nucleus falls into the lowest energy state, emitting the excess energy as radiation. The time required for this process in many cases is of the order of 10^{-14} seconds. The energy emitted leaves the nucleus in the form of γ-radiation.

If the excitation energy is relatively small (*i.e.*, of the order of 100,000 v.) the lifetime of the excited state is relatively longer, in some cases exceptionally long. These transitions are similar to the anomalous β-decay processes which, as has been pointed out, have longer half lives than the normal β-decay processes. The exceptional nuclei are called metastable. Their lifetimes are often of the order of a few seconds, some much longer. An isotope of krypton, Kr^{83}, for instance, has a lifetime of 113 minutes. Two γ-ray energies have been observed: 0.029 Mev and 0.046 Mev. A long lifetime, 13.8 hours, is also shown for Zn^{69}. The γ-ray energy for this metastable state is 0.45 Mev.

Often such nuclei apparently emit electrons rather than γ-rays. The reason for this behaviour is that the electromagnetic radiation transmits its energy to an electron before the radiation leaves the immediate vicinity of the nucleus. While this electron originally has been a part of the same atom to which the nucleus belongs, it should be emphasized that the electron never was a part of the nucleus. That is, the electron is not actually emitted by the nucleus.

The electromagnetic energy has been converted to kinetic energy of an electron which was formerly bound to the atom. These electrons are called conversion electrons. These conversion electrons can easily be distinguished from β-rays because their energy is well defined, while the electrons emitted from nuclei always have a continuous range of energies. Conversion electrons very frequently accompany γ-rays, but they are found with particularly high probability in the γ-processes of long lifetime which were described above.

IX. NUCLEAR REACTIONS

Up to now, this discussion has considered in some detail processes in which a nucleus undergoes a spontaneous transition. There exists a much more varied class of nuclear transformations, namely the transformations which occur when a nucleus collides with another nucleus or some other particle. Every nucleus is, of course, in practically continuous contact with the electrons which together with the nucleus make up an atom. Stable nuclei are not capable of reacting with these electrons. β-active nuclei may absorb an external electron, as described above. This process is closely related to ordinary β-activity and it has been treated above, under *Beta Decay*. This section will consider the collisions of a nucleus with a fast electron, with a γ-ray, with another nuclear particle, such as a neutron, proton, deuteron, a heavier nucleus or with one of the unstable particles called mesons, which themselves are generated in nuclear collisions.

Bombardment of nuclei by fast electrons throws the nuclei into excited states whose characteristic γ-radiations have been studied. The collision of a nucleus with a γ-ray may also result in the excitation of that nucleus. If the energy of the γ-ray is sufficiently high, absorption of the γ-ray will be followed by a nuclear disintegration, most frequently the emission of one or more neutrons. It has been observed that γ-rays of a characteristic resonance energy are particularly absorbable by nuclei. This resonance energy is in the neighbourhood of 20 Mev. It is somewhat higher for light nuclei and somewhat lower for heavy nuclei.

If a reaction between two charged nuclei is to be studied at least one of these particles must have considerable kinetic energy. Otherwise the electric repulsion prevents the nuclei from approaching close enough to react. According to classical mechanics one would expect that the approaching particles must possess a minimum kinetic energy if they are to get in contact with each other and if they are to react. Actually this simple argument is incorrect. The approach of two charged particles is more involved and is similar to the process of α-decay in which two charged particles are moving apart. Even if sufficient energy is not available for the two particles to come into contact according to the classical picture there remains a small probability for the collision partners to penetrate through the barrier separating them. This probability rapidly becomes smaller as the energy of approaching particles decreases. At small energies the resulting nuclear reactions occur so rarely that they become practically unobservable.

It follows that reactions between nuclei are more easily observed when the nuclei contain relatively low charge. The reactions which can be studied at lowest energies are those between two singly charged deuterium nuclei: $H^2 + H^2 \rightarrow H^1 + H^3$ and $H^2 + H^2 \rightarrow He^3 + n$. These reactions have actually been followed down to 10,000 ev bombarding energy; *i.e.*, to the energy of a "soft" X-ray tube (*see* DEUTERIUM AND TRITIUM).

Reactions between light nuclei and protons are of particular interest because according to present ideas such reactions are responsible for energy production in the sun. In some of these reactions the proton attaches itself to a nucleus and an α-particle is emitted. An example of such a reaction is $Li^7 + H^1 \rightarrow He^4 + He^4$. A second example is $N^{15} + H^1 \rightarrow C^{12} + He^4$. When more heavily charged nuclei are bombarded by protons, the emission of α-particles becomes less likely. The reason for this is similar to the reason for the long life of α-emitters. The α-particle to be emitted must surmount a high barrier. This process, therefore, becomes improbable and the nuclear reaction is likely to take another course (*see* STAR: *Stellar Structure*).

One of these other possibilities is that the proton attaches itself to the nucleus and a neutron is emitted instead. This has been observed in collisions between lithium and protons. The reaction proceeds according to the relation: $Li^7+H^1 \rightarrow Be^7+n$. One notices that the colliding partners are the same as those which lead to two α-particles according to: $Li^7+H^1 \rightarrow He^4+He^4$. It actually is frequently true that a collision between two nuclei gives rise to several competing processes. Depending on the energy of the colliding particles one or the other of these reactions will occur either preferentially or exclusively. For instance, if the energy of the bombarding proton is less than 1.6 Mev, neutron emission does not occur because the sum of energies of Be^7 and a neutron is higher than the energy of the Li^7 and H^1 by just 1.6 Mev. On the other hand, the formation of two α-particles releases energy and can, therefore, proceed at any energy of the bombarding protons providing the proton gets close enough to the lithium to react with it. Since the neutrons are unaffected by electrostatic repulsion the ejection of a neutron by a proton may proceed without difficulty in more heavily charged nuclei. An example is:

$$Sb^{121}+H^1 \rightarrow Te^{121}+n$$

A proton may also simply attach itself to the nucleus with which it collides. This happens in the reaction

$$C^{12}+H^1 \rightarrow N^{13}+\gamma$$

In reactions of this type the binding energy of the proton in the nucleus is released in the form of γ-rays. This energy release is a relatively slow process. It takes, as a rule, only 10^{-14} seconds, but the time in which a neutron or an α-particle could be released by the reacting partners is very much shorter still, namely 10^{-20} seconds or less. Thus, the reaction between N^{15} and protons could, in principle, lead to the formation of O^{16} according to the scheme $N^{15}+H^1 \rightarrow O^{16}+\gamma$. The reaction mentioned above $N^{15}+H^1 \rightarrow C^{12}+He^4$ seems, however, to occur almost exclusively because this type of rearrangement between the reaction partners happens to take a much shorter time. On the other hand, $C^{12}+H^1 \rightarrow N^{13}+\gamma$ can occur more readily because in this case no competing process exists as long as the proton does not have too high an energy. Actually both the ejection of an α-particle or of a neutron from

the carbon nucleus would require a very high proton energy.

When a nucleus is bombarded by a deuteron, reactions similar to those discussed above occur. In particular, neutrons and α-particles are found among the reaction products. The reaction to which deuteron bombardment most often leads is the ejection of a proton. This reaction occurs with relative ease even if the bombarded nucleus has a high charge. The deuteron does not need actually to penetrate to the surface of its target. When the coulomb repulsion becomes too strong the deuteron decomposes into a neutron and a proton. The neutron suffers no repulsion and reaches the surface of the nucleus while the energy of the reaction is carried away by the proton.

Among reactions with heavier nuclei mention shall be made only of the reactions with α-particles. Because of the availability of natural α-rays these were the first to be observed; they were of further historical importance in that they led to the discovery of the neutron. One of the easiest and earliest methods of producing neutrons is by the reaction $Be^9+\alpha\rightarrow C^{12}+n$. In reactions with more heavily charged nuclei α-particles can participate only if they carry a rather high kinetic energy. Even more kinetic energy would be required if the bombarding nucleus had more than two charge units.

When a nucleus is bombarded with neutrons whose energy is in excess of 1 Mev, the result is not very different from the reactions that occur when fast deuterons or protons are the bombarding particles. Of course the neutrons, not being repelled by the nuclear charge, can penetrate into heavy and light nuclei with equal ease. The result again may be the attachment of a neutron to the nucleus accompanied by the emission of a γ-ray. An example is $Au^{197}+n\rightarrow Au^{198}$. The resulting isotope of gold is unstable and decays to mercury. The fact that the resulting gold isotope is radioactive makes it easy to establish that the reaction has actually occurred in a bombarded gold sample.

A second type of reaction with neutrons is the re-emission of the original neutron plus the emission of another neutron. The first neutron serves to knock the second neutron out of the bombarded nucleus. Since the second neutron is strongly bound only bombarding neutrons carrying high energy produce this reaction. The result of this reaction is an isotope of the original bombarded nucleus having a mass number diminished by one. The reaction

$$O^{16}+n\rightarrow O^{15}+n+n$$

may serve as an example.

In another type of reaction the neutron attaches itself to the nucleus and a proton is emitted instead. This is illustrated in the reaction

$$Zn^{66}+n\rightarrow Cu^{66}+p$$

While in this reaction the neutron is free to penetrate into the nucleus, the proton encounters a potential barrier on its way out. This barrier again results from coulomb repulsion and is higher for more heavily charged nuclei. Thus this reaction will occur with considerable probability only in light nuclei or else in those cases where the outgoing proton receives a rather high energy, sufficient to overcome the potential barrier just mentioned.

The same situation is encountered if an α-particle is emitted after the neutron has attached itself to the bombarded nucleus. As an example we may mention the reaction:

$$N^{14}+n\rightarrow C^{11}+\alpha$$

The reaction products have, in this case, a greater total mass than the original neutron and nitrogen. The mass difference corresponds to 2.25 Mev and therefore only neutrons having an energy greater than 2.25 Mev will be able to produce this reaction. It might be noted that in this case neutron bombardment also gives rise to the reaction:

$$N^{14}+n\rightarrow C^{14}+p$$

This reaction releases energy, and therefore proceeds at low as well as high neutron energies. The two reactions just discussed are competing processes. This situation is quite typical. If the bombarding particle does not have much energy few types of reactions can take place. At higher bombarding energies more reactions become possible.

Among the nuclear reactions induced by neutron bombardment the fission of uranium and thorium are of greatest practical importance. As stated above, uranium may disintegrate into two roughly equal fragments even of its own accord. The rearrangement of nuclear matter, however, which leads to this fission process requires an initial investment of energy. Thus the spontaneous fission can take place only if the resultant particles penetrate a potential barrier, which is an exceedingly improbable process. If a uranium or thorium nucleus is hit by a neutron, the neutron attaches itself to the nucleus and delivers to the nucleus the binding energy of the neutron, amounting to several Mev. This energy sets the particles of which the nucleus is composed into motion. This motion may lead to the rearrangement necessary to initiate the fission process. It is interesting to note that the common isotopes of thorium and uranium, Th^{232} and U^{238}, require neutrons of relatively high initial energy if fission is to be produced. The reason is that fission is a quite improbable process unless the neutron furnishes enough energy to deform the nuclear matter to a point from where the further process is a "downhill" motion; *i.e.*, a motion which is connected with a diminution of potential energy. If a neutron fails to deliver sufficient energy to lift the nucleus to the top of the potential barrier, the fission process becomes quite improbable. In this case it is more likely that the excited nucleus will get rid of its energy either by re-emission of the original neutron or by the emission of a γ-ray. In the former case the neutron reverts to the original bombarded nucleus; in the second case, the reaction product is an isotope of the bombarded nucleus which contains an additional neutron. There is no reason why nuclear fission could not be produced by proton and deuteron bombardment as well as neutron bombardment. The protons and deuterons are, however, strongly repelled by the electrostatic field of the heavily charged uranium nucleus. Thus only highly energetic protons and deuterons are capable of producing fission.

Neutrons with an energy of 20 Mev or more are capable of producing fission in bismuth, lead and even lighter nuclei. In these cases fission probably results after a few preliminary processes have occurred. First the neutron communicates to the nucleus a high excitation energy. Thereafter the nucleus emits several particles, mostly neutrons. This process is called spallation. Neutrons escape preferentially because they need not overcome any potential barrier. Thus the nucleus is left with an unusually great excess of protons. The charge of these protons facilitates fission and a certain fraction of the bombarded nuclei actually divide into two similar particles.

The neutron reactions discussed thus far are usually referred to as fast neutron reactions. In contrast to these, slow neutron reactions signify events in which nuclei are hit by neutrons carrying a fraction of an electron volt. The neutrons in a typical slow neutron reaction possess about 100,000,000 times less energy than the neutrons in a fast neutron reaction. These slow neutron reactions are in many respects quite different from reactions in which only fast particles participate. These will be discussed in some detail since they play an important part in the release of atomic energy for useful purposes.

All the neutrons observed are products of nuclear reactions. Originally these neutrons are fast. Slow neutrons are obtained by allowing the fast ones to make a considerable number of collisions with other nuclei. There are many nuclei with which neutrons can collide repeatedly without causing nuclear reactions and without being captured by these nuclei. Frequently the only possible process is an elastic collision in which the neutron gives some of its energy to the collision partner. If, for instance, a neutron collides with a proton it loses roughly one-half of its energy in each collision. In collisions with carbon nuclei the neutron is apt to lose one-sixth of its energy. As a result 20 collisions with protons will suffice to deprive a neutron of all but one-millionth of its original energy and roughly 100 collisions with carbon nuclei produce the same result.

The energy loss, however, will not proceed indefinitely. All nuclei of the atoms in and around us participate in a disorderly motion that is produced by the heat energy shared by all bodies. The average energy of the particles at room temperature is about

$\frac{1}{40}$ ev. When the neutrons are slowed down to this energy they will cease, on the average, to lose energy in collisions. They will rather participate from then on in the general thermal agitation of all particles. Neutrons of about $\frac{1}{40}$-ev energy are therefore often called thermal neutrons. The term slow neutrons is not restricted to the thermal neutrons but includes those of somewhat higher and lower energies. Thermal neutrons, however, are typical representatives of the class of slow neutrons. It is of interest to note that thermal neutrons move with an average velocity of 1.3 mi. per second. It seems peculiar to call such neutrons slow but they are slow compared with neutrons of 1 Mev energy whose velocity is little less than 10,000 mi. per second.

Reactions of slow neutrons differ from other nuclear reactions in several important respects. Slow neutrons may be absorbed very effectively by certain appropriate materials. Thus $\frac{1}{100}$ in. of cadmium is sufficient to absorb most of a beam of slow neutrons. A beam of fast neutrons, on the other hand, penetrates approximately two inches of any condensed material before the beam is strongly absorbed or otherwise altered in its properties. Slow neutrons are not absorbed so strongly by all kinds of nuclei. In collisions with nuclei such as carbon or lead, for instance, slow neutrons are hardly ever absorbed. Furthermore a reaction between a slow neutron and a nucleus depends on the energy of the neutron in a very selective manner. The reaction of neutrons with indium nuclei are very characteristic in this respect. A thermal neutron beam is effectively absorbed by an indium foil, while neutrons of one volt energy are considerably less affected. Neutrons of a sharply defined energy of 1.44 ev are more strongly absorbed in indium foils than neutrons of any other energy.

The peculiar behaviour of neutrons described above is the result of two facts. One is that slow neutrons spend a longer time in the neighbourhood of each nucleus and are more likely to be captured in a single collision. The second fact is the existence of compound nuclei which are formed by the initial fusion of the reaction partners and which possess well-defined energy levels. As an example let us continue to consider the reaction of indium with slow neutrons. If a neutron is bound to an indium nucleus an energy of approximately 8 Mev is released. At the time that a slow neutron enters the binding energy appears as agitation of the compound nucleus. The designation of compound nucleus refers to this original agitated nucleus which is formed as a first step in the nuclear reaction.

The energy of agitation is not arbitrary but can be one of a certain number of rather sharply defined values. If the small kinetic energy of the incident neutron added to its big binding energy is just sufficient to form a compound nucleus in one of these sharply defined energy states then the neutron will enter the nucleus with a high probability. The energy at which the neutron enters with the greatest probability is called the resonance energy. The more the energy of the neutron differs from this resonance energy, the smaller will be its chance to enter the nucleus. A change in neutron energy of only one-tenth of an electron volt is sufficient to alter considerably the chance of the neutron to participate in the reaction.

These sharply defined levels of compound nuclei do not occur in the case of light atomic nuclei. This fact has been explained by a typical law of atomic physics according to which sharply defined energy levels occur only if these energy states have comparatively long lifetimes. If a state has a lifetime of 10^{-21} seconds (which is a typical period for nuclear rearrangements) then energy levels cannot be defined with a precision less than 1,000,000 v.

The sharply defined energy of compound nuclei indicates a lifetime more than 1,000,000 times longer than the time for a simple rearrangement. Why such long lives should occur when a slow neutron enters a nucleus of high weight, such as indium, may be understood in the following manner. When a neutron of small energy enters a nucleus its considerable binding energy is promptly shared as energy of agitation by the many particles of the nucleus. If the original neutron is to leave the nucleus again all of this energy must once more be concentrated on a single neutron. This process is unlikely and, on the average, takes a long time. If the nucleus consists of few particles then it will be more easily possible to concentrate the energy on a single one of these particles. On the other hand, if we have started with a fast neutron, then it will not be necessary to return to this neutron all of its energy to enable the original neutron to escape again.

Once a slow neutron has entered a nucleus and has found a compound state several reactions are still possible. The most probable of these is the emission of the binding energy of the added neutron in the form of γ-radiation. In this way an isotope of the original bombarded nucleus is formed. Thus we have the reactions:

$$H^1+n \rightarrow H^2+\gamma$$
$$O^{16}+n \rightarrow O^{17}+\gamma$$
$$U^{238}+n \rightarrow U^{239}+\gamma$$

The last reaction will be referred to again in discussing the utilization of nuclear energy.

Among the lightest and the heaviest nuclei there are a few more important reactions following neutron capture.

Protons are emitted in the reaction of slow neutrons and nitrogen:

$$N^{14}+n \rightarrow C^{14}+p$$

The resulting β-active isotope of carbon is most useful in the study of reactions in organic chemistry and biochemistry. This isotope of carbon is formed in small amounts by cosmic rays and occurs, therefore, as a "natural" activity. Its half-life is 5,568 years. By measuring the carbon activity in an archaeological sample one may determine the age of that sample (*see* RADIOCARBON DATING; GEOCHRONOLOGY).

In reactions with Li^6 and B^{10} the absorption of a slow neutron results in the emission of an α-particle, according to

$$Li^6+n \rightarrow H^3+He^4$$
$$B^{10}+n \rightarrow Li^7+He^4$$

These reactions are important because these nuclei, especially B^{10}, are very strong neutron absorbers. In contrast to indium, which preferentially absorbs neutrons of 1.44 ev energy, all neutrons are absorbed by Li^6 and B^{10}, but slow neutrons, which spend more time in the neighbourhood, are absorbed with greater probability.

The fact that slow neutrons are strongly absorbed by particular materials permits the regulation of the number of slow neutrons and allows or denies them access to certain parts of materials. The control of the energy release in chain-reacting materials is based on this property of slow neutrons.

The energy released by slow neutron capture is insufficient to cause fission in any isotope which occurs with great abundance in a natural substance. In some materials, particularly in U^{235} and Pu^{239}, slow neutrons do give rise to fission. The consequence of this fact will be discussed later.

New high-energy accelerators have produced protons carrying several hundred Mev. Bombardment of nuclei by such protons often gives rise to disintegration into several fragments. It is remarkable, however, that more gentle interactions are not unusual. Thus a proton may collide with a nucleus without changing its energy or momentum to a great extent. In the collision, however, the proton turns into a neutron, leaving its charge behind in the nucleus with which it collided. It also happens quite often that the impinging proton picks up a neutron during its contact with a nucleus. The bombarding particle changes, therefore, into a deuteron but continues on its path without any great deflection or loss of energy.

The most important result of experiments in the several-hundred-Mev range has been the production of mesons. These are unstable particles, some of which are neutral while some carry a unit of positive or negative charge. A considerable variety of these particles has been discovered. They differ not only in their charge but also in their masses, spins, lifetimes and modes of decay. At least one class of these mesons, the π mesons (pi mesons), is closely connected with the forces that bind the nucleons into stable nuclei. This connection will be discussed below.

It has become customary to designate mesons as well as nucleons, electrons and neutrinos as "elementary particles." With the increase in the number of these particles it becomes likely

that at least some of them are no more elementary than atoms are indivisible. It is expected that some simple and general laws of physics will eventually be found to explain the properties of all these particles.

X. SUMMARY OF NUCLEAR PROPERTIES

The nuclear reactions described in the last section led to the discovery of a very great number of previously unknown radioactive nuclei. These, together with the nuclei that occur in nature, are collected in the accompanying chart of properties of the nuclides. In this chart each nucleus is represented by a square. For instance, in the first section of the chart (second row from the bottom) the isotopes of hydrogen appear. The charge number 1 and the atomic symbol H (for hydrogen) appear at the left of the row. The first square corresponds to a proton. In the square is found the mass number for the proton, which is 1, and below it the abundance of protons in ordinary hydrogen is indicated. The figure 99.985 means 99.985% of ordinary hydrogen consists of light hydrogen or protons. The square to the right of the proton corresponds to heavy hydrogen or deuterium with a mass number 2. Its abundance in ordinary hydrogen is 0.015%, which is also entered. The third square in the row corresponds to tritium, the radioactive isotope of hydrogen. This isotope does not occur in nature and so the second line in the square contains a zero. Instead the half-life, 12.26 years, has been entered in the third line. The arrow attached to this isotope shows that the nucleus decays to He^3, the light isotope of helium, occurring in the next row. At the bottom of each column is the number of neutrons in the nuclei. Therefore, below the proton is found zero, indicating that this lightest isotope contains no neutrons. Below deuterium and tritium, the figures 1 and 2 indicate that these isotopes contain one and two neutrons, respectively. The next row represents the helium nuclei; then the rows correspond to lithium, beryllium, boron and heavier nuclei.

The chart is presented in five sections. Throughout the chart the three numbers occurring in the squares correspond to the mass number, the abundance and the lifetime. In the second line zero appears for all nuclei that are not found in the elements as they occur in nature. In all but a few of the heaviest elements natural terrestrial sources always have the same isotopic abundances. This abundance is indicated by the figure in the second line. It should not be taken for granted that the isotopic abundance outside the earth is the same as on the earth. This, however, seems to be the general rule.

The figures on abundance are omitted in some of the heavy nuclei in which all isotopes are radioactive and in which the isotopic abundances are dependent upon the method by which the element is obtained.

The radioactive nuclei are distinguished in the chart, not only by the fact that in their squares a lifetime appears, but also by the arrows which indicate their process of decay. β-active nuclei are distinguished by arrows which point toward the upper left if negative electrons are emitted or by arrows in the opposite direction if positive electrons are emitted. Nuclei which do not have enough energy to emit an electron but capture an atomic electron are indicated in the same way as an ordinary positive electron emitter.

Some nuclei may decay both by positive and negative electron emission. This is indicated by two arrows attached to the squares. Alpha-activity of the nuclei is shown by an arrow in the lower left-hand direction and extending to the second diagonal neighbour. Thus in every case the arrow ends on the product of the radioactive decay.

The chart shows several interesting facts. Among the light nuclei only those with approximately equal numbers of neutrons and protons are stable. Those nuclei which have a great neutron excess are β-active and emit negative electrons, thus transforming a supernumerary neutron into a proton. Nuclei having too many protons emit a positive electron and transform a proton into a neutron. The fact that among light nuclei an equal number of neutrons and protons seems to give greatest stability to the nucleus is the result of the exclusion principle. The first neutrons and protons that build up a nucleus will occupy the lowest energy states. Each additional neutron and proton will be forced into an orbit of higher energy. If the number of neutrons greatly exceeds the number of protons, the last neutron will find itself in a state of rather high energy, while states of lower energy are still available for protons. Thus energy may be released by the transformation of a neutron into a proton. A similar argument holds for an excess of protons.

As the number of protons and neutrons becomes greater the stable nuclei tend to have a greater number of neutrons than protons. The reason for this is the electrostatic repulsion between protons. Because of this repulsion the presence of many protons in the nucleus causes an increase of the energy of the nucleus and transforming a proton into a neutron will correspondingly lower the energy. Too great a neutron excess will be prevented for the reasons discussed in the preceding paragraph.

It has been mentioned that the electrostatic repulsion in heavily charged nuclei gives rise to α-activity. The frequent occurrence of α-activity in the last elements of the chart can be readily observed. Instability of nuclei caused by the excess charge is probably the reason why fewer isotopes of heavy nuclei are known and why nuclei having more than 92 charge units do not occur in nature.

While two neutrons and two protons can never occupy exactly the same state within a nucleus, a pair of such particles may be found in the same orbit. These two particles must differ in the orientation of their spins. It seems that two particles in the same orbit possess similar energies. The result is that two successive particles can be bound in a low-energy state, while the addition of a third particle will release considerably less binding energy. This circumstance is illustrated by two facts in the chart of nuclei. First, few stable nuclei exist in which both the number of neutrons and the number of protons is odd. Such nuclei are usually radioactive, emitting a positive electron, a negative electron or both. The decay product is a nucleus in which both neutron and proton numbers are even and all orbits may be considered as doubly occupied.

The result of this rule is that nuclei with odd charge number Z possess many fewer isotopes than nuclei of even charge number. The other fact appearing from the chart is that in nuclei of even charge number the even isotopes, in which the number of neutrons is even, have a greater abundance than the odd isotopes, in which the number of neutrons is odd.

It seems that the latter nuclei, containing particles in less stable orbits, originally have been formed in smaller numbers than the isotopes having an even number of neutrons and greater binding energies.

Among the β-active nuclei two general rules may also be observed. First, that β-active nuclei which are located close to stable nuclei usually decay with a long lifetime. Nuclei which are located farther from stability have shorter decay periods. The other regularity is that radioactive nuclei containing even numbers of protons and neutrons have longer lives than nuclei containing an even number of neutrons and an odd number of protons or an even number of protons and an odd number of neutrons. These nuclei in turn live longer than nuclei in which both the proton and neutron numbers are odd. These regularities may be understood in terms of the energies of nuclei. In terms of β-decay it has been mentioned that the lifetime will be short if a great amount of energy is liberated in the β-decay. The lifetime will be long if the transformation energy is small. The transformation energy is apt to be less if the decaying nucleus has relatively low energy. This will be the case if the nucleus is near the region of stability and if the nucleus contains an even number of neutrons and protons. Closer inspection of the chart will show that the rules just mentioned are not universally valid and that there are quite a few exceptions. These exceptions occur whenever a β-decay of the anomalous type is encountered, in which case, as has been mentioned, β-active substances have a relatively long lifetime.

The abundances of isotopes show a further marked regularity. Among the light elements the heaviest isotopes are frequently

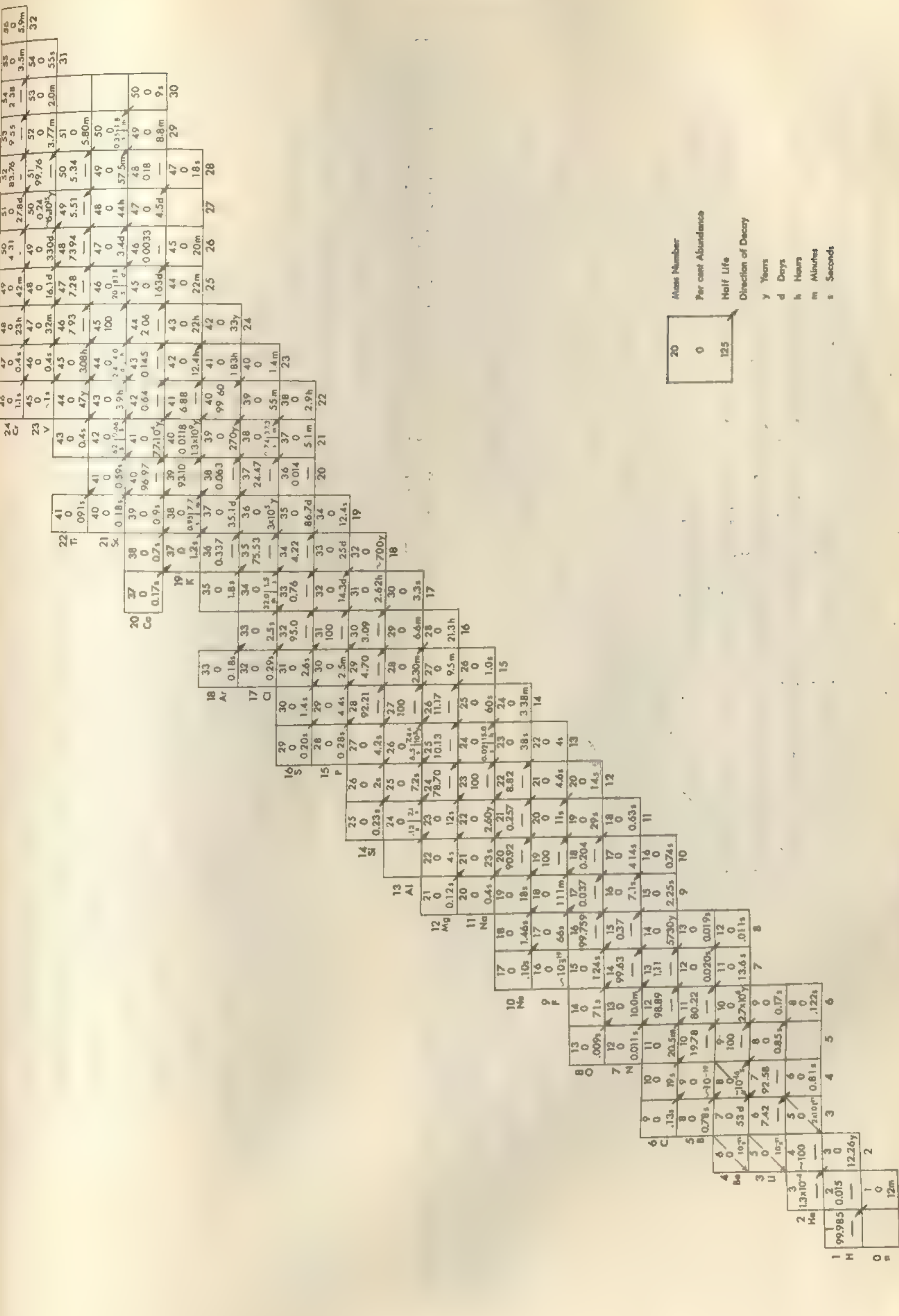


CHART OF PROPERTIES OF THE NUCLIDES

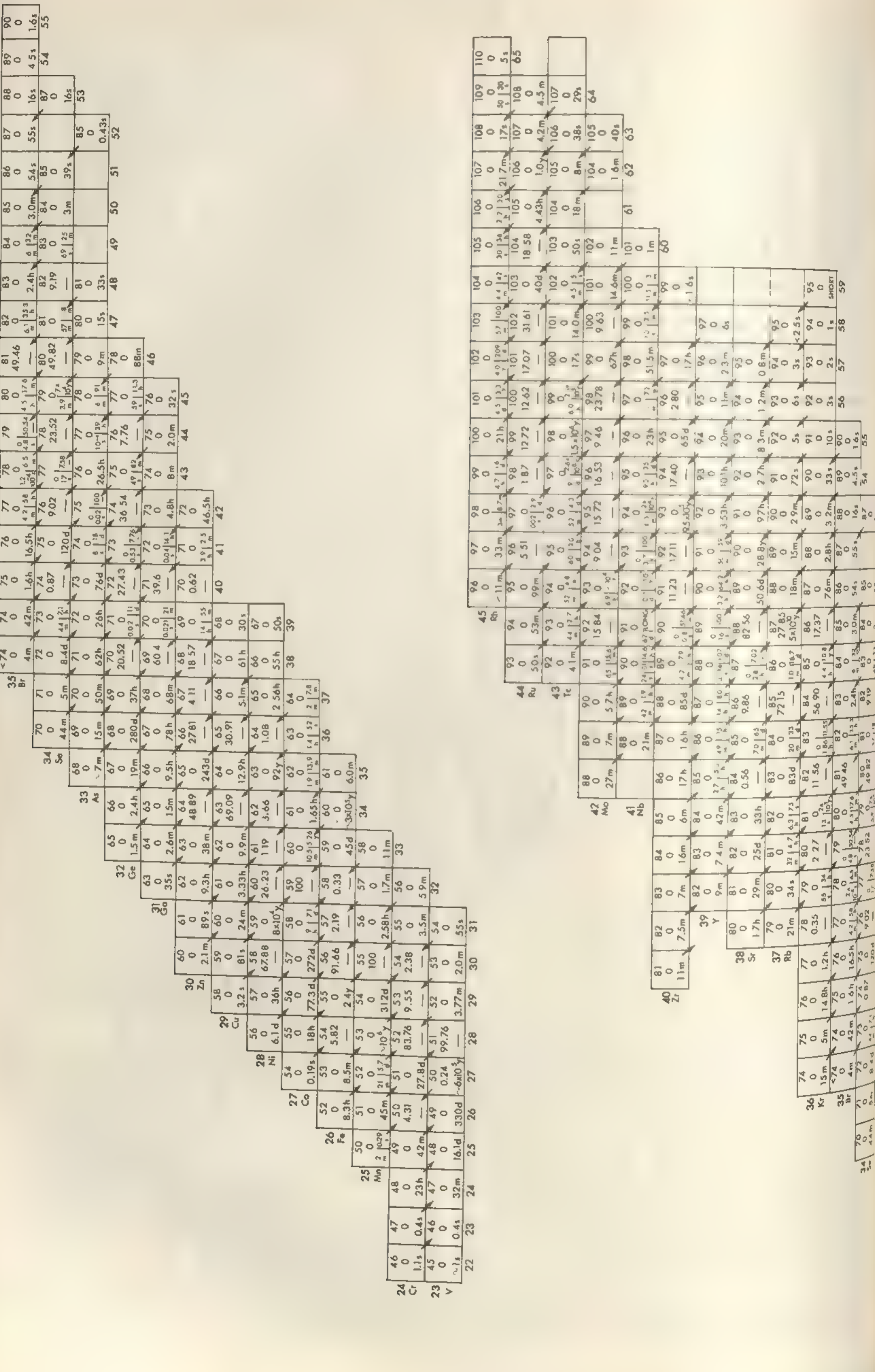
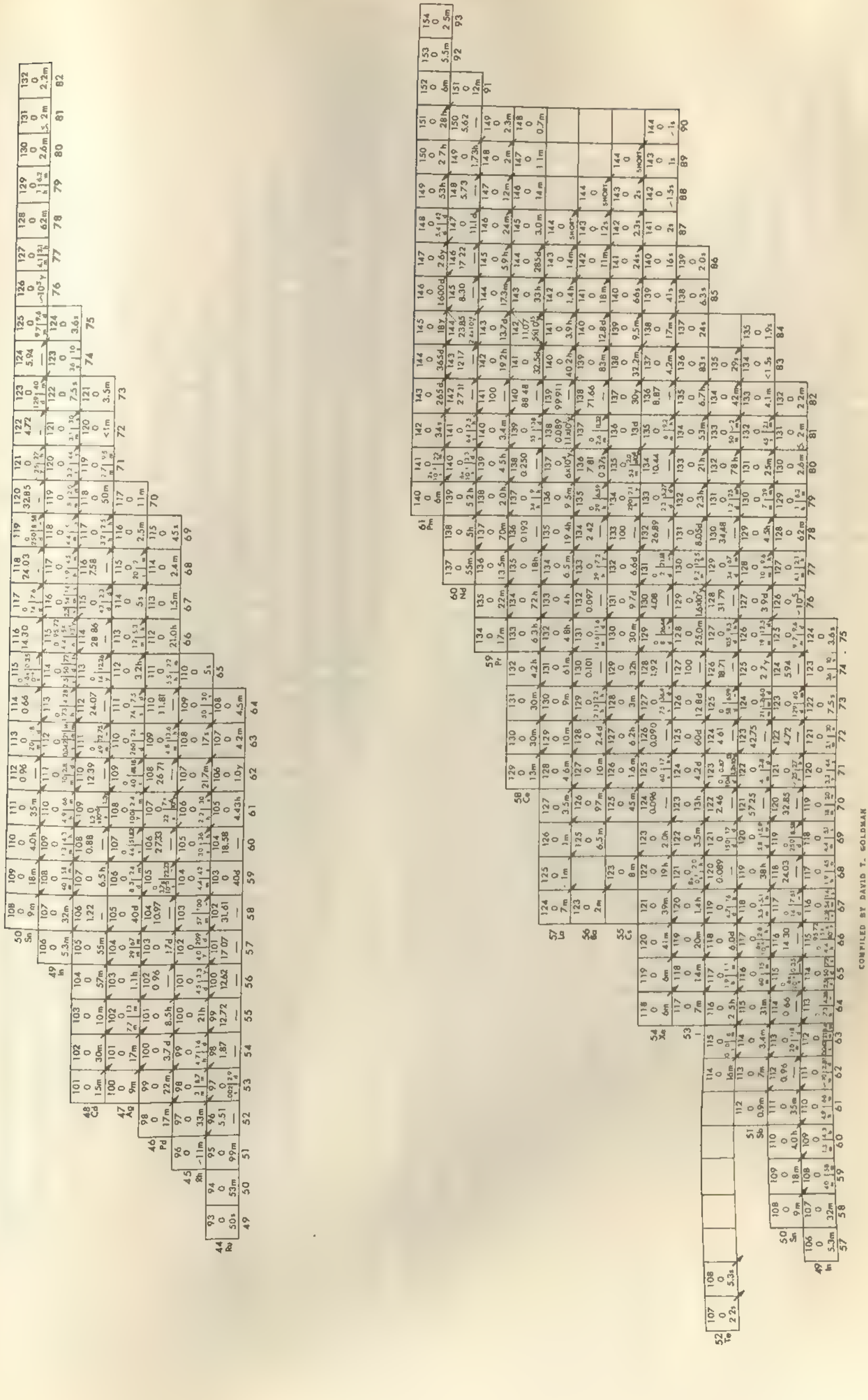


CHART OF PROPERTIES OF THE NUCLIDES—Continued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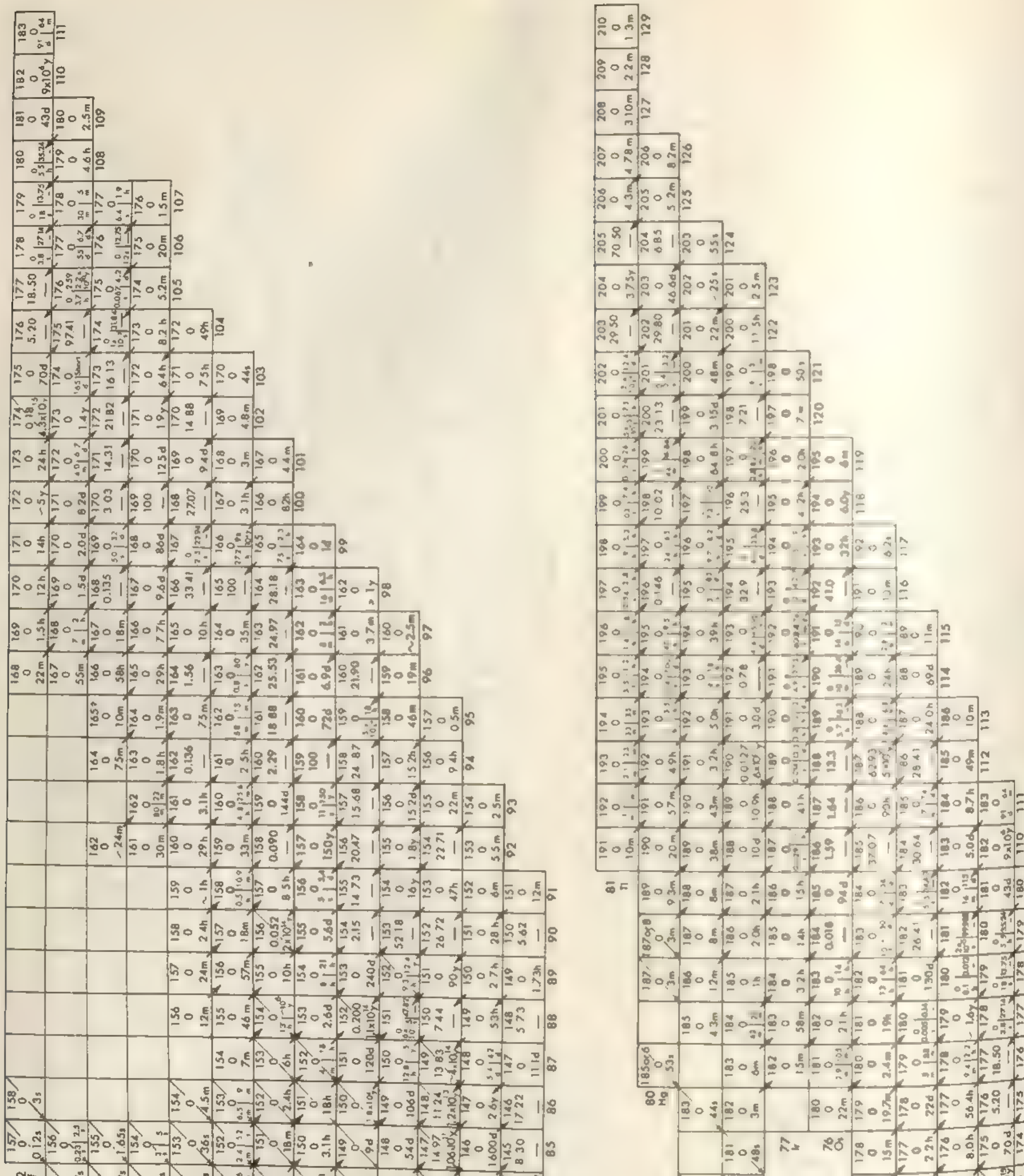

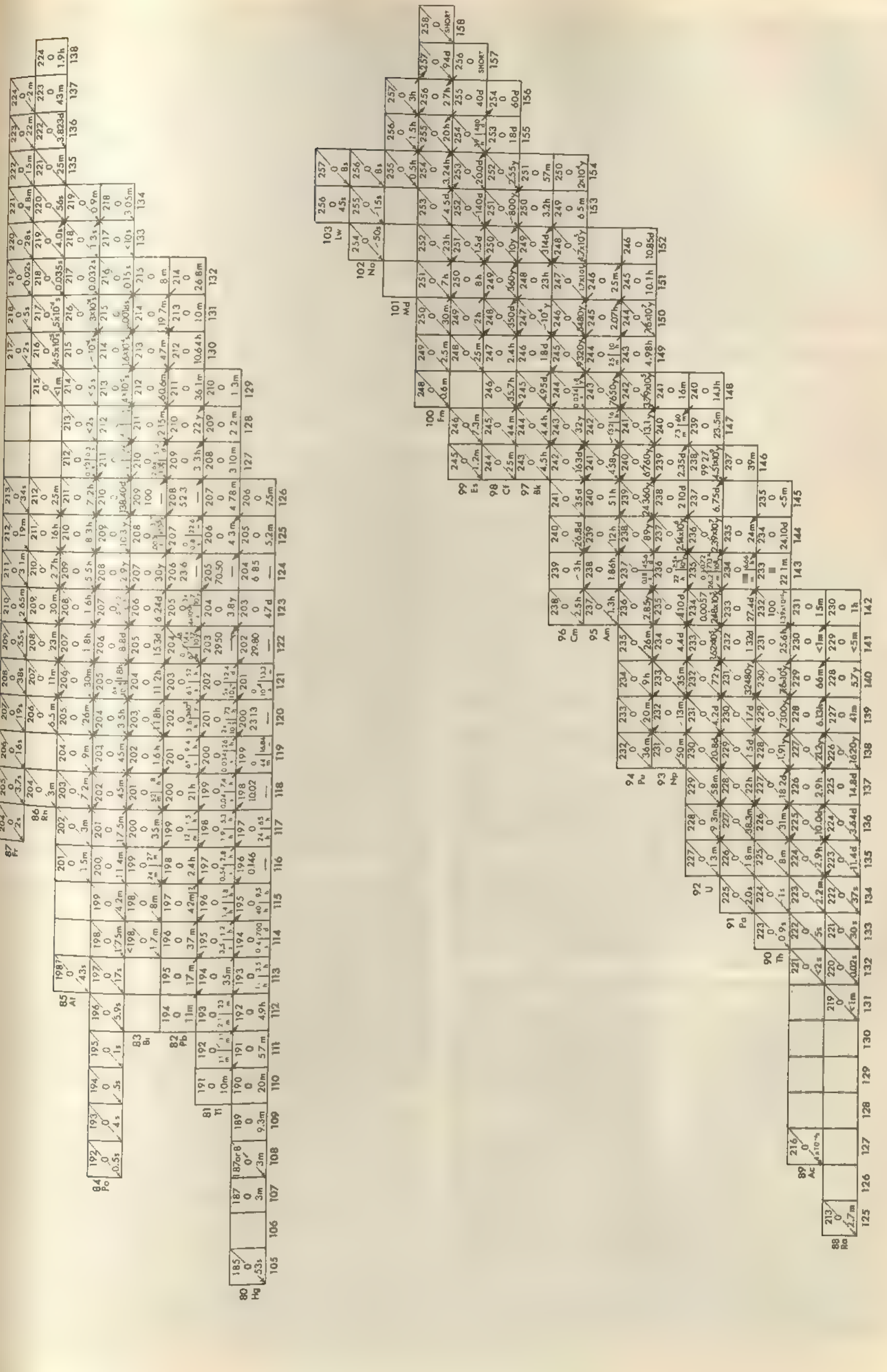

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present in small abundance. Among the heavier elements the situation is reversed. It seems impossible to explain this fact on the basis of the stability of nuclei alone and it is likely that a hint is encountered here which may throw some light on the origin of the elements (*see* COSMOGONY: *Origin of Chemical Elements*).

In this connection it is also of great interest to compare the abundance of various elements. The determination of the abundance of elements is much more difficult than the measurement of the ratio of isotopic abundances. The reason for this is that while isotopic composition is remarkably constant, at least in terrestrial materials, the mixtures of various elements depend quite strongly on whence one obtains the mixture. Other elements will be found to predominate in the crust of the earth than in meteorites, which are believed to have a composition similar to the interior of the earth. A still different composition is found in the study of the sun. Even if we restrict ourselves to the earth's crust, a different result is obtained if igneous rocks are studied, sedimentary materials, the sea or the atmosphere. Fig. 4 gives the best available guess as to the abundance of various nuclear species through-

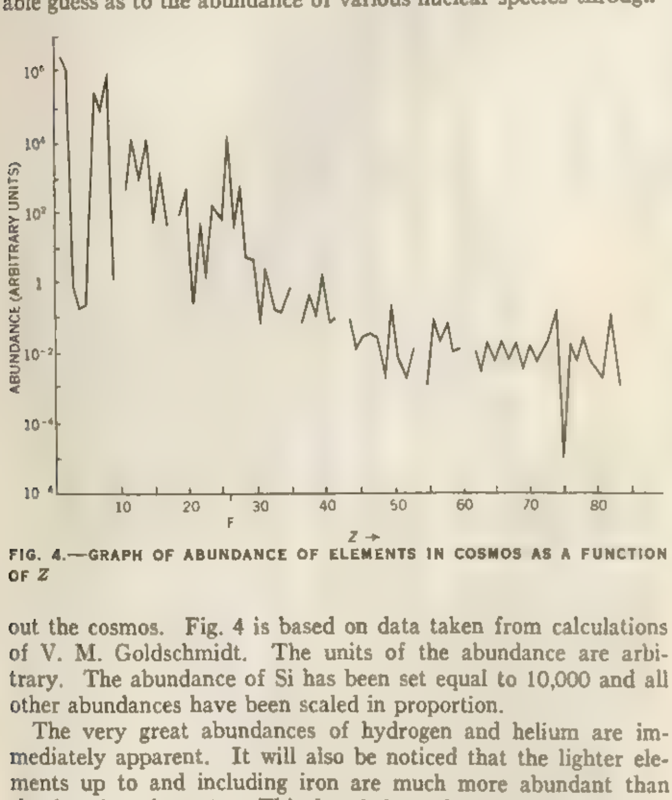

FIG. 4.—GRAPH OF ABUNDANCE OF ELEMENTS IN COSMOS AS A FUNCTION OF Z

out the cosmos. Fig. 4 is based on data taken from calculations of V. M. Goldschmidt. The units of the abundance are arbitrary. The abundance of Si has been set equal to 10,000 and all other abundances have been scaled in proportion.

The very great abundances of hydrogen and helium are immediately apparent. It will also be noticed that the lighter elements up to and including iron are much more abundant than the heavier elements. This has led to the suspicion that the lighter and heavier groups of elements have been formed by two basically different processes.

XI. NUCLEAR STRUCTURE AND NUCLEAR FORCES

The origin and nature of the nuclear forces are poorly understood. There is not even certainty that it is permissible to talk about forces within a nucleus in the customary sense of the word. Something is known, however, about the magnitude that forces between nuclear particles should have if these forces are to give rise to the effects that are observed (*see* FORCE).

A detailed theory of the interaction of slow neutrons with nuclei leads to the idea that there is very little interaction between the neutron and the nucleus until the neutron approaches to the distance of approximately one nuclear radius. At that distance the neutron is attracted to the nucleus with a strong force. The last statement is based on the fact that the union of a neutron with almost any nucleus releases a binding energy of several Mev. The facts so far described are summarized in the statement that the interaction between the neutron and other nuclear particles is a strong, short-range attraction.

If a proton approaches a nucleus the interaction at long distances is an electrostatic repulsion. By nuclear forces, of course, is meant the forces acting in addition to these electrostatic forces. As long as the proton is not in contact with the nucleus the effects of nuclear forces are considerably smaller than this electrostatic interaction. Attaching a proton to a nucleus releases a similar energy as when a neutron is attached. Thus, the interaction of the protons with other nuclear particles is again a strong, short-range attraction to which, of course, must be added the electrostatic repulsion, which acts over a greater distance.

Comparison of the binding energies of certain pairs of light nuclei leads to an important conclusion concerning nuclear forces. The first of these pairs is H^3 and He^3. The former consists of two neutrons and a proton, the latter of one neutron and two protons. The second known pair in the series is Li^7 and Be^7. The first is composed of three protons and four neutrons, the second contains four protons and three neutrons. The next pair is B^{11} and C^{11}, in which the numbers of protons and neutrons are five-six and six-five, respectively. In each of these pairs one member is obtained from the other if all neutrons are replaced by protons and all protons by neutrons. A large number of additional pairs of this type are known. For quite a few of these accurate determinations of the energy content of the nuclei are available. These energy contents differ because of the greater electrostatic repulsion prevailing in the nucleus which is more heavily charged than its partner. The remarkable fact is that the electrostatic repulsion is sufficient to explain the observed energy difference of the two nuclei in any of these pairs. We conclude that nuclear forces remain unchanged upon replacing all neutrons by protons and all protons by neutrons.

More detailed investigation of the behaviour of nuclei and also scattering experiments of protons on protons and neutrons on neutrons at various energies have led to a simple general rule. This is that neutrons and protons interact with each other in the same way as they interact with their own kind and that neutrons and protons are bound by the same forces within nuclei.

A detailed study of the proton-proton and neutron-neutron scattering at various energies has led to the conclusion that during such a scattering process the two interacting particles may exchange their charges. This exchange process gives rise to forces between the particles. It is likely, however, that these exchange forces account for only a portion of the total forces acting within nuclei. In spite of the similarity of the behaviour of neutrons and protons, the charge does therefore influence nuclear binding, but it does so in a similar way as the spin. Particles with different charge or different spin may occupy the same orbit, whereas particles with the same charge and spin may not. Furthermore, the exchange of charge and spin exerts an influence upon the nuclear forces.

It is instructive to consider what happens if the lightest nuclei are built up by adding one neutron or one proton at a time. The first combination, that of a neutron and a proton, has a relatively low binding energy of 2.2 Mev. A somewhat greater binding energy is released if a neutron or proton is added (the values are 6.2 Mev and 5.4 Mev, respectively). If a fourth particle is attached in such a way as to build a helium nucleus a very great amount of binding energy is released. The total binding energy of the two neutrons and two protons in the helium nucleus is 28 Mev. The great stability arising from this large binding energy accounts for the appearance of α-particles in radioactive decay. If we now try to attach an additional neutron or proton to the α-particle we find that the fifth particle will be bound very loosely. This will seem all the more remarkable if one considers that the α-particle is the only nucleus which fails to combine with a proton or a neutron. A glance at the chart of the previous section will show that the mass number 5 is associated with nuclei of extremely short life (about 10^{-21} sec. for He^5 and Li^5).

This situation is undoubtedly connected with the fact that according to the exclusion principle four and only four particles can be placed in the same orbit. Two particles in the same orbit must differ either in spin or charge or both. Now a nuclear particle can take two spin directions and two charge values (0 for neutrons and +1 for a proton). Thus the maximum number of particles in the same orbit is four and we must consider the He⁴

nucleus to consist of two neutrons with opposite spins and two protons with opposite spins. Since a fifth particle cannot differ by charge or spin from the four previous particles, the application of the exclusion principle indicates that the fifth particle must be accommodated in a new orbit. As a consequence, this particle will be more loosely bound and might, in fact, have a binding energy approaching zero. Properties of matter inside nuclei heavier than the helium nucleus have certain simple common characteristics. In particular, nuclear densities for these nuclei seem to be fairly constant so that the cube of the radius is proportional to the mass number A, that is to the number within the nucleus. The total binding energy of the nucleus is also proportional to this number so that the binding energy per nucleon is constant. This latter statement does not apply very well to the heaviest nuclei for which the binding energy per nucleon shows a marked decrease. This, however, is caused by the coulomb repulsions between the protons within the nucleus rather than by any intrinsic change in the characteristic behaviour of nuclear matter itself. The fact that the volume and binding energy per nucleon is roughly a constant for all nuclei beyond helium has been ascribed to a "saturation" of nuclear forces. Apparently in the helium nucleus the nucleons have achieved a nearly optimal density and binding energy.

Many of the detailed properties of the nuclei were explained by the nuclear shell model (M. G. Mayer, J. H. D. Jensen *et al.*, 1949). According to this model, individual nucleons are found in well-defined orbits within each nucleus. Each of these orbits is characterized by an orbital angular momentum, *i.e.*, a momentum around the centre of the nucleus; by a radial momentum, *i.e.*, a momentum away from and toward the centre of the nucleus; and a total angular momentum which is composed of the orbital angular momentum and the one-half unit spin momentum of the nucleon. Increasing angular momenta and radial momenta correspond to increasing energies. According to the Pauli exclusion principle, each orbit characterized by the appropriate momenta and by the spin may contain not more than one neutron and one proton. The orbits are filled in successively, those with lowest energy being filled first. The energies of these orbits can be calculated and one can therefore predict in which order the orbits of various characteristics will be filled up. One finds that a surprisingly low energy is encountered whenever an orbit has practically no radial momentum, that is, whenever the path of the nucleon can be considered as circular, provided that the angular momentum of the orbit and the angular momentum corresponding to the spin are lined up parallel to each other. There are several orbits of the kind just described which differ from each other by their orientation in the spherical field of the nucleus. When all these relatively low-lying orbits are filled up, one obtains a closed shell configuration and one arrives at a particularly stable nucleus.

The procedure mentioned above agrees with experiments particularly well for heavier nuclei. Application of these ideas shows that nuclei with unusual stability will result if the neutron number or the proton number happens to be either 50, 82 or 126. Stability of such nuclei was noticed before the explanation was given. The peculiar properties of the corresponding nuclei led to the designation of "magic numbers" for the numbers 50, 82 and 126. It is of interest particularly to mention the nucleus Pb^{208}, which is "doubly magic" since it contains 82 protons and 126 neutrons.

The nuclear shell model has been most useful in predicting angular momentum values for a great number of nuclear isotopes both in their lower state and in their excited state. The possibilities of β-decay and also the possibilities of emission of γ-rays are closely connected with these angular momenta. Therefore the shell model made it possible to obtain a consistent connection between β-decays, γ-ray emissions and detailed nuclear structure.

The explanation of nuclear structure by the shell model is similar to the explanation of the periodic system with the help of the shell model of the electrons within atoms. A quantitative difference exists, however, in that in atomic physics the difference between incomplete shells and closed shells is more marked than it is in nuclear physics.

The nuclear shell model suggests that nucleons can move across nuclei in a relatively undisturbed manner. Indeed, if that were not so, it would be hard to understand why well-defined orbits may be ascribed to individual nucleons. This conclusion is somewhat surprising since all nucleons undergo strong forces when entering or leaving a nucleus. We are therefore led to the following model of nuclear forces. When a nucleon approaches a nucleus, it is attracted into the interior of the nucleus and is therefore strongly accelerated. Inside the nucleus, the nucleon does not encounter any strong systematic change of the potential and is not exposed to any appreciable average force. It moves in this region almost as though the inside of the nucleus were free space. When leaving the nucleus, the nucleon will experience a strong retarding force, and will lose the kinetic energy which it acquired upon entering. The above discussion ignores the possibility of an energy loss the nucleon may suffer while traversing the nucleus but it gives a qualitative idea of the forces found inside a nucleus.

Further development of the nuclear shell model took place in the 1950s. It received a strong impetus from the discovery that nuclei with particles that are far from forming a closed shell configuration are strongly deformed, being ellipsoidal rather than spherical. These ellipsoidal nuclei have a number of properties that are quite analogous to those of diatomic molecules. In particular, they have energy levels, arising from their rotational motion, that are spaced proportionally to the numbers 1, 2, 3, 4, ... It is found that these rotational states can easily be excited by permitting charged particles to collide with the nucleus, a process called Coulomb excitation. Attempts to improve the shell model to include a description of these phenomena (unified model of A. Bohr and B. R. Mottelson) had a considerable success and the resulting predictions inspired a number of fruitful experiments.

The nature of nuclear forces cannot be understood unless one considers both the field in a quiescent nucleus and that in a nuclear structure whose components undergo violent motion and acceleration. The situation may be clarified by a comparison with the electric forces that confine the electrons to their orbits within the atoms. These forces actually have two manifestations. On the one hand, they influence the orbits of the electrons. On the other hand, they give rise to electromagnetic radiation. The latter phenomenon occurs when the electric configuration within an atom suffers a sudden change and part of the electric field in the neighbourhood of the atom is shaken loose.

The situation is similar in the case of nuclear forces. On the one hand, they confine nucleons to their orbits. On the other hand, one has to expect that if a nucleus is subject to sudden and violent change, a peculiar nuclear radiation will be emitted. This nuclear radiation has been identified with at least some of the mesons which have been described above.

The nuclear radiations (that is, the mesons) differ in two basic respects from electromagnetic radiation. The first difference is that electromagnetic radiation may carry an arbitrarily small amount of energy. A meson, on the other hand, cannot carry an energy less than a certain given minimum amount. A mass corresponds to this minimum energy according to Einstein's relation of equivalence of mass and energy. For the π mesons, which have been most closely identified with nuclear radiation, this mass is approximately 270 times greater than the mass of the electron and is roughly one-seventh of the mass of a nucleon. The fact that the nuclear radiation has a minimum energy is connected with the short range of nuclear forces. As a result of this short range the time of vibration of nuclear radiation will necessarily be shorter than a certain minimum time. According to the mechanics of atomic systems, short times are necessarily connected with high energies. The existence of the mesons as a form of nuclear radiation was first postulated by H. Yukawa. These mesons were then found in cosmic radiation (*see* COSMIC RAYS) and later in nuclear reactions; they possessed the qualitative features that had been predicted.

The second important difference between electromagnetic radiation and nuclear radiation as represented by mesons is connected with the electric charge carried by the radiation. Electric radi-

ation does not carry a charge; many mesons do. The π mesons which are known to be connected with nuclear forces appear in three forms: the neutral π mesons, the positive π mesons which carry one positive unit of electricity and the negative π mesons which carry a negative unit. In their interaction with nuclear matter these three kinds of π mesons behave quite similarly. This fact is connected with the rule mentioned above that nuclear forces act similarly on protons and neutrons. The spin of the π mesons is known to be zero, that is, they do not carry an intrinsic angular momentum. Their mathematical description, however, exhibits a peculiar behaviour with respect to mirror reflections. It is a consequence of this peculiar property that emission of a π meson does not in itself cause a change in the angular momentum of the emitting nucleon but it is likely to cause an exchange of angular momentum between the spin and the orbit of the nucleon.

Many other kinds of mesons have been observed and some of these may well be connected with nuclear forces in a manner similar to the connection existing in the case of the π mesons. It will be, however, clear even to the most superficial observer that present hypotheses concerning nuclear forces have been introduced piecemeal, seem to consist of several independent statements and do not proceed by a cogent reasoning from a number of simple hypotheses. These are the marks of an unfinished theory. A more nearly complete explanation will probably contain unexpected elements and will probably form a more closed and simple pattern than the present disconnected set of assumptions.

XII. ENERGY PRODUCTION IN STARS

The energy source responsible for the radiation of the sun and stars was the subject of speculation for many years. It was recognized long ago that no known chemical reaction could keep the sun supplied with energy for more than approximately 100,000 years. Yet there is geological evidence that the sun must have been radiating at its present rate for 500,000,000 years; *i.e.*, during the period in which living beings seem certain to have inhabited the earth. More recent detailed theories of the interior of the stars did not lead to any suggestions as to some novel kind of chemical reaction (some kind of rearrangement of atoms or extranuclear electrons) which could account for the extremely great amounts of energy that the sun has emitted during its long history.

Somewhat more energy could be obtained from a slow gravitational contraction of the sun. It is not easy to construct a model of the sun (or stars), however, which would permit the sun to radiate at its present rate for more than a few million years without considerable change if gravitational energy were the main source of the energy radiated. Actually, a great concentration of mass near the centre of the sun could give rise to sufficiently high gravitational energies and a slow growth of this very dense core could account for the energy emission of the sun. In order to obtain the necessary energies one would have to assume near the centre of the sun densities of matter which are approximately 10^{12} times greater than the densities of water. Such high densities had been encountered only in the interior of nuclei.

It seems, therefore, most likely that the energy of the sun and stars results from nuclear transformations. The theory of the structure of the sun and stars has led to the conclusions that the central regions of these bodies are at temperatures approximately 20,000,000° to 50,000,000° F. At these exceedingly high temperatures atomic nuclei move with sufficiently high velocities so that occasionally they come in close contact and give rise to a nuclear reaction. Actually the average energy of atomic nuclei inside the sun is only 2,000 or 3,000 ev. This energy is rather low compared with the energies usually encountered in nuclear reactions. If the kinetic energy in the sun were as high as the kinetic energy of protons or α-particles which are used in the laboratory to produce reactions, then nuclear reactions on the sun would probably go to completion in a very short time and the sun would explode, rather than produce energy at a steady rate. The small kinetic energy of nuclei in the sun has the consequence that nuclear reactions take many times 1,000,000,000 years to go to completion (*see* SUN).

It is, of course, of interest to find out which specific nuclear reactions supply the energy of the sun. While there are numerous reactions which might, in principle, be considered, practically all of them were eliminated as the actual source. Some reactions would proceed too rapidly and result in burning up the nuclear fuel too quickly. Other reactions, in which heavily charged nuclei participate, proceed so slowly that they could not produce sufficient energy. In 1937 H. Bethe and others discussed this question and arrived at the conclusion that there are two series of reactions which jointly or separately may explain the behaviour of the sun and the stars. One of these series is the following: a proton collides with a C^{12} nucleus and is captured; the capture process is accompanied by the emission of γ-rays; the resulting N^{13} nucleus is β-active and transforms into C^{13}; a second proton collides with the C^{13} nucleus and is captured, again emitting γ-rays; by this process a stable N^{14} nucleus is formed; the latter captures a proton, emitting the capture energy as γ-rays; an O^{15} nucleus results; this nucleus is β-active and transforms to N^{15}; finally a collision of a proton and N^{15} gives rise to C^{12} and an α-particle. This series of reactions can be summarized in the following formulas:

$$C^{12}+H^1 \rightarrow N^{13}+\gamma$$
$$N^{13} \rightarrow C^{13}+e^+$$
$$C^{13}+H^1 \rightarrow N^{14}+\gamma$$
$$N^{14}+H^1 \rightarrow O^{15}+\gamma$$
$$O^{15} \rightarrow N^{15}+e^+$$
$$N^{15}+H^1 \rightarrow C^{12}+\alpha$$

It will be noted that as a result of the series four hydrogen nuclei have disappeared and one helium nucleus (α) has been formed. The original C^{12} nucleus has been reproduced at the end of the reactions. Apart from the energy released in γ-rays and kinetic energy, the net reaction can be written:

$$4H^1 \rightarrow He^4+2e^+$$

Indeed, hydrogen and helium seem to be the most abundant constituents of the sun. We have seen in earlier discussions that the building up of the helium nucleus releases more energy per unit mass than any other type of nuclear reaction. Thus the proposed mechanism employs the most abundant materials in the sun in the most effective manner.

The other series of reactions is the following:

$$H^1+H^1 \rightarrow H^2+e^+$$
$$H^2+H^1 \rightarrow He^3+\gamma$$
$$He^3+He^3 \rightarrow He^4+H^1+H^1$$

The net result is the same as in the previous series, namely the transformation of four protons and two electrons into a helium nucleus.

XIII. UTILIZATION OF NUCLEAR ENERGY

The release of nuclear energy for practical purposes may be classified as controlled or explosive. Both historically and technically the two aspects are closely connected. Nuclear explosives were a key factor in the great armaments race among the major powers which began at the end of World War II. Consequently, a full account of all important developments was often available to the general public only a considerable time after they occurred. Quantitative information was in general withheld if it had any bearing on the design of weapons. However, by the time of the Geneva Conference on the Peaceful Uses of Atomic Energy in 1955, the essential information then available on the nonexplosive release of energy by fission had been published. The processes involved may be described as follows.

If a uranium or thorium nucleus is hit by a neutron of appropriate energy nuclear fission results with considerable probability (*see* section on nuclear reactions). The two approximately equal fragments into which the nucleus separates carry a total energy of almost 200 Mev in the form of kinetic energy. Some of the energy released is present as internal energy of the fragments and a part of this internal energy splits neutrons off these fragments.

As a result of each fission process a few neutrons are obtained in addition to the fission fragments. These neutrons can enter other heavy nuclei; they cause fission and give rise to more neutrons. In each one of the steps the neutrons are multiplied. This results in a rapid increase in the total number of fissions and leads

within a short time, to a number of neutrons and a number of fissions comparable with the number of nuclei in the available material.

The multiplication of neutrons and the corresponding multiplication of fission processes is called a chain reaction. This repeatedly branching chain of reactions makes it possible that starting with a few neutrons one may end with so great a number that a substantial fraction of the myriads of nuclei is eventually involved in the process.

The simple type of chain reaction described here explains the functioning of the atomic bomb. When this reaction is initiated in an appropriate piece of material, energy is released so rapidly that a violent explosion results. In explosions carried out so far the energy released is equivalent to that produced by many thousands of tons of T.N.T. Fortunately none of the materials occurring in nature is capable of supporting a simple chain reaction that would give rise to an "atom bomb" type of explosion. In both thorium and ordinary uranium an additional reaction exists which competes with the fission process and renders the process harmless. This competing process is the absorption of a neutron in thorium or U^{238} according to the reactions:

$$Th^{232}+n \rightarrow Th^{233}+\gamma$$
$$U^{238}+n \rightarrow U^{239}+\gamma$$

In order to produce atomic bombs materials are needed in which competing processes do not occur. Such a material is U^{235}, an isotope which occurs in the natural mixture of uranium with an abundance of 0.7%. Separation of this isotope from naturally occurring uranium was carried out on a large scale in the United States during World War II.

Another material which can support a simple chain reaction and which can be used in atomic bombs is Pu^{239}. Plutonium is an element which carries two more charges than uranium and is the first element that has been artificially made and handled in considerable quantity. Plutonium is obtained from the abundant isotope of uranium, U^{238}. As mentioned above, neutron bombardment transforms this element to U^{239}. This material by two successive β-decay processes becomes Pu^{239}. The latter material was also produced in the United States during World War II.

Energy of the fissionable materials may also be released in a steady manner without any explosion. In order to accomplish this, the energy released in the fission processes must be removed by heat conduction. The energy which has been conducted can then be utilized as a source of power. The excess neutrons created in the fission process must also be absorbed so that instead of a multiplying chain reaction there is a chain reaction in a steady, self-sustaining state. In the process of neutron absorption artificial radioactive products frequently are generated which can be used in research and for medical purposes.

Up to the mid-1960s the use of nuclear reactors in producing materials for research had been perhaps of greatest importance. This usefulness is due to the fact that a radioactive atom has precisely the same chemical behaviour as its known radioactive counterparts or isotopes. Thus a radioactive carbon or sulfur atom will behave precisely in the same way as a normal carbon or sulfur atom. Because of its activity, however, it can be easily discovered in the most minute quantities. Thus, one can trace the path of substances introduced into a living system or into a piece of machinery throughout its passage and incorporation in the system.

There is no difficulty in constructing a reactor in which the neutron population remains steady. In order to accomplish this, the neutrons produced in fission must be disposed of either by absorbing them in other nuclei or by allowing them to escape through the surface of the system. In every case one will construct the chain-reacting system in such a way that the ratio between neutron loss and neutron gain can be regulated. The regulation can be achieved by lowering into the reactor a neutron-absorbing substance such as a rod containing boron. Neutrons are then consumed in the reaction

$$B^{10}+n \rightarrow Li^{7}+He^{4}$$

When the system starts to operate there are only a few neutrons around, produced by the cosmic rays or other sources. The neutron-absorbing substance is then withdrawn so that the neutron loss becomes less than the gain of neutrons caused by fissions. The neutrons start to multiply and soon the neutron density and the rate of fission reaches the level at which the system is to be operated. At this time the neutron-absorbing rod is reinserted to an extent that neutron absorption and neutron production are just equal. When the operation of the system is to be shut off, the neutron-absorbing substance is pushed in farther so that the neutron loss exceeds neutron production. The number of neutrons then decreases to the small value that it had originally.

The rate at which such a system releases energy is proportional to the neutron density. The density, in turn, may be regulated at will by choosing the instant at which the neutron-absorbing material is reinserted into the pile and the increase in neutron density is stopped. From a practical point of view the rate of energy release is limited, however, because it is possible to carry out of the system a limited amount of energy in the form of heat. If more energy is produced than can be carried away, this results in an increased temperature of the entire system. As a consequence the system may shut itself off or, failing to do this, may blow up. The main problem to be solved is, therefore, not the production of energy but its control and utilization.

The regulation of the level at which the neutron density is to be kept is greatly facilitated by the fact that some of the neutrons are produced in the fission process with some delay. The delay results from the fact that some fragments of fission undergo a β-decay before they emit a neutron. The lifetime of such a β-decay process ranges from a second to a minute and neutrons are emitted with delays of corresponding duration. These delayed neutrons are utilized in operating the chain-reacting system. The system is operated under such conditions that the neutrons produced instantaneously in the process are slightly fewer than the neutrons absorbed or otherwise lost in the system. Under the circumstances the reacting system always has to wait for these delayed neutrons for effective neutron multiplication to take place. The multiplication of neutrons is thus slowed down and there is plenty of time to adjust the neutron-absorbing material when the neutron density and energy production approach the desired values, or when there is an excessive increase in power production.

It is possible to construct chain-reacting systems of rather small extension and small weight. Nevertheless, there are serious problems in the practical use of such energy sources, although their lightness and power are highly desirable in aircraft. The reason is that the fission process and also later nuclear processes accompanying it emit considerable amounts of radiation in the form of neutrons, β-rays and γ-rays. If these were allowed to escape everyone who approached the chain-reacting machine would be killed. The system must be surrounded with an absorbing shield that is thick enough to reduce these dangerous radiations to an exceedingly small fraction of their original intensity. To achieve this purpose the shield must be heavy. This sets a severe limitation on the use of nuclear energy in machines that are small and easily moved. Despite these problems, nuclear aircraft were under development in the U.S. during the 1960s. While the apparatus that produces energy is of necessity both heavy and bulky, once it is set up it can function for a long time without being supplied with additional nuclear fuel. In the long run added fuel is needed but the weight of the raw material is completely negligible compared with the weight of coal or fuel oil needed for the same energy production. Thus nuclear power plants are independent of heavy fossil fuels. At the same time they can be more easily constructed than hydroelectric plants. Thus by the mid-1960s useful electric power was being produced by stationary nuclear reactors in the U.K., U.S.S.R. and U.S.; the latter two countries were operating nuclear-powered ships, including submarines and other vessels for commercial use.

The nuclear materials that can be most easily used in constructing nuclear power plants are the same as those needed for the atomic bomb. They are the materials in which nuclear fission occurs with greatest ease without too many competing processes that absorb neutrons. It is also possible to build a nuclear power plant using only common uranium, a substance which cannot be

used in atomic bombs. The reason is that ordinary metallic uranium cannot sustain a nuclear chain reaction because more neutrons are absorbed in the isotope U^{238} than are produced by fissions in both isotopes. Neutron multiplication can be obtained if some appropriate material, such as carbon, is added to the system. The neutrons produced in fission are slowed down by repeated collisions with carbon nuclei. Finally the neutrons are transformed into thermal neutrons and the slowing-down process ends. The U^{235} reacts preferentially with these slowed-down neutrons. In spite of the fact that U^{235} is present in the normal isotopic mixture to an extent of 0.7%, successful collisions between slow neutrons and U^{235} become frequent enough to give rise to a sufficient number of fissions and an excess of neutron production. The processes described need only common materials like uranium and carbon, but the neutron excess obtained in this way is small and losses must be carefully avoided. Such neutron losses always occur at the surface of the chain-reacting system. These surface losses can be reduced by making the machine bulky (*see* NUCLEAR ENGINEERING).

If a chain-reacting system is built up from ordinary uranium many of the neutrons produced are absorbed in the abundant U^{238}. The resulting U^{239} decays into Pu^{239}, a material which is usable in more convenient plants and also in atomic bombs. It should be noticed that every process of useful atomic energy production is closely connected with the destructive use which can be made of this great energy source.

In contrast with the situation for the release of energy by fission, information on the energy release by fusion was not fully available in the 1960s. The very existence of systematic attempts to make hydrogen bombs in the U.S. was not public knowledge until late 1949. In early 1950, Pres. Harry S. Truman ordered a full-scale attack on the problem. The exceedingly high temperatures necessary for the thermonuclear reactions made laboratory experiments difficult. The most readily available method for producing such temperatures was to explode an ordinary fission bomb. This was done in the tests in the spring of 1951. The resulting measurement of the rates of reaction together with intensive theoretical work and some imaginative innovations of design made possible actual tests of weapons in 1952 and later. A test of an apparently similar type of weapon was reported in the U.S.S.R. in 1953, and a British hydrogen bomb test was performed in 1957. There are two features of these weapons which have received considerable public attention. The first is their great energy release: they are rated as megaton weapons; *i.e.*, equivalent to several millions of tons of TNT on a scale such that the first atomic bombs exploded over Japan were 20,000-ton weapons. The second is the very large quantity of fission-product radioactivity they release.

The existence of systematic attempts by the U.S. and Great Britain to produce controlled thermonuclear reactions on earth was first announced at the Geneva conference in 1955. The problem is difficult because the extraordinarily high temperatures required make it hard to confine the reaction to a region of space. Efforts were being made in the 1960s to confine such fusion reactions in magnetic fields (*see* MAGNETOHYDRODYNAMICS).

XIV. HIGH-ENERGY EXPERIMENTS ON NUCLEI

The construction of a variety of high-energy particle accelerators and improvement in particle detection techniques in the decade after 1945 made possible a number of important experiments.

The primary purpose of many of the experiments was the search for new elementary particles and the systematic study of their properties. Once the characteristics of the new particles had been established, the experiments often could give information on nuclear structure. The study of π and μ mesons illustrates this situation. When a negative π or μ meson is slowed down in solid matter, it usually will form a mesic atom. Such atoms have nuclei like those of ordinary atoms, but a negative meson moves on a Bohr orbit around the nucleus. The orbits of the meson are smaller in size than the corresponding electron orbits by the ratio of the electron to meson mass and their binding energy is larger by the inverse of that ratio. Just as in ordinary atoms, a transition from one Bohr orbit to another results in the emission of a photon. (In heavy elements and for the larger Bohr orbits photon emission by the meson is less probable than the Auger effect, in which the energy released by the transition is transferred not to a photon but to one of the electrons of the mesic atom.) Because of the higher binding energy of mesons, the most energetic photons emitted by π and μ mesons in light atoms such as carbon and beryllium are X-rays rather than visible light. In the case of the π meson, these mesic X-rays can be measured accurately by comparing them with X-rays emitted in electron transition in medium heavy elements. Such measurements led to a precise determination of the π meson energy level separations, and indirectly to a very accurate measurement of the π meson mass. In fact, the measurements were so precise that it was possible to detect small deviations from Coulomb's law for the electric force between nucleus and the π meson. These deviations had been predicted as early as 1934 on the basis of the quantum theory of radiation, but had previously not been supported by such direct and clear-cut evidence. In the case of μ mesons, it was the heavier μ mesic atoms which were studied mostly at first, and the results, together with those from electron scattering by nuclei, led to a much more accurate picture of the distribution of charge in the nucleus (V. Fitch and J. Rainwater, 1953). It turned out that for heavy elements the radius (actually square root of the average value of the square of the radius) of the charge distribution was given by $r = r_0 A^{1/3}$ where $r_0 = 1.2 \times 10^{-13}$ cm. This result was in contrast with earlier estimates of the radius which had given r_0 between 1.3 and 1.5×10^{-13} cm.

The "small" value of r_0 was confirmed by the study of electron scattering by nuclei (R. Hofstadter and coworkers, 1953), in experiments which eventually led to a quantitative determination of the shape of the charge distribution. The difference in the values of r_0 just mentioned is not a discrepancy; the nucleus has a different apparent radius depending on what method is used to look at it. The larger values are obtained from such methods as fast neutron scattering in which the finite range of interaction of nuclear forces makes the nucleus appear larger.

Another discovery in elementary particle physics which made possible an entirely new kind of insight into nuclear structure was that of the so-called Λ hyperfragments or Λ hyperons (M. Danysz and J. Pniewski, 1953). These are nuclei in which a neutron or proton is replaced by a Λ^0 particle. The resulting system lasts about 10^{-10} sec., which is the time it takes a free Λ^0 to decay into proton and π meson. The great virtue of the Λ^0 from the point of view of the study of nuclear structure is that the Pauli principle does not restrict the states a single Λ^0 can occupy in a nucleus formed of neutrons and protons.

Another discovery came out of experiments using proton beams of 100–400 Mev energy. It was found that those protons which are scattered without loss of energy are very strongly polarized; *i.e.*, the scattered protons have spins almost all of which point to one side of the plane determined by the line of flight of the incident and scattered proton. On the other hand, for incident protons of energies of 10 Mev the polarization effect is very small. Similar effects were found for neutrons. This remarkable polarization of high-energy particles made possible a series of important investigations on the spin dependence of nuclear forces.

The importance of high-energy investigations for nuclear physics was emphasized with the discovery of the antiproton (O. Chamberlain *et al.*, 1955). The existence of this particle as well as the confirmed (1956) existence of the antineutron was indispensable for the consistency of nearly all then existing attempts at a fundamental theoretical interpretation of nuclear properties. It was comforting to the theoreticians, whose attempts at a quantitative theory of nuclear forces had been frustrated, to find that one of their basic ideas was correct. In any case, the interaction of antiprotons and antineutrons with nuclei provides an important piece of evidence about the nature of nuclear forces (*see* ANTIMATTER).

See also references under "Nucleus" in the Index.

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(E. TE.; M. L. A.; A. S. W.)

NUDISM. This article deals with the conscious, intentional movement to practise nudity without separation of the sexes which commenced at about the beginning of the 20th century in the German *Nacktkultur* ("naked culture") groups. Prior to World War I they consisted largely of middle-class persons of rather strong nationalistic tendencies. Between the two world wars, the movement expanded considerably not only in membership but in its range of opinions, extending from the most conservative to the most radical. Several books and magazines describing, and some of them advocating, nudism were published.

Mainly following the German example, nudist societies were formed in England, France, Scandinavia and a few other European countries. During the 1930s similar societies were formed in the United States and Canada. The nudist movement was hindered by World War II. It has not made much progress in most of the Roman Catholic and Latin countries.

Nudist groups have been organized as membership societies or as proprietary enterprises. They have dreamed and talked of self-sustaining agricultural and industrial colonies in a suitable environment which would adopt the simple manner of life and humanitarian democracy of nudism. Such colonies as enclaves in a predominantly clothed society are hardly feasible. For the immediate future only private terrains for leisure time and recreational use are practicable. The next step may be the setting aside of some of the public baths and parks for nudist use, as has been done in a few German cities.

Prevailing moral conventions, legalized in many jurisdictions, render it difficult, especially for women, to join nudist organizations. While census enumeration of extra-legal groups is not possible, there are probably not more than several hundred thousand such members in the whole world. There is perhaps a somewhat larger number who practise nudism in small family and private groups.

The Rationale of Nudism.—Man originated as a nude animal, perhaps covered with fur. The habit of clothing the body has varied greatly in time and place. The need for protection from cold climate and from harmful animals and plants, and decoration of the body produced various types of garments.

Cultural evolution gave rise to secondary reasons for clothing. Wealth and property rights attached a symbolic meaning to dress. The garb and ornamentation became indicative of rank and wealth. The apparel has often had a ceremonial and ritual significance. Property rights in women emphasized the concealment of the female body. These factors led to powerful dress conventions, and often to ridicule and persecution of unconventional raiment, and especially of the nude body.

There arose the belief that it is immodest and indecent to expose the human, and especially the female, body, and the sexual organs of both sexes. Shame has usually been experienced at violations of these conventions as to clothing, and penalties have been imposed upon such violations.

The nudist movement is a reaction against these dress conventions. Nudists have argued that clothing cuts off the human body from the air and sunlight, and that the practice of nudity is beneficial for health, and thereby improves human beauty. It aids the rearing and education of the young by acquainting and accustoming them to the sexual traits of both sexes, whereas concealment of the body from infancy creates many harmful mental complexes.

Under society's conventions nudity is forcibly and gratuitously associated with sex in the youthful mind. It is asserted that the practice of nudism aids sex education, is the best preparation for mating and marriage, and is a powerful eugenic factor by uniting the healthiest human beings.

Its advocates hold that nudism creates a higher standard of sincerity and frankness between the sexes, by removing the last artificial barrier. It helps to destroy the notion that sex is peculiarly, and perhaps perilously, mysterious and harmful, especially in women. It weakens sex segregation and strengthens human solidarity. It encourages comradeship between the sexes in work and play, and emphasizes the disutility of clothing in many respects.

Nudism has been criticized and attacked from somewhat different points of view. On the one hand, it is alleged that the sexual areas, such as the pubic hair, the female breasts and the masculine reflex, namely, the penile erection, arouse sexual emotions (in public) and are therefore indecent and unfit to be seen.

On the other hand, it is asserted that the art of dress conceals much ugliness, and enhances the variety and beauty of human existence. Furthermore, nudism, by complete exposure, is accused of decreasing visual sex stimulus, though tactile, olfactory, auditory and gustatory stimuli may be increased. Nudism is therefore alleged to be puritanical and ascetic.

The argument against nudism that the human body, or any part of it, is indecent in the sense that it necessarily and almost inevitably arouses passionate feelings, especially in the male sex, is refuted by nearly every observer of nudist practices. Shame, or a painful consciousness of guilt at the sight of the body, disappears almost immediately. This demonstrates that it is due to artificial modesty caused by prevailing conventions of dress, and is not inherent.

Nudists hold that the movement has psychological and sociological significance for the education of the young and the relations between the sexes, and that it may aid the spread of democracy by eliminating status symbols and artificial insignia of inequality.

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NUER, a Nilotic people, some 300,000 in the 1960s, who live in the marshy and savanna country on both banks of the Nile in the southern Sudan. They are a cattle people, devoted to their herds, although milk and meat must be supplemented by the cultivation of millet and the spearing of fish, in which the many rivers, streams and lakes of their country abound. Since the land is flooded for part of the year and parched for the rest of it, the people lead a transhumant life, spending the rainy season in permanent villages built on the higher ground and the dry season in riverside camps where there are water and pasturage even at the height of the drought.

Politically, the Nuer form a group of tribes. There is little unity and much feuding within a tribe; the frequent homicides are settled, if they are settled at all, by payments of cattle effected through the mediation of a priest of the leopard skin. Such unity as they display is partly due to the fact that each tribal territory is owned by one or other patrilineal clan. The members of a clan have in their territory a slightly privileged status, although they form a minority of its population. The majority belong to other clans or are descendants of the neighbouring Dinka people, large numbers of whom have been subdued by the Nuer and incorporated into their society.

In each tribal area the men are divided into six age sets. A boy is initiated into his set at puberty with various rites, including the cutting of six deep cuts, running from ear to ear, across his forehead. All boys initiated during a period of about six years belong to the same set. Then there is a four-year interval during which no initiations take place, at the end of which a new age set is formed.

Marriage, which is polygynous, is marked by the giving of cattle by the bridegroom's people to the bride's kin, both paternal and maternal, and by betrothal and wedding ceremonies. The levirate is practised; and since it is held that every man must have at least one male heir, it is the custom for a man's kin to marry a wife to his name and to beget children by her should he die unmarried.

The Nuer clans involve segmentary lineages to which the Nuer attach great importance, and everyone knows his exact genealogical relationship to every member of his lineage and clan. Apart from these agnatic relationships, they attach importance also to kinship ties through their mothers and to affinal ties, and a Nuer can establish a kinship link of one sort or another with most of the people he meets.

The Nuer may be said to be a very religious people. They pray and sacrifice beasts of their flocks and herds to a spirit associated with the sky, but also thought to be ubiquitous, like the air. This spirit is conceived of as a single creative spirit in relation to mankind as a whole, but it is also figured in different representations in relation to different social groups, such as clans, lineages and age sets, and it may then be symbolized by material forms, often animals or plants. *See* also NILOTES.

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NUEVA ECIJA, an agricultural province in central Luzon, Republic of the Philippines, drained by the Pampanga river. Area 2,120 sq.mi. Pop. (1948) 467,769; (1960) 608,362. The eastern part of the province is mountainous but the central and western portions are a part of the level central plain of Luzon. It is the leading rice producing province (in tonnage). Other crops are sugar cane, tobacco, corn (maize), onions and other vegetables. Cabanatuán, pop. (1960) 26,397, on the left bank of Pampanga river, is a chartered city, the provincial capital, and the centre of commercial activity. The western part of the city is primarily commercial (theatres, shops, rice mills, etc.); the eastern part is the site of the government buildings, provincial hospital and schools, but has some commercial activity.

The principal towns are San José, Gapán, Cuyapo and San Antonio. After World War II, Nueva Ecija became the principal centre of dissident activities by the Hukbalahaps until the rebellion ended in the mid-1950s. (AN. C.)

NUEVA ESPARTA, a state in Venezuela, consists of about 70 islands and cays extending for a distance of some 320 mi. along the Caribbean coast. Area 444 sq.mi. Pop. (1961) 89,492, most of which live on Margarita Island (*q.v.*), the largest and most important of the group.

The capital of the state is La Asunción. The state has important fisheries; 75% of Venezuela's commercial catch takes place in the northeastern area, of which Nueva Esparta forms a major segment. Pearl fishing is important but less so than in the past. There is a small amount of agriculture and a few handicrafts—hammocks, straw hats, pottery and roof tiles. (L. WE.)

NUEVA SAN SALVADOR: *see* SANTA TECLA.

NUEVA SEGOVIA, a small department of Nicaragua, in the central highlands adjacent to Honduras. Area 1,593 sq.mi. Pop. (1959 est.) 36,351, primarily rural. The largest town and departmental capital is Ocotal, pop. (1959 est.) 3,723. Most of the population is in highland basins and valleys in the central part of the department; the remainder of the department is very sparsely settled, owing to rugged relief, poor soils and lack of transportation facilities.

The settled basins and valleys, some with fertile volcanic soils, produce coffee, livestock, corn, wheat, vegetables and subtropical fruits. A second-class road, 15 mi. long, connects Ocotal with the Inter-American highway. (C. F. J.)

NUEVA VIZCAYA, a province of the Republic of the Philippines, in north central Luzon. Area 2,627 sq.mi. Pop. (1948) 82,718; (1960) 138,090. At the junction of the Sierra Madres and the Central Cordillera, it is principally mountainous terrain and is drained by the headwaters of the Cagayán river and its longest tributary, the Magat.

Agricultural products are rice, corn, tobacco, coconuts and livestock. The capital is Bayombong, pop. (1960) 17,499. Solano, Bambang and Bagabag are other principal towns; all four are in the Magat valley. (AN. C.)

NUEVO LAREDO, a border city in the Mexican state of Tamaulipas, across the Rio Grande from Laredo, Tex. Pop. (1960) 92,627. The town has a bullring and some night life for the visiting tourist. Irrigation of the contiguous area by waters from the Rio Grande brought some growth and wealth to the city in the 1950s. At Nuevo Laredo begins the highway leading to Mexico City (757 mi.) via Monterrey, northern Mexico's industrial centre, Ciudad Victoria, and Ciudad de Valles.

The railway from San Antonio to Mexico City also passes through Nuevo Laredo. The city is a cattle and oil centre of growing importance. (J. A. CW.)

NUEVO LEÓN, a northern state of Mexico. Pop. (1960) 1,078,848. Area, 24,925 sq.mi., with its capital at Monterrey (*q.v.*). Crossed by paved trunk highways and railways between Laredo, Tex., the gulf port of Tampico, and Mexico City, the state is a major industrial section and an important agricultural region lying just north of the Tropic of Cancer. With an average altitude of about 5,500 ft., the Sierra Madre Oriental runs southeasterly through the state.

The climate is arid and semiarid in the north, where sandy wastes are covered with cactus and scrub. The eastern slopes are endowed with vegetation, and the mountainous sections are covered with forests; subtropical valleys in the east permit sugarcane cultivation.

There is considerable irrigation. Though there are a number of rivers and streams, none is navigable. Water for irrigation is in part drawn from the international Falcón dam, jointly constructed by Mexico and the United States for hydroelectric power, flood control and agricultural purposes.

Nuevo León produces few minerals, but quantities of cotton, citrus, sugar, cereals (especially maize and wheat) and vegetables. Its fibres have importance, notably *ixtle* from agaves (cactus), which also furnish distilled liquor, mescal. The main importance of Nuevo León lies in its industries. Its iron- and steelworks and smelting plants were the first heavy industry in Latin America, and in addition it supports numerous textile enterprises, a large beer factory and other industrial activities.

Nuevo León became a state in 1824. It was occupied by U.S. forces in the Mexican War. The state has no Indian population and its standard of living is near the highest in Mexico. It has well-developed air connections and good schools, colleges and hospitals. (J. A. CW.)

NUFFIELD, WILLIAM RICHARD MORRIS, 1st VISCOUNT (1877–1963), British automobile manufacturer and philanthropist. As William Richard Morris, he was born at Worcester on Oct. 10, 1877, the son of a farm labourer. The family moved to Oxford in 1880. When William was 15 years of age, his father's illness obliged him to give up his ambition of studying medicine and go out to work. The bicycle era was just beginning among undergraduates, and William set up a repair shop behind his home in James street, Cowley. He also built machines to order and raced his models with success. Later he sold and maintained motorcycles, building as many as his limited finances allowed, and naturally extended his interest to cars. In 1903 he took in a partner, but the garage went bankrupt. In 1904, with only his own tools left and a £50 debt, he started again. That same year he married Elizabeth Maud Anstey (d. 1959), whose parents lived in Oxford and who also was a keen bicyclist. There were no children.

By dint of hard work and constant application, Morris' business began to prosper again. He set up works in Cowley, and the first Morris-Oxford, an 8.9-h.p. two-seater, appeared in 1913, to be followed by the equally famous Morris-Cowley (11.9 h.p. after he had visited the United States with a designer and had contracted to buy an engine to fit into his English chassis. Then, as later, Morris aimed to produce small, reliable vehicles at the low prices made possible by standardization and mass production, and in doing so he revolutionized the British automobile industry much as Henry Ford had done in the U.S. Morris Motors Ltd., founded in 1919, survived the 1920–21 motor slump because Morris boldly slashed his prices (during 1921 the price of the Cowley four-seater dropped from £525 to £341). From then on his business expanded, and in 1923 the flourishing Morris Garages built the first MG. In the same year Morris founded Morris Commercial Cars Ltd., and in 1927 he acquired Wolseley Motors Ltd. Morris Motors Ltd. was reorganized in 1935–36 to include these three companies, and it also absorbed Riley (Coventry) Ltd. in 1938. When the firm merged with the Austin Motor company in 1952, the resulting company, the British Motor corporation, was the third largest automobile company in the world.

Morris was made a baronet in 1929 and a baron in 1934. In 1938 he became Viscount Nuffield. From about 1933 onward he began to relegate administrative control of his businesses to his senior executives—he never had any close colleagues—and to devote himself to charitable works, each of which he planned with great care and to which his donations exceeded £30,000,000 in all. Among the principal beneficiaries are hospitals; war charities; Morris employees; the Nuffield Institute for Medical Research, Oxford (founded 1935); the Nuffield trust (1936); Nuffield college, Oxford (1937); and the Nuffield foundation (1943), which aims to further "health . . . social wellbeing . . . care of the poor . . . and education."

A man of determination and an enlightened employer, Lord Nuffield was admired as an outstanding figure of British industry and revered as a great philanthropist. He died at his home near Huntercombe, Henley-on-Thames, on Aug. 22, 1963.

See P. W. S. Andrews and E. Brunner, *Life of Lord Nuffield* (1955). (M. Th.)

NUISANCE, a legal term used to denote a human activity or a physical condition on land that is harmful or offensive to others. A distinction must be drawn between a public nuisance and a private nuisance. A public nuisance is an offense against the state, either (1) because the activity occurred or the condition was created in a public place or on public land, or (2) because the activity or condition affects the morals, safety or health of the community. Illustrations of the former are obstructions of a public road and the pollution of streams, while the running of houses of prostitution and the keeping of explosives are examples of the latter. A private nuisance is an activity or condition that causes an interference with the use and enjoyment of the neighbouring privately owned lands, without, however, constituting an actual invasion of the possession of the neighbours. Thus, excessive noise, noxious vapours, disagreeable odours and vibrations may constitute a private nuisance to the neighbouring landowners, although there has been no physical invasion of their lands either above or below the surface.

A public nuisance, as such, is only actionable by the state, either by way of criminal proceedings, injunction or physical abatement. However, the same activity or conduct that constitutes a public nuisance to the community may also create a private nuisance to the neighbouring landowners. Thus, the conduct of a business in violation of a zoning ordinance creates a public nuisance, but it may also be actionable as a private nuisance by neighbouring residential landowners upon proof of decrease in market value of their homes as a result of this business activity.

Since a private nuisance is based upon interference with the use and enjoyment of land, it is only actionable by persons who have a property interest in such land. Where the interference inflicts no physical damage to the land but merely makes its use and enjoyment less comfortable, the courts look at the character of the neighbourhood to determine whether the activity or condition is an unreasonable interference with the use and enjoyment of the neighbouring landowners. Thus, a factory in a predominantly residential area may be a private nuisance while the same business in a commercial area would not be. On the contrary, an activity or condition that causes physical damage to the neighbouring land will be held to be an actionable nuisance irrespective of the character of the neighbourhood. These are usually cases involving vibrations that cause walls to crack or noxious vapours that destroy vegetation. The judicial remedies available in case of a private nuisance are an action at law for money damages or a suit in equity to enjoin the operation or continuance of the activity or condition. Where the abatement of a nuisance by injunction will impose an excessive hardship on the community, the usual practice of the courts is to deny an injunction and award money damages for the injury suffered by the neighbouring landowners. Illustrations of this are cases involving factories employing many workers in the community, who would be deprived of their livelihood if the factory were closed or forced to move.

See also Tort; Noise and Its Control. (R. R. Re.)

NUKUS, capital of the Kara-Kalpak Autonomous Soviet Socialist Republic (part of the Uzbek S.S.R.) in the U.S.S.R., is situated on the right bank of the Amu-Darya river at the head of its delta 18 km. (11 mi.) from the railway station of Khodzheili. Pop. (1959) 39,000. Founded in 1933 as a town, Nukus has a large alfalfa-processing plant and a number of small light industries mostly producing food and clothing. There are a teachers' training college, a medical training school, a museum and a theatre. (G. E. Wr.)

NULLIFICATION (State Interposition) was a doctrine that asserted the right of a state in the American federal union to prevent within its borders the enforcement of an act of the federal government not authorized by the U.S. constitution as interpreted by the highest legislative authority of the state. The doctrine reached its most advanced point of theoretical development and application in 1832 in South Carolina. The best explanations of nullification are to be found in the writings of John C. Calhoun (*q.v.*), who may have promulgated the doctrine in order to forestall a secession movement in his state. Calhoun and his precursors, who had produced in South Carolina an incipient form of the doctrine, disclaimed originality for their basic ideas, arguing that they were derived from Jefferson's Kentucky resolutions of 1798, Madison's Virginia resolutions of 1798 and report of 1799, and the Kentucky resolutions of 1799.

The resolutions that Jefferson drafted for the Kentucky legislature in 1798 asserted that the constitution of the United States was a compact subscribed to by the states, which had delegated specific powers to the federal government and retained all others; "that the government created by the compact was not made the exclusive or final judge of the extent of the powers delegated to itself"; and that the states could declare null and void within their boundaries those acts that they deemed not authorized by the U.S. constitution.

Although the Kentucky resolutions of 1799 used the word nullification and referred to the states as sovereign and independent, they were not incompatible with the view of Madison and others among his contemporaries that sovereignty in the United States was divided between the federal and state governments. Neither Jefferson nor Madison repudiated the view generally held by the framers of the constitution that the federal judiciary possessed an implied power to pass upon the constitutionality of federal and state legislation, but they denied that the states must accept its decisions as final in all cases.

Calhoun's view of the judiciary was the same as Madison's, but he rejected unequivocally and explicitly the theory of divided sovereignty. He based his interpretation of nullification on the premise that each of the states was completely sovereign, and as such, when acting through a special convention capable of ratifying the U.S. constitution or revising the state constitution, could either nullify an unconstitutional federal act or withdraw from the union.

Calhoun's most distinctive contribution to the theory of nullification was his rationale of it as an integral part of the American system of government, with aims that were positive, conservative, peaceful and national. For Calhoun, nullification was the means by which a minority in the nation, if it happened to be in the majority in a single state, could utilize a state government to force the national majority either to compromise with the minority by consenting to a revision of federal legislation or to obtain a constitutional amendment that would grant an undisputed authority to the federal government to overrule the constitutional opinion of the nullifying state. He expressed confidence that the practical outcome of nullification would be compromise or constitutional amendment, for, he argued, the national majority would surely prefer peaceful and orderly procedures to the alternatives of anarchy or civil war.

What happened in South Carolina and the national capital in 1832 and 1833, he could reasonably interpret as a vindication of his expectations. In Nov. 1832 a special state convention in South Carolina, taking the position that the delegated power of congress to levy imports was intended solely for the purpose of raising revenue and for no such purpose as encouraging manufactures, declared the tariff laws of 1828 and 1832 unconstitutional, announced that they would become null and void in the state after

Feb. 1, 1833, and warned that secession would be the consequence of federal coercion.

On Dec. 10, 1832, Andrew Jackson issued a presidential proclamation denouncing and refuting the doctrine of nullification, and in Jan. 1833 a bill was introduced in congress authorizing the president to use force to collect import duties. However, the same congress that had passed the tariff bill of 1832 in June and that was to approve the Force bill adopted the compromise tariff of 1833 on March 1. From Calhoun's standpoint, South Carolina's action had forced representatives of the national majority in congress to reconsider and to compromise with the minority.

Never in U.S. history has nullification, as it was expounded by Calhoun, been tested in all of its ramifications, although, before 1865, one of its strands or another was present in numerous federal-state disputes.

In South Carolina, the one state where an ordinance of nullification was approved by a special state convention, the controversy was settled before attempts were actually made to stop collection of import duties.

Following the supreme court decision in the case of *Brown* v. *Board of Education* (1954), declaring racial segregation in the public schools to be unconstitutional, nullification was once again discussed in the south by defenders of segregation, but no state government chose to imitate what South Carolina did in 1832. Instead, the course generally followed was to adopt state-interposition resolutions similar to the Virginia resolutions of 1798 and to avoid compliance wherever and whenever litigation, evasive legislation or an absence of federal-court decrees would permit.

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NUMANTIA, a Celtiberian town near modern Soria on the upper Douro (Duero) river in Spain, lay on a hill at the junction of two rivers. It was founded on the site of earlier settlements (from 2000 B.C.?) by Iberians who penetrated the Celtic highlands about 300 B.C. Later it formed the centre of Celtiberian resistance to Rome, withstanding attacks by Cato (195), Q. Fulvius Nobilior (153), M. Claudius Marcellus (152), Q. Pompeius (141–140) and Popillius Laenas (139–138). Finally Scipio Aemilianus, with 60,000 troops against 4,000 Numantines, blockaded it by establishing six miles of continuous lines of circumvallation, with two main and five subsidiary camps at intervals. After a siege of eight months Numantia was reduced by hunger and the survivors capitulated (133). Its destruction ended all serious resistance in Celtiberia to Rome. Numantia was rebuilt by Augustus, but it had little importance, except as a stage on the road between Caesaraugusta (Saragossa) and Asturica (Astorga). In the 11th century A.D. a village named Garray was built at the foot of the hill. The site of Numantia was excavated by Adolf Schulten (1905–12), who revealed the Celtiberian town and Scipio's siegeworks as well as other Roman camps in the neighbourhood.

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NUMA POMPILIUS, successor to Romulus as king of Rome (traditionally 715–672 B.C.). He can be accepted as a historical personage, but many of the details of his reign must be regarded with skepticism. His name indicates a Sabine origin and indeed he is said to have come from the town of Cures in the Sabine district and to have been the son-in-law of Titus Tatius. In legend he is the peaceful counterpart of the more bellicose Romulus, whom he followed after an interregnum of a year during which the sovereignty had been exercised by the members of the senate in rotation. He is credited with the founding of nearly all the early religious institutions, the formulation of the religious calendar and the organization of the priestly colleges at Rome. These reforms were, however, undoubtedly the result of centuries of religious development going back to prehistoric times and continuing down into the republican era and thus are not to be assigned to any single man.

Numa's calendar reform involved the addition of two months to an original ten and the assignment of regular dates for the annual religious festivals, thus fixing the days of business and holiday. According to tradition he built the temple of Janus, whose doors were open in times of war and closed in times of peace, appointed the first flamens (priests) of Jupiter, Mars and Quirinus; organized the Vestal Virgins along the lines of the cult at Alba; appointed the 12 Salii to supervise the worship of Mars Gradivus; established the Regia; and appointed the first *pontifex maximus*.

Several corruptions in the legend are obvious: a supposed relationship with Pythagoras, which is chronologically impossible, and the clear forgery of 14 books in Latin and Greek relating to philosophy and pontifical law supposedly written by Numa and uncovered at the foot of the Janiculum in 181 B.C. They were ordered to be burned as tending to undermine the established religion. The story of his connection with the nymph Egeria who purportedly inspired him in much of his religious reform, is likewise a comparatively late interpolation.

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NUMBER means a positive integer such as 17, a real quantity such as π or -2, or an element of any of various abstract mathematical generalizations of the system of positive integers and the system of real numbers. These generalizations include complex numbers, quaternions and other hypercomplex numbers, modular numbers and transfinite cardinal and ordinal numbers; all these types of numbers will be defined below.

POSITIVE INTEGERS

Definition of Cardinal Numbers.—The concept of a positive integer arose in prehistoric times from recognition of the fact that the number of elements in any class (say the number of sheep in a herd) can be represented in various ways (say by a pile of stones). The essential idea is that there must be a one-one correspondence between the sheep in the herd and the stones in the pile. By this we mean that it must be possible to pair off one sheep with each stone, in such a way that no sheep is counted twice, and no sheep and no stones are left over.

In the same spirit, modern mathematicians define a cardinal number as a mark associated with a class, and with all other classes in one-one correspondence with this particular class. Thus the integer 5 is the mark associated with the class of fingers on a hand and with all other classes whose elements can be paired off with the fingers on a hand.

A large variety of marks to represent the different positive integers have been developed by different civilizations. These are discussed elsewhere (*see* NUMERALS AND NUMERAL SYSTEMS). The positional notation developed by the Hindus and Arabs, in which the position of a digit to the left of the decimal point indicates the power of the radix or base ten involved, is incomparably superior to earlier systems. However, it is not to be supposed that the base ten has any unique qualifications. Our interest here is not in systems of notation or effective computation (*see* ARITHMETIC; COMPUTER; OFFICE MACHINES AND APPLIANCES) but in the fundamental ideas which underlie the use of number. Two of these are addition and multiplication.

Addition and Multiplication.—If a and b are the integers (cardinal numbers) for two classes A and B having no elements in common, and if these classes be combined to form a new class S, then the integer s representing the class S is called the sum of a and b, and we write $s = a + b$.

From this definition we easily prove the commutative and associative laws of addition,

$$a + b = b + a \quad (1)$$
$$a + (b + c) = (a + b) + c$$

Here and below, the equality sign means that the classes represented by the two sides of the equation can be placed in one-one correspondence. Thus, both $a + (b + c)$ and $(a + b) + c$ represent the combination of three classes A, B, C without common elements, having a, b, c elements, respectively.

Similarly, there may be a classes, each of which contains the same number b of elements, while no two of these classes have an element in common. If all these classes are combined to form a new class P, the integer p representing P is called the product of a and b, written $p = a \times b$.

From this definition, one can also prove the commutative and associative laws of multiplication,

$$a \times b = b \times a \tag{3}$$

$$a \times (b \times c) = (a \times b) \times c \tag{4}$$

as well as the distributive law, which asserts that

$$a \times (b + c) = (a \times b) + (a \times c) \tag{5}$$

Brief further discussions of laws (1)–(5) may be found elsewhere (*see* ASSOCIATIVE LAWS; COMMUTATIVE LAWS; DISTRIBUTIVE LAW); formal proofs may be found in textbooks on mathematics (*see* G. Birkhoff and S. MacLane, *A Survey of Modern Algebra*, ch. xii [1953]). Informal graphical proofs follow.

For example, $a \times b$ is the number of elements in a rectangular array of a rows and b columns: rotation through 90° converts this into a rectangular array of b rows and a columns. Again, $a \times (b + c)$ is the number of elements in a rectangular array of a rows and $b + c$ columns. This array is the sum of two rectangular arrays without common elements, having respectively a rows and b columns, and a rows and c columns. This is $(a \times b) + (a \times c)$.

The laws (1)–(5) are often called the five fundamental laws of arithmetic; in addition, the special unit law

$$a \times 1 = a \tag{6}$$

is evident. Other laws also follow from a detailed logical analysis of the situation. For example, equality satisfies the reflexive law, that $a = a$; the symmetric law, that $a = b$ implies $b = a$; and the transitive law, that $a = b$ and $b = c$ imply $a = c$. Moreover, addition and multiplication are single-valued operations, so that if $a = b$, then $a + c = b + c$ and $a \times c = b \times c$. To explain the relation of such laws to our definitions, consider the statement that $a = b$ implies $a + c = b + c$. This means that if there is a one-one correspondence between two classes A and B, and if C is any class having no elements in common with A or B, then there is a one-one correspondence between the combination (sum) of A and C and that of B and C.

However, a good understanding of the laws of arithmetic is possible on the basis of (1)–(6) alone.

Ordinal or Inductive Definition.—In the last two sections the concept of a positive integer was based on the concept of a class and general principles of the logic of classes. But it is also possible to take a more formalistic view and to base arithmetic on laws (1)–(6) without referring to the idea that integers represent classes.

We must first know the order of the integers (*i.e.*, which positive integer follows which). Then if we start with the principle that $a + 1$ is the successor of a (number following a), and apply repeatedly the special case

$$a + (b + 1) = (a + b) + 1 \tag{2'}$$

$c = 1$ of the associative law, we readily get the addition table. Thus, we get $5 + 1 = 6$, $5 + 2 = 5 + (1 + 1) = (5 + 1) + 1 = 6 + 1 = 7$, etc.

Similarly, the multiplication table can be constructed ordinally from the unit law (6) and the following special consequence

$$a \times (b + 1) = (a \times b) + (a \times 1) = (a \times b) + a \tag{5'}$$

of the distributive laws (5) and (6). Thus, we get $5 \times 1 = 5$, $5 \times 2 = 5 \times (1 + 1) = (5 \times 1) + 5 = 10$, etc.

Hence, we can say that the identities (2), (5), (6) imply all the arithmetic of positive integers, since they tell us how to add and multiply any two positive integers.

G. Peano put this principle in an even more striking form about 1900. He first characterized formally the sequence of positive integers by the following postulates: (i) each positive integer n has a successor, written n^+; (ii) $m^+ = n^+$ implies $m = n$; (iii) there is just one positive integer, called 1, which is not the successor of any number; (iv) any set C of positive integers which includes 1, and which includes n^+ if it includes n, must include every positive integer. Condition (iv) is called the principle of finite induction; it is intuitively evident since C includes 1, includes $2 = 1^+$ since it includes 1, includes $3 = 2^+$ since it includes 2 and so on indefinitely. It is really used above when we state that (6) and (5′) define $a \times m$ for all m.

Peano then developed the entire arithmetic of positive integers from postulates (i)–(iv), without making any other assumptions. He first constructed the addition and multiplication tables as we did above, but introducing $m + 1 = m^+$, (2′), $m \times 1 = m$ and (5′) as definitions. He then proved laws (1)–(5). The chain of reasoning involved is long (*see* C. C. MacDuffee, *An Introduction to Abstract Algebra* [1940]). We give here the special case $m + 1 = 1 + m$ of the commutative law as a sample. The law $1 + 1 = 1 + 1$ is evident. Assuming $1 + n = n + 1$, we have $1 + n^+ = (1 + n)^+$ by definition, $(1 + n)^+ = (n + 1)^+$ by assumption and $(n + 1)^+ = (n^+)^+ = n^+ + 1$ by definition. Hence the set of positive integers m for which $m + 1 = 1 + m$ is true includes 1, and includes n^+ if it includes n; hence, by postulate (iv), it includes every positive integer.

The other proofs make similar use of postulate (iv). Using it, we can further prove the cancellation laws

$$a + m = a + n \text{ implies } m = n \tag{7}$$

$$a \times m = a \times n \text{ implies } m = n \qquad (a \neq 0) \tag{8}$$

The proof of the laws of cancellation in terms of the concepts of class and one-one correspondence alone, and without the use of finite induction, is difficult for reasons which will appear later in the discussion of transfinite cardinal numbers.

Order Properties.—We can easily define the relation $a \leqq b$ in terms of classes, to mean that there is a one-one correspondence between a class A containing a elements and a subset of a class B containing b elements. In this definition, we include B as a subset of itself.

From this definition, it is easy to prove that one can add and multiply inequalities. Thus,

$$a \leqq b \text{ implies } a + c \leqq b + c \tag{9}$$

$$a \leqq b \text{ implies } a \times c \leqq b \times c \qquad (\text{if } c \geqq 0) \tag{10}$$

The restriction $c \geqq 0$ in (10), like the restriction $a \neq 0$ in (8), is added to provide for later generalizations; it is automatically fulfilled in the case of positive integers. Again, $a \leqq b$ and $b \leqq c$ imply $a \leqq c$. In addition,

for any a, b, either $a \leqq b$ or $b \leqq a$; if both hold, then $a = b$ (11)

However, the proof of this, like the proof of (7)–(8), is not easy without the use of finite induction; *i.e.*, no simple proof based on the concepts of class and correspondence is known.

Peano's definitions show that we can define addition and multiplication of positive integers in terms of the order relation. This is because m^+ is defined by the properties that $m^+ > m$, and that $n > m$ implies $n \geqq m^+$. It is curious that we can conversely define order in terms of the operation of addition. In fact,

$$a + x = b \text{ has a solution in positive integers if and only if } a < b \tag{12}$$

Subtraction and Division.—We have not introduced subtraction and division as fundamental operations for the simple reason that they can be defined as the inverses of addition and multiplication, respectively. Thus, the difference $a - b$ of two numbers a and b is defined as a solution x of the equation

$$b + x = a \tag{13}$$

and the quotient $\frac{a}{b}$ of a by b as a solution y of the equation

$$b \times y = a \tag{14}$$

If we restrict ourselves to positive integers, differences and quotients need not always exist (*cf.* $3 + x = 2$, $3 \times y = 2$), but if they do, laws (7)–(8) guarantee that they are unique.

Furthermore, the usual laws of operation, such as

$(a - b) = (c - d)$ means $a + d = b + c$

$(a - b) + (c - d) = (a + c) - (b + d)$

$(a - b) \times (c - d) = (a \times c + b \times d) - (a \times d + b \times c)$ (15)

and (*see* FRACTION)

$$\left(\frac{a}{b}\right) = \left(\frac{c}{d}\right) \quad \text{means } ad = bc$$

$$\left(\frac{a}{b}\right) + \left(\frac{c}{d}\right) = \frac{(a \times d) + (b \times c)}{bd}$$

$$\left(\frac{a}{b}\right) \times \left(\frac{c}{d}\right) = \frac{a \times c}{b \times d} \qquad (16)$$

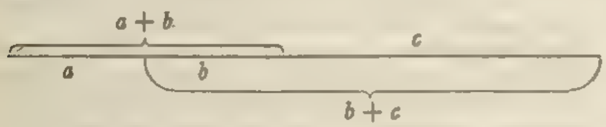
can be proved from laws (1)–(5). This is one reason why laws (1)–(5) are called the fundamental laws of arithmetic.

THE REAL NUMBER SYSTEM

Number as Quantity.—Mankind was early led to the concept of a real number by the need for symbols to represent such geometric quantities as lengths, areas and volumes and such physical quantities as weight and (more recently) electric charge.

The characteristic features of such quantities are that (1) two quantities of the same kind can be added by some obvious geometrical or physical operation (such as laying two segments next to each other on a straight line), and (2) any quantity can be divided into parts. The second feature, of infinite divisibility, is the crudest way of expressing the principle that the real number system is continuous, and not discrete like the system of positive integers.

The commutative and associative laws (1)–(2) of addition are frequently intuitively obvious from the physical definition of addition. Thus, in the case of lengths, it is obvious that $a + (b + c) = (a + b) + c$ since both represent the sum of three segments of lengths a, b, c in order on a line:



It is also obvious that $a + b = b + a$ since the segment $a + b$ can be transformed into the segment $b + a$ by rotation through 180°.

In representing geometrical or physical quantities by numbers, it is usually necessary to choose first an arbitrary unit, such as a foot, a square inch or a pound.

This unit of quantity is assigned arbitrarily the numerical value 1, and exact multiples of this quantity (*i.e.*, sums of an integral number of unit quantities) are assigned corresponding integral values. Since the entire addition table for positive integers can be constructed from the associative law for positive integers (2′), it is clear that the sum of two such quantities must be represented by the sum of the corresponding positive integers.

Multiplication; Number as Ratio.—A simple definition of the product of two quantities is not always possible. For example, if we define the product of two lengths a and b as the area of the rectangle with sides a and b, it may logically be objected that this is a quantity of a different kind.

In order to get around this logical difficulty, the Greeks suggested that a number a should be considered as representing the ratio between a certain quantity and the unit quantity, and never as representing the quantity itself. Thus, 160 lb. is a weight; the number 160 is the ratio of this weight to the weight of a pound.

This idea that numbers are dimensionless ratios has wide applicability. Thus, it leads to plausible "proofs" of the laws of multiplication. For example, the hypothesis that $a \times (b \times c) = (a \times b) \times c$ for all real numbers is given substantial support by the fact that both quantities may be regarded as representing the volume of a box of sides a, b, c. The laws $a \times b = b \times a$ and $a \times (b + c) = (a \times b) + (a \times c)$ can be given similar plausible geometric interpretations in terms of areas.

But these plausible arguments are not proofs in any rigorous sense. They depend not only on postulates for geometry, but also on definitions of area and volume.

The only known way of getting rid of these embarrassing difficulties is to define real numbers abstractly in terms of the system of positive integers, deducing all properties of real numbers by pure logic from these definitions and properties of the positive integers, and using geometrical and physical concepts only to suggest possible postulates and definitions. In this way the properties of real numbers may be made to depend on pure logic and the concept of a class alone (*see* MATHEMATICS, FOUNDATIONS OF).

We shall follow this abstract procedure henceforth.

Rational Numbers.—If we assume that division (except by zero) and subtraction are always possible, we are led inevitably from the system of positive integers to the system of rational numbers (*i.e.*, of positive and negative fractions and integers, and zero).

Thus, let us assume that every equation $by = a$ with positive integral coefficients a, b has a solution y. This corresponds to the idea that a quantity a can be divided into any positive whole number b of equal parts. Let us try also to preserve the five fundamental laws (1)–(5) of arithmetic and the cancellation law (8).

By (8), $by = a$ can have only one solution, which we write $\frac{a}{b}$

It may be shown that the usual rules (16) for adding and multiplying fractions must hold. For example, if $by = a$ and $ds = c$, then $bdy = ad$, $bds = bc$; and so $bd(y + s) = bdy + bds = ad + bc$,

which proves that $\frac{a}{b} + \frac{c}{d} = \frac{(ad + bc)}{bd}$. We can also prove

$$\frac{\left(\frac{a}{b}\right)}{\left(\frac{c}{d}\right)} = \frac{ad}{bc} \qquad (17)$$

whence division by fractions as well as by integers is positive in our new system.

Conversely, we can prove that the rules (16) do give a system in which laws (1)–(12) are valid (we let $\frac{a}{b} > \frac{c}{d}$ mean that $ad > bc$ for positive fractions); in most cases, the proof may be reduced to the corresponding law for the positive integers, by substitution in (16) and cancellation.

Similarly, suppose we assume that every equation $\frac{c}{d} + y = \frac{a}{b}$ has a solution. This hypothesis is suggested by the properties of positive and negative electric charges in physics, by the fact that distance on a straight line can be measured in two directions (right = positive and left = negative), etc.

However, it is not necessary to denote the solution of $\frac{c}{d} + y = \frac{a}{b}$ by such a complicated symbol as $\frac{a}{b} - \frac{c}{d}$. In fact, by (11), either $\frac{a}{b} = \frac{c}{d}$, $\frac{a}{b} > \frac{c}{d}$ or $\frac{a}{b} < \frac{c}{d}$. Hence, by (12), which amounts to saying that $\frac{a}{b} + \frac{x}{y} = \frac{c}{d}$ has a solution if and only if $\frac{a}{b} < \frac{c}{d}$, either $\frac{a}{b} = \frac{c}{d}$ or $\frac{c}{d} + y = \frac{a}{b}$ has a positive solution $\frac{f}{e}$, or $\frac{b}{a} + s = \frac{c}{d}$ has a positive solution $\frac{h}{g}$. Corresponding to these three cases, we write

$$\frac{a}{b} - \frac{c}{d} = 0, \; \frac{a}{b} - \frac{c}{d} = \frac{f}{e} \text{ and } \frac{a}{b} - \frac{c}{d} = -\left(\frac{h}{g}\right)$$

Moreover, instead of proving (15), we can derive the rules for operating and negative fractions and zero from

$$0 + a = a \qquad a \times 0 = 0 \qquad (18)$$

and the mysterious law

$$(-1) \times (-1) = 1 \qquad (19)$$

These in turn are necessary consequences of our laws (1)–(5). Thus, if we define 0 as $1 - 1$, by adding $a - 1$ to both sides of $0 + 1 = 1$, we get $0 + a = a$. Multiplying through $0 + 1 = 1$ by a, we get $a \times 0 + a = a = 0 + a$, whence (canceling) $a \times 0 = 0$. Finally, multiplying the equation $1 + (-1) = 0$, which defines (-1), through by -1, we get $(-1) + (-1) \times (-1) = 0$ by

(5), (6) and (18). Adding 1 to both sides, we get (19) after reduction.

A more thorough study would reveal that a considerable reduction in the number of postulates (fundamental laws needed to imply the others) is possible. Thus, all the laws for the positive fractions can be deduced from the associative law for addition, the distributive laws $a \times (b + c) = (a \times b) + (a \times c)$ and $(a + b) \times c = (a \times c) + (b \times c)$, the unit laws $a \times 1 = 1 \times a = a$, and $1 + 1 \neq 1$.

Irrational Numbers.—Fractions were employed as early as 1700 B.C. by the ancient Egyptians, but it was not until Pythagoras (530 B.C.) that the need for other numbers, like $\sqrt{2}$, was discovered. The need for such irrational numbers is amply corroborated in modern mathematical analysis, where they play a fundamental role in the integral calculus, trigonometry, etc. Pythagoras showed that the ratio x of the diagonal of an isosceles right triangle to the length of a side must satisfy the equation $x^2 = 2$ (Pythagorean theorem). However, no fraction $\frac{m}{n}$ can satisfy $\left(\frac{m}{n}\right)^2 = 2$; that is, $m^2 = 2n^2$ has no solution in integers. For 2 divides m^2, an even, and it divides $2n^2$, an odd, number of times.

Eudoxus pointed out (375 B.C.) that although $\sqrt{2}$ could not be represented exactly by any one fraction, it could be represented as a limit of a sequence of fractions (*see* NUMBER SEQUENCES). Thus, we can represent $\sqrt{2}$ in the form of an infinite decimal: $\sqrt{2} = 1.4142 \cdots$; this amounts to specifying $\sqrt{2}$ as the limit of the sequence of decimal fractions

$$1, \frac{14}{10}, \frac{141}{100}, \frac{1414}{1000}, \frac{14142}{10000}, \cdots$$

These ideas are discussed from the Greek point of view in the tenth book of Euclid's *Elements* (300[?]B.C.).

Their clear exposition from the modern point of view is due to G. Cantor (1871). Real numbers, including both rational and irrational numbers, are defined by Cantor as infinite sequences $x = (x_1, x_2, x_3, \cdots)$, $y = (y_1, y_2, y_3, \cdots)$, $\cdots$, of fractions $x_n, y_n, \cdots$, which converge in the sense that $(x_m - x_n)$, $(y_m - y_n)$, $\cdots$, approach zero as m, n increase indefinitely. We regard x as the limit of the sequence $(x_1, x_2, x_3, \cdots)$.

Equality is defined by making $x = y$ mean that $x_n - y_n$ approaches zero as n increases indefinitely. Addition and multiplication are defined by

$$\begin{aligned} x + y &= (x_1 + y_1, x_2 + y_2, x_3 + y_3, \cdots) \\ x \times y &= (x_1 \times y_1, x_2 \times y_2, x_3 \times y_3, \cdots) \end{aligned} \qquad (20)$$

Laws such as (1)–(17), valid for rational numbers, can be extended to all real numbers by the principle of continuity. For example, each approximating term $(x + y)_n = x_n + y_n$ of $x + y$ is equal to the corresponding approximation $(y + x)_n = y_n + x_n$ of $y + x$; hence, $(x + y)_n - (y + x)_n = 0$ for all n, and $x + y = y + x$ by definition of equality. In general, the principle of continuity states that laws involving continuously varying functions like $x + y$ and $x \times y$ which are valid for arbitrarily good approximations $x_n, y_n, \cdots$ of $x, y, \cdots$ must be also valid for the limit values $x, y, \cdots$.

Another interesting definition of real numbers is due to J. Dedekind (1872). By a section in the class R of fractions, we mean a division of all fractions into two classes L and U, such that $x \leqq y$ for every x in L and y in U. Each fraction (rational number) r determines a section: L consists of the $x \leqq a$ and U of the $y \geqq a$. The other sections define the irrational numbers; thus, the section dividing the fractions into the $x < \sqrt{2}$ and the $y > \sqrt{2}$ (more precisely, the positive y with $y^2 > 2$) may be regarded as defining $\sqrt{2}$. Dedekind's definition can be proved to be equivalent to Cantor's.

The real numbers defined by this process have so far been found adequate for the mathematical treatment of most geometrical and physical quantities such as length, area, weight, electric charge, etc. Not only are the fundamental laws (1)–(6) of arithmetic, the cancellation laws (7)–(8) and the order properties (9)–(11) true, but division (except by zero) and subtraction are always possible. Finally, we have the property that any increasing sequence $x_1 < x_2 < x_3 \cdots$ whose terms are all bounded above by a fixed constant c must tend to a limit.

We shall now discuss other types of numbers; in every case, we shall have to lose some of the properties of real numbers.

GENERALIZATIONS

Complex Number System.—It is clear that the equation $x^2 = -1$ can have no real solution since the square of any real quantity is positive or zero. But we can introduce $i = \sqrt{-1}$ as an imaginary number and preserve those laws (1)–(8) and (15)–(19) of addition and multiplication which do not involve the relation $a \geqq b$. To do this, we must clearly introduce all combinations $a + bi = a + b \times \sqrt{-1}$; these are the so-called complex numbers. Moreover, we must put

$$\begin{gathered} (a + bi) + (c + di) = a + c + bi + di = (a + c) + (b + d)i, \\ (a + bi) \times (c + di) = ac + (ad + bc)i + bdi^2 = \\ (ac - bd) + (ad + bc)i \end{gathered}$$

If we define addition and multiplication of complex numbers by these formulas, laws (1)–(8) and (15)–(19) will be satisfied. For example, it can be verified by substitution that the equation $(c + di)z = (a + bi)$ has the solution

$$z = \frac{a + bi}{c + di} = \frac{ac + bd}{c^2 + d^2} + \frac{bc - ad}{c^2 + d^2}i$$

Furthermore, any quadratic equation $Ax^2 + Bx + C = 0$ with real coefficients has complex roots

$$\frac{(-B \pm \sqrt{B^2 - 4AC})}{2A}$$

since even if $B^2 - 4AC = -D$ is negative, the numbers

$$\frac{(-B \pm i\sqrt{D})}{2A}$$

can be found as complex numbers.

This is a special case of the fundamental theorem of algebra, which asserts that any polynomial equation $x^n + a_1x^{n-1} + \cdots + a_n = 0$ with real or complex coefficients has a complex root (*see* COMPLEX NUMBERS; EQUATIONS, THEORY OF). Thus from a strictly algebraic standpoint, no further generalization is called for.

Although the theory of algebraic equations is greatly simplified by the use of complex numbers, it is necessary to sacrifice the properties of order. If, as by (11), either $a \geqq 0$ or $a \leqq 0$, then by (9) either $a \geqq 0$ or $-a \geqq 0$; in either case, by (10), $a^2 = (-a)^2 \geqq 0$. That is, there is no way in which we could define order so as to satisfy (9)–(11), and make negative numbers have square roots.

Complex numbers are useful not only in pure mathematics (theory of equations and function theory); they are used in discussing alternating electric currents and simplify the solution of many problems in mechanics.

Quaternions and Hypercomplex Numbers.—If we are willing to sacrifice the properties of order, and the commutative law of multiplication as well, we can obtain an interesting further extension of the complex number system, the so-called quaternions (*q.v.*).

Quaternions are numbers of the form $a + bi + cj + dk$, where a, b, c, d are real.

The sum $(a + bi + cj + dk) + (a' + b'i + c'j + d'k)$ is defined as $(a + a') + (b + b')i + (c + c')j + (d + d')k$. Multiplication is defined from the equations (generalizing $i^2 = -1$), $i^2 = j^2 = k^2 = -1$, $ij = jk = ki = -ji = -kj = -ik = -1$. Laws (1), (2), (4)–(8) are satisfied, and subtraction and division (except by zero) are possible. Further, any polynomial equation with quaternion coefficients has a quaternion root.

For many years quaternions were widely used in solving physical problems, but since about 1900 their use in physics has been replaced by that of the vector calculus.

The construction of quaternions can be further generalized. For any set of n^3 real coefficients C_k^{ij}, we can define a linear algebra, or system H of hypercomplex numbers, as follows. The elements of H are the expressions $a_1\epsilon_1 + \cdots + a_n\epsilon_n$, where the "units" $\epsilon_1, \cdots, \epsilon_n$ take the place of the special quaternions l, i, j, k, and are the same for all elements; $a_1, \cdots, a_n$ are arbitrary

real numbers. The sum of $a_1\epsilon_1 + \cdots + a_n\epsilon_n$ and $b_1\epsilon_1 + \cdots + b_n\epsilon_n$ is defined as $(a_1 + b_1)\epsilon_1 + \cdots + (a_n + b_n)\epsilon_n$. Their product is defined as the sum $a_1b_1\epsilon_1^2 + a_1b_2\epsilon_1\epsilon_2 + \cdots + a_nb_n\epsilon_n^2$, where the $\epsilon_i\epsilon_j$ are given by $\epsilon_i\epsilon_j = C_1^{ij}\epsilon_1 + C_2^{ij}\epsilon_2 + \cdots + C_n^{ij}\epsilon_n$.

Although the study of hypercomplex numbers forms an interesting branch of algebra (*see* ALGEBRAS [LINEAR]), the complex numbers and quaternions are the only systems of hypercomplex numbers with real coefficients in which multiplication is associative and division is possible.

Algebraic and Transcendental Numbers.—Numbers which, like $\sqrt[3]{5}$ and $\sqrt{-1}$, represent roots of polynomial equations $a_0x^n + a_1x^{n-1} + \cdots + a_n = 0$ with integral coefficients, are called algebraic numbers. It can be shown that any sum, difference, product or quotient of algebraic numbers is again algebraic, and that so is any root of a polynomial equation whose coefficients a_i are all algebraic numbers. For this reason, algebraic numbers form a closed subsystem of the system of complex numbers, which can be studied without using limits or other infinite processes.

Algebraic numbers have many fascinating properties (*see* NUMBERS, THEORY OF).

Real or complex numbers which are not algebraic are called transcendental. In 1851 Joseph Liouville first provided the existence of transcendental numbers; in 1873 Charles Hermite proved that the base e of natural logarithms was transcendental and in 1882 Ferdinand Lindemann proved that π was transcendental. We now know that the vast majority of real numbers are transcendental (see *Infinite Cardinal Numbers*, below).

Modular Numbers: Fields.—Another interesting class of modular number systems, each containing a finite number of elements, can easily be constructed from the positive integers. For each prime number $p = 2, 3, 5, 7, \cdots$, consider the integers $0, 1, 2, \cdots, p - 1$. The sum $a + b$ and product $a \times b$ of any two of these integers are defined as the remainders of the ordinary sum $a + b$ and product $a \times b$, when divided by p. Thus, if $p = 3$, then $2 + 1 = 0$ and $2 \times 2 = 1 = 4 - 3$; the complete addition and multiplication tables are

+	0	1	2
0	0	1	2
1	1	2	0
2	2	0	1

×	0	1	2
0	0	0	0
1	0	1	2
2	0	2	1

These number systems satisfy conditions (1)–(6), and subtraction and division (except by zero) in them is always possible. They were first studied by C. F. Gauss (*Disquisitiones arithmeticae* [1801]).

Number systems satisfying laws (1)–(6), in which subtraction and division (except by zero) are always possible, are called fields. All the fields having a finite number of elements are known—they are called Galois fields; for each prime power p^n, there is exactly one having p^n elements. An interesting theorem, proved by J. H. M. Wedderburn in 1910, asserts that for systems containing only a finite number of elements, the commutative law of multiplication is a consequence of the other laws (*see* FIELDS).

Hypercomplex number systems with coefficients in a modular field or any other field can be constructed just as easily as if the coefficients were in the field of real numbers.

Infinite Cardinal Numbers.—In the definition of a cardinal number given at the beginning of this article, there is nothing stated which requires the class to be finite. Thus, it is perfectly legitimate to ascribe the mark d (denumerable infinity) to the class J of all positive integers and every other class which can be put in one-one correspondence with J.

Similarly, it is perfectly legitimate to ascribe the mark c (power of the continuum) to the class $R\#$ of all real numbers and every other class which can be put in one-one correspondence with $R\#$.

The definitions of addition and multiplication are still valid, as are the proofs of the basic laws (1)–(6) of arithmetic. The definition of the relation $a \leqq b$ is also valid, and laws (9)–(11) can be proved for infinite numbers as well as for finite numbers; only (11) offers any difficulty.

In fact, we can even define exponentiation for infinite as well as finite cardinal numbers. But we must avoid the usual elementary definition $a^n = a \times \cdots \times a$ (n factors) and define a^b as the cardinal number of the class of all single-valued functions (*see* CALCULUS, DIFFERENTIAL AND INTEGRAL) or rules f assigning to each element x in a class of b elements a single value $y = f(x)$ in a class of a elements. One can then prove easily the usual laws of exponents

$$(a \times b)^s = a^s \times b^s,\ a^{s+t} = a^s \times a^t,\ (a^s)^t = a^{s \times t} \tag{21}$$

One can also connect the infinite cardinal numbers c and d by the interesting formula

$$c = 2^d \tag{22}$$

The main loss in dealing with infinite cardinal numbers is that the laws (7)–(8) of cancellation are no longer valid. In fact, for every infinite cardinal number γ, it can be proved that

$$\gamma = \gamma + 1,\ \gamma + \gamma = \gamma,\ \gamma \times \gamma = \gamma \tag{23}$$

These equations imply that every infinite class can be placed in one-one correspondence with a proper subclass of itself. For example, there is an obvious one-one correspondence between the class J of positive integers $1, 2, 3, \cdots$, and the class E of even integers $2, 4, 6, \cdots$; another between J and the class O of odd integers $1, 3, 5, \cdots$; it follows from the definition of addition that $d + d = d$.

From $\gamma = \gamma + 1$ we easily get $\gamma + 1 = \gamma + 2$, while $\gamma + \gamma = \gamma$ implies $2 \times \gamma = 1 \times \gamma$; hence, neither law of cancellation holds. For this reason it is impossible to extend the system of finite and infinite cardinal numbers to larger systems in which subtraction or division are possible.

From $\gamma + \gamma = \gamma$ it can easily be shown that the class of all integers $\pm n$, 0 has the same cardinal number d as the class of positive integers; from $\gamma \times \gamma = \gamma$, it follows that the class of all rational numbers $\pm \frac{m}{n}$ also has the cardinal number d; this is even true of the class of all algebraic numbers.

This suggests the conjecture that perhaps the class $R\#$ of all real numbers also has the cardinal number d. We shall now disprove this. It would mean that all real numbers could be written in a sequence, S, just as the integers $1, 2, 3, \cdots$, can be so written.

First let us imagine the numbers of this sequence to be written in decimal form. Now certain rational numbers admit of double representation, as is evident from the fact that $0.879999 \cdots = 0.880000 \cdots$. Let us agree, in all such cases, to use the mode of representations by 9s, so that every number shall have a unique decimal representation. We may now construct another number $0 \cdot x_1x_2x_3 \cdots$ as follows. Let the first digit x_1 after the decimal point be chosen apart from 0 and the first digit (after the decimal point) of the first number of S, let x_2 be chosen apart from 0 and the second digit of the second number of S; and so on. There will then be defined a number in decimal form which is obviously distinct from all the numbers of S, which disproves our conjecture.

This disproof by the diagonal process of G. Cantor can be generalized so as to apply to any cardinal number. Thus, there is an infinite sequence of distinct infinite cardinal numbers $d < 2^d = c < 2^c < 2^{2^c} < \cdots$. It is not known whether or not there are others in between the ones listed.

Since the cardinal number of the class of algebraic numbers is d, the preceding argument proves that there exist real transcendental numbers and, in fact, that there are infinitely more transcendental numbers than algebraic numbers.

Infinite Ordinal Numbers.—Consider the infinite sequence of non-negative integers $0, 1, 2, 3, \cdots$. It has the property that every nonempty subset has a first member (so-called well-ordering property). It was observed by Cantor that one can extend this sequence in exactly one way without losing the well-ordering property. Indeed, there must be a first infinite ordinal ω after all the integers, a first ordinal $\omega + 1$ after ω, a first ordinal $\omega + 2$ after $\omega + 1$ and so on. Immediately after the sequence $\omega, \omega + 1,$

$\omega+2, \cdots$, there must be a first ordinal 2ω, followed by $2\omega+1$, $2\omega+2, \cdots$; then 3ω, $3\omega+1$, $\cdots$. Evidently this process of ordinal numeration can be continued, giving numbers of the form (*see* NUMBER SEQUENCES)

$$\begin{array}{l} 0, 1, 2, \cdots \\ \omega, \omega+1, \omega+2, \cdots \\ 2\omega, 2\omega+1, 2\omega+2 \\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot \\ \omega^2, \omega^2+1, \omega^2+2, \cdots \\ \omega^2+\omega, \omega^2+\omega+1, \omega^2+\omega+2, \cdots \\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot \end{array}$$

We can identify each ordinal number α in this sequence with the set of κ preceding α, in order. Thus, 3 corresponds to the ordered set (0, 1, 2), ω with the ordered sequence of all non-negative integers and so on.

If we do this, we can define $\alpha+\beta$ as the result of laying the sequence β after the sequence α, $\alpha\beta$ as the result of substituting the sequence β for each term of the sequence α and α^2 as $\alpha\alpha$. These definitions are consistent with the notations we have introduced; however, $1+\omega=\omega\neq\omega+1$ and $\omega 2=\omega\neq 2\omega$, so that neither addition nor multiplication is commutative. On the other hand, both operations are associative, $(\alpha+\beta)\gamma=\alpha\gamma+\beta\gamma$, and we rescue the one-sided cancellation laws, $\alpha+\beta=\alpha+\gamma$ implies $\beta=\gamma$, $\beta\alpha=\gamma\alpha$ implies $\beta=\gamma$.

There seems to be no reason why the process of ordinal enumeration of the elements of a class C cannot be continued indefinitely until all the elements of the class have been counted. That is, it seems plausible to assume that every class can be well ordered.

Using this assumption, one can prove that $\alpha+\alpha=\alpha$ and $\alpha^2=\alpha$ for all infinite cardinal numbers. However, inasmuch as no infinite class not equivalent to (*i.e.*, in one-one correspondence with) the class of integers has ever been constructively well ordered, this assumption must still be accepted with reservations (*see* MATHEMATICS, FOUNDATIONS OF).

Ordered Fields.—In each of the preceding generalizations of the real number system, we have lost either the order properties (9)–(11), as in the cases of complex, quaternion and modular numbers, or the possibility of subtraction and division, as in the cases of infinite cardinal and ordinal numbers. We shall now show that there exist ordered fields, not contained in the real number system which have both the order properties and the arithmetic properties of the rational and real numbers.

Consider the class of infinite formal power series

$$a(x)=a_{-m}x^{-m}+a_{-m+1}x^{-m+1}+\cdots+a_0+a_1x+a_2x^2+\cdots \qquad (24)$$

which begin with an arbitrary positive or negative integral power $a_{-m}x^{-m}$ of the symbol x with real nonzero coefficient a_{-m}. To add two such series, add corresponding coefficients; thus, $c(x)=a(x)+b(x)$ means $c_n=a_n+b_n$ for all n. To multiply, let the coefficient c_n of x^n in the product $c(x)=a(x)b(x)$ be the sum of all products a_ib_j such that $i+j=n$; thus

$$(x+x^2-x^3+\cdots)(2x^{-2}+3x^{-1}-4+\cdots)= (2x^{-1}+5-3x+\cdots).$$

Define $a(x)\geqq 0$ to mean that $a_{-m}\geqq 0$ in (24). Finally, add 0 to the system, using (18) to define addition and multiplication by zero.

With these definitions, the fundamental laws (1)–(6) can easily be proved. It is also easy to show that subtraction is always possible. Further, division (except by zero) is always possible; thus,

$$\frac{1}{(1-x)}=1+x+x^2+\cdots$$

as in the familiar high-school formula. Hence, the formal power series (24) and 0 form a field (*see* above). Finally, if we define $a(x)\geqq b(x)$ to mean $a(x)-b(x)\geqq 0$, the order properties (9)–(11) hold.

In fact, the only property of real numbers which is not shared by our new system is the completeness property: that any increasing sequence of real numbers, whose terms are all bounded above by a fixed quantity, must tend to a limit. In fact, the increasing sequence $-1<-\frac{1}{2}<-\frac{1}{3}<\cdots$, whose terms are all bounded above by 0, does not tend to a limit in our new system. For example, it does not approach 0, since $-x$ separates 0 from every term of the sequence. Since it can be proved that any ordered field with the completeness property is equivalent to the real number system, we cannot hope to obtain any closer analogue of the real number system.

See also NUMBERS, THEORY OF and references under "Number" in the Index.

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NUMBERS (in the Hebrew Bible, BEMIDBAR), the fourth book of the Old Testament and also the fourth of the five Books of the Law or Books of Moses or the Pentateuch. It is the only one of these five not known in English by its Greek title (Arithmoi). Tertullian calls it Arithmi, a title similar to that in the Mishna. In the Hebrew Bible it is always named Bemidbar —"In the Wilderness" (Num. i, 1).

Place in the Pentateuch.—In modern times the Pentateuch has been subjected to considerable critical analysis. By the end of the 19th century the "Graf-Wellhausen" hypothesis had gained a general consensus of scholarly favour, its main conclusions being that four major documents, J, E, D and P, lay behind the Pentateuch and that they arose historically in that order. Later criticism has shown the need for some modification of this position, either by more precise literary analysis—the recognition of new sources, such as H (Holiness) or L (Lay), or the identification of strata or recensions of sources already recognized—or by the use of form-critical methods to study the history of a preliterary oral tradition. Two results seem to be firmly established: first, documentary analysis is in general not an instrument for precise and minute separation of verses and even half-verses; and second, whether the sources of the Pentateuch be literary or oral, each one of them contains both very ancient and much more recent material, so that the generally earlier sources (J and E) contain some quite late elements, while the generally later sources (D and P) incorporate some quite early material. This must be kept in mind in studying Numbers, which is composed of the earliest and the latest of the four chief sources. (For a more detailed analysis of the sources of the Pentateuch, *see* PENTATEUCH.)

Yet the place of the Book of Numbers in the Pentateuch cannot be adequately conceived without recalling the unifying and positive purpose which brought and held together the various sources, literary and oral. The Pentateuch is the book of the people of God: it explains to a later age how God once called, gathered and delivered his people out of Egypt, how he made a holy covenant with them at Sinai, how he disciplined them in the wilderness and prepared them to be his people, his servant, among all the peoples of the world. The centre of that story is the Exodus, in which, by the agency of Moses, God gathered, delivered and constituted the tribes of Israel to be his covenant people. Before that central story is told the Pentateuch relates, in the form of myth, how the God who so created his people also created the universe, and, in the form of tribal history, how all the histories of the tribes constituting the Old Testament people of God lead up to the story of the Exodus and find their meaning and significance in it. And after the central story of the Exodus has been told in the narratives of the deliverance at the Red sea and of the covenant at Sinai, the Pentateuch goes on to relate how, in ideal and exemplary fashion, God disciplined his people in the desert, to fashion them into a faithful, loving and obedient people to himself. It is in this setting of the discipline or fashioning of God's covenant people that the Book of Numbers is to be understood.

Contents.—The first part of the book (i, 1–x, 10) is substantially a continuation of the material from Ex. xix to the end of Leviticus. Ex. xix, 1 reports the arrival of the Israelites in the wilderness of Sinai; Num. x, 11 begins the account of the removal of the people from Sinai. The latter part of Exodus tells of the construction of the tabernacle for God's presence. Leviticus is devoted to the establishment of the sacrificial system and of the

priesthood. Numbers i–x, 10 reports the institutions of the Levites and of the symbolic arrangement of the people to symbolize the presence of God in their midst. The second section of Numbers (x, 11–xxi, 9) recounts the journey northward from Sinai and west of Arabah, while the third (xxi, 10–xxxvi, 13) tells of the progress east of the Arabah and the Jordan. Each section contains various laws, the last collection of which (xxxiii, 50–xxxvi, 13) anticipate Deuteronomy in legislating for the conditions that could obtain only after the conquest and settlement of Canaan. In the following table of contents the conventional source symbols (described in PENTATEUCH) are used, without prejudice to the question how far each or any of the sources were, at the time of their assimilation, written or oral (R = Redactor).

i, 1–x, 10 (P):	in the wilderness of Sinai
i:	the numbering of the secular tribes, and the place and function of the Levites
ii:	the arrangement of the secular tribes in the camp and their numbers
iii–iv:	the numbers and duties of the Levites, and their relation to the secular tribes
v–vi:	various laws
v, 1–4:	isolation of the unclean
v, 5–10:	restitution of stolen property
v, 11–31:	ordeal for jealousy
vi, 1–21:	Nazirites
vi, 22–27:	priests' blessing
vii:	princely offerings
viii, 1–x, 10:	various laws
viii, 1–4:	lamps
viii, 5–22:	consecration of Levites
viii, 23–26:	age and service of Levites
ix, 1–14:	supplementary Passover
ix, 15–23:	the fiery cloud
x, 1–10:	silver trumpets
x, 11–xxi, 9:	northward from Sinai
x, 11–36 (JEP):	leaving Sinai
x, 11–28 (P):	time and order of march
x, 29–32 (JE):	Hobab
x, 33–36 (JE):	the ark of the covenant
xi, 1–xii, 16 (JE):	incidents en route
xi, 1–3:	complaints at Taberah
xi, 4–10:	manna
xi, 11–24a:	Moses and Yahweh
xi, 24b–30:	elders and prophets
xi, 31–35:	quails and plague
xii, 1–16:	Miriam, Aaron and Moses
xiii–xv:	in the wilderness of Paran
xiii, 1–17a (P):	12 spies appointed
xiii, 17b–20 (JE):	their instructions
xiii, 21 (P), 22–24 (JE):	their journey
xiii, 25–26a (P):	their return
xiii, 26b–31 (JE), 32 (P), 33 (JE):	their report
xiv, 1–2 (P), 3–4 (JE):	popular despair
xiv, 5–7 (P):	Joshua and Caleb report
xiv, 8–9 (JE):	Caleb's encouragement
xiv, 10 (P):	Yahweh appears
xiv, 11–24 (RJE):	God and Moses
xiv, 25 (RJEP):	a new plan
xiv, 26–38 (P):	divine judgment
xiv, 39–45 (JE):	disobedient advance defeated
xv, 1–16 (P):	meat offerings by Israelites and strangers
xv, 17–21 (P):	meal offerings
xv, 22–31 (P):	offerings for sins of ignorance
xv, 32–36 (P):	sabbath breakers
xv, 37–41 (H):	wearing tassels
xvi–xvii (JEP):	rebellion of Korah, Dathan and Abiram
xvi, 1–2 (JEP):	the rebels' names
xvi, 3–11:	Korah's rebellion
xvi, 12–15 (JE):	rebellion of Dathan and Abiram
xvi, 16–24 (P):	Korah's ordeal
xvi, 25–34:	ordeal of Dathan and Abiram
xvi, 35–50:	Korah's story continued
xvii (P):	sprouting of Aaron's rod
xviii (P):	the duties and dues of priests and Levites
xix (P):	purification from contact with the dead
xx, 1–xxi, 9 (JEP):	the march to the north continued
xx, 1 (JEP):	death of Miriam
xx, 2–13:	miracle at Meribah
xx, 14–21 (JE):	Edomite hostility
xx, 22–29 (P):	death of Aaron
xxi, 1–3 (JE):	varying fortune at Hormah
xxi, 4–9 (JE):	the bronze serpent
xxi, 10–xxxvi, 13:	journey east
xxi, 10–xxii, 1 (JEDP):	toward Jericho
xxi, 10–20 (JEP):	on the march
xxi, 21–32 (JE):	victory over the Amorites
xxi, 33–35 (D):	defeat of Og
xxii, 1 (P):	before Jericho
xxii, 2–xxiv, 25 (JE):	Balaam
xxii, 2–4:	Moab and Israel
xxii, 5–14:	Balak's first invitation
xxii, 15–21:	Balak's second invitation
xxii, 22–35:	Balaam and his ass
xxii, 36–40:	Balaam and Balak
xxii, 41–xxiii, 12:	Balaam's first oracle
xxiii, 13–26:	Balaam's second oracle
xxiii, 27–xxiv, 13:	Balaam's third oracle
xxiv, 14–25:	Balaam's final oracle
xxv, 1–5 (JE):	infidelity with Moab
xxv, 6–18 (P):	infidelity with Midian
xxvi (P):	the Second Census
1–4:	directions
5–51:	the secular tribes
52–55:	allocation of land
57–62:	the Levites
63–65.	Israel reconstituted
xxvii, 1–11 (P):	female inheritance
xxvii, 12–23 (P):	the appointment of Joshua
xxviii–xxx (P):	a miscellany of laws
xxviii, 1–2:	introduction
xxviii, 3–8:	daily offerings
xxviii, 9–10:	sabbath offerings
xxviii, 11–15:	monthly offerings
xxviii, 16–25:	Passover offerings
xxviii, 26–31:	harvest offerings
xxix, 1–6:	trumpet offerings
xxix, 7–11:	atonement offerings
xxix, 12–40:	offerings for the Feast of Tabernacles
xxx:	vows made by women
xxxi (P):	destruction of Midian
xxxii, 1–42 (JEP):	the settlements east of Jordan
xxxiii–xxxvi:	summary and appendices
xxxiii, 1–49 (P):	Israel's route from Egypt to Canaan
xxxiii, 50–56 (PHD):	rule of "no compromise"
xxxiv (P):	boundaries and boundary officers in Canaan
xxxv (P):	levitical cities, refuge, etc.
xxxvi (P):	marriage of heiresses

This analysis reveals the diversity of material out of which, like other books of the Pentateuch, Numbers is made. It has in it some very early fragments of narrative poetry, as in the short quotation from the Book of the Wars of Yahweh in xxi, 14, 15; the song to the well cited in xxi, 17, 18; and the primitive apostrophe of the ark attributed to Moses in x, 35, 36. The so-called Lay document (L), which is older than J or E, is thought to be incorporated into x–xiv, 20 and xiv, 25.

Themes.—But though diverse in origin these different elements are brought together for one purpose. The various themes of the book are made to serve one dominant theme. Numbers is a predominantly priestly document; it stems from and belongs to the postexilic period of Israel's history, when an attempt was made at a theocratic form of government. Numbers is the wilderness tradition of the Hebrew people as it was articulated in such a society. The compilers did not try to give what readers in the 20th century A.D. might think to be a strictly historical record setting out the whole story as it actually happened; rather they used the concepts of a theocratic society to exhibit the meaning of the wilderness tradition as they understood it, and thereby at the same time to enable the members of the theocratic states to understand their own society more profoundly. The past, that is to say, is looked at in the light of the present, and that in turn leads to a deeper understanding of the present in terms of the past and its continuity with the present.

The mutual enrichment of meaning for both past and present can be illustrated in respect of all the major themes of the Book of Numbers. Postexilic Israel reckoned itself to be a people separated from all the nations of the world for God. This is indicated in Numbers by the fact of the census: God's people has a definite number and is distinct from all other nations and tribes.

In the days after the exile Israel placed great emphasis upon the Temple as the place in which Yahweh had chosen to dwell with his people. In the desert, so the tradition of Numbers has it, God dwelt in the midst of his people in the tent of meeting, surrounded by the 12 tribes, as he was in the centre of them as they went on the march.

Later Jewry worshiped Yahweh as an utterly transcendent God, who could not be approached by the ordinary man but had to be sought through the appointed intermediaries of priest and Levite. Similarly, in the desert, Numbers records, God was also known to be transcendent as well as present, and in the same way could be approached by the ordinary worshiper only through the agency of priest and Levite. The tent of meeting was fenced off by the levitical and priestly dwellings, and danger attended the unauthorized intruder into the tent (xvii, 12).

In Palestine after the exile it was taught that God was the one source of the Law, for church and state alike. Numbers also makes it plain that the true ordering of both social and religious life flows from divine commandments to which God's people owe unswerving allegiance.

Later Judaism looked back upon the golden age of prophecy, and so rare a phenomenon had the prophet become that he had to authenticate himself in terms of acknowledged tests (*cf.* Deut. xiii, 1–5; Num. xvi, 28–30). The same situation is shown to have been true of the days in the wilderness, where Moses was the great prophet who received his communication from Yahweh directly and not, like other prophets, in dream or vision (Num. xxi, 8), and where also tests were applied to those who claimed to prophesy for Yahweh, with striking results in certain cases (Num. xvi, 31–33). So it was underlined that in the days of the wilderness as in the time after the exile the gift of prophecy was entirely at the disposal of Yahweh. In another fashion, this is also stated in the story of Balaam, the non-Israelite who was nevertheless called to be a prophet of Yahweh.

In such ways as these the compilers of Numbers looked at and handed on the tradition of what happened "in the wilderness." They achieved two things by their skill: first, by using theological insights common and accepted among themselves, they showed the fundamental meaning of the history of the wilderness wanderings; and second, by indicating a substantial unity between the wilderness and the postexile, they reinforced and deepened the theological principles of their own theocracy. The whole hieratic structure of the postexilic community was able to act with a great deal more self-conscious competence because of this historical review.

Historicity of Numbers.—It will be apparent how alien to the whole spirit of the book and its authors it is to ask how far the book is historically accurate. Did the Israelites camp in the exact formation which Numbers describes in its opening verses? The answer is almost certainly "no." But the description of the camp's ordering was made not in order to convey precise historical information in the modern sense but rather to bring to the surface the basic meaning of the journey, however the camps may have been pitched. Modern men may well seek to press their questions about historical accuracy upon the biblical scholar; such questions can be answered. But in return the biblical scholar must point out that the admittedly "unhistorical" record is not rendered useless either to the historian or the theologian; rather does it then for the first time have a chance to repeat to modern man the meaning and the message its compilers intended it to convey.

There is almost a complete absence of any Deuteronomic influence in Numbers (*see* DEUTERONOMY); the same can be said of the Holiness code (*see* LEVITICUS). The book remains as a bringing together by editors of the late postexilic priestly school of quite old traditions and very recent recensions, and a fusing of these two elements into one book which would enable the postexilic community to understand itself more clearly as the contemporary separated people of God.

Numbers and the New Testament.—Though Numbers is very infrequently, if at all, quoted in the New Testament, it—like other books of the Pentateuch—forms the background in thought and language for many New Testament formulations. There are allusions to Numbers in all but four of the New Testament Books (Philippians, Philemon, II and III John), though actual quotation may in fact be limited to but one occasion. This appears to be in II Tim. ii, 19, where Paul follows the Septuagint text, substituting "Lord" for "God." Paul is making a point typical of Numbers: "The Lord knows those who are his," with the implication that the Lord's people are separate and have their own way of life. The account of the Nazirites in Numbers helps to an understanding of the reference to John the Baptist's diet in Luke i, 15 and to Paul's purification in Acts xxi, 23 ff. Numbers also provides a fuller though puzzling background to the references to Balaam in II Pet. ii, 15, 16, Jude 11 and Rev. ii, 14, and it provides the key to the reference to Korah in Jude 11. But the chief relationship between Numbers and the New Testament is akin to its relationship with postexilic Jewish theocracy, as a means of mutual illumination and interpretation. There are abundant instances of this in almost every book of the New Testament, and perhaps the chief of such mutual interpretations is the figure of Moses, who, like the Lord of the New Testament, did not receive the word of God secondhand, but directly (*cf.* Num. xii, 6–8).

At one point the New Testament exhibits a further development of a Numbers tradition. The story of Balaam in xxii–xxiv is not homogenous, and some scholars have discerned a difference of character in Balaam as between J's description and E's. In J, Balaam is of complete integrity, whereas it is argued that in E he is much more ready to be tempted from his integrity by the prospect of reward. Such a tendency, which is claimed to have begun to show itself in the comparatively short period between the writings of J and E, has become much more marked in P's contribution to the account in Numbers, for here Balaam is a sorcerer who instigates the seduction of Israelite women into idolatry at Peor. He is later reported as dying in battle between the Israelites and the Midianites. In the New Testament as in Josephus and rabbinic writings, Balaam is the type of all false and avaricious teachers.

Influence of Numbers.—It was the "publication" of the Pentateuch that first made the Jewish people the people of a book. Numbers inevitably shared in that vital transformation, and, as shown above, enabled postexilic Judaism to understand itself and its mission more clearly. But the book that is the basis of a people's life must be subjected to constantly developing interpretation, or else both people and book die. Both Judaism and Christianity have developed their own traditions of interpretation, in which Numbers, with the rest of the Pentateuch and indeed the rest of the Old Testament, becomes for the Jewish people and the Christian church respectively one of the documents in the light of which contemporary Jews or Christians are able to understand the way in which God deals with them now, and in the light of that understanding continually return to the text of Numbers to find that its depths are still unfathomed. *See* also BIBLE.

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NUMBERS, THEORY OF. The theory of numbers is concerned, in its elementary parts, with properties of the integers, or whole numbers, $0, \pm 1, \pm 2, \cdots$. Examples of such properties which emerged in ancient times are these: the Chinese knew in 500 B.C. that $2^p - 2$ is divisible by p, for prime numbers p; Euclid (300 B.C.) proved that there exist infinitely many primes (otherwise, if p could be the greatest prime, then as a contradiction a larger prime would divide $M + 1$, where M denotes the product $2 \cdot 3 \cdot 5 \cdots p$ of all primes up to p). While most results of this vast and beautiful subject, dealing with the universally familiar whole numbers, are easy to understand, the

proofs of many use the deepest resources of mathematics, and some of the most interesting conjectures are still unproved.

Topics in the theory of numbers will be treated under the following headings:

I. Divisibility and Primality
- 1. Elementary Definitions; Factorization Into Primes
- 2. Residue Classes: Euler's Theorem
- 3. Congruences in One Unknown
- 4. Quadratic Residues; the Quadratic Reciprocity Law
- 5. Factorization of Numbers; Mersenne Primes

II. Representation by Forms
- 1. Binary Quadratic Forms
- 2. Genera of Quadratic Forms; Formulas for Number of Representations
- 3. The Numbers Represented by a Quadratic Form; Universal Forms; Representation of Zero
- 4. Automorphs and Reduction of Indefinite Binary Quadratic Forms
- 5. Diophantine Equations

III. Topics in Analytic Number Theory
- 1. Gauss's Class-Number Conjecture
- 2. Distribution of Primes; Asymptotic Formulas

IV. Additive Theory of Numbers
- 1. Partitions
- 2. The Waring Problem, and Related Problems
- 3. The Goldbach Problem

V. Diophantine Approximation
- 1. Geometry of Numbers
- 2. Diophantine Approximation

VI. Generalizations of Arithmetic
- 1. Algebraic Numbers
- 2. Ideals
- 3. Algebras, and Their Arithmetics

I. DIVISIBILITY AND PRIMALITY

1. Elementary Definitions; Factorization Into Primes.—If a and b are integers, and $a = bc$ for some integer c, then b is called a factor or divisor of a; abbreviated $b|a$, read as b divides a; thus $1|a$ and $a|a$ for every integer a. A prime number is an integer $p > 1$ such that p has no positive factors except 1 and p; examples are 2, 3, 5, 7, 11. Other integers greater than 1 are called composite.

Every integer greater than 1 is either itself a prime or can be expressed as a product of primes in only one way (except for rearrangement of factors). This concept, called the fundamental theorem of arithmetic, is commonly proved by means of a property given by Euclid, namely, if a prime p divides ab, then p divides a or b. To establish this property Euclid showed that if d is the greatest common divisor (g.c.d.) of a and b, then there exist integers x and y satisfying $ax + by = d$ (see *Residue Classes* below). Assuming this, suppose that $p|ab$ but not a; then since p is a prime, the g.c.d. of p and a is 1, $ax + py = 1$, $abx + pby = b$, hence $p|b$.

The symbol (a,b) is frequently used for the g.c.d. of the integers a and b, assumed not both zero. If $(a,b) = 1$, a and b are called relatively prime, or coprime, and a is described as prime to b.

Several independent proofs of the fundamental theorem of arithmetic, based on mathematical induction, have appeared (H. Hasse, 1928; E. Zermelo, 1934; Ferdinand Lindemann, 1933).

See ARITHMETIC.

2. Residue Classes: Euler's Theorem.—Let m denote a given positive integer. Every integer a can be expressed in the form $a = qm + r$, where q is an integer (the quotient on division by m) and r, the remainder, has one of the m values $0, 1, \cdots, m-1$. Two integers a and b having the same remainder r are said to be congruent modulo m, abbreviated $a \equiv b \bmod m$. Clearly this is equivalent to saying that $m|a - b$. All integers congruent modulo m to a given integer are considered as forming a residue class modulo m. There are m residue classes.

If $a \equiv b \bmod m$, $(a,m) = (b,m)$. If $(a,m) = 1$ we may therefore say that the residue class of a modulo m is prime to m. Those residue classes which are prime to m are said to form a reduced system of residue classes mod m. For example, if $m = 12$, the reduced system is represented by the four residues 1, 5, 7 and 11.

L. Euler introduced the symbol $\phi(m)$ to denote the number of reduced residue classes mod m, or what is equivalent, the number of positive integers prime to m and not exceeding m. For example, $\phi(1) = 1$, $\phi(p) = p - 1$ for any prime p. One easily proves that $\phi(mn) = \phi(m)\cdot\phi(n)$ if $(m,n) = 1$, and $\phi(p^r) = p^r\left(1 - \frac{1}{p}\right)$ for any prime p and positive integer r. This facilitates the evaluation of $\phi(m)$; *e.g.*, $\phi(12) = \phi(2^2)\cdot\phi(3) = 2\cdot 2 = 4$, as noted earlier.

Let a be prime to m. If $r_1 - r_2$ is not divisible by m, the same is true of $ar_1 - ar_2$. It follows that if $r_1, r_2, \cdots, r_k$ (where $k = \phi(m)$) constitute a reduced residue system mod m, then ar_1, $ar_2, \cdots, ar_k$ comprise the same residues in a different order. Hence the difference of the products $ar_1 . ar_2 . . . ar_k$ and $r_1 r_2 . . . r_k$, which can be written $r_1 r_2 . . . r_k(a^k - 1)$, is divisible by m. Since $r_1 r_2 . . . r_k$ is prime to m, m divides $a^k - 1$.

This result, that $m|a^{\phi(m)} - 1$ if a, m are coprime, is known as Euler's theorem (1760). Fermat's theorem (1640) is the special case for a prime p, $a^{p-1} \equiv 1 \bmod p$ if $(a,p) = 1$.

By the same argument, the m residues ax ($x = 0, 1, \cdots, m-1$) are incongruent mod m, if $(a,m) = 1$; hence the congruence $ax \equiv k \bmod m$ is solvable, for any k. Hence, if $(a,b) = 1$ then for any given integer k there exist integers x, y satisfying $ax + by = k$.

Primitive Roots.—It can be shown that if $(a,m) = 1$, the least positive e such that $a^e \equiv 1 \bmod m$ must divide $\phi(m)$. If $e = \phi(m)$, a is called a primitive root of m; and the powers 1, a, $a^2, \cdots, a^{e-1}$ comprise a reduced set of residues mod m. Primitive roots have importance in various applications involving nth powers; *e.g.*, in solving binomial congruences such as $x^n \equiv k \bmod m$. C. F. Gauss proved that primitive roots exist only when $m = 2, 4, p^h$, or $2p^h$, where p is an odd prime.

3. Congruences in One Unknown.—If $a \equiv b \bmod m$ and $c \equiv d \bmod m$, it is easily seen that $a + c \equiv b + d$, $a - c \equiv b - d$, and $ac \equiv bd \bmod m$. Hence, if $f(x)$ is a sum of terms $a_0 + a_1x + \cdots + a_nx^n$ with integral coefficients, then $f(a) \equiv f(b) \bmod m$, if $a \equiv b \bmod m$. Hence, in searching for solutions (called roots) of the congruence $f(x) \equiv 0 \bmod m$, one can confine oneself to incongruent solutions mod m. The number of roots is the number of incongruent solutions mod m: *e.g.*, $x^3 \equiv 1 \bmod 7$ has precisely three roots, *viz.* $x \equiv 1, 2, 4$.

Let $m_1, m_2, \cdots, m_k$ be k positive integers, coprime in pairs, $m = m_1 \cdots m_k$. A method of solving the k congruences $x \equiv r_1 \bmod m_1, \cdots, x \equiv r_k \bmod m_k$, for an integer x, uniquely determined mod m, was known to the Chinese in the first century A.D., and is called the Chinese remainder theorem. The theorem leads to the result that the number of solutions of $f(x) \equiv 0 \bmod m$ is the product of the numbers of solutions of $f(x) \equiv 0 \bmod m_i$ ($i = 1, \cdots, k$). The search for roots of $f(x) \equiv 0 \bmod m$ can thus always be reduced to the case where m is a power of a prime. In certain cases there is a systematic way of deriving the solutions mod p^{r+1} from those mod p^r.

In the special case $m = p$ there holds an important theorem formulated by J. L. Lagrange (1768). If $(p,a_n) = 1$, the congruence $f(x) \equiv 0 \bmod p$ is said to be of degree n. Lagrange proved that the number of roots of $f(x) \equiv 0 \bmod p$ does not exceed the degree n.

As an application consider, for example, $f(x) = x(x-1)(x-2)\cdots(x-p+1) - (x^p - x)$. This is a polynomial of degree $p - 1$ at most, and $f(x) \equiv 0 \bmod p$ for each of $x = 0, 1, \cdots, p-1$ (by Fermat's theorem). This contradicts Lagrange's theorem unless every coefficient is divisible by p. Hence, the sum of the products n at a time of $1, 2, \cdots, p-1$ is divisible by p if $n \leqq p - 2$; while (by the coefficient of x),

$$1 \cdot 2 \cdot 3 \cdots (p-1) \equiv -1 \pmod p$$

a result known as Wilson's theorem.

Since $x^{p-1} - 1 = (x^{\frac{1}{2}(p-1)} - 1)(x^{\frac{1}{2}(p-1)} + 1)$, then it follows from Fermat's and Lagrange's theorems that each of the congruences $x^{\frac{1}{2}(p-1)} \equiv 1$ and $x^{\frac{1}{2}(p-1)} \equiv -1 \pmod p$ is satisfied by exactly $\frac{1}{2}(p-1)$ residues x mod p. Anticipating the following section, note that if a is any of the $\frac{1}{2}(p-1)$ quadratic residues of p, then $a \equiv x^2$, $a^{\frac{1}{2}(p-1)} \equiv x^{p-1} \equiv 1$. Accordingly, a is a quadratic residue or nonresidue of p according as $a^{\frac{1}{2}(p-1)} \equiv 1$ or $-1 \pmod p$. Putting $a = -1$ we obtain that the congruence $x^2 \equiv -1 \pmod p$ is solvable if $p \equiv 1$, but unsolvable if $p \equiv 3 \pmod 4$.

On pairing factors equidistant from the two ends, Wilson's

theorem gives $(1\cdot 2\cdot 3\cdots \tfrac{1}{2}(p-1))^2 \equiv (-1)^{\frac{1}{2}(p+1)}$ mod p. Hence if p is a prime of the form $4n+3$, $1\cdot 2\cdot 3\cdots \tfrac{1}{2}(p-1) \equiv \pm 1$ mod p. The sign + or − in the last case was investigated by P. G. L. Dirichlet *et al.* Since −1 is a quadratic nonresidue of p, and since the product of an even (odd) number of quadratic nonresidues is a quadratic residue (nonresidue), the sign is $(-1)^m$, where m is the number of quadratic nonresidues in the series $1, \ldots, \tfrac{1}{2}(p-1)$. An interesting expression found for m is $\tfrac{1}{4}(p+1) - \tfrac{1}{2}(1 + h(-p))$, where $h(-p)$ denotes the number of classes of positive, primitive binary quadratic forms of discriminant $-4p$ (see *Binary Quadratic Forms*, below). In particular, it follows that there are more quadratic residues in the first half of the interval from 1 to $p-1$, than in the second half, if p is a prime $4n+3$.

Numerous generalizations of Fermat's and Wilson's theorems have been found. One due to Gauss (1801) is as follows: if P denotes the product of the integers less than and prime to n, then $P \equiv -1$ mod n if n is 4, p^k, or $2p^k$, where p denotes an odd prime; but $P \equiv 1$ mod n otherwise.

4. Quadratic Residues: The Quadratic Reciprocity Law.—A quadratic residue of m is an integer a prime to m such that $x^2 \equiv a$ mod m is solvable for x. Other integers a prime to m are called quadratic nonresidues. Let m be an odd prime p, and consider the squares $1^2, 2^2, \cdots, (p-1)^2$. Since $p|x^2 - y^2$ implies that $p|x-y$ or $x+y$, which can hold (if x, y are distinct numbers of the set $1, 2, \cdots, p-1$) only if $y = p - x$, it is plain that there are exactly $\tfrac{1}{2}(p-1)$ incongruent quadratic residues of p. Example: every square prime to p is of the form $pn + R$, where if $p=3$, $R=1$; if $p=5$, $R=1$ or 4; if $p=11$, $R = 1, 4, 9$, $5(\equiv 4^2)$, or $3(\equiv 5^2)$.

By extensive experiment Euler had found in 1783 a theorem of great simplicity, expressing a deep property of numbers. In 1785 A. M. Legendre rediscovered the same result, which he formulated as follows. Let p and q denote distinct odd primes. Then unless $p \equiv q \equiv 3$ (mod 4) the two congruences $x^2 \equiv p$ (mod q) and $y^2 \equiv q$ (mod p) are both solvable or both unsolvable; but if $p \equiv q \equiv 3$ (mod 4), one and only one of the two congruences is solvable.

Legendre introduced the useful symbol $(a|p)$, defined to equal +1 if a is a quadratic residue of p; −1, if a is a nonresidue; 0, if $p|a$. Then the above result takes the form

$$(p|q)(q|p) = (-1)^{\frac{1}{2}(p-1)\frac{1}{2}(q-1)}$$

for any distinct odd primes p and q. He called this the reciprocity law; but his proof was incomplete. In 1795, Gauss, at the age of 18, discovered the same law, and after a year of strenuous effort found a complete proof. Later he found 6 different proofs; and more than 50 proofs have appeared since.

The result at the end of the preceding section can now be expressed by $a^{\frac{1}{2}(p-1)} \equiv (a|p)$ mod p, true also if $a \equiv 0$. Hence follow the following properties of the Legendre symbol: (1) $(a|p) = (b|p)$ if $a \equiv b$ mod p; (2) $(ab|p) = (a|p)(b|p)$; (3) $(-1|p) = (-1)^{\frac{1}{2}(p-1)}$; and by another device, $(2|p) = 1$ if $p \equiv \pm 1$ mod 8, $(2|p) = -1$ if $p \equiv \pm 3$ mod 8.

The usefulness of the Legendre symbol was increased by K. G. J. Jacobi, who, defining $(a|p_1p_2\cdots p_n) = (a|p_1)(a|p_2)\cdots(a|p_n)$, and $(a|-k) = (a|k)$ if a is positive, found that the reciprocity law still holds for any odd numbers p and q not both negative. Example: determine whether $x^2 \equiv 30$ (mod 71) is solvable; $(30|71) = (2|71)(15|71) = (+1)(-)(71|15) = -(-4|15) = -(-1|15) = +1$; the congruence is solvable (with $x = \pm 32$). Example: of what primes is 3 a quadratic residue? $(3|p) = (-1)^{\frac{1}{2}(3-1)\frac{1}{2}(p-1)}(p|3) = +1$ if $p \equiv 1$ (mod 4 and mod 3), and if $p \equiv -1$ (mod 4 and mod 3); *i.e.*, $p \equiv \pm 1$ mod 12.

Other reciprocity laws have occurred in various generalizations; *e.g.*, one involving complex integers (see *Algebraic Numbers*, below) occurred in Gauss's researches on biquadratic congruences.

5. Factorization of Numbers; Mersenne Primes.—The labour involved in factoring a large number of, say, 20 or more digits is still prohibitive. By expressing the number in special forms, it is possible to obtain limitations on the form of possible prime factors; thus, if $N = x^2 + ky^2$, where $(x, y) = 1$, then $-k$ must be a quadratic residue of each prime factor of N. Factor stencils have been developed to facilitate this process. A machine constructed by D. H. Lehmer ("A Photo Electric Number Sieve," *American Mathematical Monthly*, 40, 1933) makes it possible to test numbers of about 17 digits in a few hours.

The best table of primes is D. N. Lehmer's *List of Prime Numbers from 1 to 10,006,721* (Carnegie Institution of Washington, D.C., 165, 1914), republished in 1956.

Perfect numbers owe their beginning to the number mysticism of the Pythagoreans (500 B.C.). A perfect number is an integer equal to the sum of its divisors less than itself. The five least are: $6(=1+2+3)$; 28; 496; 8,128; 33,550,336. Euclid gave the example $2^{p-1}(2^p - 1)$, which is perfect if and only if $2^p - 1$ is a prime.

All even perfect numbers are of Euclid's type (Euler). No odd perfect number has ever been found.

Numbers of the form $2^p - 1$ are called Mersenne numbers, because in 1644 Father Marin Mersenne made a statement which implied that if $p \leq 257$, $2^p - 1$ is prime only for $p = 2, 3, 5, 7, 13, 17, 19, 31, 67, 127, 257$. Subsequent work has yielded the following results: $2^p - 1$ is known to be prime for $p = 2, 3, 5, 7, 13, 17, 19, 31, 61, 89, 107, 127$; its factors are completely known for $p = 11, 23, 29, 37, 41, 43, 47, 53, 59, 67, 71, 73, 79, 113$, and partially known for $p = 83, 97, 131, 151, 163, 167, 173, 179, 181, 191, 197, 211, 223, 229, 233, 239, 251$; it has been proved composite for $p = 101, 103, 109, 137, 139, 149, 157, 199, 193$ and 227 (H. S. Uhler, 1948–49), 241 (R. E. Powers, 1934), 257 (M. Kraitchik and D. H. Lehmer, 1932). Several primes larger than $2^{127} - 1$ (E. Lucas, 1876) were found in 1951. The national bureau of standards Western Automatic computer gave, in 1952, the five next Mersenne primes $2^p - 1$ ($p = 521, 607, 1{,}279, 2{,}203, 2{,}281$).

The ancient Greeks knew that regular polygons of 2^hm sides, where $m = 3$ or 5, can be constructed by the Euclidean (straightedge and circle) operations. Gauss, at the age of 17, proved that these constructions are so performable if and only if m is a product of distinct Fermat primes, *i.e.*, primes that are of the form $F_n = 2^{2^n} + 1$. If $n = 0, 1, 2, 3, 4$, we get the primes 3, 5, 17, 257, 65,537. But F_n is composite for $n = 5, 6, 7, 8, 9, 11, 12, 18, 23, 36, 38, 73$.

II. REPRESENTATION BY FORMS

1. Binary Quadratic Forms.—Many special quadratic forms, such as $x^2 \pm ay^2$ or $x^2 + y^2 + z^2$, had been investigated by particular methods, before Lagrange and (especially) Gauss systematized their theory, and established general methods of attack. The guiding general principle was the linear transformation.

Consider for example a form in two variables and of the second degree (*i.e.*, a binary quadratic form) $f = ax^2 + bxy + cy^2$. A number m is said to be represented by the form f if there exists a pair of integers u, v not both zero (called a representation of m by f) satisfying $au^2 + buv + cv^2 = m$. The representation is called primitive if the g.c.d. (u, v) is 1. We shall give a version of Gauss's method of finding whether a number m is represented by f.

The basic idea is that we treat not f alone, but an entire class of forms equivalent, for this purpose, to f. If we apply to f a linear transformation

$$x = \alpha X + \beta Y, \; y = \gamma X + \delta Y \qquad (1)$$

f is transformed into $F = AX^2 + BXY + CY^2$ in new variables X and Y, while $A = a\alpha^2 + b\alpha\gamma + c\gamma^2$, etc. On solving equations (1) for X and Y, we find

$$(\alpha\delta - \beta\gamma)X = \delta x - \beta y, \; (\alpha\delta - \beta\gamma)Y = -\gamma x + \alpha y$$

Hence, in order to ensure that to each pair of integers x and y corresponds one and only one pair of integers X and Y (and conversely), we shall assume that the transformations which we apply are unimodular, that is, $\alpha, \beta, \gamma, \delta$ are integers, and $\alpha\delta - \beta\gamma = 1$. Clearly the same numbers m are then represented by both forms f and F, and any representation x, y of m in f corresponds uniquely to the representation $X = \delta x - \beta y$, $Y = -\gamma x + \alpha y$ of m in F.

The forms f and F, related by a unimodular transformation, are termed equivalent. The result of applying several unimodular transformations in succession is easily seen to be another unimodular transformation, called their product. All forms equivalent to a given one are equivalent to one another, and are said to constitute a class of forms.

If $A = a\alpha^2 + b\alpha\gamma + c\gamma^2$ where $(\alpha, \gamma) = 1$, then by section 2 we can choose integers β and δ such that $\alpha\delta - \beta\gamma = 1$. Consequently, any number A represented primitively by f is the first coefficient of some form $AX^2 + BXY + CY^2$ equivalent to f. It can be shown that if β, δ is one solution of $\alpha\delta - \beta\gamma = 1$, the most general solution is $\beta + k\alpha$, $\delta + k\gamma$, where k is any integer; and that B is then replaced by $B + 2kA$.

The determinant of the form f is defined to be the number $d = ac - \frac{1}{4}b^2$. It can be shown that the determinants of equivalent forms are equal. (*See* ALGEBRAIC GEOMETRY; TENSOR ALGEBRA.)

The last result holds also for quadratic forms in n variables. We shall later use the terms determinant, class, representation, etc., for such forms, to which these terms can be extended in an obvious way. If a quadratic form f is written in the form $\sum a_{ij}x_ix_j$ (summed for $i, j = 1, \cdots, n$), one can always suppose that $a_{ji} = a_{ij}$, and the determinant of f is the determinant $|a_{ij}|$. (*See* DETERMINANT.)

So far, a, b, c may denote any real numbers. We have $af = (ax + \frac{1}{2}by)^2 + dy^2$. Hence if $d > 0$, $a \neq 0$, and af is positive for any x and y not both zero; accordingly, f represents only numbers of one sign, that of a. But if $d < 0$, f represents both positive and negative numbers. If $d > 0$, we call f definite, specifically, positive-definite if also $a > 0$; if $d < 0$, f is called indefinite.

The treatment of definite and indefinite forms now diverges. It is easily shown that any positive-definite form is equivalent to precisely one form $Ax^2 + Bxy + Cy^2$ satisfying

$$-A < B \leqq A \leqq C, \text{ with } B \geqq 0 \text{ if } C = A \qquad (2)$$

This form is called the reduced form in the class. We illustrate the process of reduction with the form $f = 15x^2 - 44xy + 33y^2$ of determinant $495 - 22^2 = 11$. Put $x = x_1 + ky_1$, $y = y_1$. Then f becomes $15x_1^2 + (-44 + 30k)x_1y_1 + (\cdots)y_1^2$; to get $-44 + 30k$ between -15 and $+15$ take $k = 1$, $f_1 = 15x_1^2 - 14x_1y_1 + c_1y_1^2$; here $c_1 = 4$ since $15c_1 - 49 = 11$. Now treat similarly the smaller coefficient c_1, and replace x_1 by x_2, y_1 by $2x_2 + y_2$, obtaining $f_2 = 3x_2^2 + 2x_2y_2 + 4y_2^2$, which is reduced. The result of combining the transformations is $x = 3x_2 + y_2$, $y = 2x_2 + y_2$, which transforms f directly into f_2.

Hereafter we assume f integral; *i.e.*, a, b, c are integers. The g.c.d. of a, b, c is called the divisor of f. If this g.c.d. is 1, f is called primitive. To avoid fractions write $D = -4d = b^2 - 4ac$, called the discriminant of f.

We prove in the case D negative that there are only a finite number of classes of integral, positive-definite, binary quadratic forms of a given discriminant $D = -\Delta$. This number is equal to the number of reduced forms satisfying (2), with $4AC = \Delta + B^2$. By (2), $4A^2 \leqq 4AC = \Delta + B^2 \leqq \Delta + A^2$, whence

$$A^2 \leqq \frac{\Delta}{3}, \text{ and } B^2 \leqq \frac{\Delta}{3}$$

To find all reduced forms of discriminant $-\Delta$ we may proceed as follows. Give B in turn each integer value such that

$$B^2 \leqq \frac{\Delta}{3} \text{ and } 4 \mid \Delta + B^2$$

factor $\frac{1}{4}(\Delta + B^2)$ as AC in all ways satisfying $|B| \leqq A \leqq C$. Discard forms such that $B = -A$ or such that $C = A$, $B < 0$.

The number of classes of primitive, positive-definite, binary quadratic forms of discriminant D will be denoted by $h(D)$.

Example: Find the reduced forms of discriminant -44. Necessarily $B = 2b$, $b^2 \leqq \frac{11}{3}$. If $b = 0$, $\frac{1}{4}(44 + B^2) = 11 = 1 \cdot 11$; if $b = \pm 1$, $\frac{1}{4}(44 + B^2) = 12 = 2 \cdot 6 = 3 \cdot 4$. This yields four reduced forms: $x^2 + 11y^2$, $3x^2 \pm 2xy + 4y^2$, $2x^2 + 2xy + 6y^2$. The last is imprimitive, with divisor 2; hence $h(-44) = 3$.

The reader can verify that $h(D) = 1$ in the twelve cases

$$-D = 3, 4, 7, 8, 11, 12, 19, 27, 28, 43, 67, 163 \qquad (3)$$

the reduced form being $x^2 + xy + \frac{1}{4}(1 - D)y^2$ or $x^2 - \frac{1}{4}Dy^2$.

An automorph of f is a unimodular transformation carrying f into itself. Every f has the trivial automorph $x = x_1$, $y = y_1$, and its negative $x = -x_1$, $y = -y_1$. The form $a(x^2 + y^2)$ has the additional automorphs $x = y_1$, $y = -x_1$; and its negative. The form $a(x^2 + xy + y^2)$ has six automorphs, of which $x = x_1 + y_1$, $y = -x_1$, is typical. All positive-definite forms not equivalent to these two have only the two trivial automorphs. It is easily proved that all the unimodular transformations carrying f into F are obtained by applying to f any automorph of f, followed by a fixed unimodular transformation of f into F.

We can now solve the problem of finding all primitive representations of A by f in the following manner, which applies equally well to indefinite forms (see *Automorphs and Reduction of Indefinite Binary Quadratic Forms*, below). We noted above that to each primitive representation (α, γ) of A by f corresponds a form $Ax^2 + Bxy + Cy^2$ equivalent to f, where B is uniquely determined mod $2A$. Equating discriminants, $B^2 - 4AC = D$. Hence we start by finding all solutions B of

$$B^2 \equiv D(\text{mod } 4A),\ 0 \leqq B < 2|A| \qquad (4)$$

For each such B construct the form

$$Ax^2 + Bxy + \left(\frac{(B^2 - D)}{4A}\right)y^2 = F_B$$

By reducing both f and F_B to reduced forms we determine whether f is equivalent to F_B, and if so can construct all unimodular transformations carrying f into F_B. The coefficients α, γ of these transformations give all the primitive representations of A by f. Different solutions B of (4) cannot yield the same representation.

Example: Find all representations of 15 by $f = 3x^2 + 2xy + 4y^2$. The solutions of $B^2 \equiv -44 \pmod{60}$, $0 \leqq B < 30$, are $B = 4, 14, 16, 26$. If $B = 4$, $F = 15x^2 + 4xy + y^2$, which is equivalent to $x_1^2 + 11y_1^2$ under the transformation $x_1 = 2x + y$, $y_1 = -x$; the corresponding representations in $x_1^2 + 11y_1^2$ are therefore $2, -1$ and $-2, +1$. Similarly, $B = 26$ yields $2, 1$ and $-2, -1$ in $x_1^2 + 11y_1^2$. If $B = -14$, $F = 15x^2 - 14xy + 4y^2$, and we find the representations $1, -2$ and $-1, 2$ in f; $B = 16$ yields similar representations in $3x^2 - 2xy + 4y^2$. Thus there are eight representations of 15 in the system of three reduced forms, two of them in f.

By a set of representations of A in f, we mean the set obtained from a given representation by applying the automorphs of f. This has a meaning even in the indefinite case when the number of automorphs may be infinite. The preceding process proves the following important result formulated by Dirichlet which holds equally true when f is indefinite.

Theorem: The number of sets of primitive representations of an integer A by the system (one form from each class) of binary quadratic forms of a given discriminant D is equal to the number of solutions of (4).

In a large number of special cases, this theorem provides immediate information on the number of representations in single forms. This is obviously true in the 12 cases in (3). For example, taking $D = -4$, we obtain the following result: a positive integer A is represented primitively as a sum of two squares if and only if A contains no prime factor of the form $4n + 3$ and A is not divisible by 4; and then the number of representations is $4 \cdot 2^k$, where k denotes the number of distinct prime factors of A of the form $4n + 1$.

By counting the primitive representations of $\frac{A}{s^2}$, for square factors s^2 of A, various formulas are obtainable for the number of sets of all representations by the system of reduced forms of discriminant D; one such formula, in the special case

$$(A, 2D) = 1, \text{ is } \sum_{k|A} (D|k)$$

i.e., the sum of the Legendre symbols $(D|k)$ for all the positive divisors k of A. Thus, in particular, the only positive integers A not represented by $x^2 + y^2$ are those containing a prime factor

$4n + 3$ to an odd power; while, if $A = 2^s p_1^{a_1} \cdots p_r^{a_r} t^2$, where the r ($\geqq 0$) distinct primes p_i are of the form $4n + 1$, and no prime in t is of that form, then the number of all representations of A as $x^2 + y^2$ is $4(a_1 + 1) \cdots (a_r + 1)$.

2. Genera of Quadratic Forms; Formulas for Number of Representations.—The last theorem provides a general formula for the number of representations of a number by a system of several classes of forms. A smaller system of great importance, of which many general properties are known is the genus.

A natural approach to the notion of genus may be derived from the following observations. If an integral form say $f = ax^2 + bxy + cy^2$, represents a number A, say $f(u, v) = A$, then obviously the congruence $f \equiv A \bmod m$ is solvable (with $x = u$, $y = v$) whatever be the modulus m. However, $2x^2 + 7y^2 \equiv 1$ (mod p^r) is solvable for every prime p and positive r, and hence solvable for every m; *e.g.*, with $3x \equiv 1$, $3y \equiv 1$, if $p \neq 3$, with $5x \equiv 3$, $5y \equiv 1$, if $p \neq 5$. But $2x^2 + 7y^2$ does not represent 1. The situation here is that there is associated with $2x^2 + 7y^2$ another class of forms, that of $x^2 + 14y^2$, which while not equivalent to $2x^2 + 7y^2$, is "equivalent to it for all congruencial purposes." And $x^2 + 14y^2$ does represent 1. The two classes, represented by $x^2 + 14y^2$ and $2x^2 + 7y^2$, happen to constitute a genus. As yet another example, $x^2 + y^2$ happens to be in a genus of one class, and $x^2 + y^2$ represents a positive integer A if and only if the congruence $x^2 + y^2 \equiv A \bmod m$ is solvable, for all m.

We shall call two integral forms equivalent in the field of reals if each is transformable into the other by linear transformations with real coefficients; *e.g.*, if $n = 2$, both must be positive-definite, both negative-definite, or both indefinite. Two forms are defined to be in the same genus if they have the same determinant d, are equivalent in the field of reals, and if for every modulus m (the modulus $2^n d$ being in fact sufficient) each is equivalent to a form whose coefficients are congruent mod m to the corresponding coefficients of the other.

There are several other sets of properties which distinguish a genus. Two quadratic forms in n variables are in the same genus if and only if they have the same determinant d and there exists a linear transformation, whose coefficients are rational numbers with denominators prime to $2^n d$, transforming one form into the other. For example, $2x^2 + 7y^2$ is carried into $x_1^2 + 14y_1^2$ by the transformation

$$x = \frac{(x_1 + 7y_1)}{3}, y = \frac{(x_1 - 2y_1)}{3}$$

The proof of the necessity of this criterion was completed for $n > 3$ only in 1940 by C. L. Siegel.

Historically speaking, genera have usually been characterized by means of sets of (more or less) easily computable invariants; Gauss (1801, $n = 2$), F. G. Eisenstein (1847, $n = 3$), H. J. S. Smith (1867, $n \geqq 3$), H. Minkowski (1884), B. W. Jones and G. Pall (1944). The most important of these are illustrated in the following section for $n = 3$.

Equivalent forms are in the same genus. A genus consists of a finite number of classes. If $n \geqq 4$, indefinite forms are in genera of one class; this is true also if $n = 3$, save in certain exceptional cases. It is probable that there are only finitely many classes of primitive, positive-definite forms in genera of one class; there are none in more than 35 variables (W. Magnus, 1938), and probably none in more than 10 variables. As an example, the three primitive forms of discriminant -44, preceding (3) in the above section on *Binary Quadratic Forms*, constitute a genus of three classes. The form $x_1^2 + \cdots + x_n^2$ is in a genus of one class only if $1 \leqq n \leqq 8$.

Some writers prefer to define class by the use of transformations of determinant ± 1, instead of Gauss's $+1$. Perhaps the main reason for preferring $+1$ is the following theorem formulated by Gauss: every genus of primitive, binary, quadratic forms of discriminant D contains the same number of classes. The situation if $n \geqq 3$ is somewhat different.

Consider a genus of primitive forms in $n(\geqq 2)$ variables. We assume the forms to be positive-definite, while mentioning that Siegel (1936), employing a suitable meaning for sets of representations, has extended the results which follow to indefinite forms. Let h denote the number of classes in the genus, and select one form $f_i (i = 1, \cdots, h)$ from each class. Let w_i denote the number of automorphs of f_i. The quantity

$$\frac{1}{w_1} + \cdots + \frac{1}{w_h}$$

is called the weight of the genus. A remarkable formula for this was suggested for $n = 3$ by Eisenstein, and was proved and generalized to any n by H. J. S. Smith (1867) and Minkowski (1884). Further, under certain restrictions, the total number of primitive representations of an integer m by the system of forms f_i of a genus was shown to be equal to the weights of certain related genera.

These results were generalized in 1935 by Siegel, to yield a formula for the numbers of representations (suitably weighted) of forms in k variables by a genus of forms in n variables; the case $k = 1$ is that of representation of numbers stated in the following paragraph.

Let $f_i(A)$ equal the number of representations of A by f_i. Then

$$\frac{\dfrac{f_1(A)}{w_1} + \cdots + \dfrac{f_h(A)}{w_h}}{\dfrac{1}{w_1} + \cdots + \dfrac{1}{w_h}} = \frac{\pi^{\frac{1}{2}n} A^{\frac{1}{2}n-1} S(A)}{\Gamma(\frac{1}{2}n) \cdot d^{\frac{1}{2}}} \tag{1}$$

where d denotes the determinant of f, $\Gamma(\frac{1}{2}n)$ is the well-known gamma-function (for which $\Gamma(m) = 1 \cdot 2 \cdot 3 \cdots (m - 1)$ if m is a positive integer), $S(A)$ denotes the product extended over all primes p, $S(A) = \chi(2) \cdot \chi(3) \cdot \chi(5) \cdot \chi(7) \cdots$ where

$$\chi(p) = \lim_{r \to \infty} p^{-(n-1)r} f(A, p^r)$$

while $f(A, p^r)$ (which can be evaluated by various methods) denotes the number of solutions of the congruence $f \equiv A$ (mod p^r). This general expression simplifies remarkably when n is even, and provides a neat formula for the number of representations of an integer A by a genus; hence by a form if the genus consists of one class.

We select several examples. Let $r_n(A)$ denote the number of representations of A as a sum of n squares. For example, $r_4(13) = 112$, since $13 = 3^2 + 2^2 + 0^2 + 0^2 = 2^2 + 2^2 + 2^2 + 1^2$, and we can permute and change signs of 3, 2, 0, 0 in 48 ways, of 2, 2, 2, 1 in 64 ways. Set $A = 2^k m$, m odd, $k \geqq 0$. If $n = 2, 4, 6, 8$ (when the genus of $x_1^2 + \cdots + x_n^2$ consists of one class), $r_n(A)$ has the following expressions in terms of the positive divisors d of m:

$$r_2(A) = 4 \sum_{d|m} (-1)^{(d-1)/2}$$

$$r_6(A) = 4\{(-1)^{(m-1)/2} 4^{k+1} - 1\} \sum_{d|m} (-1)^{(d-1)/2} d^2$$

$$r_4(A) = 8\{2 + (-1)^A\} \sum_{d|m} d$$

$$r_8(A) = \frac{16}{7} |8^{k+1} - 15| \sum_{d|m} d^3$$

Similar expressions have been obtained for many other forms in genera of one class; and for special forms of A by forms in genera of more than one class. For example, if A is of the form $4r + 3$, $r_{10}(A) = 12 \sum (-1)^{(d+1)/2} d^4$, and if A is even there is a simple expression for $r_{12}(A)$.

The formula for $r_4(A)$ was first obtained in 1828 by K. G. J. Jacobi, by equating coefficients in the expansions of certain elliptic functions. In a series of 18 articles (1858–65), J. Liouville stated without proof several identities and derived from them expressions for the number of representations by numerous quadratic forms.

The proofs of these identities are elementary, although as shown by E. T. Bell, many can be paraphrased from elliptic function identities by replacing sine and cosine terms by more general odd and even functions.

As an example we quote one of Uspensky's identities. Let $F(x, y, z)$ denote a function odd with respect to x, and even with

respect to y, z; *i.e.*, $F(-x, y, z) = -F(x, y, z)$ and $F(x, -y, -z) = F(x, y, z)$. Then $2\sum F(\delta - 2i, d + i, 2d + 2i - \delta) = \sum F(d + \delta, i, d - \delta) + 2T - U$ where the summations extend over all integral solutions of $n = i^2 + d\delta$, with d and δ positive. Both T and U are zero unless $n = s^2 (s > 0)$, in which case

$$T = \sum_{j=1}^{2s-1} F(2s - j, s, 2s - j),\ U = \sum_{j=1}^{2s-1} F(2s, j - s, 2j - 2s)$$

By various specializations of this formula, James Victor Uspensky obtained a large number of expressions for the numbers of representations by quadratic forms in two, four, six, eight, and ten variables; and all the known and certain new relations connecting binary quadratic class numbers for various determinants.

H. D. Kloosterman and V. Tartakowsky showed, about 1924, that (1) gives an asymptotic formula for the number of representations by a single form f_i, if $n \geq 4$. (See *Distribution of Primes. Asymptotic Formulas*, below.)

3. The Numbers Represented by a Quadratic Form; Universal Forms; Representation of Zero.—We shall make certain observations about the numbers represented by an integral quadratic form. As we implied earlier, a genus has the property that if $f \equiv A$ mod m is solvable for every m, and if A has the necessary sign when f is positive- or negative-definite, then some form in the genus of f represents A. For example, the two forms $f = x^2 + y^2 + 10z^2$ and $g = 2x^2 + 2y^2 - 2yz + 3z^2$ are representative of the two classes of a certain genus of determinant 10. It is easily proved that $f \equiv A$ mod p^r is solvable for every A and p, except when $p = 2$, r is large enough, and A is of the form $4^h(16k + 6)$. Hence f and g represent between them all positive integers not of the form $4^h(16k + 6)$. It might be supposed that f and g would each represent all large numbers not of the excluded form. It is easily proved that f represents all even numbers not of the excluded form; and Hansraj Gupta (1941) stated the odd numbers up to 20,000 not represented by f: 3, 7, 21, 31, 33, 43, 67, 79, 87, 133, 217, 219, 223, 253, 307, 391, 679, 2,719. But examples exist of two ternary classes in the same genus which do not represent the same large numbers.

In any case, if the genus of f consists of one class, the numbers represented by f can be determined by investigating the solvability of the congruences $f \equiv A$ (mod p^r). In this way we find that $x^2 + y^2 + z^2$ represents all positive integers not of the form $4^h(8k + 7)$, and that $x^2 + y^2 + z^2 + t^2$ represents all positive integers.

Tartakowsky (1925) showed that each class of positive-definite forms in five or more variables represents all the large numbers represented by its genus. This is not quite always true when $n = 4$, but the exceptions are known. It is definitely false (except in the trivial case of improperly equivalent forms such as $3x^2 \pm 2xy + 4y^2$) for binaries.

A quadratic form is called universal if it is positive-definite and represents all positive integers, or indefinite and represents all nonzero integers. Every universal binary is equivalent to xy. Every universal ternary with even cross-product coefficients was shown by L. E. Dickson to be equivalent to $2xy - Hz^2$ (H odd) or $2xy + y^2 - Hz^2$ ($H \equiv 2$ mod 4); if any cross-product coefficient is odd, A. Oppenheim showed it to be equivalent to $xy - Hz^2$. Srinivasa Ramanujan (1917) examined the forms $ax^2 + by^2 + cz^2 + dt^2$, where a, b, c, d are positive integers, $a \leqq b \leqq c \leqq d$; he found at most 54 such forms which may represent all positive integers. Dickson completed the proof of their universality in 1927. A complete proof, including forms with odd cross products, that there are only finitely many classes of positive-definite, universal quaternaries, was first given by A. E. Ross. Dickson proved that every universal ternary is a zero form.

A zero form is a form which represents zero for values of its variables not all zero. The theorem that every indefinite form in five or more variables is a zero form was formulated by A. Meyer (1884). Trivially, a binary form is a zero form if and only if its discriminant is a square. We shall suppose a ternary or quaternary to have been transformed into the form $f_3 = a_1x_1^2 + a_2x_2^2 + a_3x_3^2$ or $f_4 = a_1x_1^2 + a_2x_2^2 + a_3x_3^2 + a_4x_4^2$, and shall formulate necessary and sufficient conditions for such a form to represent zero. The symbol $(a, b)_p$ may be defined (see *Quadratic Residues*, above) as follows, by writing $a = p^\alpha m$, $b = p^{\alpha'} m'$ where m and m' are prime to p, and α, α' are integers:

$$\text{if } p > 2,\ (a, b)_p = (-1|p)^{\alpha\alpha'}(m|p)^{\alpha'}(m'|p)^{\alpha}$$
$$\text{if } p = 2,\ (a, b)_2 = (-1)^{(m-1)(m'-1)/4}(2|m)^{\alpha'}(2|m')^{\alpha}$$

The conditions are expressed in terms of the characters

$$c_p(f_3) = (-a_1a_2, -a_1a_3)_p,\ c_p(f_4) = (a_1, a_2)_p(-a_3, -a_4)_p$$

The former is an invariant of f_3 under rational linear transformations. The latter is needed for our present purpose only when $a_1a_2a_3a_4$ is of the form s^2k, where k is a quadratic residue mod p^r, *i.e.*, $(k|p) = 1$ if $p > 2$, $k \equiv 1$ mod 8 if $p = 2$. Evidently, $c_p(f_3) = 1$ unless $p | 2a_1a_2a_3$. We state finally: f_3 is a zero form if and only if $c_p(f_3) = 1$ for every p; f_4 is a zero form if and only if $c_p(f_4) = 1$ for every prime p such that $a_1a_2a_3a_4$ is of the above-specified form.

The theory of quadratic forms in rational coefficients, and for rational values of the variables, is much simpler than that in the domain of integers; attention should be drawn to Hasse's elegant development of this theory in the *Journal für Mathematik* for 1923.

4. Automorphs and Reduction of Indefinite Binary Quadratic Forms.—Any real, irrational number θ can be expanded into a continued fraction

$$a_0 + \cfrac{1}{a_1 + \cfrac{1}{a_2 + \cdots}},\ \text{abbreviated } a_0 + \frac{1}{a_1 +}\ \frac{1}{a_2 +} \cdots$$

where the a_i are integers, and $a_1, a_2, \ldots$ positive. Indeed, we can write

$$\theta = a_0 + \frac{1}{b_1}$$

where a_0 is an integer and $b_1 > 1$; then write

$$b_1 = a_1 + \frac{1}{b_2}$$

where a_1 is a positive integer and $b_2 > 1$; and so on. Since θ is irrational, the process cannot terminate. The rational fraction

$$\frac{p_n}{q_n} = a_0 + \frac{1}{a_1 +}\ \frac{1}{a_2 +} \cdots \frac{1}{a_n}, (p_n, q_n) = 1, q_n > 0$$

obtained by stopping at a_n, is called the nth convergent to θ. It can be proved that

$$\left|\theta - \frac{p_n}{q_n}\right| < \frac{1}{q_n^2};\ \text{and that } \frac{p_n}{q_n}$$

is a closer approximation to θ than any other rational fraction with denominator not exceeding q_n.

Lagrange observed that the continued fraction is periodic if and only if θ is a root of a quadratic equation of the type $a - b\theta + c\theta^2 = 0$, where a, b, c are integers. Here

$$\theta = \frac{(b + r)}{(2c)}$$

where $r^2 = D = b^2 - 4ac$. As a typical example, consider $a = 40$, $b = -45$, $c = 12$, $D = 105$. Then

$$\theta = \frac{(-45 + r)}{24} = -2 + \frac{(3 + r)}{24},\ b_1 = \frac{24}{(r + 3)} = \frac{(r - 3)}{4} = 1 + \frac{(r - 7)}{4}$$
$$b_2 = \frac{4}{(r - 7)} = \frac{(r + 7)}{14} = 1 + \frac{(r - 7)}{14},\ b_3 = \frac{14}{(r - 7)} = \frac{(r + 7)}{4} = 4 + \frac{(r - 9)}{4}$$
$$b_4 = \frac{4}{(r - 9)} = \frac{(r + 9)}{6} = 3 + \frac{(r - 9)}{6},\ b_5 = \frac{6}{(r - 9)} = \frac{(r + 9)}{4} = 4 + \frac{(r - 7)}{4}$$
$$b_6 = \frac{4}{(r - 7)} = b_2$$

Hereafter, the period $b_2, \cdots, b_5$ recurs.

The preceding discussion should help to explain Gauss's method of reduction of binary quadratic forms of a positive non-square discriminant D. Instead of a single reduced form (as in the case $D < 0$), each class contains a chain of reduced forms. In the case of $f = 40x^2 - 45xy + 12y^2$ this chain consists of the

forms $\phi_1 = -2x^2 + 7xy + 7y^2$, $\phi_2 = 7x^2 + 7xy - 2y^2$, $\phi_3 = -2x^2 + 9xy + 3y^2$, $\phi_4 = 3x^2 + 9xy - 2y^2$. These correspond to the period of the recurring continued fraction above, and can be obtained from f by applying in order the following unimodular transformations:

$x \to -y$, $y \to x - 2y$, to get $12x^2 - 3xy - 2y^2$ (not yet reduced); to the latter form, $x \to -y$, $y \to x - y$ to get ϕ_1; then, $x \to -y$, $y \to x + y$, ϕ_2; $x \to -y$, $y \to x - 4y$, ϕ_3; $x \to -y$, $y \to x + 3y$, ϕ_4; $x \to -y$, $y \to x - 4y$, giving $\phi_5 = \phi_1$; etc. In general, $ax^2 + bxy + cy^2$ is reduced if and only if $ac < 0$, $b > 0$, $0 < r - b < 2|a| < r + b$, where $r = \sqrt{D}$.

To complete the theory given under *Binary Quadratic Forms*, above, we observe that all the automorphs of a primitive form $ax^2 + bxy + cy^2$ of discriminant D are given by

$$x = \tfrac{1}{2}(t - bu)X - cuY,\ y = auX + \tfrac{1}{2}(t + bu)Y$$

where t, u range over all integral solutions of Fermat's equation (usually called Pell's equation), $t^2 - Du^2 = 4$. If D is a positive nonsquare integer, Fermat's equation can be shown to have a least solution T, U in positive integers (which can be found from a single period of the continued fraction for $\sqrt{D}$), and all integral solutions t, u are given by

$$\tfrac{1}{2}(t + u\sqrt{D}) = \pm\left(\tfrac{1}{2}(T \pm U\sqrt{D})\right)^k,\ k = 0, 1, 2, \cdots$$

I. Schur (1918) showed that $\frac{1}{2}(T + U\sqrt{D}) < D^e$, with $e = D^{\frac{1}{2}}$.

5. Diophantine Equations.—Diophantus of Alexandria (250 A.D.) was the first to treat systematically the solutions of equations or systems of equations in integral (or sometimes in rational) values of the unknowns. Such problems are called after his name. Infallible methods are available only for a few special cases, such as a system of linear equations, or a single quadratic equation. For a fuller discussion, *see* DIOPHANTINE EQUATIONS; FERMAT'S LAST THEOREM.

We noticed in the preceding section that if D is any positive integer (not a square), then $x^2 - Dy^2 = 1$ has infinitely many integral solutions. An important theorem of A. Thue and C. L. Siegel shows that on the contrary, if $f(x, y)$ is of degree $\geqq 3$ (and is not a power of a linear or quadratic function), and if c is a given nonzero number, then $f(x, y) = c$ has at most a finite number of integral solutions.

III. TOPICS IN ANALYTIC NUMBER THEORY

1. Gauss's Class-number Conjecture.—*The Riemann Zeta Function Conjecture.*—We saw under *Binary Quadratic Forms* above that the number $h(D)$ of classes of primitive binary quadratic forms of discriminant D is finite, and noted 12 negative discriminants for which $h(D) = 1$. No other negative D satisfying $h(D) = 1$ has ever been found. L. E. Dickson showed in 1922 that there are no others up to $-D = 15.10^6$, and D. H. Lehmer carried this in 1933 to -5.10^9. In 1934, H. Heilbronn and E. H. Linfoot proved that at most one other negative D exists satisfying $h(D) = 1$.

On the other hand, if D is positive, the tables show numerous values of D such that $h(D) = 1$, and indeed Dirichlet showed that there are infinitely many positive integers D with this property.

In *Disquisitiones arithmeticae* (1801), art. 303, will be found Gauss's conjecture that, as D tends to infinity through negative values, $h(D)$ tends to infinity. This conjecture was first proved by Heilbronn in 1934. Some of the developments preceding and following Heilbronn's proof are of interest. The analytic tools used in proving this and later results to be described began their development in the 19th century. P. G. L. Dirichlet, who called his great memoir of 1839, "Diverse Applications of Infinitesimal Calculus to Number Theory," is generally regarded as the founder of analytic number theory. After Dirichlet, it was G. F. B. Riemann who made the most fundamental advance.

The Riemann zeta function which was his invention may be defined by means of the series

$$\zeta(s) = 1 + \frac{1}{2^s} + \frac{1}{3^s} + \frac{1}{4^s} + \cdots$$

Here s is a complex variable, taking values of type $s = \sigma + it$, where σ and t are real numbers, and $i^2 = -1$. The series is convergent only if $\sigma > 1$, but determines by a process known as analytic continuation, a function defined and "regular" for all complex values s, except that it has a pole (a kind of infinity) at the point $s = 1$. A great deal is known about this function today. Riemann, in 1859, knew that $\zeta(s) = 0$ if s is any negative even integer, and that all the remaining zeros of $\zeta(s)$ satisfy $0 < \sigma < 1$ and lie symmetrically about the straight lines $\sigma = \frac{1}{2}$ and $t = 0$. Riemann conjectured that all these "nontrivial" zeros of $\zeta(s)$ lie on the straight line $\sigma = \frac{1}{2}$. In the 1960s it was unknown whether this was true or false.

It may be mentioned that G. H. Hardy proved that there are infinitely many zeros on the line $\sigma = \frac{1}{2}$, and that E. C. Titchmarsh has located all zeros up to $t = 200$.

The Riemann zeta function conjecture poses one of the most significant unsolved problems of modern mathematics. A conjecture similar to Riemann's can be made for a somewhat more general set of functions,

$$L(s, \chi) = \sum_{n=1}^{\infty} \frac{\chi(n)}{n^s}$$

known as the Dirichlet L-functions. We will not describe the $\chi(n)$, except to say that they are called characters, and have values ± 1 or 0 or roots of unity. The conjecture that there are no zeros of the L-functions with real part $\sigma > \frac{1}{2}$ is known as the Generalized Riemann Hypothesis (G.R.H.).

These conjectures are connected with several interesting questions. It seemed to be important to deduce results by assuming the truth of the G.R.H., in the hope that they might throw some light on the subject. For example, Hardy and J. E. Littlewood proved in 1923 on the basis of the G.R.H. slightly modified, that every sufficiently large odd number is equal to the sum of three odd prime numbers (see *The Goldbach Problem*, below). Again, in 1913, E. Hecke proved that if the G.R.H. holds true for all real-valued characters χ, then Gauss's conjecture about $h(D)$ follows. These results did not prove that every large odd number is the sum of three primes, or that $h(D)$ tends to infinity, but they have an interesting aftermath. In the case of Hecke's result the climax came in 1934. M. Deuring proved in 1933 that if $\zeta(s)$ has at least one zero with real part greater than $\frac{1}{2}$, then $h(D) = 1$ for only a finite number of negative discriminants D, and this was soon followed by the theorem of Heilbronn and Linfoot mentioned earlier. Then L. J. Mordell proved in 1934 that if $\zeta(s)$ has at least one zero with real part greater than $\frac{1}{2}$ then $h(D)$ tends to infinity. Finally, Heilbronn proved in 1934 that if there exists at least one real character χ for which $L(s) = 0$ for a value s with $\sigma > \frac{1}{2}$, then $h(D)$ tends to infinity. Thus by Hecke's work, Gauss's conjecture is correct if the Riemann hypothesis is true for all real characters χ; and by Heilbronn's work, Gauss's conjecture follows if the Riemann hypothesis for real characters χ is false.

It follows that Gauss's conjecture is true, but nothing can be concluded about the truth of the Riemann hypothesis itself. In passing, it should be mentioned that S. Chowla immediately revised Heilbronn's proof to make it independent of Hecke's work. C. L. Siegel immediately followed with a brief proof that

$$\frac{\log h(D)}{\log |D|} \to \tfrac{1}{2} \text{ as } D \to -\infty$$

thus giving an actual measure of how rapidly $h(D)$ tends to infinity. Siegel's formula has made possible other developments, such as I. M. Vinogradow's startling achievement of 1937, when he proved (without any unproved hypothesis) that every large odd number is a sum of three odd primes.

2. Distribution of Primes; Asymptotic Formulas.—In 1837 Dirichlet proved that there are infinitely many primes in any arithmetic progression $my + n (y = 0, 1, 2, \cdots)$, where m and n are any given coprime integers, m positive. In his article, analytic methods using fairly deep results from the theory of functions were first introduced into the theory of numbers. A number of special cases, notably $my \pm 1$, have been proved by strictly elementary methods. It is not known whether quadratic expressions such as $x^2 + 1$ represent infinitely many primes. However,

if $f = au^2 + buv + cv^2$ is primitive and not negative-definite, if $(m, n) = 1$ and the congruence $f \equiv n \bmod m$ is solvable, then f represents infinitely many primes of the form $my + n$.

Consider two functions $f(x)$ and $g(x)$ which tend to infinity with x. Examples are $\pi(x)$ = the number of primes up to x; and the function $\frac{x}{\log_e x}$. If the ratio $\frac{f(x)}{g(x)}$ tends to 1 as a limit when x tends to infinity, we say that $f(x)$ is asymptotic to $g(x)$, abbreviated $f(x) \sim g(x)$. The difference $f(x) - g(x)$, or the error in approximating $f(x)$ by $g(x)$, may then still become large with x, but will be of smaller order of size than $g(x)$. It is frequently important to estimate the magnitude of this error. The notation used for this purpose is illustrated by the equation $(x + 1)^3 = x^3 + O(x^2)$; which means that there exists a positive constant c such that, for all sufficiently large values of x, $|(x + 1)^3 - x^3| < cx^2$; here, $|3x^2 + 3x + 1| < 7x^2$ if $x > 1$. Generally, if F is a positive function of x, $O(F)$ denotes a function of x which, for all sufficiently large x, does not exceed cF in absolute value, where c is a positive constant. Examples: $\sin x = O(1)$, $(\log x)^{10} = O(x)$.

P. L. Chebichev gave asymptotic formulas for

$$\sum \frac{1}{p} \text{ and } \Pi\left(1-\frac{1}{p}\right)$$

where p ranges over the primes less than x; and proved Bertrand's postulate on the existence of a prime between x and $2x (x \geqq 2)$. Asymptotic formulas for $\pi(x)$ had been suggested by Legendre and Gauss. The simplest formula is $\pi(x) \sim x/\log x$, proved independently by J. Hadamard and C. de la Vallée Poussin in 1896. A closer approximation is given by

$$\int_2^x \frac{dx}{\log_e x}$$

the error being proved by J. E. Littlewood (1924) as $O(xe^{-t})$, with $t^2 = k \log x \log \log x$ (k a positive constant); and improved by N. Tchudakov (1947) to $t = (\log x)^\delta$, $\delta = 0{\cdot}6 - \epsilon$. The Riemann zeta function hypothesis discussed above is equivalent to the statement that the error is $O(x^{\frac{1}{2}} \log x)$.

We state a few of the simplest examples of asymptotic formulas for number-theoretic functions. For Euler's function (see *Residue classes*, above)

$$\phi(n), \phi(1) + \phi(2) + \cdots + \phi(n) = \frac{3n^2}{\pi^2} + O(n \log n)$$

The number of pairs of integers u, v satisfying $u^2 + v^2 \leqq x$ is $\pi x + O(x^{\frac{1}{3}})$. This exponent $\frac{1}{3}$ can be lowered, though it must exceed $\frac{1}{4}$, and exceedingly delicate analysis has gone into proving that we can take the exponent as low as $\frac{13}{40}$. If x is a prime, the least primitive root of x is $O(x^{\frac{1}{4}+\epsilon})$, where ϵ is any desired positive number (see *Primitive Roots*, above). If $r(x)$ denotes the number of representations of the integer x as a sum of three squares, and x is not of the form $4n$ or $8n + 7$, then $\log r(x) \sim \log \sqrt{x}$ (Siegel, 1935).

A later development of interest is the elementary proof of the fact that $\pi(x) \sim x/\log x$, by Atle Selberg (1949). His method also was applied to prove Dirichlet's theorem on the infinitude of primes in an arithmetic progression. In the same year, an elementary proof of Dirichlet's theorem based on algebraic numbers was published by H. Zassenhaus.

An interesting, as yet unproved, conjecture states there exist infinitely many pairs of primes differing by two (*e.g.*, 3, 5; 197, 199); such pairs are called twin primes. However, if their number is infinite, they are distributed much more sparsely than the primes themselves, since, as was shown by Viggo Brun in 1921, the sum of the reciprocals of the twin primes is finite, while the sum of the reciprocals of all primes is infinite.

IV. ADDITIVE THEORY OF NUMBERS

A typical problem of the additive theory of numbers may be described as follows. Consider a set S of integers $a_1, a_2, \cdots$; *e.g.*, S might contain the primes, or the cubes of primes, or the squares. Let $r(n)$ denote the number of representations of a positive integer n as a sum of s elements a_i of S. The problem is to find out what we can about $r(n)$; *e.g.*, whether $r(n)$ is always positive; or positive for all sufficiently large n; or to obtain an exact or approximate formula for $r(n)$.

1. Partitions. In particular, if $S = (1, 2, 3, \cdots)$, consists of all positive integers, the number s of summands is unrestricted, repetitions are allowed, and order is irrelevant, we have the problem of unrestricted partitions; *i.e.*, one of expressing a positive integer n as a sum of positive integers. Thus 4 has five partitions: 4, $3 + 1$, $2 + 2$, $2 + 1 + 1$, $1 + 1 + 1 + 1$.

A number of interesting facts can be proved by elementary methods, such as representing a partition by an array of dots, and collecting these dots in different orders. Thus: the number of partitions of n into m parts is equal to the number of partitions of n into parts the largest of which is m. If $p(n)$ denotes the number of partitions of n, then

$$1 + \sum p(n)x^n = \frac{1}{\{(1-x)(1-x^2)(1-x^3)\cdots\}}$$

called a generating function for $p(n)$. Generating functions are constructible for partitions variously restricted; *e.g.*, into odd parts, unequal parts, parts of the form $5n \pm 1$, etc. By transformation of generating functions results such as the following appear (those stated being first given by Euler): the number of partitions of n into unequal parts is equal to the number of its partitions into odd parts; if $E(n)$ is the number of partitions of n into an even number of unequal parts, and $U(n)$ the number into an odd number of unequal parts, then $E(n) - U(n) = 0$ unless n is of the form $\frac{1}{2}k(3k \pm 1)$, when $E(n) - U(n) = (-1)^k$. Again, the number of partitions of n into parts which differ by at least 2 is equal to the number of partitions into parts of the form $5m \pm 1$.

Among the most important later developments, we should mention an asymptotic formula for $p(n)$, developed by Hardy and S. Ramanujan (1917); and an exact expression for $p(n)$ by an infinite series, presented by H. Rademacher (1937).

2. The Waring Problem, and Related Problems.—Interest in forms capable of representing all positive integers goes back to Diophantus, of the 3rd century, who (according to Bachet de Méziriac, 1621) assumed that every positive integer is a sum of four squares. Fermat (1636) stated that: "every number is either triangular or the sum of two or three triangular numbers; every number is either a square or a sum of two, three or four squares; either pentagonal, or the sum of two, three, four, or five pentagonal numbers; and so on ad infinitum whether it is a question of hexagonal, heptagonal, or any polygonal numbers." (If billiard balls are stacked into a triangle, the number of balls will be $1 + 2 + \cdots + x = \frac{1}{2}x(x + 1)$, called a triangular number. Generally, a polygonal number of order m is given by $x + \frac{1}{2}(m - 2)(x^2 - x)$, where $x = 0, 1, 2, \cdots$; the squares are obtained when $m = 4$.) Fermat's theorem is that every positive integer is a sum of m polygonal numbers of order m.

This theorem was proved for squares by Lagrange (1772), for triangular numbers by Legendre (1798), for the remaining cases by A. L. Cauchy (1813–15).

In 1770 E. Waring stated an extension of the four square theorem in the direction of higher powers: every positive integer is a sum of at most 9 (positive, integral) cubes, also a sum of at most 19 fourth powers, at most 37 fifth powers, and in general of a limited number (whose least value we will denote by $g(k)$) of kth powers. That at least 9 cubes are required follows from the fact that 23 and 239 cannot be represented by sums of fewer cubes. The son of the great Euler noticed an integer which requires at least $2^k - 2 + [(\frac{3}{2})^k]$ kth powers. Here the symbol $[t]$ denotes the greatest integer in t.

The function $G(k)$ giving the least number of kth powers required to represent all but a finite number of positive integers is of even greater interest. Evidently $G(k) \leqq g(k)$. By Lagrange's result, $G(2) = g(2) = 4$.

Starting about the middle of the 19th century, the finiteness

of $g(k)$ was gradually proved by means of elementary but complicated methods, first for $k = 4$, then for $k = 3, 5, 6, 7, 8, 10, 12$ and 14; and finite upper bounds to $g(k)$ (which, except for $k = 3$, were not best possible) were obtained. The problem of finding anything general about $g(k)$ or $G(k)$ seemed hopeless until D. Hilbert, in a famous paper of 1909, proved the fact that $g(k)$ is finite for every k. His proof is not exactly elementary, since it is based on the transformation of a 5-fold integral (in his first presentation, a 25-fold integral). The transcendental character of his proof was eliminated by various writers, but it is still a pure existence proof and gives no method of estimating $g(k)$.

The really great invention which opened up the whole subject was the work (1917) of Hardy and Littlewood, and Ramanujan. A very important step depended on H. Weyl's previous investigation of exponential sums. By use of A. L. Cauchy's integral formula, an expression can be constructed for the coefficient c_n in the expansion of

$$(1 + x^{1^k} + x^{2^k} + \cdots)^s = \sum_{n=0}^{\infty} c_n x^n$$

Briefly, the main contribution of Hardy and Littlewood to Waring's problem and similar problems was that they invented a way to prove that if $s \geqq (k-2)2^{k-1} + 5$, at most a finite number of coefficients in the above expansion vanish, and hence $G(k) \leqq (k-2)2^{k-1} + 5$, and that they found an asymptotic expression for c_n, that is the number of ways n can be expressed as a sum of s kth powers. Later they found smaller bounds for $G(k)$.

Although Hardy and Littlewood proved that every sufficiently large integer is a sum of 19 fourth powers, 41 fifth powers, $\cdots$, 425 eighth powers, etc., they did not compute actual limits beyond which these facts would hold true. Hence their work gave no immediate information about the size of Waring's constant $g(k)$. In the hope of being able to prove Waring's original statement with the best possible values $g(k)$, L. E. Dickson urged certain of his students about 1930 to find lower limits to the constants in the Hardy-Littlewood analysis. R. D. James succeeded in this, and proved $g(6) \leqq 183$, $g(7) \leqq 322$, $g(8) \leqq 595$, in 1934; but the limits given by the Hardy-Littlewood method soon became impracticable.

The next and most important step came from the great Russian mathematician, I. M. Vinogradow. Vinogradow's earlier researches on the Waring problem had appeared in 1924; his methods were similar to those of Hardy and Littlewood, but led more rapidly to certain results. In his later work he made very important improvements, and found results which for large k were much better than those previously obtained. In particular, he ultimately proved $G(k) \leqq k(3 \log k + 10)$.

With the appearance of Vinogradow's new results, L. E. Dickson in the U.S. and S. S. Pillai in India investigated the possibility of proving the Waring conjecture in the original sense with best possible values $g(k)$, and both arrived independently in 1936 at an "almost complete" solution. Let $q = [(\frac{3}{2})^k]$. They proved that $g(k) = 2^k + q - 2$ if $k \geqq 7$, and

$$(\tfrac{3}{2})^k - q \leqq 1 - (\tfrac{1}{2})^k (q+3) \tag{1}$$

This condition is satisfied if $k \leqq 400$, and possibly for every k. When (1) does not hold, the formula for $g(k)$ is different, but was determined except for those values k (if any) satisfying

$$(\tfrac{3}{2})^k - q = 1 - (\tfrac{1}{2})^k (q+2) \tag{2}$$

The exceptional case (2) was finally solved in 1944 by I. Niven. Further, (although his proof may require minor corrections) Pillai proved that $g(6) = 73$ in 1940. Accordingly, Waring's problem was completed (1944) as regards $g(k)$, except when $k = 4$ and 5.

The best results for these cases were those of Dickson (1933) that $19 \leqq g(4) \leqq 35$, $37 \leqq g(5) \leqq 54$; and Davenport (1942 and 1939), that $G(5) \leqq 23$ and $G(4) = 16$. The latter is a best possible result, since the infinitely many numbers $16^k \cdot 31$ require 16 fourth powers. It was, up to 1944, the only best possible result known for $G(k)$, $k \geqq 3$.

In 1909 (except for an omission supplied by A. J. Kempner in 1912) A. Wieferich proved that $g(3) = 9$. In the same year Edmund Landau showed that $G(3) \leqq 8$. In 1944 Y. V. Linnik gave a proof (a lacuna being later filled) that $G(3) \leqq 7$. Dickson proved in 1939 that every number except 23 and 239 is a sum of eight cubes. Numerous generalizations of the Waring problem have been investigated, such as sums of kth powers of primes, integral valued polynomials, etc.

3. The Goldbach Problem. In an exchange of letters (1742) between Euler and C. Goldbach, it was conjectured that every integer is a sum of three primes, and every even integer a sum of two primes. Not considering 1 as prime, and omitting the even prime 2, we may formulate these conjectures for odd integers $\geqq 9$ and even integers $\geqq 6$.

No essential progress was made in solving this problem until the result (1923) of Hardy and Littlewood based on the G.R.H. (see *Gauss's Class-number Conjecture*, above). In 1930, L. Schnirelmann proved that every positive integer can be represented by a sum of at most 800,000 primes. This number was lowered to 2,208 by N. P. Romanoff in 1935; to 71 by Heilbronn, Landau, and H. F. Scherk in 1936; to 67 by G. Ricci in 1937. Supplementing the analytic methods of Hardy and Littlewood by powerful new methods of his own, Vinogradow proved that every sufficiently large odd number is a sum of three odd primes, in 1937. In the first award of the Stalin prizes in 1941, Vinogradow received a first prize of 100,000 rubles for his work on the Goldbach problem.

V. DIOPHANTINE APPROXIMATION

1. Geometry of Numbers.—A lattice (in the plane) is the configuration formed by two systems of equidistant parallel lines. The points of intersection form a point lattice. A lattice L can be defined analytically by two linear forms with real coefficients and integer variables: if x and y take all integral values, the points with rectangular co-ordinates $(\alpha x + \beta y, \gamma x + \delta y)$, where $\alpha, \beta, \gamma, \delta$ are given real numbers, form a point lattice. The four points $O = (0, 0)$, $P = (\alpha, \gamma)$, $Q = (\beta, \delta)$, $R = (\alpha + \beta, \gamma + \delta)$ are the vertexes of a fundamental parallelogram, with area $\Delta = \alpha\delta - \beta\gamma$ (which we assume not zero). In particular, if $\alpha = \delta = 1$, $\beta = \gamma = 0$, the lattice consists of all points (x, y) with integral co-ordinates. Any linear transformation $x = ax' + by'$, $y = cx' + dy'$, where a, b, c, d are integers and $ad - bc = +1$, produces a different system of parallelograms based on the same point lattice. The lattices so derived are said to be equivalent. The area Δ of a fundamental parallelogram is the same for equivalent lattices.

Consider a parallelogram with centre at O, and with two lattice points. P_1 and Q_1 of L as midpoints of adjacent sides. Let the area of the parallelogram be $4k$. If $k = \Delta$ (which is least possible), there are at least 8 points of L on the boundary, but none (except O) in the interior of the parallelogram. This fact is a special case of a famous theorem of Minkowski, which asserts that any simple, closed, convex region R symmetrical about O, and of area greater than 4Δ, contains within it points of L other than O. One may think of R as the interior of a parallelogram or of an ellipse. This theorem can be extended to n dimensions.

Other important theorems of Minkowski (some of the proofs of which use the above theorem on convex bodies) concern sets of n linear forms $\xi_i = \alpha_{i1}x_1 + \cdots + \alpha_{in}x_n$ $(i = 1, \cdots, n)$, with real coefficients α_{ij} and n integral variables $x_1, \cdots, x_n$. Supposing, for simplicity that $n = 2$, we have $\xi = \alpha x + \beta y$, $\eta = \gamma x + \delta y$. Let D denote the absolute value of the determinant $\alpha\delta - \beta\gamma$, and assume $D \neq 0$. One theorem asserts that there exist integers x and y not both zero, such that $|\xi\eta| \leqq \frac{D}{\sqrt{5}}$. A second theorem states that if b and c are positive numbers such that $bc \geqq D$ (*e.g.*, if $b = c = \sqrt{D}$), then there exist integers x and y not both zero such that $|\xi| \leqq b$ and $|\eta| \leqq c$. Both these theorems extend to n dimensions. A third theorem asserts that if ρ and σ are given real numbers, we can find integers x and y such that

$$|(\alpha x + \beta y - \rho)(\gamma x + \delta y - \sigma)| \leqq \tfrac{1}{4}D$$

The obvious extension to n linear forms would have $\frac{D}{2^n}$ on the

right. The case $n = 3$ was proved by R. Remak in 1923, but the cases $n \geqq 4$ had up to 1945 defied attempts at proof. The case $n = 4$ was proved by F. J. Dyson in 1948. After 1938, powerful methods of investigating certain nonconvex regions were developed by L. J. Mordell, H. Davenport and K. Mahler.

2. Diophantine Approximation.—The literature on the approximation of irrational numbers by rational fractions is very extensive. We saw, by continued fractions, that if θ is any irrational number, there are infinitely many rational fractions

$$\frac{p}{q} \text{ such that } \left|\theta - \frac{p}{q}\right| < \frac{1}{q^2}$$

A different proof (which is based on Dirichlet's principle that if $n+1$ objects are in n boxes, then at least one box contains two or more objects) is worth giving, because it extends easily to n-dimensional problems. Let (x) denote $x-[x]$; *i.e.*, the fractional part of x. The $Q+1$ numbers (0), (θ), (2θ), $\cdots$, $(Q\theta)$ define $Q+1$ points distributed among the Q intervals

$$0 \text{ to } \frac{1}{Q}, \frac{1}{Q} \text{ to } \frac{2}{Q}, \cdots, \frac{(Q-1)}{Q} \text{ to } 1$$

At least one interval must contain two numbers, say $(q_1\theta) = q_1\theta - p_1$, $(q_2\theta) = q_2\theta - p_2$, where p_1, p_2, q_1, q_2 are integers, and $0 \leqq q_1 < q_2 \leqq Q$. Hence $p = p_2 - p_1$ and $q = q_2 - q_1$ satisfy

$$|q\theta - p| < \frac{1}{Q}, \left|\theta - \frac{p}{q}\right| < \frac{1}{qQ} \leqq \frac{1}{q^2}$$

If θ is irrational, there will be a larger Q_1 such that

$$|q\theta - p| > \frac{1}{Q_1}$$

new approximations can be determined by means of Q_1. An extension of this argument proves the result of Dirichlet: If $\theta_1, \theta_2, \cdots, \theta_k$ are any real numbers, then one can find integers $p_1, \cdots, p_k$, and q such that

$$\left|\frac{p_i}{q} - \theta_i\right| < \frac{1}{q^{1+1/k}}, \ (i = 1, \cdots, k)$$

if at least one θ_i is irrational there are infinitely many solutions p_i and q.

In 1884 L. Kronecker proved that if θ is any irrational number there are integers n such that $(n\theta)$ is as near as we please to any number in the interval 0 to 1; briefly, $(n\theta)$ is dense on the interval $(0, 1)$. Moreover, as proved about 1912, this distribution is uniform over the interval $(0, 1)$; *i.e.*, if I denotes a subinterval of $(0, 1)$ of length I_1, and if n_I of the points (θ), (2θ), $\cdots$, $(n\theta)$ fall in I, then $\frac{n_I}{n} \to I_1$, as $n \to \infty$. In *Mathematische Annalen*, 77 (1916), Weyl proved that a necessary and sufficient condition for uniform distribution of the numbers $(f(n))$, $n=1$, 2, 3, $\cdots$, is that $\frac{1}{n}\sum_{k=1}^{n} e^{2\pi i h f(k)} \to 0$ as $n \to \infty$ for every integer h.

Transcendental Numbers.—Any real number which is not algebraic (*see* below) is called transcendental. Interest in transcendental numbers perhaps first arose in connection with the classical problem of squaring the circle, one which could be performed by Euclidean constructions if and only if the number π were expressible by means of square roots and rational operations. The impossibility of this construction was demonstrated when F. Lindemann proved the transcendence of π in 1882.

Liouville proved a theorem which shows how to obtain as many transcendental numbers as we please (1851). It states that if ξ is a real algebraic number of degree η and K is any constant, then there exist at most a finite number of rational fractions

$$\frac{p}{q} \text{ such that } \left|\frac{p}{q} - \xi\right| < \frac{K}{q^{n+1}}$$

Hence a number with a sufficiently rapid sequence of rational approximations is transcendental (*e.g.*, this is true of .1010010-0010$\cdots$).

Among the numbers known to be transcendental we may mention e, π, $\log_e 2$, $2^{\sqrt{2}}$, e^{π}. In 1900, Hilbert proposed the problem of proving that if α and β are algebraic numbers, α not 0 or 1, and β is irrational, then α^β is transcendental. This was proved in 1934 by Alexis O. Gelfond and T. Schneider, independently.

VI. GENERALIZATIONS OF ARITHMETIC

1. Algebraic Numbers.—Gauss was the first to extend the notions of arithmetic (integrality, divisibility, primality, etc.) to systems other than the ordinary integers. He defined a complex number $a = a_0 + a_1 i$ (where a_0, a_1 are rational numbers and $i^2 = -1$) to be a complex integer if a_0 and a_1 are ordinary integers. Ordinary integers will hereafter be called rational integers. Divisibility is defined as usual: $b|a$ if $a = bc$ in complex integers. The number $a_0 - a_1 i$, called the conjugate of a, may be designated by a'. The product aa' is the rational integer $a_0^2 + a_1^2$, and is called the norm of a. If $a = bc$, then $a' = b'c'$, $aa' = (bb')(cc')$, so that the norm of b is a factor (in the ordinary sense) of the norm of a. The only complex integers which divide all complex integers are those of norm 1, the units ± 1 and $\pm i$. If $b|a$ then the associates ub of b, where u is any unit, are also factors of a. If the complex integer p (not a unit) has no factors other than its associates and units, p is called a prime. It turns out that $p = p_0 + p_1 i$ is a complex prime if the norm of p is a rational prime of the form $4n + 1$, or if $p = \pm(1 \pm i)$, or if p is the associate of an ordinary prime of the form $4n + 3$. One proves that $p \mid ab$ only if $p \mid a$ or $p \mid b$, and deduces the fundamental theorem of arithmetic in the system of complex integers. Virtually all the theorems of ordinary theory of numbers have analogues among complex integers.

E. E. Kummer, in studying Fermat's equation $x^n + y^n = z^n$ (*see* FERMAT'S LAST THEOREM), developed the theory of integral elements in the fields generated by nth roots of unity (Gauss's case is $n = 4$), and found (about 1847) that the fundamental theorem of arithmetic does not always hold true in such systems.

To illustrate this, consider the system of numbers $a = a_0 + a_1\theta$, where $\theta^2 = -5$ and the a_i are rational numbers; a is called integral if the a_i are rational integers. The conjugate a' is now $a_0 - a_1\theta$ and the norm of a is $aa' = a_0^2 + 5a_1^2$. As before, if $b|a$, then the norm of b divides the norm of a. Hence the units (of norm 1) are ± 1. The number $1 + \theta$ (of norm 6) must be a prime, because neither 2 nor 3 are norms. This prime $1 + \theta$ is a divisor of $(1 + \theta)(6 + 5\theta) = -19 + 11\theta = (-1 + 3\theta)(4 + \theta)$. But $1 + \theta$ is not a divisor of $4 + \theta$, since the norm 6 does not divide the norm 21. Hence the fundamental theorem of arithmetic (with many of its consequences) does not hold.

If θ is a real or complex solution of an algebraic equation of the type $a_0x^n + a_1x^{n-1} + \cdots + a_n = 0$, where the coefficients a_i are rational numbers, θ is called an algebraic number. It is called an algebraic integer if it satisfies such an equation with $a_0 = 1$, and $a_1, \cdots, a_n$ integers. Examples are i and $\sqrt[3]{6}$. One frequently considers the algebraic integers in a given algebraic field, which consists of all numbers of the form $b_0 + b_1\theta + b_2\theta^2 + \cdots + b_r\theta^r$ with rational coefficients b_i. The sum, difference, and product of two algebraic integers in a field are easily seen to be algebraic integers in the same field.

2. Ideals.—Suppose that S is the system of all algebraic integers, denoted by $a, b, \cdots, s, t$ in a given algebraic field. Divisibility, units, associates, etc. are defined much as in the preceding two examples. Factorization into primes may not be unique. However, by adjoining to the system S a set of ideals, presently to be defined, the fundamental theorem of arithmetic can be made to hold.

If $a = bc$, then clearly the set of all multiples sa of a (where s ranges over all the integral elements of S) is included in the set of all multiples sb of b. Thus the notion of divisibility of integers can be replaced by the notion of inclusion of one set in another. The set of all multiples sa of a given number a will be called an ideal, more specifically, a principal ideal. More generally, an ideal is a set of numbers in an algebraic field, such that if u and v are any numbers in the set then $su + tv$ are in the set, where s and t range over all the integers of the field. In the case of rational in-

tegers, if u and v are any rational integers not both zero, then the set of numbers $su + tv$ is the same as the set of numbers md, where d is the g.c.d. of u and v; hence every ideal is then principal. The same is true in Gauss's case of numbers $a_0 + a_1i$. But the field generated from $\theta^2 = -5$ contains nonprincipal ideals.

The product of two ideals is the ideal obtained by multiplying each element of one by each element of the other, and then constructing all combinations $su + tv$ (s and t integral, u and v in the ideal). The principal ideal consisting of all multiples sa of a will be denoted by (a); the ideal consisting of all combinations $su + tv$ by (u, v). It can be shown that every ideal in an algebraic field can be expressed in this way by one or two terms. The ideal (1) plays the role of the number 1; *i.e.*, for any ideal α, $(1)\,\alpha = \alpha$. An ideal whose elements are algebraic integers is called integral. A prime ideal is an integral ideal with no divisors except itself and (1).

The fundamental theorem of arithmetic can be shown to hold in an algebraic field, if each algebraic integer a is replaced by its principal ideal (a), and the system is enlarged to encompass all the integral ideals of the field: every ideal which is not a prime can be expressed as a product of prime ideals in only one way.

This may be illustrated in the above example with $\theta^2 = -5$ as follows. Let $\alpha = (1 + \theta, -1 + 3\theta)$, $\beta = (1 + \theta, 4 + \theta)$, $\gamma = (6 + 5\theta, -1 + 3\theta)$, $\delta = (6 + 5\theta, 4 + \theta)$. The ideals $\alpha, \beta, \gamma, \delta$ are easily shown to be prime ideals (with respective norms 2, 3, 23, and 7), and the factorization of $(-19 + 11\theta)$ into prime ideals is simply $\alpha\beta\gamma\delta$. The factorizations previously given were $\alpha\beta\cdot\gamma\delta = (-19 + 11\theta) = \alpha\gamma\cdot\beta\delta$, and it is not surprising that $\alpha\beta|\alpha\gamma\cdot\beta\delta$ without dividing $\alpha\gamma$ or $\beta\delta$.

3. Algebras, and Their Arithmetics. Other generalizations of number are found in the extensive theory of linear algebras, which we will illustrate only very briefly. A simple example is the algebra of quaternions (*see* QUATERNIONS). These are symbols of the form $a = a_0\cdot 1 + a_1i_1 + a_2i_2 + a_3i_3$, where we will suppose the a_i to be rational numbers, and the basal elements $1, i_1, i_2, i_3$ satisfy the multiplication table $1\cdot b = b\cdot 1 = b, i_1^2 = i_2^2 = i_3^2 = -1, i_1i_2 = i_3 = -i_2i_1, i_2i_3 = i_1 = -i_3i_2, i_3i_1 = i_2 = -i_1i_3$. Algebraic operations are performed in the usual way, except that multiplication is in general not commutative (*e.g.*, $i_1i_2 \neq i_2i_1$), and the order of multiplication must be preserved. The resulting algebra has many applications, physical and geometrical. The question here is, what shall be meant by an integral quaternion?

In 1886, R. Lipschitz defined a to be integral if the co-ordinates a_i are rational integers, and was able to prove the following result resembling the fundamental theorem of arithmetic. Define a', the conjugate of a, to be $a_0 - a_1i_1 - a_2i_2 - a_3i_3$. The product aa' will be found to be $a_0^2 + a_1^2 + a_2^2 + a_3^2$, a rational integer called the norm of a, abbreviated $N(a)$. From $a = bc$ follows $a' = c'b'$, and hence $aa' = (bc)(c'b') = b(cc')b' = (bb')(cc')$, or $N(a) = N(b)N(c)$. The units are the eight quaternions $u = \pm 1, \pm i_1, \pm i_2, \pm i_3$ of norm 1. If b is a left divisor of a (*i.e.*, $a = bc$ in integral quaternions), then the right associates bu are also left divisors of a.

A prime quaternion is an integral quaternion a (not a unit) such that if $a = bc$ in integral quaternions, then b or c is a unit. It is easily proved that a quaternion is prime if and only if its norm is a rational prime number; *e.g.* $1 + i_1$ of norm 2, $2 + i_1 - 2i_2 + 2i_3$ of norm 13. Factorization into primes is in general not unique. For example, $3 = (1 + i_1 + i_2)\ (1 - i_1 - i_2) = (1 + i_1 + i_3)(1 - i_1 - i_3)$, yet the primes $1 + i_1 + i_2$ and $1 + i_1 + i_3$ are not right associates. However, suppose now that a is primitive, *i.e.* that a_0, a_1, a_2, a_3 are relative-prime, and that $N(a)$ is not divisible by 4. Factor $N(a) = p_1p_2\cdots p_r$ into rational primes, not necessarily distinct, but in a definite order. Lipschitz's result is this: there exist prime quaternions $t_1, t_2, \cdots, t_r$ of respective norms $p_1, p_2, \cdots, p_r$ such that $a = t_1t_2\cdots t_r$; this factorization into primes is unique, for the given order of $p_1, \cdots, p_r$, except that we can introduce unit factors in the trivial way illustrated by $t_1t_2t_3 = (t_1i_1)(-i_1t_2i_3)(-i_3t_3)$. This theorem yields a large number of arithmetical applications; *e.g.*, he proved thereby the formula for the number of representations of integers as a sum of 4 squares.

However, the definition of integral quaternion was somewhat arbitrary. A. Hurwitz was led by natural considerations to define a to be integral if the a_i are either all integers, or all halves of odd integers. For example, $\frac{1}{2}(1 + i_1 - i_2 + i_3)$ is integral, of norm 1. The resulting arithmetic is better behaved with respect to the prime 2 (it being unnecessary to restrict $N(a)$ to be not divisible by 4,—but still necessary to assume a primitive).

We owe, finally, to L. E. Dickson an adequate and unique characterization of a system of integral elements in any linear algebra (*Algebras and Their Arithmetics* [1923]). This includes Hurwitz's system and the theory of algebraic integers as special cases, and has formed the basis of much subsequent work.

The first half of the 20th century saw many extensions of the theory of numbers to various algebraic systems. Not all theorems extend easily, and some lead to rather surprising results. The prospects for original research were, by the 1960s, by no means exhausted.

See also references under "Numbers, Theory of" in the Index.

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NUMBER SEQUENCES are sets of numbers arranged in order so that there is a first, a second and so on. The sequence may be finite or infinite, according as the number of terms is limited or unlimited. The best-known infinite sequence comprises the natural numbers listed in order of size: 1, 2, 3, 4, 5, ... A number sequence is to be distinguished from a mere set or collection of numbers. In fact there are sets of numbers which, it can be proved, cannot be arranged as sequences. An illustration of this is the set of all positive real numbers, which can be conceived as the collection of the lengths of all possible straight line segments, measured against some arbitrary unit of length such as one inch.

A few cases of number sequences as they arise in various parts of mathematics are sketched below.

Simple Sequences.—Arithmetic progressions, harmonic progressions and geometric progressions are types of simple sequences. An arithmetic progression is a sequence in which the difference between any two successive terms is the same, say the constant difference d. If the first term is denoted a, then the arithmetic progression can be written in the form

$$a, a + d, a + 2d, a + 3d, \ldots$$

It can be established that the nth term of this sequence is given by $a + (n - 1)d$, and the sum of the first n terms by

$$\tfrac{1}{2}n[2a + (n - 1)d]$$

An arithmetic progression, then, is a sequence for which the first differences are constant. Now consider the sequence of squares of the natural numbers: 1, 4, 9, 16, 25, 36, . . . , n^2, ... Here the first differences are 3, 5, 7, 9, 11, . . . , and the second differences are constant: 2, 2, 2, 2, ... Whenever a number sequence has constant second differences, it must be formed by some second-degree algebraic expression; the simplest example, n^2, has just been cited.

A more complicated example is the sequence 2, 4, 12, 26, 46, . . . formed by the algebraic expression $3n^2 - 7n + 6$ by substituting successively $n = 1$, $n = 2$, $n = 3$ and so on. It also has constant second differences; in this case each equals 6. This law generalizes: if a sequence has constant kth differences, then the sequence must be formed by an algebraic expression of degree k. Thus if a sequence derives from a third-degree algebraic expression (*e.g.*, n^3) the third differences are constant.

An interesting result (P. G. L. Dirichlet) concerning arithmetic progressions of natural numbers is that if a and d have no common divisor, as for example in case $a = 7$ and $d = 10$, then the sequence contains infinitely many prime numbers. (The prime numbers are 2, 3, 5, 7, 11, 13, 17, . . . ; *see* ARITHMETIC: *Theory of Divisors*.)

A harmonic progression is a sequence of numbers with reciprocals that form an arithmetic progression; *e.g.*, $\frac{1}{3}, \frac{1}{5}, \frac{1}{7}, \frac{1}{9}, \frac{1}{11}, \ldots$. A geometric progression is a sequence such that the ratio of any two consecutive terms is the same number, say r. If the first term is denoted a, then a geometric progression can be written in the form

$$a, ar, ar^2, ar^3, ar^4, \ldots$$

The nth term is given by ar^{n-1} and the sum of the initial n terms of this sequence is obtained from

$$\frac{a(1 - r^n)}{1 - r}$$

If r falls between -1 and $+1$, the expression for the sum of n terms approaches $a/(1 - r)$ as n increases beyond all bounds. A familiar case of this occurs in any infinite repeating decimal. For example, the number .232323 . . . can be thought of as the sum of all terms of the sequence

$$\frac{23}{100}, \frac{23}{10{,}000}, \frac{23}{1{,}000{,}000}, \ldots$$

This is the infinite geometric progression with $a = \frac{23}{100}$, $r = \frac{1}{100}$, and with sum $\frac{23}{99}$.

Geometric progressions play a considerable role in the mathematics of finance, because a sum of money that is earning compound interest grows from one interest period to the next in the form of a geometric progression.

The Role of Sequences in Calculus.—Modern formulations of calculus lean heavily on limits of infinite sequences. An infinite sequence $a_1, a_2, a_3, \ldots$ is said to have limit b if $a_n - b$ becomes arbitrarily small as n increases; technically stated, the sequence has limit b if for any given positive number ϵ all but a finite number of terms of the sequence $a_1 - b, a_2 - b, a_3 - b, \ldots$ lie between ϵ and $-\epsilon$. The sequence $\frac{1}{2}, \frac{2}{3}, \frac{3}{4}, \frac{4}{5}, \ldots$, for example, has limit 1. Not all sequences have limits, as in the case $2, \frac{1}{2}, 3, \frac{1}{3}, 4, \frac{1}{4}, 5, \frac{1}{5}, \ldots$. The integral concept in calculus can be defined as a limit of a sequence, and one of the central problems of the theory is to show that such sequences have limits (*see* LIMIT).

Definition of Irrational Numbers.—There are alternative ways of defining the system of real numbers, comprising the rational and irrational numbers (*see* NUMBER), to put the matter on a solid logical foundation. One standard way (G. F. L. P. Cantor) is to define irrational numbers as limits of appropriate sequences of rational numbers. A sequence of rational numbers $a_1, a_2, a_3, \ldots, a_n, \ldots$ to be used in defining a number must be a regular sequence, in the sense that to every positive number ϵ there corresponds an integer n such that $a_m - a_n$ lies between ϵ and $-\epsilon$ whenever m is greater than n. Two regular sequences $a_1, a_2, a_3, \ldots$ and $b_1, b_2, b_3, \ldots$ define the same number if the sequence $b_1 - a_1, b_2 - a_2, b_3 - a_3, \ldots$ has limit zero. For example $\sqrt{2}$ may be defined by the decimal sequence 1, 1.4, 1.41, 1.414, 1.4142, . . . , the successive terms of which can be determined by any of the customary methods for computing square roots. The number $\sqrt{2}$ may be defined by other sequences; for instance, by 2, 1.5, 1.42, 1.415, 1.4143, ... By applying the preceding theoretical test to these two sequences, it is found that $b_1 - a_1, b_2 - a_2, b_3 - a_3, \ldots$ is the sequence 1, .1, .01, .001, . . . with limit zero.

Algebraic operations such as addition and multiplication are readily defined for regular sequences, simply by addition and multiplication of corresponding terms, and it can be proved that these operations again yield regular sequences. It is found that, if this process is repeated and regular sequences of real numbers are examined, such sequences always have real numbers as limits; thus no further extension of the number system in this direction is necessary.

See also SERIES.

BIBLIOGRAPHY.—K. W. Anderson and D. W. Hall, *Sets, Sequences and Mappings* (1963); K. Knopp, *Infinite Sequences and Series*, trans by F Bagemihl (1956), L. M. Graves, *Theory of Functions of Real Variables*, 2nd ed (1956), F Waismann, *Introduction to Mathematical Thinking*, trans by T J. Benac (1951), is less technical. (J. N.)

NUMENIUS (2nd century A.D.), Greek philosopher, important as a forerunner of the Neoplatonism of Plotinus, was a native of Apamea in Syria. Though generally classed as a Neopythagorean, he is more accurately described as a Platonist. His hierarchy of three gods—the first, identical with Plato's "idea of the good," existing in self-contained transcendence; the second, the demiurge of Plato's *Timaeus*, which forms and rules the universe; and the third, the universe itself—seems to represent an attempt to get a systematic theology out of Plato's dialogues with the help of ideas borrowed from Aristotle and looks at first sight very like the hierarchy of being in Plotinus. But his first god is an Aristotelian "intellect," not the Plotinian "One"; and his second is much closer to Plotinus' higher soul than to his intellect. The works of Numenius, however, were much studied in the school of Plotinus.

BIBLIOGRAPHY.—For the surviving fragments of Numenius *see* F. Thedinga, *De Numenio philosopho Platonico* (1875). *See* also T. Whittaker, *The Neo-Platonists*, 2nd ed. (1918); A. H. Armstrong, *The Architecture of the Intelligible Universe in the Philosophy of Plotinus* (1940). (A. H. Ar.)

NUMERALS AND NUMERAL SYSTEMS. Just as the first attempts at writing came long after the development of speech, so the first efforts at the graphical representation of numbers came long after people had learned to count. Probably the earliest way of keeping record of a count was by some tally system involving physical objects such as pebbles or sticks. Judging by the habits of primitive tribes of the present as well as by the oldest trace remaining of written or sculptured records, the earliest numerals were simple notches in a stick, scratches on a stone, marks on a piece of pottery or the like. Having no fixed units of measure, no coins, no commerce beyond the rudest barter, no system of taxation and no needs beyond those to sustain life, people had no necessity for written numerals until about the beginning of what are called historical times. Vocal sounds were probably used to designate the number of objects in a small group long before there were separate symbols for the small numbers and it seems likely that the sounds differed according to the kind of object being counted. The abstract notion of two, signified orally by a sound independent of any particular objects, probably appeared very late.

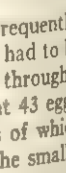
Number Bases.—When it became necessary frequently to count to numbers larger than 10 or so, the numeration had to be systematized and simplified; this was commonly done through use of a group unit or base, just as we might today count 43 eggs as three dozen and seven. In fact, the earliest numerals of which there is definite record were simple straight marks for the small numbers, with some special form for 10. These symbols appear in Egypt as early as the first dynasty (*c.* 3400 B.C.), and in Mesopotamia as early as *c.* 3000 B.C. These dates long precede the first known inscriptions containing numerals in India (*c.* 300 B.C.), in China (3rd century B.C.) and in Crete (*c.* 1200 B.C.). Some ancient symbols for 1 and 10 are as follows:

EGYPTIAN HIEROGLYPHIC, *c.* 3400 B.C. . . . .

EGYPTIAN HIERATIC, *c.* 3400 B.C. . . . .

CRETAN INSCRIPTIONS, *c.* 1200 B.C. . . . .

SUMERIAN AND LATER, *c.* 3000 B.C. . . . .



This special position occupied by 10 stems from the number of human fingers, of course, and is still evident in modern usage, not only in the logical structure of the decimal system but in the English names for the numbers. Thus eleven comes from Anglo-

Saxon *endleonfan*, literally meaning "(ten and) one left (over)," and twelve from *twe-lif*, meaning "two left"; the endings -teen and -ty both refer to 10, of course, and hundred comes originally from a pre-Greek term meaning "ten times (ten)."

It should not be inferred, however, that 10 is either the only possible base or the only one actually used. The pair system, in which the counting goes "one, two, two and one, two twos, two and two and one," etc., is found among the ethnologically oldest tribes of Australia, in many Papuan languages of Torres strait and the adjacent coast of New Guinea, among some African pygmies and in various South American tribes. Other tribes of Tierra del Fuego and the South American continent use number systems with bases three and four. The quinary scale, or number systems with base five, is very old, but in pure form seems to be used at present only in Saraveca, a South American Arawakan language; elsewhere it is combined with the decimal or the vigesimal system, where the base is 20. Similarly, the pure base six scale seems to occur only sparsely in northwest Africa, and is otherwise combined with the duodecimal, or base 12, system.

In the course of history the decimal system finally overshadowed all others, and it is now found in all nations of high culture on the entire globe, except those of Mexico and Central America, where the number 20 was used in astronomy and thus became firmly entrenched. Nevertheless, there are still many vestiges of other systems in our own culture, chiefly in commercial and domestic units, where change always meets the resistance of tradition. Thus there occurs 12 as the number of inches in a foot, pence in a shilling, months in a year, and twice 12 hours in a day; and both dozen and gross measure by twelves. In English the base 20 occurs chiefly in the word score ("Four score and seven years ago . . .") but other traces are found in pre-English Celtic, Gaelic, Danish and Welsh. The base 60 still occurs in measurement of time and angles.

NUMERAL SYSTEMS

It appears that the primitive numerals were |, ||, |||, and so on, as found in Egypt and the Grecian lands, or −, =, ≡, and so on, as found in early records in the far east, each going as far as the simple needs of people required. As life became more complicated, the need for group numbers became apparent, and it was only a small step from the simple system with names only for one and 10 to the further naming of other special numbers. Sometimes this happened in a very unsystematic fashion; very recently, for example, the Yukaghirs of Siberia counted, "one, two, three,

TABLE I.—*Comparison of Selected Systems of Numerals*

EUROPEAN	1	2	3	4	5	6	7	8	9	0
ARABIC	١	٢	٣	٤	٥	٦	٧	٨	٩	٠
DEVANAGARI	१	२	३	४	५	६	७	८	९	०
TIBETAN	༡	༢	༣	༤	༥	༦	༧	༨	༩	༠
KASHMIR	𑇑	𑇒	𑇓	𑇔	𑇕	𑇖	𑇗	𑇘	𑇙	𑇐
BENGALESE	১	২	৩	৪	৫	৬	৭	৮	৯	০
SIAMESE	๑	๒	๓	๔	๕	๖	๗	๘	๙	๐

three and one, five, two threes, two threes and one, two fours, ten with one missing, ten." Usually, however, a more regular system resulted, and most of these systems can be classified, at least roughly, according to the logical principles underlying them.

Simple Grouping Systems.—In its pure form a simple grouping system is an assignment of special names to the small numbers, the base b, and its power b^2, b^3, and so on, up to a power b^k large enough to represent all numbers actually required in use. The intermediate numbers are then formed by addition, each symbol being repeated the required number of times, just as 23 is written XXIII in Roman numerals.

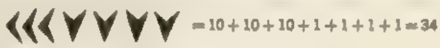
The earliest example of this kind of system is the scheme encountered in hieroglyphs which the Egyptians used for writing on stone. (Two later Egyptian systems, the hieratic and demotic, which were used for writing on clay or papyrus, will be considered below; they are not simple grouping systems.) The hieroglyphic symbols were:

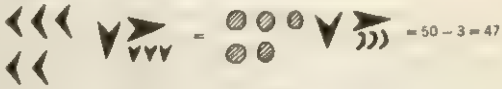
Thus, since the Egyptians customarily wrote from right to left, they would have used for $243{,}688 = 2(10^5) + 4(10^4) + 3(10^3) + 6(10^2) + 8(10) + 8$ the symbol

Numbers of this size actually occur in extant records concerning royal estates and may have been commonplace in the logistics and engineering of the great pyramids.

Cuneiform Numerals.—Around Babylon, clay was abundant, and the people impressed their symbols in the damp clay tablets and then baked the tablets in the sun or in a kiln, thus forming documents which were practically as permanent as stone. Since the pressure of the stylus gave a wedge-shaped symbol, the writings are known as cuneiform (Lat. *cuneus*, a wedge, and *forma*, a shape) inscriptions. The symbols could be made either with the pointed or the circular end of the stylus, as follows:

For numbers up to 60 these symbols were used in the same way as the hieroglyphs, except that a subtractive symbol was also used:





The cuneiform and the curvilinear numerals occur together in some documents from about 3000 B.C. There seem to have been some conventions regarding their use; the cuneiform type was always used for the number of the year or the age of an animal, while wages already paid were written in curvilinear and wages due in cuneiform. For numbers larger than 60 the Babylonians used a mixed system, described below.

Greek Numerals.—The Greeks had two important systems of numerals, besides the primitive plan of repeating single strokes, as in ||| ||| for six, and one of these was again a simple grouping system. Their predecessors in culture—the Babylonians, Egyptians and Phoenicians—had generally repeated the units up to nine, with a special symbol for 10, and so on. The early Greeks also repeated the units to 9, and probably had various symbols for 10. In Crete, where the early civilization was so much influenced by those of Phoenicia and Egypt, the symbol for 10 was —, a circle was used for 100 and a rhombus for 1,000. Cyprus also used the horizontal bar for 10, but the precise forms are of less importance than the fact that the grouping by tens, with special symbols for certain powers of 10, was characteristic of the early systems of the near east.

The Greeks, entering the field much later, and influenced in their alphabet by the Phoenicians, based their first elaborate system chiefly on the initial letters of the numeral names. This was a natural thing for all early civilizations, since the custom of writing out the names for large numbers was at first quite general, and the use of an initial by way of abbreviation of a word is universal. These initial numerals, in modern characters, were

Π OR Γ, PI, FOR ΠΕΝΤΕ (PENTE), 5;
Δ, DELTA, FOR ΔΕΚΑ (DEKA), 10; OFTEN WRITTEN LIKE O;
H, AN OLD ATTIC BREATHING, LIKE OUR h, LATER REPRESENTED BY A SPECIAL SYMBOL LIKE Ͱ, FOR ΗΕΚΑΤΟΝ (HEKATON), 100,
X, CHI, FOR ΧΙΛΙΟΙ (CHILIOI), 1,000;
M, MU, FOR ΜΥΡΙΟΙ (MYRIOI, MURIOI), 10,000

These numerals were frequently combined with the symbol for 5; thus

ΓΔ OR ΓΔ, PENTE-DEKA, FOR 5 x 10, OR 50;
ΓH, PENTE-HEKATON, FOR 5 x 100, OR 500;
ΓM, PENTE-MURIOI, FOR 5 x 10,000 OR 50,000

Therefore, in this notation

36,756 = MMMΓΧΓΗΗΓΠΙ

This system appears in records of the 3rd century B.C. but was probably used much earlier. In the 2nd century of our era it was described by the grammarian Herodianus, and hence these characters are often spoken of as Herodianic numerals. They are more properly called Attic numerals, being the ones always found in the Attic inscriptions.

Roman Numerals.—The direct influence of Rome for such a long period, the superiority of its numeral system over any other simple one that had been known in Europe before about the 10th century, and the compelling force of tradition explain the strong position that the system maintained for nearly 2,000 years in commerce, in scientific and theological literature, and in belles-lettres. It had the great advantage that, for the mass of users, the memorizing of the values of only four letters was necessary—V, X, L and C. Moreover, it was easier to see three in III than in 3, and to see nine in VIIII than in 9, and correspondingly easier to add numbers—the simplest of all the operations.

As in all such matters, the origin of these numerals is obscure, although the changes in their forms since the 3rd century B.C. are well known. Of the various theories that of Theodor Mommsen (1850) has had the widest acceptance. This was that the use of V for 5 is due to the fact that it is a kind of hieroglyph representing the open hand with its five fingers. Two of these gave the X for 10. Three of the other symbols, he asserted, were modifications of Greek letters not needed in the Etruscan and early Latin alphabet. These were *chi*, which appears in inscriptions not only as X but also in such forms as ⊥, ↓, and which later became the L that was arbitrarily chosen for 50; *theta* Θ, which was selected for 100, being finally changed to C under the influence of the word *centum* (hundred); and *phi* Φ, to which was assigned the value 1,000, and which finally took the forms I and M, the last being chosen because of the word *mille* (thousand).

The oldest noteworthy inscription containing numerals representing very large numbers is on the *Columna Rostrata*, a monument erected in the Roman forum to commemorate the victory of 260 B.C. over the Carthaginians. In this a symbol for 100,000, which was an early form of (((I))), was repeated 23 times, making 2,300,000. This illustrates not only the early Roman use of repeated symbols but also a custom which extended to modern times —that of using (I) for 1,000, ((I)) for 10,000, (((I))) for 100,000 and ((((I)))) for 1,000,000. The symbol (I) for 1,000 frequently appears in various other forms, including the cursive ∞. All these symbols persisted until long after printing became common. In the middle ages a bar (*vinculum, titulus*) was placed over a number to multiply it by 1,000, but this use is not found in the Roman inscriptions. When the bar appears in early manuscripts it was merely for the purpose of distinguishing numerals from nouns, as in the case IIVIR for *duumviri*. We also find in the middle ages such forms as $|\overline{X}|$ or $|X|$ for 1,000,000 and $|\overline{M}|$ for one thousand hundred thousand.

Of the later use of the numerals, a few of the special types are as follows:

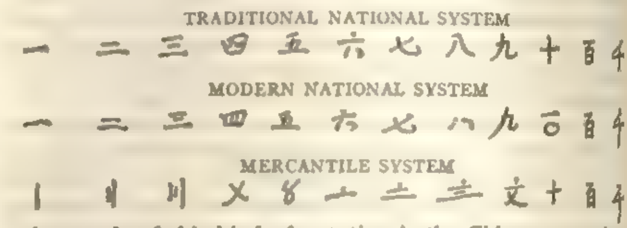
1. $\overline{c}$ · lxiiij · ccc · l · i, for 164,351, Adelard of Bath (*c.* 1120)
2. II.DCCC.XIIII, for 2,814, Jordanus Nemorarius (*c.* 1125)
3. MƆCLVI, for 1,656, in San Marco, Venice
4. cIↄ.Iↄ.Ic, for 1,599, Leiden ed. of Capella, 1599
5. IIIIxxet huit, for 88, a Paris treaty of 1388
6. four Cli.M, for 451,000, Baker's arithmetic (1568)
7. vj.C for 600 and CCC.M for 300,000, Recorde (*c.* 1542)

The first represents the use of the vinculum; (2) represents the place value as it occasionally appears in Roman numerals; (3) illustrates the not infrequent use of Ɑ (like D, originally half of (I), the symbol for 1,000); (4) illustrates the persistence of the old Roman form for 1,000 and 500, and the subtractive principle so rarely used by the Romans for a number like 99; (5) shows the use of *quatre-vingts* for 80, commonly found in French manuscripts until the 17th century, and occasionally later, the numbers often being written like iiij^{xx}, vij^{xx}, and so on; (6) represents the coefficient method, "four C" meaning 400, a method often leading to forms like ijM or IIM for 2,000, as shown in (7).

The subtractive principle is seen in Hebrew number names, as well as in the occasional use of IV for 4 and IX for 9 in Roman inscriptions. The Romans also used *unus de viginti* for 19 and *duo de viginti* for 18, occasionally writing these numbers as XIX (or IXX) and IIXX, respectively. On the whole, however, the subtractive principle was little used in the numerals of the classical period.

Multiplicative Grouping Systems.—In multiplicative systems special names are given not only to 1, b, b^2, etc., but also to the numbers 2, 3, . . . , $b-1$; the symbols of this second set are then used in place of repetitions of the first set. Thus if we designate 1, 2, 3, . . . , 9 in the usual way, but replace 10, 100 and 1,000 by X, C and M respectively, then in a multiplicative grouping system we should write 7,392 as 7M3C9X2. The principal example of this kind of notation is the Chinese numeral system, three variants of which are shown in Table II. In the traditional notation, 2,605 would appear as 二千六百五 (here written from left to right rather than vertically downward, as is customary). The modern national and the mercantile systems are positional systems, as described below, and use the circle O for zero.

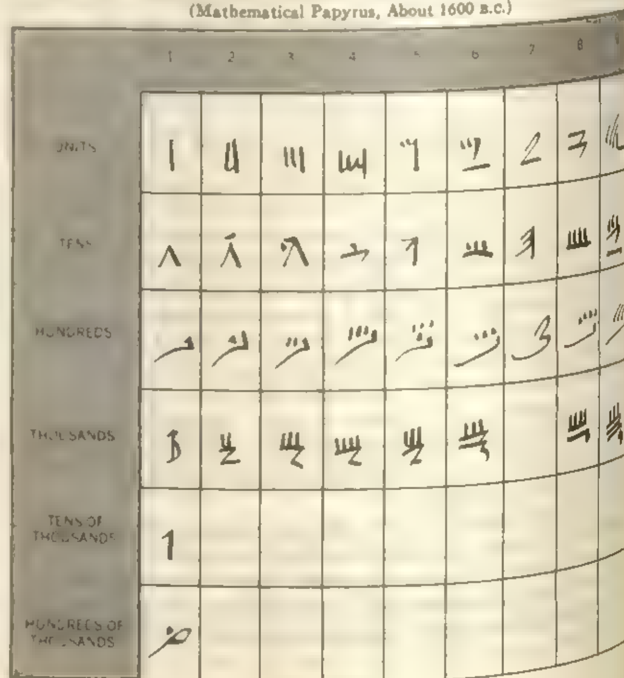
TABLE II.—*Chinese Numeral Systems*

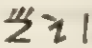


Ciphered Numeral Systems.—In the ciphered systems, names are given not only to 1 and the powers of the base b but also to the multiples of these powers. Thus, starting from the artificial example given above for a multiplicative grouping system, we would obtain a ciphered system if we gave unrelated names to the numbers 1, 2, . . . , 9; X, 2X, . . . , 9X; C, 2C, . . . , 9C; M, 2M, . . . , 9M. This requires memorizing many different symbols, but it results in a very compact notation.

The first ciphered system seems to have been the Egyptian hieratic (literally, priestly) numerals, so called because the priests were presumably the ones who had the time and learning required to develop this shorthand outgrowth of the earlier hieroglyphic numerals. An Egyptian arithmetical work on papyrus, employ-

TABLE III.—*Egyptian Hieratic Numerals*
(Mathematical Papyrus, About 1600 B.C.)



ing hieratic numerals, was found in Egypt about 1855; known after the name of its finder as the Rhind papyrus, it provides the chief source of our information about this numeral system. With the symbols as indicated in Table III, the number 3,052 would be written (from left to right) as  (the customary way of writing was from top to bottom). There was a still later Egyptian system, the demotic, which was also a ciphered system.

As early as the 3rd century B.C. a second system came into use in Greece, paralleling the initial-letter system but better adapted to the theory of numbers and more difficult of comprehension by the trading classes. These Ionic, or alphabetical, numerals were simply a ciphered system in which nine Greek letters were assigned to the numbers 1–9, nine more to the numbers 10, . . . , 90, and nine more to 100, . . . , 900. Since, however, there were only 24 letters in the Greek alphabet, three were added, namely the Phoenician *vau* (shaped like our letter F), *koph*, *qoph* or *koppa* (shaped somewhat like our Q, and indeed derived from the same source) and a character known in modern times as *sampi* (then shaped somewhat like the Greek π, but tipped about 45° to the right, and represented here by S). The numerical values of the letters are shown in Table IV. The thousands were often indicated by placing a bar at the left of the numeral, thus:

TABLE IV.—*Ionic Greek Ciphered Numeral System*

	1	2	3	4	5	6	7	8	9
UNITS	A	B	Γ	Δ	E	[F]	Z	H	Θ
TENS	I	K	Λ	M	N	Ξ	O	Π	[Q]
HUNDREDS	P	Σ	T	Υ	Φ	X	Ψ	Ω	[S]

/A = 1,000; /B = 2,000; /I = 10,000; /T = 300,000

Such numeral forms were not particularly difficult for computing purposes once the operator was able automatically to recall the meaning of each. To be able to express 10,407 by MTZ would have seemed to a Greek considerably simpler than our system. Only the capital letters were used in this ancient numeral system, the lower-case letters being a relatively modern invention.

Other ciphered numeral systems include Coptic, Hindu Brahmi, Hebrew, Syrian and early Arabic. The last three, like the Ionic, are alphabetic ciphered numeral systems. The Hebrew system is shown in Table V.

TABLE V.—*Hebrew Ciphered Numeral System*

UNITS	א	ב	ג	ד	ה	ו	ז	ח	ט
	1	2	3	4	5	6	7	8	9
TENS	י	כ	ל	מ	נ	ס	ע	פ	צ
	10	20	30	40	50	60	70	80	90
HUNDREDS . .	ק	ר	ש	ת	ך	ם	ן	ף	ץ
	100	200	300	400	500	600	700	800	900

Positional Numeral Systems.—Our own number system is an example of the positional system, in which after the base b has been adopted, the digits $1, 2, \ldots, b-1$ are given special names, and all larger numbers are written as sequences of these digits. It is the only one of the systems that can be used for describing arbitrarily large numbers, since each of the other kinds gives special names to various numbers larger than b, and an infinite number of names would be required for all the numbers. The success of the positional system depends on the fact that, for an arbitrary base b, every number N can be written in a unique fashion in the form

$$N = a_n b^n + a_{n-1} b^{n-1} + a_1 b + a_0$$

where $a_n, a_{n-1}, \ldots, a_1, a_0$ are digits; *i.e.*, numbers from the group $0, 1, \ldots, b = 1$. We then represent N to the base b by the sequence of symbols $a_n, a_{n-1}, \ldots, a_1 a_0$. It was this principle which was used in the multiplicative grouping systems, and the relation between the two kinds of systems is immediately seen from the earlier noted equivalence between 7,392 and 7M3C9X2; the positional system derives from the multiplicative simply by omitting the names of the powers b, b^2, and so on, and by depending on the position of the digits to supply this information. It is then necessary, however, to use some symbol for zero to indicate any missing powers of the base; otherwise 792 could mean, for example, either 7M9X2 or 7C9X2.

The Babylonians developed (2000–3000 B.C.) a positional system with base 60—a sexagesimal system. With such a large base it would be awkward to have unrelated names for the digits 0, 1, . . . , 59, so a simple grouping system to base 10 was used for these numbers. For example,

$$256{,}058 = (60)^3 + 11(60)^2 + 47(60) + 38$$

In addition to being somewhat cumbersome because of the large base chosen, the Babylonian system suffered until very late from the lack of a zero symbol; the resulting ambiguities may well have bothered the Babylonians as much as later translators.

Mayan Vigesimal System.—In the course of early Spanish expeditions into Yucatan it was discovered that the Mayans, at an early but still undated time, had a well-developed positional system, complete with zero. It seems to have been used primarily for the calendar rather than for commercial or other computation; this is reflected in the fact that although the base is 20, the third digit from the end does not signify multiples of 20^2 but of 18×20, thus giving their year a simple number of days. The digits 0, 1, . . . , 19 are, as in the Babylonian, formed by a simple grouping system, in this case to base 5 (*see* Table VI); the groups were written vertically.

TABLE VI.—*Mayan Vigesimal Number System*

The Concept of Zero.—Neither the Mayan nor the Babylonian system was at all suited to arithmetical computations, because the digits—the numbers less than 20 or 60—were not represented by single symbols. The complete development of this idea must be attributed to the Hindus, who also were the first to use zero in the way it is now used in the western world. As was mentioned earlier, some symbol is required in positional number systems to mark the place of a power of the base not actually occurring. This was indicated by the Hindus by a dot or small circle, which was given the name *sūnya*, the Sanskrit word for vacant. This was translated into the Arabic *sifr* about 800 A.D., with the meaning kept intact, and the latter was transliterated into Latin about 1200, the sound being retained but the meaning ignored. Subsequent changes have given us our words cipher and zero.

A symbol for zero appeared in the Babylonian system in about the 3rd century B.C. However, it was not used consistently, and apparently was used only to hold interior places, never final places, so that it was impossible to distinguish between 77 and 7,700, except by the context.

DEVELOPMENT OF MODERN NUMERALS AND NUMERAL SYSTEMS

Several different claims, each having a certain amount of justification, have been made with respect to the origin of our present numerals, commonly spoken of as Arabic but preferably as Hindu-Arabic. These include the assertion that the origin is to be found among the Arabs, Persians, Egyptians and Hindus. It is not improbable that the intercourse among traders served to carry such symbols from country to country, so that our numerals may be a conglomeration from different sources. The country, however, which first used, as far as we know, the largest number of our numeral forms is India. The 1, 4 and 6 are found in the Aśoka (*q.v.*) inscriptions (3rd century B.C.); the 2, 4, 6, 7 and 9 appear in the Nānā Ghāt inscriptions about a century later; and the 2, 3, 4, 5, 6, 7 and 9 in the Nasik caves of the 1st or 2nd century of our era—all in forms that have considerable resemblance to our own, our 2 and 3 being well-recognized cursive derivations from the ancient = and ≡. None of these early Indian

inscriptions gives evidence of place value, or of a zero that would make our place value possible. Hindu literature gives evidence that the zero may have been known before our era, but we have no inscription with such a symbol before the 9th century.

The first definite external reference to the Hindu numerals is a note by Severus Sebokht, a bishop who lived in Mesopotamia *c.* 650. Since he speaks of "nine signs," the zero seems not to have been known to him. By the close of the 8th century, however, some astronomical tables of India are said to have been translated into Arabic at Baghdad, and in any case the numerals became known to Arabian scholars about this time. About 825 al-Khwarizmi wrote a small book on the subject, and this was translated into Latin by Adelard of Bath (*c.* 1120) under the title of *Liber Algorismi de numero Indorum*. There is some reason for believing that the numerals found their way into Europe even earlier than into Baghdad, but the earliest European manuscript known to contain them was written in Spain in 976.

The advantages enjoyed by the perfected positional system are so numerous and so manifest that the system has gradually been adopted in more and more countries, and because of the dominance of Europe in cultural and political matters, the Hindu-Arabic numerals and the base 10 are now also generally accepted. These might be said to be the nearest approach to a universal language yet devised by man; they are to be found in Chinese, Japanese and Soviet scientific journals, and in English, German and Greek.

There is one island in present-day life, however, in which the familiar decimal system is no longer supreme: the electronic computer. Here the binary positional system has been found to have great advantages over the decimal. In the binary system, in which the base is 2, there are just two digits, 0 and 1; the number two must be represented here as 10, since it plays the same role as does ten in the decimal system. The first few numbers are

$$
\begin{aligned}
0&: 0\\
1&: 1\\
2&: 10 = 1(2) + 0\\
3&: 11 = 1(2) + 1\\
4&: 100 = 1(2^2) + 0(2) + 0\\
5&: 101 = 1(2^2) + 0(2) + 1
\end{aligned}
$$

To return to the example used before, 256,058 has the binary representation 111 11010 00001 11010. The reason for the greater length of the binary number is that a binary digit distinguishes between only two possibilities, 1 or 0, whereas a decimal digit distinguishes among 10 possibilities; in other words, a binary digit carries less information than a decimal digit. Because of this its name has been shortened to bit; a bit of information is thus transmitted whenever one of two alternatives is realized in the machine. It is of course much easier to construct a machine to distinguish between two possibilities than among 10, and this is another advantage for the base 2; but a more important point is that bits serve simultaneously to carry numerical information and the logic of the problem. That is, the dichotomies of yes and no, and of true and false, are preserved in the machine in the same way as 0 and 1, so in the end everything reduces to a sequence of those two characters. *See* also BINARY NUMBERS; FINGER NUMERALS.

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NUMERIAN (MARCUS AURELIUS NUMERIUS NUMERIANUS), Roman emperor A.D. 283–284, succeeded his father, Carus, in the summer of 283, in the midst of a Persian war, beyond the Tigris. He led the army home, but contracted a disease of the eyes, which confined him to a litter, while his father-in-law, the praetorian prefect Aper, commanded the army. Late in 284, when the army had reached the Bosporus, he was found dead. Aper was accused of his murder and executed, and the throne passed to the commander of the household guards, Diocletian (*q.v.*). (JN. R. M.)

NUMIDIA, the Roman name of part of Africa north of the Sahara with varying boundaries in the east and west, at times corresponding roughly with those of modern Algeria. (For the physical geography of the region *see* ALGERIA.) Its earliest inhabitants were divided into tribes and clans and were racially indistinguishable from the other Berber inhabitants of most of early north Africa. Little can confidently be said of its prehistory, as it was isolated from the mainstream of Mediterranean history. From the 6th century B.C. points along the coast were occupied by the Carthaginians, who later, in the 3rd century B.C., expanded into the interior as far as Theveste (Tebessa).

Numidians are frequently found in Carthaginian armies. They remained seminomadic and backward, however, till the reign of Masinissa (*q.v.*), who was the chief of the tribe called Massyli living near Cirta (Constantine). At first an ally of Carthage, he went over to the Roman side in 206 B.C. and was given further territory extending as far as the Mulucha (Moulouya) river. For nearly 50 years Masinissa retained the support of Rome, though it was the prosperity of Carthaginian agriculture that was his inspiration in his efforts to settle the Numidian pastoralists as peasant farmers. He seized much Carthaginian territory and probably looked forward to ruling all north Africa.

On his death in 148 the Romans prudently divided his kingdom among several chieftains, but the progress of civilization among the Numidians was not seriously interrupted; indeed after 146 it received new impetus as thousands of Carthaginians fled to Numidia after the destruction of Carthage. Politically the situation deteriorated after 118 with the usurpation of Jugurtha (*q.v.*), an illegitimate prince, and his forcible reunification of Numidia. He avoided Roman intervention by bribery and intrigue until he overreached himself by killing Italian immigrants at Cirta. After a war of varying fortunes he was surrendered to the Romans by Bocchus of Mauretania in 105. Rome continued to dominate Numidia through client kings, though Numidian territory was much reduced. The third and final attempt by a Numidian to found a powerful state was that of Juba I, between 49 and 46 B.C., ending with his defeat by Julius Caesar at Thapsus.

Caesar formed a new province, Africa Nova, from Numidian territory, making a boundary between it and Mauretania along a line running roughly southwest from the mouth of the Ampsaga (Wadi al Kebir) to the Chott al Hodna. Augustus united Africa Nova with Africa Vetus but Caligula made the commander of the third legion (*legio III Augusta*) virtually independent of the proconsul of Africa, with jurisdiction over most of the old Numidian territory; a separate province of Numidia was formally created by Septimius Severus. Italian immigration was on a modest scale except in the northern part of the territory, where supporters of Caesar had been given lands; the chief cities there were Cirta, Cuicul (Djemila), Milev (Mila) and Rusicade (Philippeville).

In the 1st century A.D. the nomads of the steppe country south of Cirta were pacified and the Aurès mountains were encircled by roads. The third legion took up its permanent station at Lambaesis (Lambessa), near which grew up cities with substantial veteran elements such as Thamugadi (Timgad), Mascula (Khenchela) and Diana Veteranorum (Zana). As a result of increased security the population and prosperity (primarily agricultural) of Numidia increased substantially in the first two centuries A.D. But while a modest number of native communities advanced to municipal status, the majority of the population, particularly the peasants on the large estates and in the mountainous areas, were little touched by Roman civilization.

Christianity spread rapidly in the 3rd century A.D., and in the 4th, Numidia became the centre of the Donatist schism (*see* DONATISTS). This movement had a fanatical and puritanical outlook and was particularly strong among the peasants, to whom it appealed as a focus of protest against deteriorating social conditions; it also had a substantial following among the intelligentsia. Imperial repression merely drove the movement underground. Some cities still enjoyed some prosperity but Numidia suffered from the malaise affecting the whole empire. After the Vandal conquest (A.D. 429), Roman civilization declined rapidly and the native elements revived, to outlive in some places even the tide of Arabic conquest in the 8th century and to persist till modern times.

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(B. H. WA.)

NUMIDIDAE, the guinea fowl family, comprising a group of native African birds closely related to and formerly considered a subfamily of the pheasant family (Phasianidae). *See* GUINEA FOWL.

NUMISMATICS (an 18th-century term derived from the Latin *numisma* and Greek *nomisma*, "a coin") is the study of coins, including medals but excluding seals. A coin may be defined as a piece of metal stamped with a "type," *i.e.*, device, or inscription showing that it is issued by an authority that guarantees its value. Paper money, which serves the same purpose, is sometimes considered to be a part of numismatics also. Aesthetic and commemorative medals are produced by the same methods as coins and are discussed here; for military decorations *see* MEDALS AND DECORATIONS. This article is divided into the following main sections:

I. INTRODUCTION

1. The Scope and Materials of Study.—Coins or coinlike objects were first issued in Asia Minor in the later 7th century B.C. and in the far east at about the same time. Their use was quickly adopted around the Mediterranean and has since spread over the whole civilized world. Being made in most ages of precious metal, or alternatively possessing a substantial token value, they have always been prized, often hoarded and, therefore, frequently buried for safety. The contents of such savings banks have been dug up in all ages, and not least by modern mechanical excavators and deep plows, so that the coins of past civilizations exist and continue to be found in vast numbers preserved, almost imperishably, out of all proportion to most other generally surviving remains. Studied alongside other evidence, literary or archaeological, they yield a wide range of information, which, though its importance can be exaggerated or misinterpreted in isolation, is specially valuable for chronology and economics. Coins may reflect the wealth and consequence of cities and states, and study of their distribution may help to define the physical extent of territorial dominion (as with the coinage of the kings of pre-Roman Britain) or to illustrate major commercial connections in a known chronological setting. Thus the popularity in ancient times of Athenian silver tetradrachms in the Levant and of Corinthian silver staters in Magna Graecia testifies to established trends of trade at definite periods; the finds of early Roman imperial gold in India corroborate Pliny's reference to the drain on Roman gold to pay for Indian and other eastern luxuries; and the huge finds of Arab silver coins in Scandinavia show the extent of trade for furs on behalf of the wealthy Abbasids and Samanids. One result of such widespread commercial contacts is that certain currencies have acquired special international preeminence. In ancient times those of Athens, Corinth and Philip II of Macedon were widely popular; so, in medieval times, were the gold dinars of the early caliphs and the gold ducats of Florence and Venice, while in modern times the silver dollars of Mexico and Maria Theresa of Austria and the gold sovereigns of England have played a similar part. The economic importance of numismatics is seen also in moments of national decline, when depreciation reflects financial stress; the heavily alloyed Roman antoniniani of the 3rd century A.D. tell their tale as readily as the inflated paper currency of Germany in and after 1919.

No less valuable than the economic evidence yielded by a comparative study of coins is their purely documentary importance, which may be more absolute. Together with medals they present an unrivaled series of historical portraits from the 4th century B.C. down to the present day, many of them otherwise unknown, like those of the Greco-Bactrian kings or of usurpers during the Roman empire. Greek coinage is a particularly notable contribution to the history of art, displaying not only the beauty and strength of many artistic traditions but also (like Roman coinage) the miniature likenesses of numerous large-scale sculptural and architectural works now lost. The imperial coinage of Rome, apart from its portraiture, is important above all for the remarkable detail of its chronological and political content; and from both Greek and Roman coins very much can be learned of mythology and religion. The Christian influences active in medieval Europe can be similarly measured from medieval currencies, beginning with that of Byzantium.

The principal metals of which ancient coins were made were electrum, gold, silver, copper, brass and bronze, all of them more or less proof against decay. Their use at first was generally dictated by availability. The earliest coins of Asia Minor were of electrum, a natural alloy of gold and silver (later to be produced artificially) washed from Lydian rivers; gold became the major currency metal of southwest Asia as a whole, being derived from Scythian, Pontic and Bactrian sources; the city-states of the Greek mainland preferred the silver that adjacent mines supplied; and

the mines of Italy led to the choice of bronze for the earliest coinage of Rome. With the development of internal economies and external trade, gold, silver and copper or bronze quickly came to be used side by side; Philip II of Macedon popularized gold in Greece, and gold, together with silver, competed strongly with copper in the Roman imperial currency, becoming paramount in the Byzantine and Arab empires and in the great commercial currencies of the Italian republics of the 13th century onward. Silver, however, was nearly always powerful in Roman currency and was the major coinage metal of Europe from the 8th to the 13th century. Bronze or copper was first used for small change in Greece from the late 5th century B.C., and in the Roman and Byzantine systems as well; the vast currency of China consisted of these metals down to modern times.

The foregoing metals furnished most currencies until the early 20th century, when the appreciation in value of gold and silver and the need to economize led to the general production of paper currencies for the higher units of value, accompanied by token units of lower value expressed in terms of nickel (used, exceptionally, in Bactria in the 3rd century B.C.), cupronickel, bronze and, in times of postwar stress, aluminum and aluminum bronze. Few coins of pure silver are now to be found in Europe or the British Commonwealth as a whole. Lead, which may easily decay, has seldom been used for coinage, except by the Andhras of ancient India and in the more recent coinages of the Malay States. Iron, very occasionally used in antiquity, *e.g.*, in Sparta, reappeared in German coins of World War I. Zinc was employed by Rome as a constituent of fine brass coins and as an element in the alloy of a few Chinese coins from the 15th to the 17th centuries. Tin, or a tin-bronze alloy, furnished the material for some Celtic coins in Gaul and Britain in the last century B.C. In times of siege or special crises, currencies have been produced from leather, cloth, card, paper, etc.

2. Coin Collections.—The enormous number of coins produced from the earliest days has for a long time resulted in organized collecting, partly because of the natural curiosity felt in each period about the past and partly because of the recognition that the political, economic and artistic significance of previous coinages can be reconstructed only by the most complete assemblage possible. The continuous history of coin collecting begins with the Italian Renaissance, and Petrarch was characteristic of his time in forming a classical series. During the 15th and 16th centuries many collections were made, often on a handsome scale, by princely or noble persons, for whom Greco-Roman coins possessed an appeal compounded of moral challenge and artistry. Among the more famous cabinets were those of Jean, duc de Berry; of the d'Este family; of the emperor Maximilian I; and of Matthias Corvinus. The two last collections became the nuclei respectively of the present national collections of Austria and Hungary; later the cabinet of Louis XIV was to serve France similarly, just as that of the Stuarts might have served England but for its dispersal in the Puritan revolution. Collections formed up to the 17th century consisted mainly of classical coins. The systematic reproduction of the types of ancient coins either by casting or from falsified dies resulted in the inclusion in most cabinets of spurious and often imaginative pieces.

The 17th century initiated a period of systematic analysis; numismatic scholars set out to compare, catalogue and publish the existing great collections, both public and private. Italy possessed over 350, France and the Low Countries about 200 each and Germany not many less. Thus the self-imposed task of such a compiler as André Morell, in undertaking the detailed recording of 25,000 ancient coins, was formidable; he and his like traveled from place to place in search of material at once massively and often uncritically accumulated. The advent of such compilations had important results. Distinction between the genuine and the spurious became surer; analytical syntheses based on detailed catalogues began to teach the principles of scientific numismatics; the recording of new material was all the more keenly undertaken; and the part played by numismatic evidence in historical reconstruction was increasingly understood, even within the still inevitable limitations of faulty knowledge or misinterpretation.

From the 18th century onward it was therefore all the more important to collect on a scale at once wide and discriminating; and whether in charge of a royal cabinet, like the eminent Joseph Eckhel (1737–98) at Vienna, or the possessor of a splendid private collection, like William Hunter (1718–83) at Glasgow, the 18th-century collectors made a great contribution. Lesser collectors could also advance the science; their numbers were to grow in the 19th century, with the output of authoritative catalogues (including the British Museum series from 1873) and informed handbooks. This growth was reflected in the foundation (beginning in 1836 with the Numismatic Society of London, now the Royal Numismatic society) in many European countries of specialist societies responsible for scholarly publications. But the day of the great private collection was not yet done: superb cabinets were formed in the late 19th century, and that of R. C. Lockett in the 20th bore comparison with all except the greatest museum collections. In general, however, the small collections of the 20th century, enormously increased in numbers, have had to specialize somewhat narrowly to achieve scientific value. Public museums have taken over the main task of forming large collections of great detail and range; those of London, Oxford, Cambridge, Glasgow, Paris, Berlin, Vienna, Munich and New York are among the richest. Nevertheless an essential link has remained between the large public collections and the smaller private collector, whose sharp eye and keen curiosity continue to be responsible not only for a considerable influence upon taste but also (far more important) for the discovery or recognition of many key pieces of historical importance.

London emerged, and still remains, the world's largest numismatic market (with an annual turnover of immense value), serving the interests of public collections and private collectors in many lands. Inasmuch as these interests are, jointly, directed increasingly toward the systematic elucidation of historical and economic problems, international co-operation has become more important, being exercised through the International Numismatic commission, itself associated with the International Committee for Historical Sciences. But below this apex there spreads out a vast body of private collectors in many lands, whose interests may often have been stimulated in childhood by the chance gift or discovery of a handful of coins.

3. Technique.—The technique of producing coins and medals has developed continuously from earliest times; and, though machinery has diminished creative aspects in design, the artist's part in making relief designs has never been eliminated. Hand and eye, jointly, remain supreme.

The two methods of producing coins and medals are casting and striking. Casting, technically simplest but seldom employed in antiquity for regular coinage, was the method preferred by all the greatest Renaissance artists, from Pisanello in the 15th century onward, for the production of medals larger and more sensitive than striking would permit. A model was built up (or carved out) in wax or clay and then impressed in a mold of fine sand or other material, from which a metal cast could be taken. German artists, to eliminate the subsequent chasing allowed by Italians, often carved their model in hardwood or fine stone, or even sometimes intaglio in clay, afterward baked. Many medals apparently of the 15th or 16th century are after-casts of the original casting their detail coarsened by continuous reproduction. Plaquettes (small decorative reliefs, not commemorative, generally single faced and rectangular) are also cast from molds.

A coin or medal is struck when a metal blank, placed between engraved dies, is then impressed by hammerblows or other pressure. Modern dies are of hardened steel. Even in ancient times they had to be of specially hard metal: the Greeks used bronze, the Romans also iron or even steel. A die can be hand cut directly, like an intaglio gem. Or a positive punch can be carved in relief and the design then hammered intaglio into softer metal afterward hardened. A curious combination of dies in intaglio and relief is seen in the coinages of certain south Italian Greek cities in the late 6th century B.C. and also in the thin medieval bracteates of Germany. Some early medieval Muslim dies were probably cast in bronze or iron from lead or clay matrixes and

ANCIENT GREEK COINS

1. Asia Minor, late 7th century B.C., electrum. 2. Probably Ephesus, early 6th century B.C., electrum. 3. Lydia, Croesus, 561–546 B.C., gold. 4. Phocaea, mid-6th century B.C., electrum. 5. Athens, mid-6th century B.C., silver. 6. Corinth, late 6th century B.C., silver. 7. Metapontum, mid-6th century B.C., silver. 8. Syracuse, 479 B.C., silver. 9. Persia, 4th century B.C., gold. 10. Aegina, mid-6th century B.C., silver. 11. Naxos (Sicily), about 460 B.C., silver. 12. Syracuse, late 5th century B.C., silver. 13. Athens, 5th century B.C., silver. 14. Cyzicus, mid-5th century B.C., electrum. 15. Cyzicus, about 394 B.C., silver. 16. Corinth, late 4th century B.C., silver. 17. Macedonia, Philip II, 359–336 B.C., gold. 18. Macedonia, Alexander the Great, 336–323 B.C., gold. 19. Tarentum, mid-4th century B.C., silver. 20. Macedonia, Alexander the Great, 336–323 B.C., silver. 21. Syria, Antiochus I, 281–261 B.C., silver. 22. Athens, late 2nd century B.C., silver. 23. Pergamum, C. Claudius Pulcher, about 55–54 B.C., silver

NUMISMATICS

BY COURTESY OF THE ASHMOLEAN MUSEUM, OXFORD

ROMAN COINS

1–7 ROMAN REPUBLIC. **1.** Rome, uncia, late 3rd century B.C., bronze. **2.** Rome, silver quadrigatus, late 3rd century B.C. **3.** Rome, silver denarius, early 2nd century B.C. **4.** Rome, silver denarius, late 2nd century B.C. **5.** East, Sulla, 82–81 B.C., silver. **6.** Rome, Julius Caesar, 44 B.C., silver. **7.** Greece, Brutus, about 43–42 B.C., silver. *8–23 ROMAN EMPIRE.* **8.** East, Augustus (27 B.C.–A.D. 14), gold. **9.** Rome, Vespasian (69–79), silver. **10.** Rome, Trajan (98–117), bronze. **11.** Rome, Claudius (41–54), bronze. **12.** Rome, Galba (68–69), bronze. **13.** Rome, Elagabalus (218–222), bronze. **14.** Rome, Philip I (244–249), silver. **15.** Trier, Maximian Herculius (286–305), bronze. **16.** Ticinum, Constantine I (306–337), gold. **17.** Amiens, Magnentius (350–353), bronze. **18.** Antioch, Valens (364–378), gold. **19.** Carthage, Galerius Maximian (Caesar, 293–305), silver. **20.** Antioch, Constantine I (306–337), bronze. **21.** Trier, Constantine I (306–337), bronze. **22.** Trier, Theodosius I (379–395), silver. **23.** (Reverse shown) Trier, Constantius I (Caesar, 293–305), gold

ANCIENT, MEDIEVAL AND LATER EUROPEAN COINS

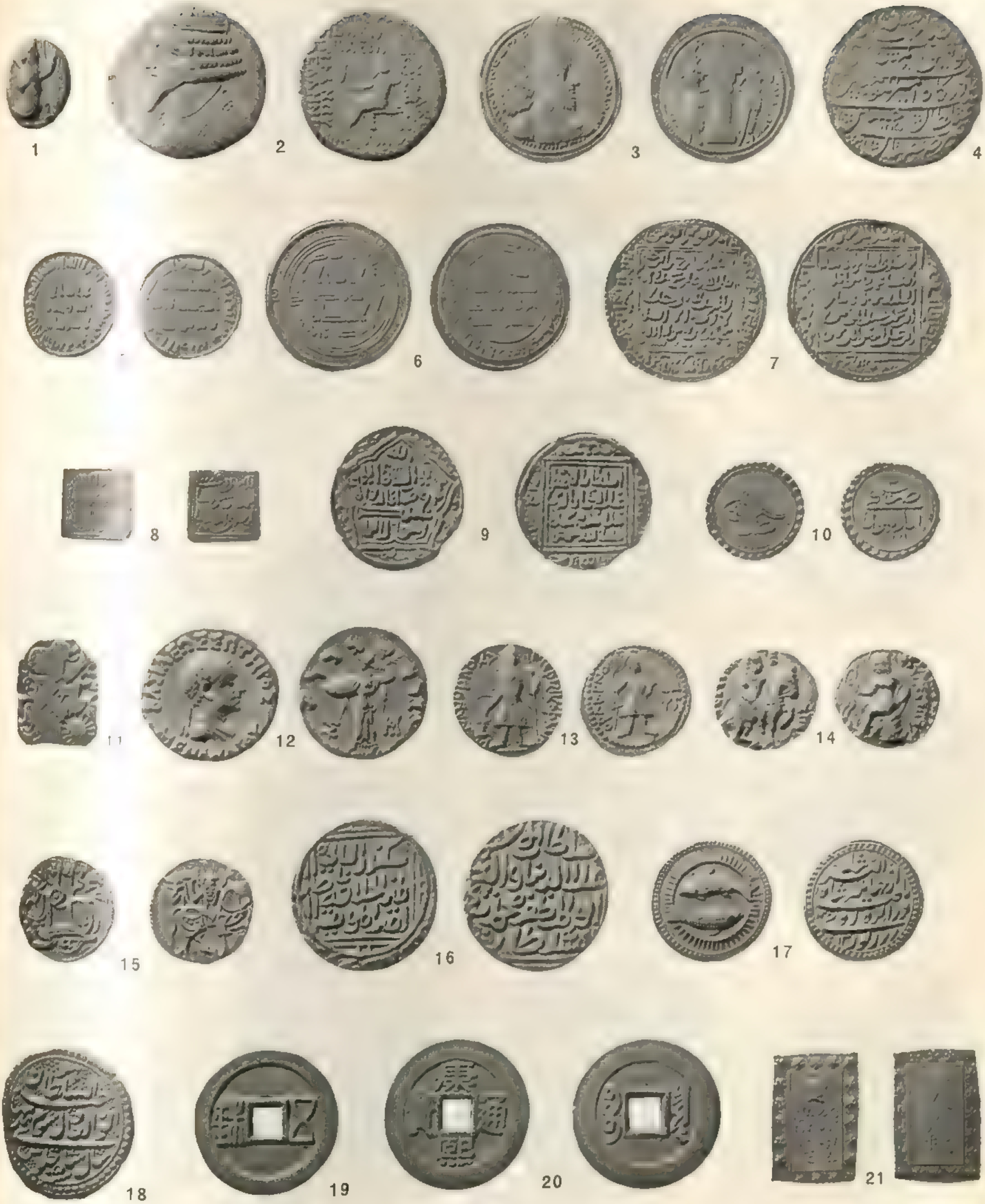
1. Marseilles (Merovingian Franks), early 7th century, gold. 2. Reims, Theodebert II, 597–612, gold. 3. Constantinople, Anastasius I, 491–518, gold. 4. Constantinople, Anastasius I, 491–518, bronze. 5. Constantinople, Justinian II, 705–711, gold. 6. Dorestadt (Carolingian), Charlemagne, 768–814, silver. 7. Emperor Louis I the Pious, 814–840, silver. 8. Augsburg, Emperor Henry II, 1014–24, silver. 9. Venice, Louis I the Pious, 814–840, silver. 10. Brandenburg, Emperor Otto I, 1170–84, silver bracteate. 11. Benevento, Grimoald IV, 806–817, silver. 12. Brindisi, Emperor Frederick II, 1220–50, gold. 13. Venice, Tommaso Mocenigo, 1414–23, gold. 14. Hungary, Charles Robert, 1309–42, gold. 15. France, Louis IX, 1226–70, silver. 16. Naples, Charles I, 1266–85, silver. 17. France, Philip VI, 1328–50, gold. 18. Aquitaine (Figeac), Edward the Black Prince, 1362–76, silver. 19. Castille (Seville), Peter I, 1350–69, gold. 20. Milan, Galeazzo Maria Sforza, 1476–94, silver. 21. Tirol (silver taler), Sigismund of Austria, 1439–96. 22. Rome, Pope Sixtus IV, 1471–84, gold

NUMISMATICS

BY COURTESY OF THE ASHMOLEAN MUSEUM, OXFORD

BRITISH COINS

1. Ancient British, mid-1st century B.C., gold. 2. Cunobelinus, about A.D. 10–40, Colchester, gold. 3. Carausius, 286–293, London, bronze. 4. Early Saxon, 7th century, London, gold. 5. Mercia (Peada), 7th century, silver. 6. Offa, 759–796, Mercia, silver. 7. Alfred, 871–901, London, silver. 8. Northumbrian Vikings, about 903, Cnut, silver. 9. Aethelred II, 979–1016, Oxford, silver. 10. William I, 1066–87, Oxford, silver. 11. Henry III, 1216–72, London, gold. 12. Edward III, about 1355, London, silver. 13. Henry VIII, about 1509, London, silver. 14. Elizabeth I, 1561, London, silver. 15. Charles I, 1625, London, silver. 16. Commonwealth, 1656, London, silver. 17. Charles II, 1663, London, gold. 18. Edward I (Ireland), about 1280, Waterford, silver. 19. Alexander III of Scotland, about 1280, silver. 20. James VI of Scotland, 1592, Edinburgh, gold. 21. Edward III, 1360–69, Calais, gold. 22. Henry VII, 1489, London, gold



BY COURTESY OF THE ASHMOLEAN MUSEUM, OXFORD

ORIENTAL COINS

1–4 PERSIAN. 1. Daric, 4th century B.C., gold. 2. Arsacid, Phraates IV, 28–27 B.C., silver. 3. Sasanian, Shapur I, A.D. 241–272, silver. 4. Safavid, Sultan Husain, Isfahan mint, 1703, silver. *5–10 ISLAMIC.* 5. Umayyad caliphate, dinar, 700, gold. 6. Umayyad caliphate, dirham, Wasit mint, 724, silver. 7. Almohad, al-Murtada, double dinar, *c.* 1250, gold. 8. Almohad, square dirham, Fès mint, 13th century A.D., silver. 9. Il-khanid, Uljaitu, Erzurum mint, 1304, silver. 10. Ottoman, Mustafa III, Istanbul, 1760, gold. *11–18 INDIAN.* 11. Punchmarked, *c.* 3rd–2nd century B.C., silver. 12. Indo-Greek, Menander, mid-2nd century B.C., silver. 13. Kushan, Kanishka, early 2nd century A.D., gold. 14. Gupta, Kumaragupta, *c.* 414–455, gold. 15. Ohind, Samanta Deva, early 10th century A.D., silver. 16. Delhi, Ala-ud-Din Muhammad, 1313, silver. 17. Mogul, Jahangir, zodiacal muhur (Pisces), Agra mint, 1618, gold. 18. Mysore, Tipu Sultan, rupee, 1787, silver. *19–21 FAR EAST.* 19. China, five chu, 2nd century B.C.–6th century A.D., bronze. 20. China, Sheng-Tsu, board of revenue mint, 1661–1722, brass. 21. Japan, ichi-bu gin, 1837, silver

BY COURTESY OF FORD NUMISMATICS PUBLICATIONS

18TH- AND 19TH-CENTURY NORTH AMERICAN COINS

1. Spanish-American gold ingot issued under the reign of Philip V and bearing his stamp. Minted in Mexico City and dated 1744. 2. Gold coin-ingot issued by the Jesuits in 1707 at their Tubac mission in Arizona. 3. Fifty-dollar piece (1851) authorized by Augustus Humbert, U.S. Assayer, and minted by Moffat and Co., San Francisco, Calif. 4. Fifty-dollar piece (1853) of the U.S. Assay Office of Gold, successor to Moffat and Co. and immediate predecessor of the federal branch mint at San Francisco. This is the only specimen extant. 5. Fifty-dollar piece (1855) of Kellogg and Co., another private mint in San Francisco. Dies were made by Ferdinand Gruner. Only 13 specimens known. 6. Fifty-dollar piece (1855) of Wass, Molitor and Co., another private mint in San Francisco. 7. Two hundred-dollar ingot (1853) of the U.S. Assay Office of Gold, San Francisco. The illustration is of the only known example

then chased and hardened. Engravers' instruments in antiquity were the graver and dotting punch (seldom, perhaps, the drill); rock crystal could supply the magnifying glass that extraordinary fineness of work often necessitated. Medieval engravers made great use of letter and other punches in die-cutting. Modern dies are generally prepared by the operation of the reducing machine (since *c.* 1839) upon a large-scale metallized model, producing an exact small-scale facsimile capable of being used as a master punch.

Ancient blanks were cast, often in globular form. They could also be cut from bars. Thin medieval blanks were clipped from sheet metal; modern ones are punched from strips. In antiquity the lower die, for the obverse, was let into a fixed block; the upper die was the termination of a loose bar. The blank was placed on the fixed die, the loose die placed upon the blank, and the top of the bar hammer-struck with one or more blows. Lack of a "collar" allowed metal to spread or split, and the loose die was quick to wear out. The Romans tended to arrange their dies in a fixed relationship, presumably by interlocking box-dies; a similar use of pegs and slots may have been common medieval practice. Under Pope Julius II (1503–13), Bramante experimented with a press for lead seals. Leonardo da Vinci made progress toward a coining press, and the screw press was duly evolved; substitution of gradual pressure instead of a violent blow upon the dies and the blank resulted in a much longer life for dies and in coins of neater fabric, especially after the development of the "collar." For further discussion of modern coinage, *see* MINT.

In design, the high relief of Greek and earlier Roman coins, though subject to wear in circulation, encouraged a sculptural treatment, in which lettering took a minor part. Late Roman, Byzantine and medieval coins show a flat treatment, typical of modern coins, in which lettering became more important; its finest use is seen in the purely inscriptional types of Arab and Persian coins. The problem of composing within a circular field was variously solved at different times, as will be seen in the following survey by countries.

4. Origins of Coinage.—In both east and west, coinage proper was preceded by more primitive currencies, nonmonetary or semimonetary, which survived into the historic age of true coins. At all times barter has been a valued means of exchange, not least because it is capable of expressing small as well as large values conveniently, and in the absence of a good system of small change it has probably always been vigorous. But even in ages of barter certain standards of value have tended to emerge, notably cattle and implements, and these often became or suggested a medium of exchange. The earliest currency of China of the 8th century B.C. consists of miniature spades and billhooks, with an inscription indicating the authority. The small bronze celts frequently found in hoards in western Europe probably played a monetary role. Even in modern times such things as fishhook currency have been known.

Metal has always achieved wide popularity as an exchange medium, being durable, divisible and portable; and the origins of true coinage lie there. Ancient Egypt, which never developed a true coinage, was using gold bars of set weight from the 4th millennium B.C.; and the currency of gold rings was thereafter common. In the near east also, which (like Egypt) had access to gold, gold rings long served the dual purposes of adornment and currency, supplemented by gold and silver bars from which segments could be cut. The choice of metal was, as usual, suggested by availability. Around the Aegean sea heavy talents of copper, ingots of 25 kg. or more in weight, were in currency several centuries before true coinage, and the discovery of an iron bar with a handful (*drachma*) of fractional iron spits (*obeloi*) dedicated in the Heraeum at Argos, perhaps as part of Pheidon's metrological reforms, shows such currency continuing until historical times. Similar bundles of spits have been found elsewhere and are evidence for the desire to subdivide a heavy and cumbrous unit into smaller fractions for normal use. At the other end of the scale there was, ultimately, the desire to express the value of a talent of copper or iron in terms of gold or silver; and Homer, who speaks of metal basins, tripods and axes as gifts and prizes in a way that shows them as a recognized standard of wealth, also speaks of the talent of gold; *i.e.*, the value of a heavy base-metal talent expressed in a little pellet of gold. In Italy rough lumps of bronze (*aes rude*) formed a currency from early times, being succeeded by stamped bars of regular weight; and Caesar's record of the ancient British use of iron bars as currency is still borne out by not infrequent finds.

Such "heavy" currencies, mainly characteristic of European lands, show the employment of metals from which implements would normally be made. The impact upon this system of the gold of the east, and later of the silver of Greece, produced the need to value such metals in gold and silver, and this in turn resulted in the need to control and guarantee the quantity of gold and silver so used, to avoid constant weighing. Once gold (and then silver) gained acceptance as conveniently small expressions of relatively high value, with a visible mark of guarantee, the stage of true coinage, as it first appeared in Asia Minor and India, had been reached. Not all lands, however, adopted true coinage: the easternmost fringes of the Greek world lacked it, and so too Egypt, until the conquering Ptolemaic dynasty introduced it. Finds of Greek coinage in such areas, chopped and gouged and partly melted, show that the imported coinage of others was still accepted there as mere metal bullion. Carthage and Etruria were likewise without coinage until the 5th century.

II. GREEK COINS

1. Early Development, *c.* 650–490 B.C.—True coinage began soon after 650 B.C. Ancient writers—the 6th-century Xenophanes quoted in the 5th by Herodotus—ascribed its invention to the Lydians, "the first to strike and use coins of gold and silver." This statement, however, best refers to the action of Croesus of Lydia (560–546 B.C.) in producing a bimetallic system of pure gold and pure silver coins. The coinage he displaced was of electrum, the natural mixture of gold and silver that the Greeks called "white gold"; and the foundation-deposit of the Artemisium at Ephesus shows that electrum coins were being made about a century before Croesus—though not, as was once held, before 650 B.C. This early electrum coinage, which was current in Lydia and Ionia, and possibly in other adjoining areas of Asia Minor, consisted of small, thick, bean-shaped pieces, with a device stamped in relief on one side, the other side being roughly impressed. Their intrinsic value fluctuated according to their gold and silver content; but the weight of the unit was fairly steady around seven to eight grams, and the types stamped on them are the guarantee of authority. The earliest coins of Croesus were similarly of electrum, stamped on one side with the facing heads of a lion and a bull; and this type was duly transferred to his bimetallic series of pure gold and pure silver.

Croesus' relations with Greece were close, and his bimetallic system may have owed something to the fact that Greece had itself now produced its first silver coins. The oldest are of Aegina, with, obverse, a turtle—associated with Aphrodite—and, reverse, an incuse square. Tradition, *e.g.*, in Pollux and elsewhere, regarded these as struck by Pheidon of Argos in virtue of his supremacy over Aegina; but the coins are too late to claim association with him in Aegina. They began no earlier than the late 7th century, when Aeginetan maritime ascendancy was growing, incidentally spreading the Aeginetan weight standard for coinage, based on a drachma of about six grams, over much of the Peloponnese and also the Aegean, where similar currency was produced in the islands. Ambition and pride stimulated two neighbouring powers to strike their own coins. Corinth with its "pegasi" (from their constant obverse type of a pegasus) was coining silver from *c.* 575 with a light drachma of about 3 g., and it is reasonably certain that in Athens in the first half of the 6th century Attic coins, based on a drachma of about 4.25 g. derived from Euboea and with a variety of obverse types, including an owl (the reverses, like those of the Corinthian pegasi, were impressed with a punch), were supplanting the earlier coinage of Aegina. These early silver coins, while much less valuable intrinsically than the electrum and gold coins of Asia Minor, nevertheless possessed considerable purchasing power: the Aeginetan and Attic-Euboic didrachms and

the Corinthian tridrachm were high denominations suitable for major commerce and not for everyday life. For intercity transactions these "staters," *i.e.*, standard units, were conveniently linked by the mina weight ($\frac{1}{60}$ of a talent) of 425 g., made up by 150 Corinthian, 100 Attic and 70 Aeginetan drachmas. Fractional pieces developed only slowly.

Between 550 and 500 the practice of coinage had spread to many parts of the Greek world, usually out of commercial convenience, though also partly to satisfy civic pride. From the Persian empire, with its vast gold and silver coinage, successor to that of Croesus, to Magna Graecia and Sicily, and from the Dorian colony of Cyrene, rich in the cultivation of silphium, to the Greek or semi-Greek cities of Thrace, there was a network of varied and competitive currencies, generally of fine quality and steady weight. Improved minting techniques began to affect their appearance. A second type, in relief, was substituted gradually for the roughly impressed reverse punch. The important effect of this on the development of coin types is well seen in the reorganized coinage of Athens from *c.* 525, in which the obverse bears the Athena head and the reverse the owl of Athens—religious patron and civic device; the monarch's head on an English penny goes back, through Alexander's deified head, to the head of Athena, and the symbol of Britannia derives ultimately from such state badges as the owl. In certain cities of Italy and Sicily, however, including Tarentum and Metapontum, a different technique was popular, the obverse type in relief being repeated intaglio on the reverse, very probably with the object of concealing the older types of coins imported for restriking. For a long time the early coins of Greece carried no inscriptions or, at most, with very rare exceptions, a letter or two. The type of a seal (φώκη) at first indicated Phocaea without even the later explanatory Φ; a koppa (ϙ) was sufficient to add to the pegasi of Corinth; ΣΥ could indicate Sybaris, while ΑΘΕ was comparatively explicit for Athens. That the force of such abbreviated ethnics is genitival, referring to the coin and its badge, is shown by the form of longer legends. These are very rare on early coins: *I am the badge of the bright one* above a stag on a group of electrum coins from Ephesus, *the stamp of Gortyna* on an early Cretan coin. Later usage was to favour the simple genitive plural, fully expressed, *e.g.*, Συρακοσίων, though the nominative was not unknown.

Greek coin types, early and even later, were simple in conception and often taken from the animal world. They include many kinds of animals (with the bull, symbol of a river, very common); birds (such as the owl of Athens, the eagle of Zeus at Olympia, the dove at Sicyon); insects (like the bee of Ephesus); fabulous creatures (like the griffin at Abdera); and vegetable objects. Not uncommonly such types were chosen as punning allusions to a city's name—the lion at Leontini, the goat at Aegae, the quince at Melos, the sickle-shaped harbour at Zancle, the *selinon* leaf at Selinus, the cock, harbinger of *hemera*, the day, at Himera. In others a city's staple product was proclaimed, like silphium at Cyrene, a silver-miner's pick at Damastium, a bunch of grapes at Naxos, a wine jar at Chios. Frequently cult associations dictated the choice of type. Tarentum showed its mythical founder, the dolphin rider Taras; Cnossus the Minotaur or Labyrinth; Croton the tripod of Apollo; Poseidonia a statue of Poseidon. Human or anthropomorphic figures, however, were comparatively rare on early Greek coins, though the famous gold darics and silver shekels of Persia showed the Great King in the attitude of attack. Much more popular was the representation of idealized heads of deities, which, once established for the two Athenas, Parthenos and Chalinitis, at Athens and Corinth, quickly became the vogue elsewhere, encouraged as they were by the development of double-relief coinage, which allowed the head of a civic deity to be paired on the other side by the city's symbol. The Greek tyrants, as a rule, chose to respect the theory of coinage as the corporate expression of state economy: the famous tetradrachms of Athens, with, obverse, Athena head and, reverse, owl, were first made by a nondemocratic government and yet bore no reference to a tyrant's rule. Coinage, indeed, was from the first (with the possible exception of some of the earliest electrum) regarded as too important a matter for private production, and the traditions that, rightly or wrongly, associated all the great lawgivers, Pheidon, Solon and Lycurgus, with the institution of coinage as well as with reform of weights emphasize its position as a fundamentally corporate right.

In Sicily the defeat of Carthage in 480 B.C. was fittingly celebrated by the striking of the famous decadrachms (*Demareteia*) associated with Queen Demarete, wife of King Gelon. These superb and now very rare examples of early classical genius showed on the obverse the head of Arethusa (the fountain nymph of Syracusan Ortygia), wreathed for victory, and on the reverse a triumphal chariot above a fleeing lion, symbol of conquered Africa.

2. From the Persian Wars to Alexander the Great, 490–336 B.C.—For a century and a half the previous pattern of Greek coinage spread widely all over the Greek world, its quantity stimulated by a growing sense of nationalism, its intrinsic quality kept high by commercial competition, and its technique (like that of the allied art of sculpture) raised to new and often superb levels in an age of self-confidence. In the last half of the period the designing and engraving of coin dies reached a standard seldom if ever to be surpassed. The head of a patron deity was now generally established as the obverse type and was often shown in very high relief, sometimes indeed facing, or nearly facing, as a tour de force. Engravers, especially in Sicily and Italy, began to sign their dies, indicating a status far above that of mere artificers and thus preserving the names of masters otherwise unknown. Reverse types, now more complex, increasingly showed groups or genre scenes, *e.g.*, the splendid frontally squatting Silenus on the coinage for the refounding of Sicilian Naxos in 461, or Dionysus seated backwards on a donkey at Mende, or the many mythological compositions on Cretan coins, often diminishing the previous importance of the city badge. Inscriptions, though still often contracted, were in general use. The principal coinage metal was silver, of which the Attic weight standard gradually conquered the Aeginetan. Electrum was continued in the east, at Cyzicus, Lampsacus, Mytilene and Phocaea, traveling thence mainly to the Black sea; in the west it was coined at Carthage. In both areas it was produced as an artificial alloy. Gold was continued in the darics of the Persian kings and in the fine later series of Lampsacene staters; it was also struck at Panticapaeum in the Black sea and on occasion at Syracuse, Tarentum and Cyrene. Toward the end of the period Philip II of Macedon instituted what was to be a world-famous gold coinage, undercutting and ousting that of Persia. Bronze made its appearance late in the 5th century as a substitute for the minute silver coins that had hitherto been increasingly necessitated as small change.

The currencies of the period included a few that were of world importance. The silver of Corinth and her Adriatic colonies was very numerous and was abundantly accepted, outside the Corinthian territories, by Italy and Sicily. The electrum of Cyzicus bore types that deliberately recommended it to many markets. Persian gold and silver coins enjoyed immense popularity in the 5th century. Metapontum, Tarentum, Thurium, Velia and Syracuse were among the more prolific silver mints of the west. But the most famous commercial currency of all was that of Athens, the silver tetradrachms of which were struck in large numbers, fine quality and obstinately unchanged appearance. These coins traveled widely in trade and were frequently hoarded outside Attica itself; moreover they received the compliment of imitation in distant areas, *e.g.*, Egypt, Arabia and Persia, which came to prize them for their reliable weight and quality.

Predominance of Athens.—The economic expansion of Athens in the late 6th century was greatly stimulated in the early 5th notably by the exploitation of richer veins in the Laurium silver mines. Athens' naval hegemony in this century crystallized in the Confederacy of Delos and developed into near-imperial control, economic as well as political, over her allies; and it may have been as early as 449 that Athenian edicts forbade the striking of silver coins by the allies or the use of currency, weights and measures other than the Athenian, and provided that previously minted local currencies should be handed in for exchange against that of Athens. The subjection of Aegina to Athens from 456 and the cessation of her famous and long competitive "turtles" facilitated

the monetary dominance of the "owls," which was carried further, stage by stage, as Athenian "allies" revolted, were reconquered and lost their independence. But the embargo put by Athens on local silver coinage was not absolute and perhaps was not expected to be. Major allies like Samos, Chios and Lesbos continued their own currencies; Phocaea, Mytilene and Cyzicus, though ceasing to coin in silver, continued with electrum. In other cities, small change in silver was issued. Beyond the effective range of Athenian power, cities in Pamphylia, *e.g.*, Aspendus, and in Thrace, *e.g.*, Abdera and Aenus, could continue silver coinage on a non-Attic standard, and the failure of Athenian control is seen in the sudden and often beautiful coinages of cities that threw aside its dominance, like Olynthus from *c.* 430, or in the changed weight standard of others; *e.g.*, Acanthus. During the Peloponnesian War, Sparta cut off the supply of silver from Laurium, and by 407 Athens was melting the gold Nikai from the Parthenon to make emergency coins, followed next year by bronze small change —an unpopular substitute for the tiny silver coins previously carried in the mouth. City after city now rebelled against Athens, and there was a sudden burst of independent coinage.

Athenian coinage revived, with unchanged types, after Conon's successes in 394. But former allies were wary, and defensive leagues were formed, as shown by the coinage issued at that time, with a type of Heracles and the inscription ΣΥΝ(*μαχικόν*) ("the alliance"), by Cnidus, Ephesus, Samos, Byzantium and other cities under Rhodian leadership. Rhodes spread its own coinage (with its head of Helios and punning badge of a rose) widely in the east Mediterranean. Phocaea and Mytilene established a monetary union for their electrum. From 404 the Aeginetans were coining again, and on their former weight standard, though with a tortoise replacing the former turtle. Corinthian coins continued to pour out. In the north a variety of important mints opened, and coins from mints in Asia Minor, notably Cnidus and Ephesus, testify to the great prosperity brought by autonomy.

Artistic Development.—In contrast to the deliberate archaism of Athenian types a wide flowering was seen elsewhere. Sometimes this was the result of hybridizing influence, as when Greek artists rendered Scythian motifs at Panticapaeum or Punic ones for Carthage and such of her Sicilian colonies as Segesta and Eryx. Sometimes an artistic tradition was regional, harsh and arresting, as in Crete or, as in Massilia and Emporion in the far west, a weak reflection of finer styles. Generally, however, there was an internationally high standard in coin design. Elis, guardian of the temple of Olympian Zeus and famous for its four-yearly Olympic games, no doubt attempted to impress visitors with superb coinage, the product of a fine local school that has left the initials or part-names of some of its masters. On the coins issued from *c.* 500 to 322 the thunderbolt and eagle of Zeus were shown with Victory in various attitudes; later the heads of Zeus and Hera were nobly represented. In north Greece brilliant artistry characterized the coins of Amphipolis (with a nearly frontal head of Apollo), Acanthus and Chalcidian Olynthus. The coins of Clazomenae and Cnidus in east Greece were also notable for their design.

It was in Italy and Sicily that the finest work appeared. In Italy, Tarentine silver continued its type of Taras on a dolphin. In the middle of the 5th century the agonistic type showing a horseman appeared; the celebrated Tarentine cavalry were thus commemorated down to the middle of the 4th century. About 340 Tarentum issued very beautiful gold coins with a head of Persephone and, on the reverse, the infant Taras appealing to Zeus enthroned. Heraclea, founded in the middle of the 5th century, issued fine staters with a helmeted Athena, and Heracles seated, or strangling or wrestling with a lion. Metapontum introduced a most striking head of its founder, Leucippus. Other mints of the time were at Neapolis, with its types of the siren Parthenope and her father, the man-headed bull Achelous; at Velia, with its head of a nymph and, on the reverse, the eastern type of a lion attacking a bull; at Thurium, with its unusually fine head of Athena and the powerful bull on the reverse; and at Terina, remarkable for its beautiful treatment of the Victory type.

In Sicily, and particularly in Syracuse, the engraver's art reached perfection. The coins of Syracuse showed many varieties of the heads of Arethusa and Persephone, and the chariot of the reverse was found capable of very varied treatment. After the middle of the 5th century, artists began to sign their work, and it is thus possible to prove that other towns engaged engravers from Syracuse. The Syracusan coinage was mainly silver. During the siege by the Athenians, beautiful little gold coins were struck with, reverse, Hercules strangling a lion. With the prosperity following the enemy's defeat, Syracusan art reached its zenith. As the Demareteion commemorated the defeat of the Carthaginians, so the great series of decadrachms perpetuated the memory of the victory of 413 over the Athenians. The agonistic types and the word *athla* on some of them show that they were distributed at the games held to celebrate the victory; their types were widely copied, and their engravers, Cimon and Euaenetus, gained a place among the world's greatest artists.

Among other cities of Sicily there was a notable series from Acragas in the 5th century, with its beautiful double-eagle type, seen most magnificently on the rare and famous decadrachms. Camarina showed fine types of the river god Hipparis and the nymph Camarina on a swan. Himera before its destruction in 408 issued some very interesting types, such as the nymph Himera sacrificing, while Silenus beside her bathes at the thermal spring for which Himera was noted; or Pelops in his chariot, referring to a victory of a Himeran at the Olympic games, which Pelops is said to have founded. Catana used the artist Heracleidas to design a splendid facing head of Apollo. Selinus abandoned its parsley leaf and issued a number of very remarkable types, notably that of Apollo and Artemis in their quadriga and, on the reverse, the local hero sacrificing at an altar, a type that refers to the cessation of the plague as a result of appeals to Apollo as healer.

3. From Alexander the Great to the End of the Roman Republic, *c.* 336–31 B.C.—Alexander introduced a new era in coinage, struck in vast quantities at a variety of mints from Macedon to Babylon with uniform types and weights. After his death the Diadochi and their successors were to reflect the importance of his coinage in their own differentiated issues—Seleucus in Syria, Philip Arrhidaeus in Macedon, Lysimachus in Thrace and Ptolemy in Egypt, where, except for tentative gold coined by Tachos and Nectanebo II between 361 and 343, no coinage had previously been struck. Alexander's influence on the Greek fringe was no less marked. The Arsacid kings of Parthia instituted a Greek style of coinage, and the Bactrian kings did similarly, culminating in the splendid portrait decadrachms of Amyntas *c.* 150 B.C., while even farther to the southeast Indo-Greek kings struck coins, inscribed in both Greek and Prakrit, down to the end of the 2nd century. The flood of coins of Philip II and Alexander, penetrating Europe from the Balkans, resulted in progressive imitations by Celtic peoples westward along the Danube, until these imitations themselves influenced coins in the 1st century B.C. in Gaul and Britain. In the Mediterranean west, by contrast, Greek coinage yielded to the steady growth and advance of Roman power; the issues of Spain and Mauretania late in the period were of hybrid Greco-Roman origin.

The coinage of Alexander established a new style: the coin-portrait became an almost regular feature in a Greek currency that was predominantly regal. The portrait, however, was not at first that of a living monarch. Philip II and Alexander were content with their names on their coins, of which the obverses showed, for Philip, Apollo and Zeus and, for Alexander, Heracles and Athena. Alexander added the title basileus (king) only after his Persian conquest. After his death his deified portrait appeared on the coins of Lysimachus in Thrace and on the early coins of Ptolemy I in Egypt. It was not till 306 that a living king put his own portrait on his coins, when Ptolemy I appeared, still as god, with the aegis of Zeus. Seleucus I similarly put himself on his coins as Dionysus; in time the divine attribute was dropped, and the ruler appeared as a mortal wearing only the royal diadem. In Macedon, Arrhidaeus, Cassander and Antigonus still followed the types of Alexander; and the early coins of Demetrius Poliorcetes (336–283) were without a portrait. Soon, however, his own

portrait appeared, still with the horns that deify him. His successors had only types of deities. Pyrrhus did not appear on any of his extensive coinages, but the last two kings of Macedon, Perseus and Philip V, left very fine portraits. The kings of Pontus, notably Mithradates VI, had a magnificent series of portraits. The kings of Pergamum used the same portrait throughout, that of the founder of the dynasty, Philetairus I, and the Ptolemies in Egypt throughout their long series used only the head and legend of Ptolemy I, except on certain special issues. Among the early Seleucids, Antiochus I was reluctant to drop the portrait of Seleucus I, but the portrait of the reigning monarch became the rule; from farther east came the long series of portraits of the Arsacids and the unparalleled series of Bactrian and Indian kings.

After the vast issues of gold by Philip II, Alexander (under whom its price in relation to silver cheapened to 10:1) and Lysimachus, gold was but rarely struck. Silver was the general metal of coinage; the Attic standard, which Alexander had adopted for his tetradrachms, became the monetary standard of the western world, and there was a great increase in the bronze coinage. Egypt, however, kept to its own standards and to gold.

As the greater part of the Greek world was now ruled by the Diadochi, their various coinages naturally formed the main currencies of commerce. Third-century Athenian coinages were scarce except in bronze. In 229, however, Macedon lost its supremacy over Athens, and friendly relations were established between Athens and Rome. Shortly after 200 the abundant issue of tetradrachms of the "new style" began, which went on for just over a century. The Athena of these coins is not the familiar "archaic" one but a copy of the head of the Parthenos of Phidias, and the owl on the reverse is now perched on a Panathenaic amphora. The ΑΘΕ still remains, but a number of personal names, symbols and letters are added to the reverse, chronicling a long series of magistrates and throwing light on the organization of the Athenian mint and, also possibly, on that of the mines. The other great coin-issuing city, Corinth, went on striking its stater till 229, when, with Corinth's surrender to Antigonus Doson, the long series came to an end.

Rise of Rome.—After the Roman conquest of Greece it is clear from the resumed activity of the mints that the Greek cities were autonomous in one respect at least, for the silver coinage required in Greek territory could be supplied only by Greek mints, the task being beyond the power of Rome at this time. The Thessalians issued silver coins of the type of Zeus and Athena and the legend *Thessalon;* a similar coinage was issued by the Boeotians; Maronea and Thasos issued tetradrachms which became a great commercial currency for trade across the Danube with the barbarians, who imitated them. Macedon itself issued tetradrachms bearing the names of Roman governors. In Asia, after the defeat of Antiochus III at Magnesia, there was an outburst of tetradrachms of Attic weight and local types at towns like Lampsacus, Smyrna and Magnesia. Other cities similarly resumed the issue of Alexander tetradrachms, adding a small symbol to mark the town of issue; *e.g.,* Miletus, Samos, Rhodes. These Alexander types continued down to the middle of the 2nd century, when the Roman province of Asia was set up and cistophori replaced them. These, so called from the Dionysiac chest, which formed the principal type, were first struck at Pergamum after 228 B.C.; the reverse is a bow in a case between two serpents.

In the west the rise of Rome in the 3rd century introduced a new factor into the history of Greek coinage. The first coinage to disappear was that of Etruria—a silver issue curiously always left blank on one side—after a life of two centuries. Rome's early intercourse with the Greek cities of Italy is reflected in the Romano-Campanian coinage. In the south the Italian campaign of Pyrrhus left its mark on various coinages, notably at Tarentum. The towns of Magna Graecia gradually lost their silver coinage under Roman influence, although Greek bronze coins lasted till the 1st century at Paestum.

In Sicily in the 3rd century, Syracusan coinage began to dominate the whole island; the types are mainly imitations of those of the 5th and 4th centuries. The Punic Wars brought the Romans to Sicily, where the Carthaginians had been established since the end of the 5th century and had struck coins of Syracusan and other Sicilian types with Punic legends and later with their own types. Sicily became a Roman province; henceforth only bronze was struck in it, and these local coins continued into the first century, when the last trace of Greek coinage in the west disappeared.

4. Subsidiary Greek Silver Coinages under the Roman Empire.—Although Greek coins under the Roman empire were nearly all of bronze and intended for circulation in and around the cities that issued them, exceptional coinages in silver were allowed by Rome as a continuation, for wider regional use, of important preconquest currencies. The largest of these, running from Augustus down to Diocletian's coinage reform, was minted at Alexandria to supply the needs of Egypt. In addition to silver it included at first tetradrachms of billon (successors to the Ptolemaic tetradrachms); these declined in fineness until by the middle of the 3rd century A.D. they were of mere bronze. Inscriptions were always in Greek. The obverses always bore the emperor's portrait, while the reverses (dated in regnal years by Greek numerals) showed a wide variety of types embracing Hellenistic Roman and Egyptian symbolism, often of peculiar interest and sometimes rendered with skill. Later coins from the Alexandrian mint are commonly found even outside Egypt.

In Syria silver tetradrachms continued to be struck, mainly at Antioch but also at Tyre and some other mints. These gradually became baser in the course of the early 3rd century. Bronze was also struck by the Romans at these mints and frequently bears the letters *S C* (*Senatus consulto*), showing, like similar issues at Rome, imperial initiative exerted through senatorial agency. Of several other local silver coinages the large series of drachms struck at Caesarea in Cappadocia from Tiberius to Commodus is the most important. The usual type was a local one of Mount Argaeus, but common denarial reverses are also found.

A number of vassal states and protectorates continued to issue their own coinages in the precious metals until they became Roman provinces. The only gold coinage of this kind is that of the kings of the Bosporus, who struck coins from the time of Augustus to the beginning of the 4th century, with the Roman emperor's head on one side and the local dynast's on the other. This coinage became gradually debased, passing from gold to electrum, then to silver and billon and ultimately to copper in the 3rd century A.D. In Africa the kings of Mauretania continued to strike their own gold and silver until their realm became a Roman province in A.D. 40.

5. Coinage in Judaea.—Another preimperial series continued under the Roman empire was that of Judaea. Except for rare silver coins of much earlier date, with types of Greek origin but marked with brief Hebrew inscriptions, there were no Judaean issues until *c.* 135 B.C.; the Seleucid coinage of Syria had in the meantime supplied the currency necessary. Antiochus VII, however, had granted to Simon Maccabaeus the right of coinage, which enabled the natural resistance of the Maccabees to Greek polytheism to be satisfied by the representation of specifically Jewish objects—a chalice; a lulab (bundle of twigs) and ethrog (citrus fruit) symbolizing the feast of Tabernacles; a basket of fruit and palm tree. These coins, like those of the rest of the dynasty were of copper. Alexander Jannaeus (103–76 B.C.) was the first of the Maccabaean priestly princes to style himself king on his coins, which bore his name and title in Greek, as well as Hebrew but Pompey's withdrawal of the kingly title was reflected in the coins of John Hyrcanus II. Antigonus Mattathias (40–37 B.C.) the last of the Maccabees, introduced the seven-branched candlestick as a type. Under the Herodian dynasty, from 37 B.C., Greek alone was found on Judaean coins. Herod Philip (4 B.C.–A.D. 34) gravely infringed Jewish convention by showing the effigy of the Roman emperor, but the symbolism of Herod Agrippa I (41–44) was more adroit: in Judaea he avoided the imperial portrait but introduced his own in Caesarea.

From A.D. 66, silver shekels and halves (once dated much earlier) were coined, with some bronze, at "Jerusalem the Holy" to mark the first revolt against Rome: issues of year 5 (A.D. 70–71), a precarious one for the insurgents, are very rare. After the Flavian conquest there were no further Jewish coins until the second revolt

(132–135) of Bar-Cochba, when silver and bronze, frequently overstruck on Roman imperial issues, briefly proclaimed *the redemption of Israel* and *the freedom of Jerusalem*. Jewish coinage ceased with Hadrian's refounding of Jerusalem as Colonia Aelia Capitolina.

6. Greek Bronze Imperial Coinage, to A.D. 268.—Under the Roman republic many Greek cities and districts continued to issue their own bronze coins, and, particularly in Asia, these local Greek coinages went on under the empire down to Gallienus, thus closing the 1,000 years of Greece's numismatic history. These coins have a high historical and archaeological value.

The right of coinage in Greece was sometimes continuous and sometimes intermittently permitted by the emperor or governor. Coins were struck not only by single towns but jointly by alliances of towns (*homonoiai*). The general type is everywhere the same; obverse, a bust and, reverse, a type of local interest. Under the republic the Greek cities usually placed on the obverses of their coins an allegorical bust—that of some local hero or of the people, the senate or the local city goddess. The people (*demos*) in Asia Minor is usually personified as a young male bust; the municipal council (*boule*) and the senate (*sunkletos*) appear as young veiled females. The Tyche of the city appears as a female bust wearing a mural crown. The goddess Roma is found as a helmeted female; *e.g.*, at Smyrna. Under the empire the usual obverse type is the head of the emperor, as on the imperial series proper. There are some notable exceptions. Macedonia, for example, had the head of Alexander the Great. Athens was privileged by Hadrian to use the head of Athena in place of the emperor's.

It is the reverse types of this series of coins that give them their importance. The coins of Athens preserve representations of many statues famous in antiquity that have long since perished, such as the Athena Parthenos of Phidias, the great Athena Promachos on the Acropolis, visible far out at sea, or the Dionysus of Alcamenes. A coin of Elis preserves the Olympian Zeus of Phidias, and one of Lacedaemon the Apollo of Amyclae. Local cults are everywhere illustrated, and incidents in the lives of all the divinities of Greek mythology are common types. Not only are there gods and goddesses but also all kinds of local deities, like river-gods and nymphs. Local celebrities are also recorded; *e.g.*, Homer at several of the various towns that claimed him as a native (notably Smyrna), Anacreon at Teos, Sappho at Eresus in Lesbos, Herodotus at Halicarnassus, Alcaeus at Mytilene, which recorded on its coins a whole series of its famous men, the majority of whom are not otherwise known. Not only are famous Greeks commemorated; the travels of Hadrian in the provinces led to the issue of many specially fine coins, some of which bear the portrait of his favourite Antinous. Reverse types also represent many architectural views (temples especially) of great importance.

Agonistic types are very numerous on account of the great part played by games and festivals in the life of the time. Their celebration is frequently recorded on coins. In conclusion mention may be made of a notable example of the preservation of a local tradition on a Greek imperial coin. On a coin of Septimius at Apameia in Phrygia there appear as reverse type a man and woman in a chest or ark floating on water, with a raven on the top and a dove flying above with a branch in her beak; to remove any doubt about the scene that is represented, the ark is labeled ΝΩ (NO), and the coin is evidence of the local tradition that the ark rested on the mountain behind Apameia.

III. ROMAN COINS

1. The Beginnings.—Although Roman coinage soon diverged from Greek conventions, its origins were similar. Rome, founded in the 8th century B.C., had no true coinage until the 3rd. Roman historians later attributed coinage unhesitatingly to the much earlier regal period: some derived nummus (a coin) from Numa, and Servius Tullius was credited with silver coinage, as well as with bronze stamped with the device of cattle. Roman historical tradition, however, seriously confused the elements of the true picture. Rough, unworked lumps of bronze (*aes rude*) were certainly used as a metal currency from the 6th century, if not much earlier, perhaps in rare conjunction with very small quantities of unworked gold and silver, themselves also passing by weight. Simultaneously standards of value appear to have been expressed in terms of cattle and sheep, as is clear not only from the derivation of *pecunia* ("money") from *pecus* ("cattle" or "sheep") but also from the early assessment of fines in oxen and sheep. From this it was falsely concluded that bronze coins marked with the device of cattle existed from the 6th century. In fact the expression of values in terms of cattle may have lasted, officially, into the 5th century, for it was not until the decemvirs codified the law and drew up the Twelve Tables (451–449 B.C.) that fines were fixed in bronze; and this bronze still consisted of unworked lumps or, at most, rough bars of irregular weight.

During the 4th century B.C. Roman contact with the Greek cities of south Italy slowly increased; these included such prolific mint cities as Nola, Hyria and Naples. The coinages of these cities consisted of silver didrachms, of which Rome presumably made use in any necessary dealings with them. A hint is given, however, of widening Roman monetary interests by two issues (the second of extreme rarity) of bronze token coinage inscribed Ῥωμαίων (with Neapolitan types) and *ROMANO*, respectively. These, though certainly not produced at Rome, may perhaps be regarded as the earliest coins in the name of the Romans, struck at Naples *c.* 325–285 within the terms of their alliance and intended for use in Campania, as distinct from Rome and Latium. It is unlikely, indeed, that a mint in the proper sense existed at Rome before 289, the year to which Pomponius assigned the establishment of *tresviri* who should be *aeris flatores* ("bronze casters"); and this mint (in the temple of Juno Moneta) did not yet produce true coins but *aes signatum*, bronze bars (of about six pounds) lacking a mark of value but bearing on each side a clearly recognizable type (including cattle) and perhaps equivalent in value to a Greek silver didrachm.

These *aes signatum* bars were halfway between *aes rude* and true coinage. In 269 true coinage appeared. It consisted of *aes grave*, large circular cast coins of bronze all bearing marks of value, from the as (weighing one pound) down to its twelfth, the *uncia;* the obverses showed the head of a deity, *e.g.*, Janus on the as, the reverses a ship's prow. These were paralleled (and had perhaps been just preceded) at mints elsewhere by similar cast coins; their types showed not, as at Rome, Latin deities but rather Greek (in the south) or Umbrian and Oscan. At the same time there appeared struck silver didrachms, on the standard of the Greek silver coins of Campania, bearing Greek types, *e.g.*, head of Ares, and horse, but marked *ROMANO* and *ROMA* respectively. Accompanied by small bronze token coins (struck and not cast), these were issued from Campanian mints, and they probably continued down to the Second Punic War, terminating in a new issue of silver coins of Roman style and with Roman types (marked *ROMA*), including Jupiter in a quadriga, from which their name of quadrigati was derived; they were imitated, characteristically in electrum, by the Carthaginians in Capua. The quadrigati were of the weight of the lighter Romano-Campanian didrachms and reflected the rising cost of silver at a time of stress; concurrently the cast bronze coinage of Rome dropped steadily in weight from an as of one pound to one of three ounces or less, becoming increasingly a token coinage as the output of silver coin increased. Financial stress is similarly to be seen in the exceptional issue of gold units and halves, with a Janus head on the obverse corresponding to that of the quadrigati. Toward the end of the Second Punic War the quadrigati were replaced by silver coins of half their weight, with a Victory on the reverse, and hence called victoriati; some of these were certainly struck at Rome, others coming from various and still uncertain mints in south Italy. By *c.* 190 a predominantly silver coinage, Latin-inscribed, was in production at Rome and other mints selected by Rome; it was accompanied by bronze coinage so greatly reduced in standard and thus size that it could at last be struck instead of being cast. The sequence in which the metals had been either cast or struck was reflected in the full title of the three mint officials, the *tresviri aere argento auro flando feriundo*—for the casting and the striking of bronze, silver and gold.

2. Introduction of the Denarius.—Adjustment of the previously fluctuating relationship between bronze and silver was first secured by the issue of the silver denarius (marked *X*, *i.e.*, 10 bronze asses), together with fractional coins, also of silver, marked *V*, *i.e.*, 5, and *IIS*, *i.e.*, $2\frac{1}{2}$ asses (or a sesterce or sestertius). The evidence of Plautus, combined with that of coin hoards and other factors, suggests a date for the new coinage *c.* 190 B.C., though in fact the true date may be about 20 years earlier. The denarii were lighter than the quadrigati; their types were a Roma head on the obverse, with the Dioscuri and *ROMA* on the reverse; and they were perhaps struck at a number of mints (including Rome), like the issues before 190. The victoriati, again lighter (their weight standard had come from Illyria), were issued until *c.* 150 B.C., being perhaps intended for principal circulation outside Italy. The denarius, however, which came to be issued in quantity, quickly established itself as the major currency of the time in the central and western Mediterranean. In her eastward expansion Rome learned to make use of local currencies—gold staters of Macedon and silver tetradrachms of Athens or Asia. Rome was also prepared to employ Macedonian gold in the west, as was shown by the release to western markets of large quantities of gold staters after *c.* 150 B.C. In the 2nd century B.C., Roman coinage in gold was very rarely undertaken. Coinage in bronze, on the other hand, was continued, but further variation in silver/bronze values was seen in two further developments. The as dropped in weight to that of an uncia and then less, becoming a token currency; together with its fractions, it was now always struck and not cast. Secondly, the value of the denarius in terms of bronze was altered, being revalued *c.* 133 at 16 instead of 10 asses; the silver quinarius (now of 8 asses and with the types of the victoriatus) became rare; and the silver sesterce (now equal to 4 asses) virtually disappeared. After *c.* 80 B.C. the striking of bronze was discontinued until the time of Caesar.

These developments mirrored the economic difficulties of the day. Reduction of the weight of the as from 1 oz. to $\frac{1}{2}$ oz. in 89 B.C. was accompanied temporarily by debasement of the denarius, resulting in the issue of denarii with serrated edges, intended to show that they were not plated.

3. Control and Content of the Coinage.—The coinage was controlled by the senate, acting for the sovereign people; and the conduct of the mint of Rome, and also of Italian branch mints elsewhere, was in the hands of a board of junior magistrates, the *tresviri* already mentioned. From about the middle of the 2nd century each of the three *tresviri* normally issued coins bearing his own name, and on special occasions these were supplemented by issues of quaestors, curule aediles, prefects or praetors; these were distinguished by special inscriptions like *ex s*(*enatus*) *c*(*consulto*) and *ex a*(*rgento*) *p*(*ublico*). The function of all these officials was to put out a given quantity of coinage of given purity.

The moneyers' names at first were shown as simple monograms, seen on denarii of early date bearing the types, standard for some four decades, of *ROMA* head on obverse, with the Dioscuri and *ROMA* on reverse. The Dioscuri reverse was followed by Diana or Victory in a biga (two-horse chariot), and these again by figures of Jupiter, Juno or Apollo in a quadriga, coinciding with the moneyers' names in fuller form. In the mid-2nd century B.C., however, newer tendencies appeared, as when Sextus Pompeius Fostlus paired the Roma obverse with a reverse showing his traditional ancestor Faustulus in the act of discovering the wolf and twins; the reference was to the greatness of Rome, but it was to be seen through the lineage of a moneyer. Later republican denarii gave keen expression to party politics, as when corn ears recorded *c.* 100 the purchase of grain by the quaestors Piso and Caepio, or the head of Ceres with ploughing oxen proclaimed the program of the Marians, or Sextus Nonius Sufenas advertised the games that, as praetor and a supporter of Sulla, he had staged for the Roman populace.

It was in the provinces, however, that the republican coinage took the decisive steps toward its finally imperial character. Campaigning generals began, in the 1st century B.C., to operate (by virtue of their imperium) mints for paying their troops in the field. In Italy mint policy had usually looked beyond personal politics to the state. But the military coinages of the *imperatores* equated the state with the personalities of the generals themselves. Such were the aurei and denarii struck from eastern mints *c.* 82–81 by Sulla, with, obverse, *L. SVLLA* and head of Venus (his family patroness) and, reverse, *IMPER*(*ator*) *ITERVM*, priestly jug between trophies. Pompey issued comparable aurei *c.* 61 (also in the east). From these precedents the earlier coinage of Julius Caesar followed naturally in the late 50s and early 40s, with obverse, *CAESAR*, elephant (the family badge) and, reverse, priestly symbols, or, obverse, head of Venus (his traditional ancestress) and, reverse, *CAESAR*, Gaulish trophy and captives. Such coinages still avoided the portraiture of a living man, the only examples of which hitherto had been on provincially struck coins; *e.g.*, Flamininus' features on the famous gold (now very rare) that he coined in Greece in the 2nd century B.C.

4. Caesar and After.—In the last year of his life Caesar developed personal control of the coinage to a point at which it lay ready to hand for Augustus to use, a few years later, as a fully imperial instrument. Already from 46 B.C. coinage in gold had been instituted in Rome by Caesar's lieutenant Hirtius. Caesar's seizure of the treasury, and his expansion of the annual board of moneyers from three to four members, indicated his intention to deal absolutely with the coinage. In 44, denarii were issued in considerable quantity by his *quattuorviri*, bearing the portrait of Caesar on the obverse, with such inscriptions as *DICT*(*ator*) *QVART*(*o*) or *DICT*(*ator*) *PERPETVO*, and Venus Victrix or other semipersonal reverse types. For the token coinage a new alloy was now first struck—yellow orichalcum or brass, a copper-zinc alloy heated with calamine. Caesar may have enjoyed a monopoly of zinc from mines in Cisalpine Gaul.

From 44 to 31, bronze coinages were struck at various non-Italian mints, notably in or around Sicily, by officials attached to the cause of one or other of the members of the second triumvirate—Antony, Octavian and Lepidus. But the principal issues of these years were of gold and silver. The mint of Rome continued its regular series until *c.* 37 and then ceased. Antony's coinage emanated at first from Gaul, then increasingly from eastern mints, including his cistophori and denarii (some showing his head conjoined with Cleopatra's) struck in Asia: his vast issue of often base denarii showing warships and military standards shortly before Actium, was eastern. Octavian coined mainly in Gaul, Italy and Africa. The piratical movement of Sextus Pompey was reflected in the activity of a mint or mints in Sicily.

It was characteristic of most of the gold and silver after 44 that it showed portraits of the rival statesmen on the obverses, with reverses that alluded to their achievements or policies. This was true even of the "liberators" who murdered Caesar, for a famous eastern issue in the name of Brutus showed his portrait with *BRVT*(*us*) *IMP*(*erator*) on the obverse, with reverse *EID*(*ibus*) *MAR*(*tiis*)—the fatal Ides of March—and daggers flanking a cap of liberty. By the close of the Roman republic three factors had entirely transformed the originally simple idiom of the early denarial coinage: gold was freely struck in addition to silver; the types of both were personal to military leaders and included living portraiture; coinage could be produced, through exercise of imperium, elsewhere than at Rome. All these were fundamental in the imperial coinage from Augustus onward.

Early Imperial Mint Policy.—Augustus (27 B.C.–A.D. 14) based the coinage on the aureus of $\frac{1}{42}$ of a pound of gold, equivalent to 25 denarii, each of $\frac{1}{84}$ of a pound of silver, the metals being struck almost pure. The denarius was valued at 16 asses. Base-metal coinage consisted of brass sesterces and dupondii (equal to four and two asses), with copper asses, halves and quarters. The as was the commonest coin. Nero in A.D. 64 lightened aureus and denarius to $\frac{1}{45}$ and $\frac{1}{96}$, respectively, but debasement of silver subsequently took place. Under Septimius Severus it reached 40%, and Caracalla issued a debased double denarius of the weight of only $1\frac{1}{2}$ denarii. Gallienus' copper double denarius, only washed with silvery coating, marked a monetary breakdown only partially cured when Diocletian and Constantine again made good the firm basis for supplementary pure silver and abundant copper coinage.

Augustus' earliest gold and silver were coined chiefly in the east, *e.g.*, at Ephesus and Pergamum, and more briefly at Emerita in Spain. Bronze also was mainly eastern, though some was struck at Nemausus (Nîmes). The Rome mint was reopened *c.* 23 B.C. for gold and silver and remained open for this purpose until *c.* 12 B.C.; its bronze continued irregularly. From 12 B.C., Lugdunum (Lyons), with other mints of uncertain identity, undertook the main western coinages in gold, silver and bronze; after interruption Lugdunum was again a major bronze mint in Nero's last years and under the Flavians; it was active also in the 3rd century, when Siscia, Mediolanum and Viminacium were coining as well. After 64 Rome was once more the chief mint for all metals. Official mintages were supplemented by a mass of regional or local coinages, from Roman colonies, from towns that coined by special permission, from preimperial mints continuing in the east, and from Alexandria, while official coinages from eastern mints, *e.g.*, Caesarea in Cappadocia and Syrian Antioch, provided necessary currency for Roman frontier forces there.

The bronze of Rome was marked *S(enatus) C(onsulto)* and continued to bear the names of the *tresviri monetales* (now reduced to their traditional number) until 4 B.C. But *S C* also appeared on bronze from Lyons and Antioch in imperial provinces, showing that whatever nominal senatorial rights of coinage still lingered on—the *tresviri* are known until the 3rd century—the emperor wielded effective control over all metals everywhere. This was logical, since his economic powers were equally comprehensive. In fact the old senatorial mint was transferred from the temple of Juno Moneta on the Capitoline and merged, probably after the fire of 64, with an imperial establishment for gold and silver in the Third Region. Henceforth it worked in sections—six were normal later—each controlled immediately by an imperial procurator and staffed by slaves or freedmen. Imperial supremacy of mintage as a whole is implicit in the nearly constant appearance, on gold, silver and bronze alike, of the portrait and some elements of title of all emperors from Augustus onward; *e.g.*, *Imp(erator)*, *Caesar*, *Augustus*, *Tribunicia Potestate*.

Portraits and Types.—Caesar's use of his own portrait upon coinage set a precedent; although under Augustus and Tiberius token denominations occasionally lacked the imperial portrait, it was thereafter an essential element of virtually every gold, silver and bronze coin of the official mints, as also of nearly all provincial and local coins. Emphasis on the personality of the emperor (extended sometimes to empresses, sons or deceased members of the imperial house) was a powerful instrument in a coinage, which, bearing also the imperial titles in brief form, reached throughout a vast empire; the coin portrait enjoyed an almost sacred respect under a political system that normally required or encouraged the worship of the emperor's Genius. The great series of imperial portraits, from Augustus down to Romulus in A.D. 476, is artistically outstanding. Many of the finest appeared on the large brass sesterces down to the 3rd century and on the even larger bronze medallions produced for presentation; but particular care was taken over the portraits for gold, which, being softer, showed a beautiful and highly sensitive impression. Nothing is known of the portrait artists, though it is likely that they were often from the Greek east.

Imperial reverse types, if artistically less remarkable, are uniquely important for the unparalleled fullness of the historical commentary—religious, political and social—that they supply. The major mints provided annual evidence of imperial interests: victories in war; frontier defense, *e.g.*, *Rex Parthis datus* of Trajan; a well-earned peace, *e.g.*, the *Pace terra marique parta Ianum clusit* of Nero; the birth of an heir or alternative provision for the succession; public shows; acts of social reform or public relief, *e.g.*, *Civitatibus Asiae restitutis*; imperial journeys, *e.g.*, *Adventus Augusti*; and religious or other anniversaries, *e.g.*, the *Felix temporum reparatio* on Rome's 1,100th birthday. Their interpretation demands care, since, being selected by imperial officials, their tenor can conflict with the attitude of anti-imperial historians. But they show the efforts made by emperors, as the omnipotent semireligious heads of a huge and heterogeneous empire, to conciliate and mold opinion. They contributed powerfully to the growing conception of the *Aeternitas Imperii Romani*, seen no less in the special types of eagle (the soul flown heavenward) or funeral pyre or temple in honour of "good" emperors consecrated as *divi* than in the annual record of military victory, economic security and provincial peace, and implicit in the regularity of imperial succession. The normal colour given to this imperial program was religious, for the coinage types commonly embraced such characteristically Roman concepts as Aequitas, Fides, Concordia, etc.—social virtues operating in the guise of minor deities.

5. The Fourth Century and After.—Diocletian's institution of the tetrarchy, by which the empire was divided administratively between two Augusti and two Caesars, brought fundamental changes in social and economic policy; the instability of prices called for complete renewal of the monetary system. His coinage reforms took place in stages from *c.* 286 to *c.* 296. First, new aurei (issued in some quantity) were struck at 60 to the pound of gold. Then, *c.* 293–294, new silver coins, of good purity, were struck at the revised Neronian weight of 96 to the pound of silver. Finally, *c.* 294–296, new copper coins appeared, which (perhaps pieces of 5 denarii) were larger and intrinsically more valuable than the small debased double denarii of previous reigns. The contemporary names of these silver and copper pieces are not known. This reformed coinage was struck at a variety of mints from London to Alexandria, most of which coined in all three metals, though some produced only silver and copper, or even copper alone. Types were closely controlled in the silver and copper coinage; in the latter the almost universal type was for some years that of the Genius "Populi Romani." The obverse bore the portrait of one or other of the tetrarchs, each of whom coined with portraits of all four.

The breakdown of the tetrarchy after 306 weakened the new system. Copper was quickly and steadily lightened, and silver came to be struck only very sparingly. Gold, however, for so long the basis of imperial coinage, continued in good supply; and though Constantine's solidus showed a reduced weight-standard (from $\frac{1}{60}$ to $\frac{1}{72}$ of a pound of gold—setting the standard for the famous bezant of the Byzantine empire), there was no shortage of gold throughout the rest of the 4th century. In time silver coinage increased, especially after *c.* 350, when the miliarense ($\frac{1}{1000}$ of a gold pound) and smaller denominations appeared in some quantity. By the end of the 4th century the size of copper coins had dropped very sharply, and in the 5th, until the western empire collapsed in A.D. 476, the western coinage consisted finally of gold with a little silver, struck mainly from the mints of Ravenna and Rome.

From 312, when Constantine took Rome, coin-types at all mints began to show new tendencies. The imperial portrait, often armoured and warlike, was still the dominant feature. Reverses displayed complementary themes represented in a way unknown to the 3rd century or before—the glory of the army, vows for continued imperial rule, the constant struggle against barbarian pressure on the frontiers. The old variety of pagan gods—Jupiter excepted—mainly disappeared, though Sol, popular from Aurelian onward, was used specially by Constantine. Christian emblems did little to take their place, though the Christian monogram, the Greek letters chi and rho superimposed, sometimes on a standard, began to appear with Constantine and was combined with the alpha and omega under Constantius II and Magnentius. On the whole, however, there was an unavowed truce between Christianity and paganism, only occasionally broken, as when Julian deliberately revived a range of pagan, and especially Egyptian, types; the full development of the Christian tradition in coinage was reserved for Byzantium.

IV. COINAGE IN WESTERN EUROPE, AFRICA AND THE BYZANTINE EMPIRE FROM THE 5TH TO THE 10TH CENTURY

The fall of Roman power in the west left the gold currency of the Byzantine empire undisturbed; it was to become the most dominant single influence in European coinage for 1,000 years, competing at first with the gold of the Arab caliphates and lat-

terly with that of the great Italian commercial republics as well. Byzantine coinage, in its continuity, contrasted strongly with the often erratic monetary systems from the 5th to the 7th centuries in western Europe, where Germanic invaders inherited the apparatus, money included, of the Roman empire. In general, the main features of late Roman coinage were taken over. Emphasis on gold continued, with silver and (where it was struck at all) some bronze; gold chiefly served for the triens ($\frac{1}{3}$ of the Constantinian solidus). The types of the gold coins for some time reflected Byzantine prestige, for they showed on the obverse the "portrait" (purely formalized) and titles of the reigning Byzantine emperor, toward whom widespread respect was paid even when western kings began to add their personal monograms to the normal Victory reverses. Imperial prerogative, so powerful an influence upon western gold, had less effect on silver, the types of which in the west became more flexible; in bronze, where obvious efforts were sometimes made to link with traditional Roman design, flexibility was greater still. In technique these coinages varied widely: that of Italy was not without elegance; that of Spain developed an elaborately stylized balance, depending largely on its bold letter-forms; the highly abstracted figures of Gallic coins have found great favor among 20th-century artists, while those of Africa and England were in general considered artistically inferior. The weights of gold coinages were kept at a reasonably steady level, though fineness ultimately declined with the economic decline of the issuing kingdoms themselves.

1. Post-Roman Coinage of the West.—In Italy the Herulian Odoacer (476–493) had coined in silver and bronze at Ravenna after setting up a Teutonic kingdom. The Ostrogothic coinage that followed, from Theodoric (493–526) onward, consisted of gold, mainly imitating current Byzantine issues and with the imperial portrait (Theodoric's fine portrait on a unique triple-solidus is wholly exceptional). Silver and bronze were supplementary. The normal mints were Ravenna, Milan and Rome, the last of which, emphasizing the senate's lingering role, employed essentially Roman types for its bronze, though its portraits, *e.g.*, of Theodahad, are substantially Gothic conceptions. Silver usually bore a king's monogram, though the name (in the form *Dn . . . Rex*) might also appear in full. The Lombards of Italy (568–774) had no distinctive coinage of their own until the gold struck in the name of Grimoald, duke of Beneventum (662–671), which was followed by gold and silver from a number of mints elsewhere. In Africa the Vandal kings Gunthamund (484–496) and Hilderic (523–531) issued silver and bronze coinage, respectively, inscribed with their names; the types and denominations looked to imperial models and, in the case of the bronze, to those of Carthage especially. Vandal gold was perhaps struck by Gaiseric (428–477) or Hunneric (477–484), in the Byzantine emperor's name, but in the absence of any royal monogram it cannot easily be attributed. The chief Spanish coinage was that of the Visigoths, who controlled south Gaul also and—after Leovigild (568–586)—Suevia (modern Galicia), with its rich gold mines; hence the fact that of 79 Visigothic mints a high proportion was concentrated in northwest Spain. Visigothic gold coinage was produced in quantity down to the early 8th century and consisted almost entirely of thirds, at first imitating Byzantine models, and bearing kings' names with such titles as *D*(*ominus*) *N*(*oster*), *Pius*, *Iustus* and *Rex*. The most prolific mints were Mérida, Toledo, Seville, Tarragona and Cordoba; coinage continued until the Arab invasion of Spain.

In Gaul the Burgundians struck their own imitative gold thirds, first, under Gundobad (473–516), inscribed with a recognizable royal monogram, though not yet displacing the imperial name and portrait. The largest of the Gaulish coinages, however, was that of the Merovingian Franks, beginning with Clovis (481–511). The gold consisted mainly of thirds, at first with some subsidiary silver and copper, inscribed by Theodoric of Austrasia (511–534) and Childebert I of Paris (511–558) with their own names. As elsewhere, the types of the gold borrowed steadily from the imperial series, either the former Roman or the current Byzantine. Reverses showed a Victory, though the theme of the "cross on steps" of Tiberius II (578–582) gradually displaced it, beginning in the south. Obverses generally showed a profile bust derived however remotely, from imperial models; in time there was some borrowing of frontal busts under Visigothic influence. A profound break with tradition came when Theodebert I (534–548, substituted his own name on his gold for that of the Byzantine emperor —a change that in turn was to influence Visigothic gold. The right of striking gold had meanwhile been widely extended, for in addition to coins declaring their royal origin *in palatio* (principally at Paris) there were others, which became much more profuse, coined by cities, towns and ecclesiastical foundations. Presumably such mints operated by royal permission; their numbers were great—nearly 500 in all—and they were distributed over an area including not only what is now France but also the Low Countries, the Rhineland and Switzerland. The types of Merovingian gold coins diverged increasingly from imperial models: nearly all of them were inscribed on the obverse with the name of the issuing authority, most often municipal, and on the reverse with the name of the moneyer, who, as in the case of Eligius (St. Eloi of France), might be well known both as a cleric and as a goldsmith. As the Merovingian dynasty drew to a close in the 8th century, gold coinage became poorer in quality, and it gave way to the small silver denarius, of about 1.2 g., struck in quantity. This change heralded the Carolingian revival of the denarius.

Coinage supply to England was interrupted when the mints of Roman Gaul were closed *c.* 395, and scarcely any gold or silver coin entered the former country during *c.* 450–550. Subsequent penetration of Merovingian gold encouraged a brief Anglo-Saxon coinage of gold thirds (*see* below).

2. Coinage in the Byzantine Empire.—Inspiring many features of these transient coinages, but outliving them all, stood the currency of the Byzantine empire. It was based on the gold solidus ($\frac{1}{72}$ of a pound) of Constantine—the bezant of 4.5 g. (about 70 gr.) maximum, which dominated so much of European trade down to the 13th century. Down to the 10th century halves and thirds were also used. This gold was proverbial for its purity until the 10th century. The fundamentally religious nature of the empire was fully reflected in the coinage: throughout ten centuries there was scarcely a single issue that did not look direct to the Christian faith, since apart from reverse types and legends, which were purely religious, the obverses showed the emperors as specifically Christian rulers by the use of adjuncts or appropriate inscriptions.

Byzantine coinage began effectively with the reign of Anastasius (491–518). Thenceforth it consisted, in addition to gold, of silver and bronze. Silver, always rather rare, consisted of the small siliqua or keration, followed by the larger miliaresion and the still larger hexagram. Bronze was in most periods very commonly struck. Its appearance and tariffing were reformed by Anastasius, who issued large pieces marked *M*, *K*, *I* and *E* (equal to 40, 20, 10 and 5 nummi); other multiples were found either later or locally, as *IB* (equal to 12 nummi) at Alexandria. Such marks of value continued until Basil I (867–886), after whom the recognition of specific bronze denominations becomes difficult. Constantinople itself was the main mint in all three metals, which were coined also at Carthage and Ravenna. Thessalonica, Nicomedia, Cyzicus, Antioch and Alexandria struck bronze only; at one time or another Rome struck gold and bronze, while Syracuse and Catania also contributed. The technique of gold and silver minting was generally high. That of bronze, which had a token character, was coarse, and the practice of overstriking former coins was often employed.

Types and Legends of Byzantine Coins.—The types, though they suggest considerable uniformity, in fact display steady development and, occasionally, abrupt change. For gold the earliest obverses were diademed profile busts or helmeted facing busts, both common on previous coins of eastern and western empires. The facing bust showed the emperor in military panoply with cross in his hand or on his helmet, and if the cross was lacking on the obverse it appeared on the reverse. With Justin I and Justinian I (527), the seated figures of the emperors were shown side by side. Thereafter the facing head became more common; from the time of Phocas (602–610) it was increasingly formalized

a process that reached its climax in the 8th century, with ceremonial vestments taking the place of earlier military robes. Under Heraclius (610–641) the habit began of showing the bust or standing figure of the emperor with that of one or more of his sons; and, with figure-types now more common, it was possible to show emperor and empress together, or even, as with John I Zimisces (969–976), the emperor being crowned by the Virgin, with the hand of God above. The reverses of the gold coins at first emphasized the Victory (doubtless regarded as an angel) of previous issues. Tiberius II (578–582) introduced the cross potent on steps, a type destined to play a long and important part. Standing figures of members of the imperial family came later. Justinian II (685–711) was the first to use the haloed bust of Christ, of both a youthful and an older aspect: Christ had previously been shown only on a coin of *c.* 450, in the act of marrying Pulcheria to Marcian. The iconoclasm of Leo III (717–741) and his successors banished such divine representations in favour either of the cross on steps or of imperial figures on the reverses, but with Michael III (842–867) the bust of Christ returned. From Basil I the throned, full-length figure of Christ predominated.

The obverses of the silver coins, beginning with profile busts, thereafter included seated figures, facing busts and purely epigraphic designs incorporating imperial names and titles. The introduction of the larger hexagram by Heraclius in 615 allowed fuller scope for later designers, whose reverses often consisted of a cross on steps or a bust of Christ surrounded by legends, such as *Deus Adjuta Romanis* or *I H S Christus Rex Regnantium;* from the 10th century the cross bore a central portrait-medallion of the emperor himself.

In bronze coinage there was at first less flexibility. The earliest types were, obverse, a profile bust and, reverse, cross and mark of value. Under Justinian I (527–565) the facing bust prevailed, and in his 12th year he introduced the dating of his bronze coins on the reverse, in the form *Anno XII;* the inclusion of a regnal date was thereafter normal on bronze until Constans II (641–668). From the time of Justin II (565–578) the obverses showed two or more standing imperial figures, and sometimes the reverses too, combined (until Basil I) with the mark of value. Not until the 10th century was there any abrupt change. Thenceforth the reverses were taken up wholly by three or four lines of inscription; and the anonymous bronze coins of John Zimisces combined such a reverse, reading *Iesus Christus Basileu(s) Basile(on)*, with an altogether new type of obverse showing the facing bust of Christ designated *Emmanuel.*

The orthography of Byzantine coin-legends became remarkably complex as the Latin and Greek alphabets were increasingly mingled and when individual letters took on new or specialized forms and words were severely abbreviated. At first the inscriptions were purely in Latin, the emperor's names and titles being in the conventional form *D(ominus) N(oster)—P(ius) F(elix) Aug(ustus).* Even before Anastasius, however, *Perpetuus* had been a variant for *P.F.*, and, abbreviated in the form *PP*, it finally prevailed. In the 7th century, Greek letters were more commonly mixed with the Latin, in such legends as that of Justinian II when he styled himself *Servus Christi;* and in the later 8th the general shift to Greek from Latin conceptions was plain in the emperor's new title of *βασιλεύς*, that of *δεσπότης* (at first reserved for the heir-apparent) also coming in later as an imperial equivalent, with the variant *δέσποινα* for an empress regnant. The title *αὐτοκράτωρ* was introduced in the 10th century, which also saw the beginning of comparatively long votive inscriptions, as *Lord, help thy servant.* Metrical inscriptions (a practice commoner in Asia than in Europe) began in the 10th century; though they never became common, they were often elaborate.

Economic Role of Byzantine Coins.—Byzantine gold coinage, until its debasement from the 10th century, was immensely important in the economic life of the Levant and western Mediterranean. The total output of gold was immense, and its influence can be judged partly from the distribution of the coins themselves and partly by the typological influence exerted by the Byzantine upon other coinages, from the first Arab-Sasanian gold of the east to that of Italy and Gaul in the west. In the 5th and 6th centuries Byzantine solidi accumulated in the Baltic area, doubtless in payment for furs; and, in the 6th and 7th, solidi of a slightly lighter weight (*solidi mancussi*—probable source of the term mancus) were hoarded over a very wide area, including France, the Low Countries, Scandinavia, Germany, the Balkans, Russia, the Levant and north Africa. In these last two regions Byzantine gold competed from the 7th century with the increasing output of Arab gold dinars.

3. Charlemagne and the Carolingian Coinages.—While the bezant and dinar maintained gold currency along the Mediterranean, northern Europe from the 8th century suffered a shortage of gold and turned its almost exclusive attention to silver, inherently more convenient as a unit of exchange. A previous Merovingian tendency to introduce silver alongside gold was carried much farther when the Carolingian ruler Pepin the Short (752–768) replaced gold by silver, introducing the denier, which was to be the basis of all medieval coinage in the north. His new coin settled at first to a weight of 1.28 g. ($19\frac{3}{4}$ gr.) and was wider and thinner than previous silver pieces. The normal types were simple—obverse *R P* (for *Rex Pepinus*), reverse *R F* (for *Rex Francorum*).

Charlemagne (768–814) reorganized northern currency in a way that affected it permanently. Coining at first simply as *Carolus R F*, he defeated the Lombards in 774 and entered Rome, becoming king of Lombardy as well. His deniers were later made wider and still heavier (about 25 gr.), and he introduced the smaller and subsidiary obol or half denier. The main types of his deniers were threefold: the monogram of his Latinized name Carolus; a temple (sometimes a gateway); and more rarely a portrait. Monogram deniers were coined in France, Germany, north Italy and northeast Spain; temple deniers were also widely struck, often inscribed *XRISTIANA RELIGIO*, though this legend was sometimes replaced by the name of a major French mint-city. On Christmas day 800 Pope Leo III crowned Charlemagne as Roman emperor, and thenceforth his deniers, either with the temple type and "Christian" legend or with a mint-name alone, styled him *Kar(o)lus Imp. Aug.*, sometimes adding *Rex F(rancorum) et L(angobardorum)*. His mints lay mainly in France, the Rhineland and the Low Countries; those in north Italy and northeast Spain were few.

Louis le Débonnaire (814–840) continued his father's monetary system with little essential change. But the infringement of his mints emphasized the economic importance of northern ports, especially the Frisian Duurstede, from the neighbourhood of which (including perhaps Hamburg) emanated large numbers of more or less skilful copies of the gold sous (or, occasionally, of the half-sous) that Louis struck. These portrait coins originally were designed presumably for presentation to the Holy See, since the reverse bore the inscription *MVNVS DIVINVM* around a cross. They were struck sparingly, and no Carolingian gold thereafter appeared. Charlemagne's pattern of coinage, sometimes varied, was extended to Lotharingia, with such powerful mints as Cologne, Metz, Trier and Strasbourg. From the time of Louis II and III (877–882) the Carolingian currency pattern weakened, and feudal coinages made their first appearances. Louis IV d'Outremer granted coinage-rights to the archbishop of Reims as early as 850, and the system was swiftly developed in the 10th century, concessions being made to a large number of ecclesiastical foundations and even in a few cases to lay lords as well. In Spain, Carolingian mints were established only in the extreme northeast, at Barcelona, Ampurias and Gerona. The kingdom of Aquitaine, under Charlemagne, was reserved to the Frankish king's son, and its coins were modeled strictly on the Carolingian pattern. Northern Italy was an integral part of the territories controlled by the earlier Carolingians, but from the middle of the 9th century changes began to show: the deniers of Pavia and Milan, though retaining essentially Carolingian types, became much broader and thinner, with wide rims like those of the later German bracteates. Venice, a republic from the late 7th century, ruled by a doge under Byzantine protection, did not coin until the 9th, when it struck deniers for the Carolingians; but after Lothair I it omitted mention of the imperial name. At Rome papal coinage began with Adrian I (772–795),

Byzantine in style and types, but after Charlemagne's visit in 774 all deniers (except during an imperial interregnum) were struck jointly with the pope's monogram and the emperor's name, down to 904; thenceforth the papal name appeared in full and alone. The principalities of Beneventum and Salerno and the duchies of Naples and Amalfi fell within the Byzantine-Arab orbit, and their gold, silver and bronze showed these besides Carolingian influences; bronze coins in particular followed Byzantine models, while the gold tari of Salerno were curious copies of Arab dinars. In central Europe, Carolingian coinage was not reflected east of the Rhineland, but in the north the imitation of Carolingian money in or around Duurstede bred more distantly derivative issues elsewhere, possibly even in Scandinavia; these were in effect silver deniers, but their types, with their emphasis on ships and animal designs, show them to belong to the Nordic, as opposed to the Teutonic, stream of monetary design.

V. THE LATER MEDIEVAL AND MODERN COINAGES OF EUROPE

The change of power from Frankish to German emperors in the 10th century saw the silver denier extended into central and northern Europe; it was issued from a great variety of mints, imperial, regal, autonomous and, above all, feudal. In the east the decay of the Byzantine empire was reflected in the debasement of its gold coinage to electrum; after the temporary fall of Constantinople to western crusaders in 1204, Byzantine tradition was carried on in the silver coinages of the derivative empires of Trebizond, Nicaea and elsewhere. The revival of gold coinage in Italy in the 13th and 14th centuries, promptly copied elsewhere, led to the need for a silver denomination larger than the denier, and the grosso and its equivalents soon spread widely. From the 14th century the outward appearance of coinage was fundamentally changed from its former Gothic stiffness: the Italian Renaissance pointed the way to naturalism in portraiture and to greater fluency of ornament. In the 15th century the first Italian experiments were made with mechanical methods of coining (*see* below), and by the 16th the new techniques were being generally adopted. The effects were important: the traditionally privileged nonregal mints were incapable of competing with the mechanical power needed to cope with the intensive coinage not only of the large gold denominations resulting from the influx of Spanish-American treasure after 1493 but also with the equally large silver thalers or dollars, starting with those of the German Joachimsthal mines, which were in turn required. Multiplication of gold and silver coinages, and their larger denominational values, emphasized the need for token coinages, which were steadily produced from the 17th century. England was effectively on the gold standard from the end of the 18th century, together with Portugal, but it was not until the second half of the 19th that European countries in general followed suit. Paper currencies of this period were fully redeemable in gold coin, but the gold standard was abandoned in World War I; since then paper has been redeemable only in "silver," which in most countries since 1918 has consisted increasingly of nickel or other base-metal alloys.

The coin-types of the later medieval period started with the simple devices, often crudely executed, which the Carolingian coinages made widely familiar—a monogram; legends (whether arranged in circular or linear form); a cross; a "temple" or church of elementary shape; or a more or less formal portrait. Portraiture, schematically stiff on later Byzantine money, was revived with striking realism most notably in Renaissance Italy and thereafter flourished. Reverses revealed feudal influence in shields of arms and civic emblems (either inanimate badges or devices with animal or human figures); after Renaissance modes prevailed, these were retained in adapted forms. These developments set the general pattern of modern coinage, usually with an obverse portrait and some form of national badge or arms on the reverse. From *c.* 1800 onward this pattern has been standardized to a large degree.

1. Portugal.—Coinage began, after the expulsion of the Moors, with Afonso I (1128–85), whose gold maravedis, copied from the gold of the Almoravids, retained certain Arab features in design. Some base silver was also struck. Rights of coinage were, from the start, reserved to the kings, almost without exception. Pedro I (1357–67) reformed the coinage on the basis of the gold d[illegible] of about 4.9 g., with types copied from those of contemporary France: obverse, king enthroned; reverse, ornamented cross. There was a similarly imitative silver gros tournois. Pedro's successors developed his system. Copper was struck from the 15th century. From the 16th to the 18th centuries gold was coined in quantity and in denominations of handsome size down to the half-escudo. In the 19th century the basic gold denomination was the crown. In the 20th century token denominations (in terms of centavos) have prevailed in various alloys, though silver was introduced in 1954 for the ten-escudo piece and for certain purely commemorative issues.

2. Spain.—As in Portugal, the coinage struck after the expulsion of the Moors was almost without exception regal. That of Navarre started under Sancho III (1000–35) with deniers of Carolingian influence. The series of Castile and León began with similar pieces under Alfonso VI (1065–1109), and that of Aragon under Sancho Ramirez I (1063–94). Among the earliest gold, struck from the mid-12th century, was that of Alfonso VIII of Castile (1158–1214), copying an Arab gold dinar but with Christian instead of Islamic professions in its Arabic script. Gold portrait doblas appeared under Sancho IV of Castile and León in the 13th century, and the portraiture under Pedro I in the 14th was of high quality. Gold coinage multiplied in the 15th century, with Henry IV coining huge pieces up to 230 g. of superb Gothic style; silver and billon were also in good supply. The union of the crowns of Castile and Aragon in 1479, and subsequently the influx of American precious metals, resulted in an abundant coinage in gold (the excelente and its multiples) and silver (the real and its multiples) —the silver piece of eight being the famous Spanish dollar. This last denomination enjoyed enormously wide currency, and its types (obverse, royal portrait; reverse, pillars of Hercules with *PLUS VLTRA* on scroll) were universally known, especially in the 18th century, and continued into the 19th and 20th centuries, being used by Alfonso XIII and, with appropriate changes, by Gen. Francisco Franco.

3. France.—The dynasty of Hugh Capet (987–996) made no immediate change in the previous Carolingian coinage system: deniers and their halves, the obols, continued, tending to decline in fineness, and their types, except for the cross pattée, were of Carolingian derivation. His kingdom was limited to the northern centre of France, and feudal deniers began to appear in abundance elsewhere: the most important and numerous were those issued from the 10th century by the abbey of St. Martin at Tours with a "castle" type destined to exert wide influence. This *monnaie tournois* was lighter than the royal *monnaie parisis*, generally at the ratio 4:5. Louis IX in and after 1262 reformed the coinage. The sou, hitherto a coin of account, became in 1266 the silver gros tournois, $\frac{23}{24}$ fine and weighing about four grams; its types continued the "castle" of the denier tournois but with an arrangement of concentric inscription and ornament, which was frequently imitated elsewhere. With this there appeared a gold écu, with the royal lilies on a shield. Subsequent development down to the 15th century emphasized more and larger gold denominations; silver continued, often debased. Design reached magnificent heights in Gothic splendour, seen in the masse d'or, mouton d'or, ange d'or and franc d'or; the Anglo-Gallic issues of the time were comparably beautiful. Feudal coinage was severely limited, that of Brittany and (at first) Aquitaine being most important, together with a number in Provence. Types in Aquitaine later showed some English influence, while in the gold of the south that of the Florentine florin was noticeable. The 16th century saw the adoption of broad, thick silver coins familiarized by the testons of Italy; these, together with the gold écus, set the general pattern. Early in the 17th century the use of machinery for coining was the subject of experiments by Nicolas Briot; both he and Jean Warin were famous for their technique and style under Louis XIII. The later 17th and 18th centuries, though their coinage was of considerable external magnificence (latterly at the hands of the Roettiers), was not devoid of monetary difficulty and fluctuation. Louis XV s[illegible]

pressed independent local or provincial minting, Strasbourg being the last of such mints to survive, though royal branchmints continued in a number of cities. Under the Revolution Louis XVI coined first as constitutional king, in gold, silver and copper; but from 1793 the issues were wholly republican, with the inscriptions *République française, Liberté,* etc., and the symbols (cap of liberty, cock) that have survived in modern French coinage. The precious metals were in short supply; gold and silver were demonetized and large quantities of paper circulated in their place, together with copper. In 1793 the decimal system was adopted, in terms of francs, decimes and centimes, coins now being dated by the revolutionary era; gold coinage was effectively lacking until the time of Napoleon. From 1866 France was joined with Belgium, Italy and Switzerland in a monetary convention defining the denominations, quality and weight of gold and silver coinage in terms of francs. In the 20th century alloys were introduced, and the Vichy government of Henri Philippe Pétain (whose portrait appeared on some coins) also used zinc, iron and aluminum. From 1950 paper money was increasingly replaced by alloy coins, the "heavy" revalued franc being introduced in 1959.

4. **The Low Countries.**—The Merovingian and Carolingian periods had seen the operation of a few mints. Subsequently the area became distributed among the authority of a number of dukes, counts, seigneurs and ecclesiastics, Luxembourg, Hainaut, Flanders, Brabant and Holland being conspicuous. Their coinages reacted closely to the influence exerted by the neighbouring great powers. In the 16th century the Low Countries passed to the house of Austria, and the daalder made its appearance. English military operations were accompanied by the issue of gold pieces imitated from those of the current English coinage but differentiated by their inscriptions. The 16th century produced some remarkable siege-pieces from Amsterdam, Bergen op Zoom and elsewhere as a result of resistance to Spanish and French pressure. With the establishment of the Kingdom of Holland under Louis Napoleon in 1806, coinage began to conform with that of the Napoleonic empire. Belgium emerged as an independent kingdom in 1831, and from 1886 its coins either have been minted in equal numbers of French-inscribed or Flemish-inscribed specimens or have been bilingual.

5. **Switzerland.**—The coinage of Switzerland illustrates the varying fortunes of this land, its gradual growth and consolidation. First there was the gold money of the Merovingian kings, among whose mints were Basel, Lausanne, St. Maurice-en-Valais and Sitten (Sion). The silver deniers that Charlemagne made the coinage of the empire were issued by fewer mints. The dukes of Swabia began to strike at Zürich in the 10th century, and the empire during the 10th and down to the 13th century granted the right of coinage to various ecclesiastical foundations, bishoprics and abbeys. Bern was allowed a mint by the emperor Frederick II in 1218 and other towns and seigneurs subsequently gained the same right. The demi-bracteate appeared about the middle of the 11th century, and about 1125 it was superseded by the true bracteate, which lasted until about 1300. The 14th century witnessed the rise of the Swiss confederation, and by degrees the cantons struck their own money. These, together with the coins of some few sees and abbacies, formed the bulk of Swiss money of the medieval and modern periods. The separate cantonal coinage, interrupted by the French occupation, was finally suppressed in 1848, when a uniform currency was adopted.

6. **Italy and Sicily.**—At the close of the Carolingian period the coinage of Italy fell into two main classes. In nearly all of the north, including Rome, it consisted of silver deniers of Carolingian derivation, mainly struck at Pavia, Milan, Lucca and Verona. At Venice and over most of the south the dual influences of the Byzantine and Arab empires were prominent. Monetary fashions were shown in the coinage of Sicily struck by the Normans. Robert Guiscard (1075–85) struck gold tari of almost wholly Arabic appearance, together with bronze of Byzantine style. Roger I of Sicily latinized the bronze, and Roger II as *Dux Apuliae* coined silver ducats of Byzantine type; arab-style gold tari still continued for commercial reasons, since the great Fatimid coinage was then the currency of all western Muslims. After southern Italy and Sicily had fallen to German power, Frederick II (1212–50) restored a Latin coinage of gold, of splendid style and execution and good fineness, in proto-Renaissance style. His gold augustale of about 5.2 g. and its half, struck *c.* 1231 at Brindisi and Messina, had as obverse the emperor's laureate bust with inscription *IMP. ROM. CESAR AVG.* and, reverse, the imperial eagle with a continued inscription, *FRIDERICVS.* They were accompanied by billon deniers. Sicily soon passed to Charles I of Anjou (1266–85), and its Angevin coinage, like that of Naples, assumed the beauties of the French medieval style, succeeded in turn by that of the Aragonese kings.

In northern Italy leading cities were issuing silver (with or without the imperial name) with a free choice of types—portraits, badges or figures of patron saints and others, with explanatory legends. Mantua celebrated Virgil; Florence from *c.* 1189 showed its lily with St. John the Baptist; and Genoa, the *janua,* or eponymous gate. Venice, abandoning the imperial name early in the 12th century, set a precedent *c.* 1192 in the issue of the larger silver grosso or matapan, using the henceforth familiar types of Christ on the reverse and, obverse, St. Mark presenting the gonfalon to the doge. The influence of the gold coinage of Frederick II on such cities was soon evident. Genoa was striking gold as early as 1252. Florence at the same time issued the first of its famous and much more profuse series of fiorini d'oro or gold florins. The lily continued as the civic type, together with the standing figure of the Baptist; regular weight (about 3.50 g., 54 gr.) and fineness won the fiorino universal fame and the compliment of wide imitation; double florins were introduced in 1504. Venice followed in 1284 with its gold ducat or zecchino (sequin) of the same weight, with types developed from the former Venetian silver: the figure of Christ is surrounded by an inscription abbreviated from the metrical *Sit tibi, Christe, datus quem tu regis iste ducatus* ("May the sovereignty which thou dost exercise, be accorded to thee, O Christ"). Venetian ducats rivaled Florentine florins in commercial influence and were widely copied abroad, especially in the Latin Orient, multiples being occasionally struck. The series begun under Giovanni Dandolo continued with the names of the successive doges until the early 19th century.

At Rome no papal coins appeared from 984 until purely epigraphic types recorded the names of Leo IX and the emperor Henry III in 1049–1054. Thereafter there was a further gap until Urban V (1362–70). The senate of Rome coined silver deniers from 1188, with the antique legend *Senatus Populus Q.R.* and figures of SS. Peter and Paul. In 1252 Brancaleone struck deniers with the seated figure of Rome and the legend *Roma Caput Mundi;* Charles of Anjou in the 13th century and Cola di Rienzo in the 14th also coined, as Roman senator and tribune, respectively. Senatorial gold ducats were introduced on the Venetian model in 1350. Papal coinage returned from Avignon in 1367 with Urban V, who assumed rights over the mint of Rome; gold, silver and bronze later developed, with types (crossed keys, tiara, personal arms and many different emblems) that with few interruptions have lasted ever since. From 1869 papal coinage has mainly been of a commemorative nature, as is true of the modern papal coinage, in silver, acmonital (stainless steel) and bronze, of denominations corresponding with the Italian state coinage.

The patronage given by the popes to notable artists, *e.g.,* Francia and Cellini, resulted in a fine and often lavish standard of design in their coins and medals. Similar patronage was shown by the noble houses of Ferrara, Mantua, Milan and elsewhere, whose coinages from the 15th century attained a splendid level. The size of gold and silver denominations was growing, as witness the silver teston of 1472 (*testone* means "large head"); and the portraits made by Caradosso, Francia and others of equal fame are among the finest small-scale Renaissance work. Later coins of still larger size of the duchies of Savoy and Florence are remarkable. Italian coinage continued to be divided among a number of kingdoms, principalities and duchies down to 1861, when Victor Emmanuel I first coined as king of all Italy. The metals were gold, silver and bronze; alloys were introduced under Umberto I (1878–1900). Under Victor Emmanuel III (1900–46) reverse types borrowed heavily from the antique, and his later issues reflected the influence of the Fascist regime, being dated by the Fascist era

from 1936 (year XIV) as well as by the Christian. From that same year he appeared as emperor (of Ethiopia) as well as king of Italy, and after 1939 coins were struck for him, with a helmeted portrait, as king of Albania. After World War II the republican coinage of Italy, in aluminum and steel, concentrated mainly on symbols of agricultural fertility and national industry.

7. Germany and Central Europe.—The complex coinages of Germany allow only a very brief sketch of some of their main features. Territorially the German issues began and developed in an area that has since been many times divided, and from which Austria, Hungary, Czechoslovakia and Yugoslavia have emerged as separate powers. Classification of these issues remains one of the most formidable numismatic problems.

From the 10th to the 12th centuries the Carolingian pattern of coinage was continued; but with the advent of the Swabians under Conrad III in 1138 unity disappeared. In the west the silver denier continued. In the east the coinage of bracteates was developed—silver coins of much lighter weight and so thin that they bore only a single type, repoussé on the reverse, for which a special technique (including the use of wooden dies) was devised. The western deniers were in part from imperial mints, scattered among a much larger number of feudal mints, representing ecclesiastical rather than lay authorities. Westphalia produced a profuse ecclesiastical coinage; that of Cologne was especially important, showing the former Carolingian "temple" combined with the linear inscription *S(ancta) Colonia A(grippinensis)*; and that of Münster was comparable in influence. This area was conservative and prosperous: the weight of its deniers was well maintained, and although Anglo-Saxon and, later, English and Byzantine influences became noticeable, its types showed little tendency toward major change.

In the eastern region a sharp decline in weight led to the thin, single-type bracteates, and the designs quickly broke away from Carolingian tradition. Issued by a wide variety of authorities, many of them ecclesiastical, these coins showed a great range of human figures and portraits (saintly and secular) together with representations of churches, castles and heraldic devices in an essentially medieval Germanic style. Difference between the heavier western deniers and the lighter eastern bracteates was perhaps partly responsible for the emergence of the mark. This weight of solid silver, the mass of which varied from one time and area to another, stood at about $\frac{2}{3}$ of the gold pound, which equaled 240 western silver deniers.

Transition from medieval to modern coinage took place with the emperor Louis IV of Bavaria (1314–47), who introduced gold and multiplied the silver grossus already issued (with adaptations from the gros of Tours) by Cologne under Henry VII (1308–13). Louis reduced the number of purely imperial mints. Those which operated by rights granted to the nobility, the churches and certain municipalities were still very numerous, and from these henceforth appeared the bulk of German coinage, including from 1520 the large silver thalers (so called from the Joachimsthal mines in Bohemia). In the 16th and 17th centuries the thalers and their multiples, of handsome and even ornate appearance, with, obverse, portraits and, reverse, elaborate heraldic devices, dominated the silver currency of Germany, rising in value as minor coins were debased. Thalers of Saxony and Brunswick are specially well known. The thaler continued as a unitary denomination down to the 19th century in Germany proper, but in 1870 German adherence to the gold standard caused its abandonment. From 1870 the kings of Prussia as emperors coined for all Germany: henceforth the innumerable local variations in coinage were subsumed under the gold reichsmark of 100 pfennigs, the silver standard being abandoned. After World War I the rulers of German states abdicated or were deposed, and everywhere the value of the mark declined to zero, its place being momentarily taken by inflated paper currencies. Silver was coined mainly for commemorative pieces between World Wars I and II, including the Hindenburg portrait-pieces; zinc, aluminum and alloys furnished the wartime currency of 1939–45. After 1948 the coins of western Germany were inscribed *Bundesrepublik Deutschland;* those of eastern Germany, *Deutschland* alone (with emblems of industry and fertility).

In Austria there was a ducal silver coinage in the 11th centur[illegible] It remained crude until the 14th century, when Albert II [illegible] 58) introduced a gold florin of Florentine character. The gro[illegible] peared with Frederick III (1440–93): thereafter developmen[illegible] parallel with that of Germany, with thalers taking a promin[illegible] place. Those with the portrait of Maria Theresa acquired [illegible] popularity on either side of the Red sea. They continued [illegible] coined in large numbers at Vienna and London, with the date [illegible] for circulation in those regions: 24,000,000 were struck in 1940–41 from British mints alone.

The Bohemian ducal coinage of deniers from the 10th to the 1[illegible] centuries showed the mingled influences of Byzantine, Scandina[illegible] vian and even English models; by the 12th century the Prague mi[illegible] was developing its own style. Wenceslas II first produced the gros in 1300, and John of Luxembourg (1310–46) the first gold f[illegible] with, obverse, crown and, reverse, rampant lion. The regal coin[illegible] age of Hungary began with the deniers of St. Stephen (1001–38), and the style remained crude until Charles Robert of Anjou (1309–42)—Carobert—reorganized the monetary system with a [illegible] bearing gold florin and a silver gros modeled on those of Naples and Rome.

With the formation of the Austro-Hungarian empire in 1848 the coinage of the two countries, including Bohemia, was unified During 1857–68 the coinage conformed to the terms of a monetary convention with Germany. The coins of Austria and Hungary were differentiated from 1868: the former were inscribed in German or Latin, and the latter in Magyar. Since 1923 the republican coinage of Austria, well designed, has been conspicuous for its commemorative silver coins. That of Hungary, under the regency of Adm. Miklós Horthy, emphasized the historic crown of St. Stephen; under Soviet domination the types have concentrated on symbols of revolution, peace, fertility and industry, together with special types for silver, showing notable public buildings in Budapest.

Czechoslovak coinage from its inception in 1918 has shown the lion of Bohemia: special coinages have commemorated St. Wenceslas (in gold) and Tomas Masaryk and—since the Soviet occupation—Stalin (in silver). The republic of Yugoslavia, similarly an offshoot of Austria-Hungary, has a currency based on paras [illegible] dinars. That of Albania, until its domination by the U.S.S.R. drew heavily on classical Greek traditions for its range of types.

8. Scandinavian Countries.—The origin of the coinage of the Scandinavian states, Norway, Denmark and Sweden, is clearly English and due to the Danish conquest of England. The Runic alphabet was employed, though not by any means exclusively, on many of the early coins of Denmark and Norway. The Norwegian series began with Haakon the Great (*c.* 970–995), who copied the pennies of Aethelred II. In the second half of the 11th century a coinage of small, thin pennies began, which developed into bracte[illegible] Magnus V (1263–80) restored the coinage, more or less imitating the English sterlings of the time. The money of Denmark began with pennies of Sweyn I (985–1014), which were copied from the coinage of Aethelred II; the coins of Canute (Cnut) the [illegible] (1014–35) and Hardicanute (Hathacnut) (1040–42) were [illegible] English in character. With Magnus (1042–47) other influe[illegible] especially Byzantine, appeared, and the latter was very strong [illegible] der Sweyn Estrithson (Svend Estridsen) (1047–76). Bracte[illegible] came in in the second half of the 12th century. The coinage [illegible] difficult to classify until the time of Eric of Pomerania [illegible] There were important episcopal coinages at Roskilde and [illegible] in the 12th and 13th centuries. Sweden had very few [illegible] coins; they began with imitations by Olaf Skötkonung (99[illegible] of English pennies and included the usual bracteate coinage [illegible] The money was restored by Albert of Mecklenburg (13[illegible] The thaler was introduced by Sten Sture the younger [illegible] 20). The money of Gustavus Adolphus (1611–32) is histor[illegible] interesting. Under Charles XII (1697–1718) there was [illegible] curious money of necessity: the daler was struck as a small copper coin, sometimes plated, and the types included Roman divinities. At the same time and later there was a large issue of enor[illegible] plates of copper, stamped with their full value in silver mone[illegible] a countermark.

The modern coinage of Norway—an independent kingdom from 1905—is, like that of Denmark, remarkable as including certain denominations pierced with a central hole. That of Sweden has included some large commemorative pieces of silver. In Denmark the Copenhagen mint has produced a colonial coinage for Greenland. Iceland, formerly joined with the Danish crown, has struck republican coins since 1944.

9. Poland.—After monetary beginnings derived from Germany, Poland developed a 16th-century coinage in gold, silver and billon that reflected its status as the greatest power in eastern Europe: its thalers were especially remarkable for fine portraiture and decoration, including the superb pieces coined by Danzig after 1567 when this area sought Polish protection. Dismemberment of Poland in the 17th and 18th centuries was followed by fluctuations in status, which have continued ever since. The coinage of independence after World War I celebrated national symbolism and national heroes, whether living, like Jozef Pilsudski, or dead, like Jan Sobieski III. On the coins produced during German occupation in World War II and under Soviet control thereafter, the Polish eagle has been a prominent emblem.

Danzig struck its own coinage (in pfennig and gulden) while a free city (1920–39).

10. Russia and the Balkans.—The earliest Russian coins began with the princes of Kiev in the 10th century and showed strong Byzantine influence. The staple coinage later came to consist of small silver kopecks and their halves (dengi); these were of Mongolian derivation, and the earliest bore on one side the khan's name and title in Arabic and on the other the name of a tributary grand prince in Russian, together with some figure-device. The names of the khans were omitted as the power of the princes grew. Ivan IV (1547–84) standardized the types of the dengi as "Tsar and Grand Prince of all Russia," showing a uniform design of a mounted lancer. From the 15th to the 17th centuries there was continuous monetary difficulty, reflected by clipping and counterfeiting, until reforms began in 1654. Peter the Great (1689–1725) reorganized the currency: gold was coined regularly from 1701, and silver rubles and billon kopecks also appeared, together with copper fractions. In 1725, after his death, copper "plate money" was briefly produced (as in Scandinavia) at Ekaterinburg. Recoinage on a large scale occurred in 1741. Under Catherine II (1762–96) copper rubles of great size were briefly struck, and from this period substantial five-kopeck pieces were in common production; the same reign saw a Russian copper coinage in Georgia. In the 19th century Russian coinage followed conventional lines apart from the short-lived introduction in 1828 of platinum (at about $\frac{2}{3}$ the value of gold) for pieces of 3, 6 and 12 rubles. The silver ruble, however, remained the monetary basis, worth 100 kopecks. Soviet issues since the revolution have been mainly of bronze and alloys, with scarce silver and, very rarely, gold; types have usually included such symbols as the hammer and sickle and the star, together with allusions to industry and agriculture, though the Russian eagle was used at first.

Finland, under Russia, struck in gold, silver and bronze down to 1917; since then, as Suomi, its coins (using the Roman alphabet) have shown the Finnish lion. Latvia coined as an independent state from 1918 to 1940. Lithuanian independence, similarly until 1940, was reflected in autonomous coinage, with the type of a galloping knight.

The medieval coinages of the northern Balkan states are of great morphological interest. They are chiefly silver grossi, showing a mixture of Byzantine and Venetian influences. The Bulgarians had a regular silver coinage from Ivan Asen I (1186–96) to Ivan Shishman (1371–95). Modern Bulgarian coinage began in 1879. The Serbian coinage lasted from Vladislav I (1234–40) to the middle of the 15th century. There was also a coinage of the bans of Bosnia (late 13th to 15th centuries). The independent city of Ragusa is remarkable for the bold style of its early copper (13th century, inspired by Roman models of the 4th century) and the richness and variety of its later issues.

In Rumania a princely coinage from 1866 became a royal one, of orthodox pattern, from 1881; the 20th-century types, until the fall of the monarchy in 1947, were remarkably varied. That of Greece began in 1828 with the republican government set up after the battle of Navarino: the basis was the silver phoenix of 100 lepta. This was followed, under the monarchy from 1833, by the drachma of similar value. The 20th century (including the period of republican government) emphasized the types of ancient Greece, though modern issues have broken from this tradition.

11. The Later Byzantine Empires.—From the time of Basil II (976–1025) the Byzantine coinage entered upon a stage of development that, in contrast to what had gone before, showed medieval tendencies. The fabric of the gold nomismata and also of the silver began to change, from using a narrower, thicker blank (flan) to one wider and thinner, which was also given a curious cup-shape, hence the name "nummi scyphati"; gold scyphati declined in purity until, under Nicephorus III (1078–81), they were very base. Silver remained generally scarce; the issue of bronze became uneven. New conventions in legends and types were introduced: Constantine IX (1042–55) showed on his silver an invocation to the Virgin in iambic trimeter; and an invocation used by Romanus IV (1067–71) took the form of a hexameter, carried over from obverse to reverse. This latter issue was notable also for a very beautiful representation of the Virgin standing with the Child in her arms. Figures of the saints appeared in the 12th century, first St. George, and then SS. Theodore, Demetrius and Michael. At the same time the intrinsic quality of the coinage had sunk to a level of desperate confusion, seen most plainly under Alexius I Comnenus (1081–1118), whose "gold" was sometimes no more than billon or even bronze. Under Michael VIII (1261–82) and Andronicus II (1282–1328) the emperor was shown kneeling to be crowned by Christ, with a remarkable reverse type of the Virgin amidst the walls of Constantinople. The influence of western types was seen powerfully in the bronze struck by Andronicus II with, reverse, a cross pattée surrounded by a circular inscription within a double border. Western influence continued in the 15th century, especially under John VIII Palaeologus, whose visit to Italy in 1438 (when Pisanello made his splendid portrait medal) doubtless familiarized him with the designs of the grosso and gros, imitated unmistakably on John's silver with double bands of concentric lettering. By this time the Byzantine idiom in coinage was virtually dead, and it had become more truly a late medieval coinage.

The capture of Constantinople by the Crusaders in 1204 saw the power of the Byzantine empire split among a number of smaller authorities, of which the "empires" of Thessalonica and Nicaea were short-lived: in both the coinage (where it can be attributed with certainty) was of normal Byzantine character. The empire of Trebizond, however, continued a separate existence until 1461, and its small silver Byzantine-style pieces, called "Comnenian white money," were prized for their purity and enjoyed a wide currency. It was through such means that the influence of Byzantine types was exerted on the contemporary coinages of Armenia and elsewhere in Asia Minor. (C. H. V. S.)

VI. UNITED STATES COINS

The first coins struck in the North American colonies were silver shillings, sixpences and threepences, made by John Hull and Robert Sanderson, silversmiths, at a mint in Boston from 1652 to 1682, by order of the general court of Massachusetts Bay colony. This mint dated its coins 1652 over the entire 30-year period to conceal the continuous mintage from British authorities in London.

With very few exceptions, the coins circulating in the colonies until the Revolution were unauthorized private issues or old worn coppers no longer acceptable in England or Ireland. Silver was rare (consisting mainly of Spanish and Mexican dollars) and gold almost nonexistent. Copper was then a semiprecious metal, and in theory (though seldom in practice) 24 copper halfpence contained a shilling's worth of copper. Some of the colonies, notably those in New England, repeatedly experimented with paper money with disastrous results. Ostensibly to satisfy the colonists' needs for metallic currency, but in reality for the benefit of Cornwall mineowners, the Royal mint in 1688 issued tin farthings bearing the image of James II on horseback and the curious denomination of $\frac{1}{24}$ of a Spanish real. The Rosa Americana pieces, struck by

William Wood of Wolverhampton under royal patent dated July 12, 1722, received a disappointingly small circulation in New York and New England. Another coinage by Wood in 1722–24, intended for Ireland but rejected there because of scandalous circumstances surrounding his purchase of the royal patent (which was furiously attacked by Jonathan Swift in his *Drapier Letters*), was shipped to the North American colonies. Later these coins were supplemented by quantities of lightweight imitation halfpence, made principally in Birmingham, Eng. Alone among the colonies, Virginia (because of a provision of its 1606 charter) had an official copper coinage executed at the Royal mint in 1773. New Hampshire authorized one William Moulton to make coppers in 1776, but the number was extremely small. The continental congress uttered pewter dollars in the same year to provide moral support for its inflated paper currency. These bore a sundial, the word Fugio, the motto Mind Your Business and 13 links for the united colonies.

The end of the Revolution in 1783 occasioned the manufacture and circulation of immense quantities of British copper tokens designed for the American trade—many bearing fanciful portraits of General Washington. Between 1785 and 1789 the Republic of Vermont and the states of Connecticut, New Jersey and Massachusetts awarded contracts to various individuals to strike copper coins, and congress similarly licensed James Jarvis in 1787 to make cents of the same design as the 1776 dollars. All these ventures were failures, the authorized coins being driven out of circulation by British tokens, Birmingham halfpence and the lightweight issues of "Machin's Mill" (a clandestine mint near Newburgh, N.Y., which imitated state coppers and British halfpence). The copper panic of 1789–90 followed, coppers of all kinds dropping to 72 to the shilling from their former 14 or 15.

Congressional efforts to establish a national mint had resulted in the issue of the historic 1783 Nova Constellatio silver patterns of 1,000, 500 and 100 units, from dies by the Englishman Benjamin Dudley, exemplifying the extraordinary Morris plan, which reconciled the diverse colonial moneys of account. In 1786, however, congress adopted instead the Jefferson proposals for a decimal monetary system based on the dollar, and in 1792 the mint was finally built in Philadelphia, with David Rittenhouse as director. Jefferson tried vainly to hire as die engraver a Swiss, Jean Pierre Droz, who nevertheless furnished dies, hubs and presses. Before the mint was quite ready, the first official American silver coin, the half disme, was struck in Oct. 1792 in John Harper's cellar a short distance away, from dies by Robert Birch and Joseph Wright, who were also responsible for the regular cents and half cents of 1793. Silver followed in 1794 and gold in 1795, the engraver being Robert Scot.

Later designers of American coins included Gilbert Stuart (1796 silver), Titian Peale and Thomas Sully (the 1836 dollars engraved by Christian Gobrecht), Augustus Saint-Gaudens (1907–33 ten- and twenty-dollar gold pieces, called eagles and double eagles), Bela Lyon Pratt (1908–29 half eagles and quarter eagles), Victor Brenner (the Lincoln cent), James Earle Fraser (the buffalo nickel), A. A. Weinman and Hermon MacNeil (1916 silver), John Flannagan (1932 quarter dollar), Laura G. Fraser, Chester Beach and Gutzon Borglum (various commemorative coins).

The discovery of gold and silver in various regions and the difficulty of transporting large quantities of bullion through country menaced by Indians and bandits prompted the founding of both private and federal local mints. The Bechtlers of Rutherfordton, N.C., coined locally mined gold long before the government built a mint in Charlotte. The California gold rush stimulated coining by many bankers and assayers. Private coinage was legal so long as the coins contained full bullion weight and purity and imitated no official issues; Bechtler and Moffat gold (the latter coined by Moffat and Co. at San Francisco) circulated at about par until the Civil War, while lightweight private gold took a discount. The California private mints mostly ceased operations when the San Francisco federal branch started, but those in the less accessible regions of Colorado continued long afterward, and as late as 1901 one Joseph Lesher struck octagonal silver dollars in that state.

In the period 1851–1900 occurred many brief experiments with

Official Colonial and United States Mints

Location	Founded	Began Coinage	Closed	Remarks
Boston, Mass.	1652	1652	1682	Silver
Rupert, Vt.	1785	1785	1788	Copper
New Haven, Conn.	1785	1785	1788	Copper
Rahway, N.J.	1786	1786	1788	Copper
Morristown, N.J.	1786	1787	1788	Copper
Boston, Mass.	1786	1787	1789	Copper
New Haven, Conn.	1787	1787	1788	Copper
Philadelphia, Pa.	1792	1792		Fugio
Charlotte, N.C.*	1836	1838	1861	Gold
Dahlonega, Ga.*	1836	1838	1861	Gold
New Orleans, La.*	1836	1838	1909	
San Francisco, Calif.†	1853	1854	1955	
Denver, Colo.‡	1862	1906		
Carson City, Nev.	1869	1870	1893	

*Seized by the Confederate government in 1861.
†Successor to the U.S. assay office, 1852–53.
‡Successor to the private mint of Clark, Gruber & Co., 1860–62.

odd denominations: bronze 2-cent, nickel and silver 3-cent and silver 20-cent pieces; an overweight silver "trade" dollar designed for use in trade with the Orient; gold three-dollar and four-dollar coins. All proved superfluous. A law of 1873 discontinued the silver dollar until political pressure from mine owners forced through congress an 1878 act requiring the mint to buy 2,000,000 to 4,000,000 oz. of silver monthly and coin the entire amount into silver dollars. Coinage was discontinued in 1935. Millions of the silver dollars long remained stored in banks and treasury vaults but eventually they became scarce and in 1964 a new minting was authorized. Gold was recalled in 1934, but gold coins of numismatic interest may be retained in any quantity by "collectors of rare and unusual coin" (presidential order 6260). By an act of 1853 all silver coins except the dollar are fiduciary; *i.e.*, lightweight and current by government authority rather than bullion value. The passing of 19th-century artistic canons has been reflected in American coin designs, which since 1909 have portrayed statesmen rather than personifications of liberty. All the above influences have combined to make the 20th-century American coinage system the simplest in use in any major nation. (W. H. Br.)

VII. COINS OF THE BRITISH ISLES, COLONIES AND COMMONWEALTH

1. Ancient Britain.—The earliest coinage of Britain consisted of small, cast pieces of speculum, a brittle alloy with about ¼ tin and ¾ copper. These coins copied the bronze of Massilia of the 2nd century B.C. and circulated, mainly in southeast England, early in the 1st century B.C.; their relationship with contemporary iron currency-bars is uncertain. At the same time uninscribed gold coins of the Gaulish Bellovaci, imitated from the famous gold stater of Philip II of Macedon (obverse, Apollo head; reverse, chariot), were being introduced, probably by trade. The first Belgic invasion, *c.* 75 B.C., brought variants of these, from which arose a complex family of uninscribed imitations; the study of their distribution in Britain has ascribed them to more or less well-defined tribal areas in the south and east; some are crude, but the best illustrate the peak of Celtic art in Britain. The gold was of variable quality. After the second Belgic invasion (following Caesar's reconnaissance in 55 B.C.) the coinage entered a historic phase through the addition (in Latin, and with Roman titles) of the names of kings. Roman influence under Augustus prompted the introduction of silver and copper to reinforce the gold (of varying purity) and the Romanization of previously Celtic types. Claudius' conquest in A.D. 43 ended native coinage, except for crudely cast billon pieces long continued in Hampshire and Dorset; the gold of the Brigantes in Yorkshire was the last to disappear.

2. Roman Britain.—Unofficial copies of Claudian bronze were produced in Britain to alleviate shortage of token coinage after the Conquest. Thereafter no coinage, official or unofficial, was produced until the reign of the usurper Carausius (A.D. 286–293), who coined profusely in orthodox Roman fashion at London and elsewhere in gold, silver and copper; the same was done briefly by Allectus (A.D. 293–296). Diocletian's London mint was continued under Constantine until A.D. 324; thereafter, except during the usurpation of Magnus Maximus (A.D. 383–388), Britain lacked a

official mint, being supplied with coinage mainly from Gaul. Imitative bronze pieces, however, which had first appeared in the 3rd century, continued to be made in the 4th. Sometimes these were of crude style and small size, and it is possible that in their crudest and smallest form (like those found at Lydney) they remained in partial currency in the 5th century after the Roman evacuation.

3. Early Anglo-Saxon Coins.—Infiltration of Merovingian gold from France in the 6th century (together perhaps with Runic-inscribed pieces from farther east) prompted the issue of Anglo-Saxon gold "thirds" in the 7th; solidi were only very rarely struck owing to their high intrinsic value. Output, never great, was confined chiefly to the London-Kent area. The London mint, almost certainly episcopal, signed its coins (obverse, facing head; reverse, cross) with the name *LONDVNIV;* Kentish coinage (whether from Canterbury or elsewhere) was mainly regal; in addition there was a perhaps small Mercian series and another from York. A further series, copied from late 4th-century Roman prototypes, was struck *c.* 650 when the gold content was fast diminishing. Gold coinage soon gave way to that of small silver sceats (about 1.29 g., or 20 gr.) of essentially different style. Some had Runic legends, including the name, supposedly, of Peada, king of Mercia (fl. 656); most, however, were nonregal, and their legends, where they exist, *e.g.*, on coins bearing the name of London, are latinized. Types were very varied and some almost certainly originated in Frisia, where sceats are found in large quantities, denoting the trading connection that called for their use; these show animal and floral design. In the south the sceats lasted until *c.* 800. Similarly small silver sceats were developed (at first with animal designs) in the middle of the 8th century in Northumbria, where they quickly gave way to copper, which lasted for about a century and showed the plainest possible types—a central cross on each side surrounded by the names of kings from Egfrith (670–685) onward or of archbishops or moneyers. This northern series ended *c.* 850.

4. Anglo-Saxon Penny Coinages.—English coinage proper begins with the silver penny of Offa, king of Mercia (757–796); first struck at around the weight of the sceat and, from about 790, up to about 22½ gr. (equal to 240 to the Tower pound). The new pennies showed Carolingian influence in their broad, flat forms. Their designs, however, insofar as they were not influenced by late Roman coin-portraiture, displayed a brilliant originality (both in Anglo-Saxon portraiture, freely conceived and delicately modeled, and also in pattern design and decorative lettering), which had no equal for some centuries. Offa's coinage, though minted expressly for him as *Rex Merciorum,* was mainly current in the southeast and was probably struck at Canterbury, which had contained a mint (responsible for a first penny-coinage under Aethelberht II, 748–762) until the battle of Otford brought Kent under Mercian suzerainty. Evidence for this lies in the fact that the moneyers of Offa were also those of the kings of Kent, and the coins of archbishops of Canterbury, including Jaenbeorht (died 792), bore the names of Offa and his successor Coenwulf: under Ceolwulf (821–823) the mint-name of Canterbury appeared on the coins. Offa struck pennies with the portrait and name of his wife Cynethryth as *regina M(erciorum)* and also issued, doubtless for presentation purposes, gold pieces copying a 774 dinar of the caliph al-Mansur but with the addition of *OFFA REX.* Ceremonial gold coins, like Offa's, all now represented by unique examples, were minted, perhaps partly for use in paying the Romescot, by Archbishop Wigmund of York (837–854?), Edward the Elder (899–924), Aethelred II (978–1016) and Edward the Confessor (1042–66).

Offa's coinage, with, obverse, king's name (with or without portrait) and, reverse, decorative ornament with moneyer's name, influenced design under the kings of Kent and East Anglia, though there was a growing tendency to employ on the reverse an inscription in three lines or around a central cross. This is seen in the coinage of the Wessex kingdom, which was produced first at Winchester, then, after the battle of Ellendun in 825, at Canterbury, still the only permanent mint south of the Humber. Under Aethelwulf (839–858) a uniform type of coinage was achieved for all southern England except East Anglia. The Viking invaders, from *c.* 870, left an important mark on English coinage, including the use of the "London monogram" by Halfdene, who occupied the city in 872, and new designs of north-European derivation. York was their principal mint, together with Lincoln, from which numerous memorial coins of SS. Peter and Martin were issued. Meanwhile Alfred (871–899) greatly extended the Wessex kingdom, as shown by his operation of mints: Canterbury (still much the largest), Gloucester, Exeter, Winchester, London and Oxford (the last sometimes disputed). His coins (which included fractions of the penny) were of careful workmanship and showed Viking influence in their design. The 10th century saw the power of English kings spread quickly northward. Under Aethelstan (924–939), who could use the title *Rex totius Britanniae* with justification for the first time, there were nearly 30 mints at work, mainly southern and central but reaching up to Chester; under Edgar (959–975) there was much more uniformity of type. The Council of Grateley under Athelstan had enacted that each permitted mint was to have but one moneyer, with certain specified exceptions; *e.g.*, London had eight. By the time of Aethelred II more than 70 mints were at work; London, Winchester, Lincoln and York were the largest and most profuse. From about this time the types were generally standardized: obverse, king's portrait and, reverse, some cruciform design. Regional differences of style or treatment superseded the earlier predominance of Canterbury, due perhaps to the regional production and distribution of coining-dies.

5. Post-Conquest Coinage.—The Norman Conquest made little change in the mint system or in the coinage (though the facing portrait acquired great popularity); the pre-Conquest moneyers stayed in office and struck coins for William I. After his reign the number of mints tended to decline. The pennies of William II have nothing in their legend to distinguish them from his father's issues, but it is possible to allot eight types to William I and five to his son. Forgery gave Henry I much trouble, and one step he took to prevent it was to issue his later coins with a snick in the edge to show that the silver was good. He also coined round halfpence: previously silver pennies had had to be halved to produce a smaller denomination. The civil wars of Stephen's reign produced many interesting coins, such as those struck in Matilda's name as *Imperatrix* and the pennies of Eustace Fitzjohn and other barons, very much on the pattern of feudal issues in France.

Henry II ceased the regular change of types customary since William I's reign and struck one type till 1180. As a result the work of the English mints reached its lowest level; the coins frequently have only a letter or two of the legends and fragments of the type. His short-cross penny, so called from its reverse design, first issued in 1180, remained unchanged—including the name *Henricus*—not only by Henry II but also by Richard and John and Henry III till 1247, when Henry III coined the long-cross penny with the arms of the cross extended to the edge of the coin to discourage clipping. He also reduced considerably the number of mints. Edward I subordinated all mints to the authority of the master-worker in London, William de Turnemire. In 1279 he introduced a new type of penny, with, obverse, bust of the king and, reverse, long cross with three pellets in each angle, a type that was much imitated abroad and persisted on silver till Henry VII. The moneyers' names disappeared from the reverse legends, and their place was taken by the name of the mint; *e.g., CIVITAS LONDON,* etc. Edward I also struck halfpennies and farthings to replace the cut pennies that had hitherto done duty for small change. He also introduced a groat, or fourpenny piece (groat = gros or grossus of European coinage), but this larger coin did not establish itself till Edward III's reign. The coins of Edward I, II and III cannot be distinguished by their legends; a minute study of detail has, however, enabled them to be attributed satisfactorily. Privileged ecclesiastical mints still continued active.

Henry III had attempted in 1257 to issue a gold coinage by striking the gold penny (45 gr.) of the value of 20 pence silver, later raised to 24; but the difficulty of rating gold to silver proved insuperable, and the coinage was withdrawn. In 1344 Edward III issued his fine gold series: florin, leopard and helm (½ and ¼ florin), all with the scriptural legends henceforth popular, but his effort to introduce a gold currency was without success. The attempt was renewed with the noble (struck at London and, later, at Calais),

and, after various experiments with its weights, a gold coinage was finally established in currency in 1351 with a noble of 120 gr. of gold and its subdivisions, the half- and quarter-noble. In the same year the silver penny was reduced to 18 gr. and the groat issued (on Flemish models). The noble was valued at 6*s*. 8*d*. The obverse type of the noble, the king in a ship, is supposed to allude to the naval victory of Sluis. The reverse type is a floreate cross with considerable ornamentation. The weight of the noble was reduced by Henry IV in face of foreign competition. Edward IV distinguished his noble by a rose on the ship (rose-noble or ryal) and raised its value to 10*s*., while a new gold coin, the angel, was introduced to replace the old value of the noble at 6*s*. 8*d*.; the penny was reduced to 12 gr. The angel is so called from its type of St. Michael and Lucifer. The reverse is a ship with a cross in front of the mast. (In the 16th century the angel became the piece given to those touched for king's evil [*q.v.*]. It was struck for this purpose down to the reign of Charles I, and small versions were struck by the later Stuarts and pretenders, but it was not again issued as legal tender.)

The next important change in the coinage was not till the reign of Henry VII. This was the introduction in 1489 of the sovereign, a splendid gold coin of 240 gr., current for 20*s*., with, obverse, the king seated on an elaborate throne and, reverse, a Tudor rose with central shield of arms. He also issued (certainly by 1504) the first English shilling or teston, a handsome coin with a fine portrait by Alexander of Brugsal, but this did not attain much currency. Henry VII altered the types of the smaller silver coins by replacing the three-centuries-old cross and pellets by a long cross and shield, while the inscription *POSVI DEVM ADIVTOREM MEVM* took the place of the mint legend; the stereotyped bust was replaced on the groat by an excellent profile portrait and on the penny by the king seated. Henry VIII debased the gold coinage and reduced the weight of the sovereign, the reverse type of which was now the royal arms supported by a lion and dragon. He introduced the gold crown of 5*s*., with its half, raised the angel to 7*s*. 6*d*. and introduced the George noble to take its old value of 6*s*. 8*d*.—so called from its type of St. George and the Dragon. In 1544 he issued the base shilling or teston of 12 pence and debased the silver coinage. When Edward VI again restored a coinage of fine silver, he introduced the silver crown of five shillings (the first English coin dated in arabic numerals), which took the name of the gold piece of the same value introduced a few years earlier. The reign of Mary is notable for the appearance of the portrait of her husband, Philip II of Spain, on the shilling.

Elizabeth continued her father's denominations and restored the purity of the silver coinage. She soon discontinued the groat, Edward VI having introduced the silver sixpence and threepence, although she continued its half, the twopence. Her "portcullis," or trade coinage for use by the East India company, appeared in 1600–01. She also experimented with machinery for coinage, although the immemorial rights of the "manual" moneyers delayed its establishment until after the Restoration. James I introduced a number of new gold coins, the most important being the "unite" or sovereign (20*s*.), so called from its legend (*Faciam eos in gentem unam*, "I will make them into one race") alluding to the union of the crowns. In his reign the number of denominations in use reached its maximum. Charles I made no changes in the coinage until the Civil War (when parliament coined in London, and the king's mint traveled with him); the king's financial difficulties added many new coins to the English series. These included 20*s*. and 10*s*. pieces in silver, the large gold £3 pieces of Oxford and the fine Oxford silver crown, by Rawlins, with a view of Oxford below the usual type of the king on horseback; the siege-pieces rudely struck on silver plate at various royalist strongholds show to what straits the king's party was reduced. Under James I and Charles I are found the first English copper coins, the "Harrington" farthings; they were not struck by the king but under contract. From 1649, copper tokens, mainly of farthing value, were produced in large numbers by a wide variety of municipalities and private traders. The coinage of the Commonwealth is remarkable for the simplicity of its types, and this is the only period of English coinage when the legends have been in English. Coins were struck with Cromwell's bust and superscription, but, although not uncommon, they never seem to have been put into currency.

6. Modern Coinage.—The modern coinage dates from the reign of Charles II. After issuing the old denomination of hammered money in the first two years of his reign, he replaced the unite or broad in 1662 by the guinea, so called from the provenance of its gold. This was a 20*s*. piece. It was not until 1717, after various oscillations, that its value was fixed at 21*s*. His silver coins were the crown, half-crown, shilling, etc., all regularly and beautifully struck by Jan Roettier with the new mill that was then established at the mint. In 1672 he introduced the bronze half-penny and farthing with the Britannia type. The finest coin of his reign is not a regular issue. It was the "Petition" crown made by Thomas Simon, engraver at the mint under the Commonwealth, and bears on the edge a petition to the king that he might be given the same office under the new regime. For the great recoinage under William II provincial mints were briefly opened at Bristol, Exeter, Chester, Norwich and York. The coinage of the 18th century calls for no remark, but mention may be made of the practice of recording the provenance of the metal of particular issues, as in the *VIGO* issues of Anne struck from captured Spanish bullion in 1702, the *S*(*outh*) *S*(*ea*) *C*(*ompany*) silver of George I, and the *LIMA* coinage of George II made of bullion brought by Anson from his voyage around the world. The so-called Anglo-Hanoverian coinage from George I to George IV was in fact the coinage struck by them as electors of Hanover. Toward the end of the century the scarcity of government silver was largely made good by Spanish dollars, with or without a bust of George III countermarked upon them, and by tokens issued by the Bank of England. The deficiency in copper, briefly remedied by large "cartwheel" issues, was made up by private issues of vast numbers of tokens. In 1816 the great recoinage took place with the introduction of the sovereign and silver coins each with Benedetto Pistrucci's design, St. George and the Dragon. England was now formally on the gold standard. In 1848, in the reign of Queen Victoria, the 2*s*. piece (florin) was issued and proved a most popular coin. The double florin, which was first issued in 1887, did not take the public fancy; the practical disappearance of the crown piece from circulation also reflects the public prejudice against large coins, though commemorative crowns have remained popular. No United Kingdom coinage was circulated for Edward VIII.

The gold sovereign disappeared from internal currency in 1914, soon after the outbreak of World War I, after a career of 300 years (as sovereign, unite, guinea and again sovereign), but it has continued to be struck in irregular quantities for export abroad where it has had to compete with forged copies. Silver was alloyed up to 50% in 1920 and since World War II has given way to cupro-nickel: the silver threepence has been replaced by an angular coin of nickel-brass.

Coinage of royal maundy money, continuous since the 18th century, is still maintained with the annual issue of silver pieces of 1*d*., 2*d*., 3*d*. and 4*d*.: the English silver penny and groat thus still survive.

Wales has had no independent coinage, except perhaps for the penny of Howel Dda (*c*. 904–949/950), Saxon in style and struck by the moneyer Gillys, who worked at Chester for Edgar: the penny attributed to Llewelyn (1075–79) is probably a blundered Ruddlan coin of William II.

7. Scotland.—Coinage began by following English usage in regard to types and weights: the earliest silver pennies were those of David I (1124–53) and copied Stephen's, though the use of profile portraits in the 13th and 14th centuries showed an interesting divergence. Gold nobles and silver groats were issued by David II in 1356–57 on the standard of Edward III. From Robert III onward the French or Flemish standard for gold was preferred, and during the 16th century, especially under James V and Mary, a very strong continental influence on design was apparent in a series of gold coins of originality and frequent beauty. Silver coins had begun to show debasement of metal, and as early as James III copper small change—"black" farthings—had been introduced. The Scottish coinage of James VI and I marked a peak in range and variety: after the union of the crowns in 1603 Scots coinage

decreased in quantity and ceased in 1707 after the union of the parliaments. Hitherto the value of Scottish coinage in relation to English was 12:1. Under George VI a shilling with a Scottish reverse was first coined as part of the general English series.

8. **Ireland.**—Irish currency from the 8th to the 10th centuries consisted mainly of Anglo-Saxon, French, Viking and Arabic silver; in the later 10th and 11th centuries silver pennies of the Norse kings of Dublin imitated Anglo-Saxon and Scandinavian models. There were also thin silver bracteates copying Norman types. Anglo-Irish coinage proper began with silver pennies and halfpence of John (the only coins to bear his name, which did not appear on English coins), some with the triangle design, some with the Angevin star and crescent. Dublin, Waterford, Cork, Limerick and Trim were striking silver (increasingly base) from groat down to farthing from the 13th to the 15th centuries. The "three crowns" coinage with the saltire cross (the Fitzgerald arms) beside the shield came in with Edward IV and was continued by Richard III and Henry VII. "Harp" groats were struck at Dublin under Henry VIII (with initials of his queens), followed by his much baser issues. Gold was never coined, but copper was introduced quite early. In Ireland as in England the English Civil War produced a number of siege-pieces, notably the Inchiquin and Ormonde money. James II for his Irish campaign issued his vast "gun-money" series (usually, in fact, of brass), including crowns and half-crowns, to be redeemed in silver when he should regain the throne. Irish coinage was discontinued in 1822; from then on Irish needs were served by English coinage. In 1928 the coinage of the Irish Free State (later the Republic of Ireland) was introduced, with, obverse, harp on all denominations, and reverses bearing a range of animal, bird and fish designs, admirably conceived and delicately executed.

9. **Isle of Man and Channel Islands.**—The Isle of Man first had its own coinage, in bronze, from 1709 to 1733 under the earls of Derby; this was continued, in 1758 only, for the earls of Athol. Regal coinage in bronze appeared intermittently from 1786 to 1839. The characteristic badge was the "three-legs" or triskelis. Since 1840, English issues have been current.

Jersey and Guernsey have had their own bronze coinage for well over a century, showing the shield of three leopards proper to the duchy of Normandy. Variation of types has occurred since World War II, the end of which prompted also the special issue of the Jersey "liberation penny."

10. **Colonies and Commonwealth.**—British colonial issues, begun under Elizabeth I with silver for the East India company, were extended in the 17th century. New England colonists struck the silver "pine tree" and "oak tree" money from 1652; Charles II issued silver rupees at Bombay for the East India company with the company's arms; at the same period silver and copper "hog money" (obverse, boar; reverse, ship) was issued for Bermuda; and James II struck tin coins, with an equestrian portrait, for American plantations.

The 18th century saw few official attempts to provide colonial coinages; thus currency in the British West Indies was based on Spanish, Portuguese and Brazilian gold and especially on Spanish silver dollars, normally cut and counterstamped. Spanish dollars were similarly used in the early 19th century at Sierra Leone. In the 19th century, however, colonial issues proper multiplied. That of the Ionian Islands, from 1819, was among the earliest. In Malta third farthings were issued by William IV and Victoria. Gibraltar had copper from 1842. Farther afield token bronze had been coined for Nova Scotia and New Brunswick from 1823, giving way to official issues later; a general coinage for Canada appeared in 1858. Ceylon's coinage began with bronze half- and quarter-farthings and silver three-halfpence from 1838. The private raj of Sarawak had coinage from 1841, and from 1863 this showed the portraits of the Brooke rajas. Australian coinage of sovereigns started as early as 1855 (the result of the gold rush). In Cape Colony little coinage was produced until the Boer republic of South Africa (which produced Paul Kruger's portrait-coinage of gold, silver and bronze) had been incorporated in the Union. Silver and bronze for Hong Kong began in 1863, and closely succeeding years witnessed the start of colonial issues for Jamaica, Cyprus (with its device of lions on a shield), Mauritius, Zanzibar (an arabic series and thus without portraits in deference to Muslim feeling), North Borneo, Honduras and elsewhere.

In the 20th century the progression of formerly colonial areas to autonomy has produced a contrast between their coinages and those of still colonial character. Coins of the colonies have continued in general to show a crowned bust of the monarch; those of the self-governing commonwealth powers have exchanged a crowned for an uncrowned bust. New Zealand issues, with Maori designs prominent, began only in 1933. Indian and Pakistani coinages, each bilingual (with English retained), have grown out of the former imperial Indian coinage, the British sovereign's head being replaced in India by pictorial designs and in Pakistan by calligraphic and symbolic devices. Regrouping of British possessions in western, central and eastern Africa has necessitated coinage changes, including autonomous issues for Ghana. The coins of the Central African Federation (the Rhodesias and Nyasaland) showed the uncrowned bust of autonomous authority; Nigeria and the east African territories show the crowned bust. Concerning later established coinages of the smaller colonies, mention may be made of that of the Fiji Islands from 1934, often showing a turtle, and of the Seychelles from 1939. In Sarawak the coinage of the Brooke rajas ended with the cession of the territory to the crown in 1946. Finally it may be noted that the issue in 1929 of bronze "puffins" and halves in Lundy Island with the portrait of its owner, M. C. Harman, was held to be illegal.

In general the coins of full commonwealth members and of colonies alike have emphasized on their reverses either national symbols or national heraldic devices, while the inscription around the sovereign's portrait has shown a growing tendency to be rendered in English instead of Latin. (C. H. V. S.)

VIII. COINS OF LATIN AMERICA

1. **The Colonial Period.**—Spanish colonists brought with them to the new world the Castilian currency system, which had been regulated as to standard, weight and size of the coins within a bimetallic pattern by the ordinances of Ferdinand and Isabella issued in Medina del Campo in 1497. The double base of the system were the gold *excelente* (replaced in 1535 by the *escudo*) and the silver *real*. The coins of Spanish America were therefore of gold and silver, that is, the *escudo* and the *real* and their multiples and dividers. The two series were specifically: in gold, the *escudo* (3.38 gms.), two-*escudos*, four-*escudos*, eight-*escudos* or *onza* (the famous gold ounce) and the half-*escudo* or *escudito*, coined in some mints at the end of the 18th century; in silver, the *real* (3.43 and 3.38 gms.), its dividers, the half-*real* and the quarter-*real* or *cuartillo*, and its multiples, two-*reales*, four-*reales* and eight-*reales* (this last known also as the *peso fuerte* or *duro*). During the 16th century, for a brief period, a coin of three *reales* was minted in Mexico. Gold was not minted in a uniform manner until after the second half of the 17th century; until then Hispanic-American currency had been almost exclusively silver coinage. Copper was not minted in Spanish America except in small quantities during the 16th century in Santo Domingo and briefly in Mexico; during the wars of independence it reappeared in emergency coinages.

There are two very characteristic kinds of Hispanic-American coinage, according to the minting technique used: the hammered coin and those of more improved conformation manufactured by means of a minting press or mill. The hammered-down coin of some periods presents a relatively tidy appearance, being very nearly round and containing all the lettering and required symbols, but that of other mintages is frequently of very poor appearance, and only the most essential elements of the design, such as value, identifying sign of the minting house and the mark of the assayer, are distinguishable. These coins of rude mintage are called *macuquinas* (cob). In the 18th century, by ordinances of Philip V, the setting up of adequate machinery for the minting of a perfectly round coinage, with milled and corded edge, became mandatory.

The type of the Hispanic-American coin was very characteristic: its most constant elements were Hercules' Columns and the motto "Plus Ultra," plus the monarchy's coat of arms, either in its en-

tirety or reduced to some of its components, mainly the castles and lions. In edge-milled coinage the same elements were employed in silver pieces, with the addition between Hercules' Columns of an image of the two crowned hemispheres; this was called the *moneda columnaria* (columnar coinage) and was minted until 1772. From that date on, by ordinances of Charles III, silver coinage carried on the face a bust of the reigning monarch and on the reverse the coat of arms, a system already utilized in the gold pieces.

2. Hispanic-American Colonial Mints.—In the beginnings of the colonial period currency was scarce, and very frequently transactions were accomplished through the use of metal foundry pieces; these carried merely the stamp of a royal official, which guaranteed the standard and the fact that the crown's rights had been satisfied. In time several mints were established. Of these, two were of particular importance because of the very large quantities of precious metals, especially silver, minted there: that of Mexico, founded in 1535 and operating until 1821, and the one at Potosí, established *c.* 1574 and operating until 1825. Other minor ones, and their dates of operation, were those of Santo Domingo (1542 to the end of the 16th century and 1818 to 1821), Lima (1568 to 1570, 1575 to 1588, 1659 to 1660 and 1684 to 1824), Santa Fe de Bogotá (1626 to 1821), Guatemala (1731 to 1822), Santiago de Chile (1749 to 1817), Popayán (1732 and 1749 to 1822) and Cuzco (1698 and 1824). Coinage of any of these mints had uniform currency through the entire Spanish empire, and the pieces had uniformity of type. They were distinguished by the symbol of the mint, carried on every coin. The following are some of the symbols used: Mexico, M̊; Potosí, P and, in the edge-milled coins, PTSI and PTS in monogram fashion; Lima, P, L and, in the edge-milled coins, LIMA and LIMAE in monogram fashion; Santiago de Chile, S̊; Guatemala, G and NG (for Nueva Guatemala); Santa Fe de Bogotá, NR (for Nuevo Reino); Popayán, P, PN and P^{N}; Santo Domingo, SD; Cuzco, C° and CUZ.

3. Dissemination of Hispanic-American Coinage.—The larger silver and gold pieces, the eight-*reales* or *pesos fuertes* and the ounces, became in modern times the international currency par excellence. Their dissemination throughout the world was brought about by the uniformity of their standard and milling characteristics. In many countries they were counterstamped in order to adapt them to a local monetary system or to authorize their currency. These counterstamped issues constitute interesting numismatic series. The removal of smaller coins to other parts of the world was generally prohibited in order to avoid a scarcity of this currency.

4. Emergency Coinages in the Era of Independence.—During the wars of independence, between 1810 and 1826, emergency mints were established in different parts of the continent, by the royalists as well as by the patriots. The coinages were almost always crudely designed, being in some instances merely foundry coinage. On other occasions the coins had merely fiduciary value, that is, no intrinsic value at all, as was the case with the numerous coinages of the Mexican patriot Morelos, who produced eight-*reales* pieces in copper. Only in Mexico were there mints of some importance, in ten different localities. The coinage situation became further complicated when the authorities of the opposing forces started counterstamping each other's coins in order to use them within their own camps.

5. The Independent Countries.—The independent states that arose in Latin America after the revolution of 1810 proceeded to mint new coins, but until the middle of the 19th century the bimetallic system established by Spain, with its different units in *reales* and *escudos*, remained intrinsically the same except for the addition of smaller copper fractionary units. After 1850, within a period of about 15 years, all the states adopted the decimal system for their coins, and the *peso* became the unit, though in several cases it took a special name. Within the second half of the 19th century bimetallism became a thing of the past. It was generally replaced by the gold standard, which in the course of the 20th century was replaced in turn by fiduciary currency or paper money, coinages being limited to fractionary pieces or to "merchandise coins."

6. Brazil.—Coins minted in Spanish America circulated abundantly in Brazil from the 17th to the 19th centuries. They were given their official value in terms of the Portuguese *reis*, the corresponding amount being indicated by counterstamping. Hispanic-American eight-*reales* pieces carried an overstamp that was at first of 480 *reis* and that increased until in edge-milled coins it amounted to 960 *reis*. By the end of the 17th century and the beginning of the 18th, mints were established in Rio de Janeiro, Bahia and Pernambuco, but joint circulation of both Hispanic-American and Portuguese coinages continued. The practice of counterstamping disappeared during the first decades of the 19th century, although Hispanic-American eight-*reales* pieces and the equivalent coins of the independent Latin American countries continued to be reminted with the value of 960 *reis* for some time. The Brazilian monetary unit that eventually became the *milreis* was subsequently transformed into the *cruzeiro*, which is divided into 100 cents. (A. DE A.-M.)

IX. ASIATIC COINS

1. Ancient Persia.—*Achaemenids.*—The ancient kingdoms of the middle east, Egyptian, Sumerian, Babylonian, Assyrian and Hittite, had no coined money. The use of coins reached Persia from the Lydian kingdom of Croesus and the Persian satrapies of Asia Minor. The first Achaemenid ruler to strike coins was probably Darius I (522–486 B.C.) as Herodotus suggests. The coins of the dynasty were the daric struck from gold of very pure quality and the siglos in silver; 20 sigloi (shekels) made a daric, which weighed 8.4 gr. The types of both coins were the same: obverse, the Persian king in a kneeling position holding a bow in his left hand and a spear in his right; reverse, only a rough irregular incuse caused in the striking. In shape they were roughly oval, being struck from round or rather egg-shaped globules of metal. These pieces were uninscribed and remained in issue unaltered in type until the fall of the empire. The issue of gold was the royal prerogative, but the conquered Greek and other cities and states were allowed to issue silver and copper while a number of Persian satraps struck silver in their own names. To this latter class belong a number of the earliest and finest portraits on coins. On the fall of the empire, various satraps, such as Mazaeus, who ruled Babylon for his new master Alexander the Great, struck silver coins of their own.

Parthians.—Alexander's coinage and that of the Seleucids were purely Greek in character. In the middle of the 3rd century B.C. the Parthians became a great power in Persia. They had an extensive but monotonous coinage in silver (tetradrachms and drachms) and copper. The tetradrachms and drachms bear the bust of the king on the obverse, and Arsaces, the founder of the dynasty seated holding the Parthian bow on the reverse of the drachms while the usual reverse on the tetradrachms is the king seated receiving a wreath from Victory or a city goddess. The coins do not bear the name of the issuer but that of Arsaces, which was used as a dynastic title. Most of the coins are dated in the Seleucid era; on the later coins the Greek becomes corrupt and is often joined by an inscription in Persian.

Some local dynasties (such as those of Persis and Characene), vassals of the Parthian kings, also struck coins.

Sasanians.—The Sasanian coinage was very extensive in silver, and the early emperors also coined gold, although rarely. The copper coinage also seems to have been small. The coin types throughout the dynasty are the same: on the obverse is a bust of the king with his name and titles, and on the reverse a fire altar, usually with two attendant priests. From the reign of Kobad the reverse legend gives the mint and the regnal year of issue. The standard of the gold coins is derived from that of the Roman solidi; the silver coins are drachms following the Parthian standard and are remarkable for their broad thin form, which was copied by the Arabs for their silver coins. The execution of the portraits in the early coins is remarkably fine but is later debased.

2. Islamic Coins of the West and of Western and Central Asia.—The conquering Muslims at first imitated the coinage of their predecessors. In the western provinces they issued gold and copper pieces imitated from contemporary Byzantine coins, modi-

ving the cross on the reverse of the latter somewhat to suit Muslim susceptibilities. In the eastern provinces the Arab governors issued silver dirhams which were copies of late Sasanian coins (mostly of those of Khosrau II) with the addition of short Arabic inscriptions on the margin and often the name of the Arab governor in Pahlavi; even the crude representation of the fire altar was retained. Toward the end of the 7th century the fifth Umayyad caliph, 'Abd-al-Malik, instituted a coinage more in keeping with the principles of Islam. This "reformed coinage" was of gold (first issued in A.D. 698–699), silver (first issued in 696–697) and copper. The old coin, called dinar (from the Aramaic derivation of the Roman denarius aureus), derived its standard (4.25 gr.) from the Byzantine solidus; the standard of the silver coin (dirham, from the name of the Sasanian coin, which in its turn was derived from Greek drachma) was reduced to 2.92 gr., but it retained in its thin material and style some features of its Sasanian predecessor; the name of the copper change, *fals*, comes from Latin *follis* (a small piece of money). The reformed gold and silver coinage has no pictorial type, only inscriptions, and with rare exceptions this remained the rule in Islamic coinage. This may limit its artistic interest, though the skilful arrangement of the inscriptions often gives it high aesthetic value. Moreover, the inscriptions, which from the earliest time usually contain the name of the mint and date, and in time the ruler's name and title, give the Islamic coins a high historical value.

The reformed dinar and dirham bear on the obverse the Muslim profession of faith: *There is no god but God: he has no associate,* and around it the marginal legend: *In the name of God; this dinar (or dirham) was struck at . . . in the year . . . .* The reverse area has a quotation from Koran cxii, *God is one; God is eternal; He begets not and is not begotten nor is there any one like unto Him.* Around is Koran ix, 33: *Mohammed is the apostle of God sent with guidance and the religion of truth to make it prevail over all other religions averse though the idolators may be.* This type of coin, issued from Spain and Morocco to central Asia, gave Muslim coinage the character that it held for centuries. In mid-8th century the Abbasids overthrew the Umayyad caliphate but at first made little change in the coinage beyond some alterations in the inscriptions. In time the caliph's name was added and, at the provincial mints, that of the local governor, and in the 9th century a second marginal inscription was added: *To God belongs the order before and after and that day believers shall rejoice in the help of God* (Koran xxxi, 3–4).

The Abbasid caliphate broke up in the 9th and 10th centuries, and the succeeding independent rulers regularly put their own names on the coins, although they retained that of the caliph of Baghdad, whose nominal authority was still recognized. Thus in north Africa and Egypt the Idrisids, Aghlabids, Tulunids and Ikhshidids had their own coinage. From the eastern provinces there are the coins of the Tahirids, Saffarids (both in the 9th century), and the Buyids (10th–11th centuries). In central Asia there was the extensive coinage of the Samanids, mainly in silver. In north Africa and Egypt the extensive Fatimid currency in gold introduced a new type of dinar with legends of the usual type but arranged in three concentric circles. In the west the Umayyads of Spain issued a copious coinage from the middle of the 8th to the beginning of the 11th centuries, first in silver only but during the 10th century also in gold; their tradition was continued during the 11th century by the small local rulers of Spain who succeeded them and by the Almoravids, who united Morocco and Spain in one empire.

Islamic gold coinage became one of the great currencies of the medieval world, and the dinar enjoyed great popularity on the western shores of the Mediterranean. It was referred to in Europe in earlier times under the name of mancusus, while the Almoravid dinar was known as morabiti (whence Spanish maravedi). There are also imitations produced; *e.g.*, in Catalonia. The quarter dinars (known as tari) of the Fatimids, who ruled also in Sicily, were imitated in southern Italy and Sicily and by their Norman successors. Enormous quantities of silver dirhams of the various dynasties also reached eastern and northern Europe and more especially Scandinavia, where they are often dug up in great hoards.

The Almohads, who succeeded the Almoravids in the 12th century, introduced a coinage that was new both in its standard and its form. Their fine gold coins (dinar, 2.3 gr.; the more usual coin is the double dinar) count among the most beautiful coins produced in the Muslim world; the dirham (1.5 gr.) is square. The coinage of the Almohads survived also among their successors, well to the end of the middle ages, and was also widely current, and imitated, on the European shores of the Mediterranean.

In the east the successors of the Seljuks (Artukids, Zangids, etc.), who, owing to the scarcity of silver, issued large copper coins, introduced a striking innovation: they adopted a number of different types borrowed from all sources, ancient Greek and Roman, Sasanian and Byzantine. The Seljuks of Asia Minor (12th–13th centuries) had silver coins showing a horseman with a mace over his shoulders, or a lion and sun. Farther east the Ghaznevids (10th–12th centuries), on their conquest of India, struck coins with Sanskrit inscriptions for their Indian dominions.

In the 13th century the Mongols swept through all Asia except India. The khans of the Golden Horde issued an extensive series of small silver coins (which influenced early Russian coinage). The Il-khans of Persia struck large and handsome coins in all three metals (in addition to Arabic legends they bore the khan's title in Mongolian). In the 14th century Timur (Tamerlane) revived the power of the Mongols and struck silver and copper coins. His son Shahrukh introduced a new type of dirham, with, obverse, profession of the faith with the name of the first four caliphs on the margin and, on the reverse, his title.

Meanwhile the new gold coinage of Europe, the Venetian ducat, rapidly spread in the east. It was used as currency up to the 18th century, and its standard (3.56 gr.) was adopted for Islamic coins.

Ottoman Empire.—The original coinage of the Ottomans consisted of small silver coins (akche, called asper by Europeans). Gold coins were not struck before the end of the 15th century; before and after that century, foreign gold, mainly the Venetian ducat, was used. Various European silver dollars also circulated extensively. From the 17th century onward various attempts at reform were made; a notable innovation was the introduction of the *tughra*, an elaborate monogram formed of the sultan's name and titles, which occupies one side of the coin.

Modern Persia, Afghanistan, Turkestan.—The earlier coins of the shahs of Persia were large thin silver pieces of central Asian style, but in the 18th century the form changed, and the coins became smaller and thicker as in India. The legends were usually in the form of rhyming couplets; gold was not common till the 18th century. Cities issued copper with local emblems. Some of the products of the Persian mints were of huge size and were pieces struck for presentation.

The emirs of Afghanistan who became independent of Persia in the 18th century struck gold and silver on the standard of the Mogul emperors, whose poetical legends they also copied. Of the various smaller modern dynasties that ruled central Asia till the Russian conquest, the emirs of Bukhara and of Khokand were notable for their extensive issues of gold pieces. Since the 19th century gradual westernization resulted in the adoption of European styles in currency by the various Islamic countries.

3. India.—*Ancient and Early Medieval.*—There is no reason to doubt the independent origin of coinage in India although it was soon so much modified by Greek influence that the question was long disputed. The earliest coins are pieces of silver, very commonly square, and of copper, punched with various symbols on both sides. Of about the same date are the square and round cast copper pieces with similar but less varied symbols. These pieces circulated all over India and belong to at least the 4th century B.C. From the 3rd century onward there are the copper coinages of numerous states and dynasties, which show increasing Greek influence. Their few silver coins were directly influenced by the hemidrachms of the Greek rulers of northwest India of the 2nd century B.C. The types of these are of considerable mythological and religious interest. Technically they are interesting as showing the evolution of a type from a series of separate punches to the grouping of the punches on a die.

Early in the 2nd century B.C. the Greeks of Bactria began to

invade India, and their coinage is remarkable for its fine series of portraits and for the number of names it records of rulers otherwise unknown. Prakrit legends begin to appear alongside corrupt Greek; the Greek in time becomes more and more corrupt as the Greek rulers were replaced by foreign invaders who copied their types. (The coins of the Saka rulers are conventionally called "Indo-Scythian"; those of the Parthian princes who ruled in what is modern Afghanistan, "Indo-Parthian.") The Greek deities gradually give place to Indian ones on the coins.

In the middle of the 1st century A.D. the Kushans founded a great empire in northwest India; they have left a wealth of gold and copper coins with legends in an Iranian language in a corrupt Greek character. The Kushan coins bear on the obverse the king sacrificing and, on the reverse, deities of all the religions of the time, Greek, Roman, Zoroastrian, Hindu and Buddhist. These types of king on obverse and deity on reverse became the general style of north Indian coinage for the next 1,000 years; the Kushan coinage continued rapidly degenerating till the 4th or 5th century, over a much more limited area; the type was continued by the kings of Kashmir down to the 10th century and adopted and modified by the great Gupta emperors in the 4th century. The latter struck an extensive gold coinage with long legends in poetical Sanskrit and many interesting types, often medallic in nature, but, on their coins for general currency at least, always betraying the Kushan prototype. Among the more notable Gupta coins are those that commemorate Chandragupta's horse-sacrifice or those that record his skill as a lyrist, to which he also testifies in his inscriptions.

In western India a dynasty of satraps of Persian origin had been ruling since the 1st century B.C. Their extensive coinage of silver only is dated and therefore of a historical value unusual in India or any early coinage. This kingdom was overthrown by the Guptas at the end of the 4th century, and they at once began to imitate this silver coinage not only locally but also in their own territory, which seems previously to have had no silver coins. The Ephthalites, who destroyed the Gupta and other civilizations in the 6th century, have left numerous coins, imitated from Sasanian, Gupta or Kushan prototypes. Degenerate copies of these seem to have been the coinages of northern India until the revival of various Hindu dynasties from the 10th century onward. A notable innovation was the neat silver coinage of the Shahis of Gandhara of the "bull and horseman" type in the 9th and 10th centuries, extensively imitated by the Muslim conquerors of India and the contemporary minor Hindu dynasties. The other type favoured by the medieval Hindu dynasties for their gold coinage was that of a seated goddess—going back to a Gupta reverse—and an inscription with the king's name on the other side.

The coinages of southern India form a class by themselves. In the later centuries B.C. and early A.D. the Andhras ruled a great kingdom in central south India; their coinage is mainly of lead and has types of the usual indigenous character.

The later medieval dynasties of south India struck coinages mainly of gold, the type of which is usually the badge of the dynasty; the Cheras of Malabar, for example, had an elephant, the Chalukyas of the Deccan a boar, the Pandyas a fish, and the cup-shaped pieces of the Kadambas bear a lotus. The Chola dynasty introduced under northern influence the type of a king standing on obverse, and on the reverse the king seated, which spread through south India and was taken to Ceylon by the Chola conquest and adopted by the local rajahs there. The great Hindu kingdom of Vijayanagar (Mysore) left a large series of small gold and copper coins with the types of various deities, which had considerable influence on the modern coinages of southern India, including those of the various foreign companies.

Islamic.—The earliest Arab invaders had reached India in the 8th century and founded a dynasty in Sind, which has left numerous very small silver coins of the Umayyad ~~type~~. The coinage of the Ghorid dynasty and its successors from the 12th century onward is varied and extensive, mainly gold and silver tankas (or rupees) of 10.76 gr. They are large thick pieces with the profession of faith on one side and the name of the king, mint and date on the other. A feature of this coinage is the unsuccessful attempt made by Mohammed Tughluq (A.D. 1325–51) to replace gold and silver coinage by brass tokens. Gold was hardly issued at all in the 15th and 16th centuries and for a time the coinage was mainly billon. Sher Shah Sur (1539–45), one of the ablest of his line, issued a large silver currency of a type, carrying the profession of the faith and names of the four caliphs, that was imitated by the Mogul successor of the Surs.

The coinages of Babur and Humayun, the first two of the Mogul conquerors of India, are not extensive and are of central Asian character. With the next two, the Great Moguls Akbar and Jahangir, is found a series unrivaled for variety and, within limitations, beauty—the gold coins of Jahangir are noble examples of Muslim calligraphy. In the 16th century the type that goes back to Sher Shah prevails, the profession of the faith with the names of the first four caliphs and the emperor's titles on the other side. Aurangzeb replaced the confession of faith by the mint and date and this remained the usual type till the end of the dynasty. The emperor's name is usually enshrined in a Persian couplet to the effect that the metal of the coins acquires added lustre from bearing the emperor's name. Nearly 50 such verses are found on Jahangir's coins. The latter's reign is also remarkable for the series of coins bearing the sign of the zodiac, and for the set of portrait mohurs, one of which represents him holding a wine cup. From the beginning of the 18th century the coins become stereotyped and the epigraphy loses its beauty. The English and French East India companies for years copied the native types from the coinages and did not strike on European lines till the 19th century. A uniform coinage for territories under British administration was introduced in 1835. The right of native states to mint their own coinage was gradually curtailed by the British government until there were very few independent coinages. The most important native state mint was Hyderabad. Since 1950 and 1948, respectively, India and Pakistan have had their own coinages.

Miscellaneous.—Mention should also be made of the extensive coinage in gold and silver with Sanskrit legends of Nepal; the coinage of Tibet, related to that of Nepal; the long series of octagonal gold and silver coins of Assam struck until the British conquest; and the brief coinage of Burma in the 19th century.

4. China.—The earliest Chinese coins are small bronze spades and knives, copies of the spades and billhooks and other small articles of husbandry that had been used for barter. The knives (tao) are about six inches long and bear the value and name of authority issuing it; pu money, a modified form of the spades, circulated widely in the 5th and 4th centuries B.C. Small change was supplied by cowrie shells in this period, as it had been long before the invention of a coinage; there was also an issue of bronze imitation cowries. Round money with a hole in the centre was issued about the middle of the 3rd century, but it was not till 221 B.C. that the reforming Shah Huang Ti (221–210 B.C.) superseded all other currencies by the issue of round coins of half an ounce (pan-liang), which were continued by the Han dynasty. This coin became gradually reduced and debased and was replaced in 118 B.C. by the emperor Wu Ti's five-chu piece, which remained the coin of China for the next eight centuries; a break in the monotony of the regular coinage was formed by the archaistic innovations of the usurper Wang Mang (A.D. 9–23), who issued a modified form of the pu and tao currency and a new round coin (ho tsien).

The history of Chinese coins is the history of the gradual debasement of the government currency until it was overwhelmed by the increasing activity of forgers and a new coin was instituted. The five-chu piece lasted till the rise of the T'ang dynasty, when the emperor Kao-tsu in 618 issued the Kai-yuan coin, which gave the coinage of all the far east its form till the end of the 19th century—a round coin with a square hole and a four-character legend of the form "current money of (regnal period)." The Southern Sung dynasty (A.D. 1127–1279) dated their coins on the reverse with regnal years, and the Ming dynasty (A.D. 1368–1644) put the mint name on the reverse, as did the Ch'ing dynasty (A.D. 1644–1912), the latter giving it in Manchu characters. Paper money has been in use in China since the 9th century and was current almost to the exclusion of regular coins under certain Mongol emperors, for example, Kublai Khan, whose paper money is

described by Marco Polo. For over 2,000 years the copper cash with occasional multiples of it was the only coinage of China; gold and silver were current by weight only, the latter in the form of boat-shaped ingots (sycee). The monotony of the series was only rarely broken. With the increasing popularity of Spanish colonial and Mexican dollars as a silver currency in China, several attempts were made to institute a silver coinage in the 19th century; not till the very end of the 19th century were mints established to strike silver and copper coins of European style in all the provinces. One of the last of these, a rupee of Szechwan, was the only coin of the Chinese empire to bear the head of an emperor. This was because it was intended to compete for Tibetan trade with the Indian rupee. Under the republic, coins were at once struck with the portraits of Sun Yat-sen and Yüan Shih-kai, and the various generals who fought for control of China issued their own coins, some in gold, the first in Chinese history. The currency, both of the Chinese people's republic and of Formosa (Taiwan) is the yuan (dollar). The very extensive series of talismans, coinlike in shape but usually larger, should be noted. Many are Taoist and Buddhist in their legends and types; others are simply lucky pieces.

5. Japan.—The art of coinage was borrowed from China by Japan, whose first bronze coins were issued in A.D. 708. Down to the middle of the 10th century 12 different issues were made, each of a different reign. For the next 600 years, however, no government coins were issued, and the currency was supplied by imitations of contemporary Chinese coins made by the great nobles. In the 17th century the copper kwan-ei was first issued, in 1624, and remained in vast variety the usual issue for over two centuries. The ei-raku and bun-kyu sen of the 19th century were the only other regular copper coins. Unlike China, Japan has had a gold and silver currency since the 16th century. The gold coins are large flat pieces in the shape of rectangles with circular corners, the largest size being obans and the smaller kobans; these bear various small official stamps and a large signature in ink of a mint official. They range in length from 6 in. to ½ in. Other gold pieces are the small rectangular pieces of one and two bu issued from time to time; round gold is rare and usually of provincial mints. There have not been many issues of silver, usually in small rectangular pieces; the so-called bean money with the figure of Daikoku, god of wealth, is not a currency but was made to add to the large, long silver presentation pieces to bring them up to a certain weight.

In 1869 a mint on European lines was established in Tokyo, and gold, silver (yen or dollars) and copper have since been regularly issued from it. After World War II the yen was retained as the unit of currency. The e sen of Japan are not coins but amulets and bear figures of Daikoku, Itsibu fishing and others.

6. Korea.—Korea had a bronze coinage of the Chinese style after the 12th century, but it was only with the institution of Shang Ping cash at numerous mints, with an elaborate system of dating or, rather, numbering the issues between 1790 and 1881, that its coinage became common. Attempts were made to establish a silver currency during the years preceding Japanese rule.

7. Vietnam, Cambodia, Laos.—Annam, since the mid-20th century absorbed into the state of Vietnam, began by imitating Chinese coins and had a regular bronze coinage of its own on the Chinese model from the 10th to the 19th centuries. Silver became common in the 19th century in the form of narrow oblong bars. Amulets or, rather, presentation pieces in gold, silver and copper were created in a variety of designs bearing auspicious inscriptions, quotations from the Chinese classics, etc., in addition to the king's name. The native coinage ceased when Annam became a French possession. After independence from France, Vietnam substantially retained the western alphabet on its often very attractive coinage. Separate coinages were in circulation in Cambodia, Laos and North Vietnam.

8. Thailand.—Siam, as Thailand was previously known, down to the middle of the 19th century struck gold and silver in the form of balls formed by doubling in the ends of a short thick bar of silver, and bearing the stamp of the reigning monarch ("bullet" coins). Since *c.* 1860 it has had a coinage on European lines with portraits and issues in gold, silver, copper and, later, nickel, though "bullet" coins circulated until 1909. (J. AL.; S. M. SN.)

X. AFRICA

Ethiopia, which developed a coinage influenced by Arab models in the early Byzantine period, in modern times has long enjoyed the currency of the silver Maria Theresa thalers; but from Menelik II (1889–1913) onward handsome portrait-coins of its emperors have been produced in gold, silver and bronze, with reverses showing the lion of Judah. Eritrea, federated with Ethiopia in 1952, had a fine thaler-size coinage in the late 19th and early 20th centuries. Libyan coinage after 1949 bore a singularly fine portrait of Idris I. The currency of Liberia for over a century has consisted mainly of copper or bronze; the elephant has displaced the head of Liberty. France's widespread dependencies have since World War II showed the French cock, or the head of "Marianne," and often the cross of Lorraine on the reverse. Of Portuguese dependencies Angola has had copper coins since 1814. Coinage for the Congo began with copper in 1887; later issues, some hexagonal, have shown fine elephant designs.

XI. MEDALS AND MEDALLIC ART

Aesthetic and commemorative medals (as distinct from war medals) have a history going back to the classical period. Under the earlier Roman empire, various bronze pieces were struck with special care, bearing specially elaborate types, and not related by weight to the coinage; these (now conventionally termed medallions) were in fact medals, wholly official and imperial in their emphasis. They tended to die out as the habit of precious-metal multiples increased.

In the late 14th century, commemorative pieces appeared, struck for the Carrara family, lords of Padua, in a classicizing style to celebrate the independence of their city. About the same time medals, this time of richest late medieval style, were made, probably as repoussé shells of gold and silver, for the duc de Berry, representing famous Christian rulers of the past.

1. The Renaissance.—Renaissance medals began with the Italian Antonio Pisano, known as Pisanello, born at Verona in the 1390s. First famous as a painter of portraits and animals, he made a portrait medal of the Byzantine emperor John VIII Palaeologus in 1438, followed by a brilliant series for princely and noble persons. All were cast and not struck; they showed a technical perfection allied to a pure naturalism and a genius in composition that gained them universal fame. The fashion of privately commissioned portrait-medals rapidly spread, and among the more famous 15th-century artists were Matteo de' Pasti, Sperandio Savelli, Giovanni Boldù (with a curious leaning to the antique), Francesco Francia, Caradosso Foppa and, a little later, Niccolò Fiorentino and Leone Leoni. This last was in some sense a rival of Benvenuto Cellini, whose medallic work, so far as can be judged, was disappointing, perhaps because (together with Caradosso) he was thinking increasingly of the substitution of mechanically contrived striking for the casting process, which hitherto had given Renaissance medals their superbly sensitive treatment and finish. The Italian medals of the 15th and 16th centuries reveal a common formula—obverse, a portrait; reverse, a device (sometimes pictorial and naturalistic, more often an *impresa,* or badge of devious, riddlelike significance) referring to the person represented on the obverse.

In France the earliest medals were in the medieval late Gothic style; the transition to Italian Renaissance took place at the end of the 15th century: the Lyons medal welcoming Anne of Brittany and Charles VIII, her first husband, in 1494 was fully Gothic, but that for Anne and Louis XII in 1500 was well advanced toward the new naturalism. The principal influences on French medallic art in the 16th century continued to be exerted by Italian artists, including Cellini, who worked for Francis I; but Henry II favoured native talent, employing among others Étienne de Laune, and under Charles IX the emergence of a new, robustly dramatic style may be attributed to Germain Pilon.

Medallic art in the Netherlands had its origin with Italians in the 15th century, but from the 16th century native masters ap-

peared, of whom the painter Quentin Massys (*c.* 1466–1530) was among the first with his fine medal of Erasmus, 1519. The most prolific and technically skilled artist, if not by any means the greatest, was Jacob Jonghelinck (1531–1606), sculptor, engraver, mint-master and goldsmith; Steven van Herwyck was much superior, showing some real affinity with the dominant Italian school.

German Renaissance medals from the first followed an independent tradition. Their emphasis was upon realism in portraiture; the portrait image was very large in relation to the field it occupied, and often strongly featured, heavy, harsh or formidable. The reverses concentrated on complex and sometimes overloaded heraldic designs. In the technique of casting, these works showed high perfection from 1514 onward. The chief centres of activity were Augsburg and Nürnberg, each the home of metalworking and goldsmithery. Among the best-known artists of the 16th century were Hans Schwarz, Friedrich Hagenauer, Christoph Weiditz and Matthes Gebel.

Renaissance medallists had thus shown the brilliant possibilities of profile portraiture on a small scale, not as an imitation of the antique, but as an up-to-date idiom transcending stiff medieval forms. The effect on coinage was of course dramatic, particularly when machinery first began to increase the facilities for the mass production of fine portrait-coins from well-designed, well-cut dies. But the subsequent reverse reaction upon medallic art of the mechanical production of coins was less happy. Although the best medallists throughout the 16th century continued to use the casting process for their most important medals, even when they were also die-engravers by profession, official patronage, requiring number rather than quality, tended to favour the struck medal.

2. The 17th and 18th Centuries.—In the first half of the 17th century France emerged as the finest centre of medallic art, with Guillaume Dupré and Jean and Claude Warin as the supreme exponents of the baroque medal-portrait. Dupré (1574–1647) was both sculptor and metalworker, and his preference was for the cast medal, in which he memorably combined elegance, decorative instinct and technical splendour. Jean Warin (1604–72), no less elegant or accomplished, was perhaps more robust; his output, moreover, was great, and in an age when machinery was taking its place in France he did not hesitate to strike as well as to cast. Claude Warin (d. 1654), less brilliant and less sure, was nevertheless outstanding in the succession of artists who mirrored admirably an age of combined luxury and academic taste. Their influence abroad was strong. In England it was a Frenchman, Nicolas Briot (1580–1646), who infused the coins and medals of Charles I with refinement and delicacy (also, incidentally, pressing on with the introduction of machinery); and the summit of English medallic art, when the skill of the metalworker was still taking the fullest legitimate advantage of the facility given by machinery, was reached by the brothers Abraham and Thomas Simon (*c.* 1622–92, *c.* 1623–65), whose baroque portraits are unsurpassed for brilliance and virtuosity. These developments are the last full flowering of medallic art before it passed into the clever, mechanical mediocrity of the 18th century, exhibiting a taste that was at once international and increasingly routine. Only perhaps in the great papal series of 18th-century medals did some real life survive.

3. The 19th and 20th Centuries.—The academic tradition encouraged in France by the empire and consolidated in England (after the classical Italianate brilliance of Benedetto Pistrucci) by the long reign of Victoria only began to break down after 1870. The French revival took its rise in François Ponscarme (1827–1903). By the extraordinarily sensitive study of character in portraiture, by the search for a dignified realism and for a harmonious relation of type to background and by the freeing of his portraits from the raised border that had for so long enclosed them, he inaugurated a return to the true principles of the art that Pisanello had established. The movement was continued under Jules Chaplain (1839–1909), and its fruits were to be seen even later in the splendid cast medals of the French-trained English artist Theodore Spicer-Simson (1871–1959). Elsewhere the occasional artist of real talent emerged, such as Anton Scharff (1845–1903) in Germany or Alphonse Legros (1837–1911) in England; but in general the use of the reducing machine has continued to tie the artist to his model and make him too careless of its translation into metal. In the first quarter of the 20th century the level of medallic art was everywhere very low, being characterized either by harsh treatment or insipid feeling. In the second quarter the standard rose sharply: not only did portraits increase in number and quality, but the medal borrowed from the plaquette in including purely genre, symbolic and also poetical subjects. More important still, the casting technique began to recover its lost popularity, especially in Italy, where the talent for portraiture and design was strong. In the United States outstanding sculptors have created cast medals, notably David Smith's polemic symbols and Jacques Lipchitz' commemorative roundels. In France casting has been less favoured, but modern French medals exhibit a high degree of poetically complex design and symbolism, as well as a combination of very sensitive portraiture: Josette Coeffin, Raymond Corbin, Henri Dropsy, André Galtié and Georges Lay have all made medals of memorable beauty. Holland has produced I. J. Pieters, and Finland the late Gerda Qvist; in England, beside the native talent of Mary Gillick could be set the contrasting qualities of A. Loewenthal (an expert in preparing models for casting) and P. Vincze. There was no lack of fine and accomplished portraiture, and this, combined with reconsideration of technique and willingness to allow medals to express some poetic or symbolical content, made the mid-20th century a period of experiment in which promise was higher than it had been for a long time past and which required only intelligent patronage to make the fashion for medals thrive again.

XII. PAPER MONEY

The earliest paper currency recorded is apparently that of the T'ang dynasty in China in the 8th century A.D., consisting of receipts for deposits of cash, and Marco Polo's residence in China in the 13th century familiarized him with the monetary notes (printed on mulberry bark paper and sealed in red) of Kublai Khan. Thereafter no paper currency was devised or produced until the Bank of Sweden briefly issued printed notes in 1661, doubtless to ease difficulties caused by coinage based on a cumbrous copper standard. In London a system had already just begun whereby merchants wishing to deposit money with the goldsmiths received a receipt promising to repay; such promissory notes could pass among merchants as currency, though being wholly in manuscript, they were limited in number and thus in circulation. The Bank of England, founded in 1694, at once began to issue promissory notes for "running cash," *i.e.*, such sums as depositors wished to withdraw; the first notes were handwritten, but plans were swiftly made for plate-printed notes (with blank spaces for the payee's name and for the date) for £5 upward.

The fact that these notes could be drawn in favour either of a named person or of "bearer" carried the corollary that they were no longer promissory certificates but, being capable of transference, a form of monetary exchange. Concurrently it became more necessary for an issuing bank to define the prudent balance of "running cash" to be held available for cash demands on presentation of notes, and private banks in the 18th and early 19th centuries that over-issued notes in relation to their cash reserves not infrequently failed, as was the case with John Law's bank in France in 1720. Subsequent practice tended to place the issue of paper money under state scrutiny: in the United Kingdom, for example, the only notes issued are those of the Bank of England, the Royal Bank of Scotland and the Ulster bank, and, although the number of notes issued need not bear an absolutely fixed relationship to British gold reserves, there is always an adequate reserve of other cash behind them. (This is in contrast to 1793 and 1797 when there was a rush to draw out gold, and cash payments had to be suspended in favour of notes.) To this extent notes, although purely token pieces of paper, are based on the strength of the country's economy as a whole.

Sharply distinct from bank-notes are those notes issued in times of necessity. Thus the bills of credit printed by the government of Massachusetts in 1690 originally stood in lieu of hard cash for the colonial troops engaged against the French in Canada; the co-

lapse of the French economy during the French Revolution called forth the assignats (*q.v.;* printed certificates of monetary value to fill the gap caused by the flight and loss of metallic currency); and emergency notes were issued by R. S. Baden-Powell during the siege of Mafeking (1899–1900). Slightly different was the "Bradbury" issue of notes (5*s.*, 10*s.* and £1) undertaken by the British treasury (over the signature of Sir John Bradbury, its permanent secretary) to stabilize the British currency system in and after 1914 when gold was withdrawn from circulation: in this emergency measure, the treasury assumed a responsibility that the Bank of England could not at immediate notice discharge.

The economic dangers arising from the temptation to print too many notes in relation to genuine monetary reserves, *i.e.*, to reduce paper money to a wholly token status, are well shown by the unhappy history of Confederate currency in the United States (in 1864 its value was estimated at only 10% of its face-value in gold) or by the inflation of the German mark after World War I, when, with each successive decline in value, notes were printed of ever growing face-value, until total collapse was reached with the issue of notes individually to the value of millions of marks.

Because notes are generally large enough to bear on their face a considerable amount of information, *e.g.*, issuing authority, value and date, they can also declare the territorial limits of their validity. Paper money has thus often been used for "closed-economy" groups or communities, such as an army-group in a particular theatre of war or an internment camp. Such official vouchers were the notes issued by the British economist Robert Owen in the early 19th century on behalf of the National Equitable labour exchange: these directed the store-keeper of the exchange to deliver goods worth from 10 minutes' to 80 or more hours' work, on the assumption that all men work equally hard and that value can thus be measured evenly in terms of time-output.

With the greatly increased use of paper money its physical design radically changed, not least as a guard against forgery. Paper, originally suitable for manuscript insertions, was specially made and became both tougher and smoother. Printing, originally in black upon plain white from an engraved plate, later called for the fullest skill of engravers and polychrome printers. With the disappearance of gold from the world's currencies paper money was assured of a long future, and, although many countries were disinclined to produce notes of less than the equivalent of about a dollar, the use of paper for higher sums (particularly after the inflation caused by World War II) became usual. (C. H. V. S.)

U.S. Paper Currency.—The continental congress and the individual states fared poorly with their paper emissions before, during and after the Revolution, and the federal government issued no paper money (except a few promissory notes, all long since redeemed) until the Civil War. Nevertheless, most states authorized banks to utter paper money to the amount of their gold reserves. With inadequate supervision, abuses developed; most banks inflated their notes, that is, they issued more than their gold assets could cover, in the hope that not too many people would demand redemption in specie. Many banks failed in 1860–62 when their creditors demanded gold in quantity for their paper money and when their debtors in turn defaulted on payments to the banks. Despite the resulting financial hardship, even larger issues of inflated paper currency followed; it is reliably estimated that, exclusive of the Confederate treasury and Southern state notes, over 3,500 varieties were in circulation up to 1862.

To help finance the Civil War, congress suspended specie payments and uttered some $60,000,000 in paper money in 1861, and larger amounts thereafter, proclaiming them legal tender although they were unredeemable in anything until 1879. From 1863 to 1876, as a substitute for jealously hoarded coins, the government printed nearly $369,000,000 in fractional currency, each bill being less than a dollar in value. The shortage of coins was so acute that postage stamps were being used as a medium of exchange, and the earliest regular fractional notes depicted stamps, the 25-cent note bearing five reproductions of the five-cent stamp, for example. After 1875, fractional notes were redeemed in silver.

Beginning in 1878 the government issued silver certificates backed by, and redeemable in, the silver dollars that were starting to accumulate in treasury vaults. Congress from 1863 to 1933 authorized many banks to issue notes backed by funds deposited in Washington, D.C., for the purpose, but the majority of these notes have been recalled. At irregular intervals from 1865 to 1922 the Treasury emitted gold certificates, but these were recalled in 1934. After 1914 the federal reserve banks issued fully secured notes. The cost of the special paper used for currency occasioned the reduction in note size in 1929. After 1933 U.S. paper money thus mostly comprised uniform silver certificates and federal reserve notes. Silver certificates are no longer being issued.

(W. H. Br.)

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NUMMULITE, any of the thousands of extinct species of foraminiferan protozoa whose shells are often indicators of oil-bearing rock. See FORAMINIFERA.

NUN, a member of an order or congregation of women, living a life of religious observance under vows of poverty, chastity and obedience. In Roman Catholic canon law only women living under solemn vows are nuns (*moniales*); those under simple vows are properly called sisters (*sorores*). Widows and penitents, by dispensation, are received into all orders except the Carthusian, which requires complete bodily integrity. See MONASTICISM; WOMEN'S RELIGIOUS ORDERS.

NUNATAK, a hill or mountain peak appearing above the surface of a glacier. Greenland is for the most part covered by an icecap which moves slowly downward to the sea. It will rise upward and pass over a barrier if there is no outlet, but will flow between and around mountain peaks leaving them standing as hills (nunataks) above the general surface of the icecap. There are also nunataks in Antarctica but they are less numerous and more widely scattered. The term is an Eskimo loanword.

NUNC DIMITTIS, the canticle in the Bible also known as the Song of Simeon, beginning "Lord, now lettest thou thy servant depart . . ." (Lat. *Nunc dimittis servum tuum, domine*. . .). It was uttered by the aged Simeon when the Virgin Mary brought the infant Jesus to the Temple to be presented to God (Luke ii, 29–32). Since at least as early as the 4th century the Song of Simeon has formed part of the church's evening worship; it contains a reference to Christ's salvation as the light of the gentiles, which makes it appropriate for use when the church relies on the divine light through the hours of darkness. It is part of vespers in the Orthodox *Euchologion*, of compline in the Roman breviary and of evensong in Anglican prayerbooks. At the end of the liturgy of St. John Chrysostom it is repeated by the priest as he takes off his stole.

NUNCIO, the resident representative of the pope in major countries, diplomatically accredited to the government (since the congress of Vienna, dean in some countries of the diplomatic corps), and also endowed with certain papal rights of jurisdiction over the Catholic faithful. The office is historically related to that of the apocrisiary at the Byzantine and Frankish courts (5th and 6th centuries) and to that of later papal fiscal officials. Angelo Leonini, sent to Venice in 1500, is usually regarded as the first official nuncio. A nuncio differs from a legate, whose office is temporary. Internuncio is the title used in some countries of nonambassadorial status. Apostolic delegate (equivalent to minister plenipotentiary) is the title used in some countries. An apostolic delegate differs from a nuncio in that he lacks diplomatic status.

See also LEGATE; VATICAN. (J. C. MY.)

NUNEATON, a municipal borough (1907) in the Nuneaton parliamentary division of Warwickshire, Eng., on the Anker river and the Coventry canal, 19 mi. N.N.E. of Warwick. Pop. (1961) 57,376. The prefix "Nun" was added to its name when a Benedictine nunnery was founded there between 1155 and 1159. Situated near a coalfield and granite quarries, Nuneaton has large engineering and brick works and a flourishing textile industry. Other trades are leather dressing, boxmaking, fellmongering and the manufacture of needles. In 1819 Mary Anne Evans, who wrote under the name of George Eliot, was born at Chilvers Coton, Arbury, now within the borough.

NUNES, PEDRO (PETRUS NONIUS) (1492–1577), Portuguese mathematician and geographer, the peak figure in Portuguese nautical science, was born at Alcacer do Sal in 1492. He was professor of mathematics at Lisbon and Coimbra, and was made royal cosmographer in 1529 when Spain was disputing the position of the Spice Islands and maps did not agree in their longitude. He devoted himself to such problems, to maps and map projections. He was the first to show that a loxodrome course gives a spiral route, and published studies of the sphere and of the oceans. In 1538 he went to Spain, but returned to Portugal in 1544, when he was the best informed man in the world on the new discoveries of Spain and Portugal. He died at Coimbra in 1577.

See A. Cortesao, *Cartografia e Cartografos Portugueses*, 2 vol. (1935). (A. DS.)

NÚÑEZ, RAFAEL (1825–1894), leading Colombian political figure of the late 19th century, was born Sept. 28, 1825, in Cartagena. He entered politics in the Liberal party while in law school, and moved to the national political scene in 1853. Holder of many high government offices, pre-eminent political figure from 1880, three times president of Colombia (1880–82, 1884–86, 1886–92), he was leader of the independent faction of Liberals. A Radical Liberal rebellion in 1884 forced Núñez into alliance with the Conservatives and enabled him to institute a series of reforms called the Regeneration, including the concordat of 1888 ending religious conflict (1850–85) and the existing centralized constitution of 1886 terminating federalist anarchy (1858–86). Regarded as the leading intellect of his time, an active publicist and journalist, Núñez wrote on politics and economic policy and composed volumes of poetry. Domineering, able, opportunistic, he was during his public career on both sides of every national controversy. He died in El Cabrero, on Sept. 12, 1894. (R. L. GE.)

NÚÑEZ CABEZA DE VACA, ALVAR (*c.* 1490–*c.* 1560), Spanish explorer, was treasurer of the ill-fated expedition of Pánfilo de Narváez to Florida in 1527–28. Of 300 men who disembarked, only four, including Cabeza de Vaca, ever returned to civilization. For eight years they wandered among the Indians

of the Gulf coast and northern Mexico though their exact route has long been debated. Cabeza de Vaca's adventures (which he related upon his return) probably led to the De Soto expedition of 1538, and without question inspired the Coronado enterprise of 1540, both of which probed deeply into areas which later formed part of the United States.

Returning to Spain to seek recompense for his services, he was appointed governor of the province of Rio de la Plata. He reached Brazil in March 1541, and from November of that year to March 1542, he traveled 1,000 mi. to Asunción, the provincial capital. Intrigue and rebellion led by Domingo Martínez de Irala resulted in his seizure, confinement and (in 1545) deportation to Spain. The council of the Indies, finding him guilty of malfeasance in office, sentenced him to banishment from the Indies and to military service in Africa. Upon his appeal, the council reduced the sentence but never reversed the judgment. Cabeza de Vaca died in obscurity and poverty.

See Morris Bishop, *The Odyssey of Cabeza de Vaca* (1933); for sources, Cabeza de Vaca, "The Narrative" in *Spanish Explorers in the Southern United States* (1907). (K. M. S.)

NÚÑEZ DE ARCE, GASPAR (1832–1903), Spanish poet and statesman, once regarded as the great poet of doubt and disillusionment, though his rhetoric is no longer found moving. He was born in Valladolid on Aug. 4, 1832, became a journalist and Liberal deputy, took part in the 1868 revolution and was colonial minister for a time after the Restoration. He died in Madrid on June 9, 1903. As a dramatist he had some success, his best play being the historical *El haz de leña* (1872), but he attained celebrity with *Gritos del combate* (1875). This volume of verse sought to give poetic utterance to religious questionings and the current political problems of freedom and order. His longer poems include *Última lamentación de Lord Byron* (1879); the allegorical *La selva oscura* (1879); a study of Luther, *La visión de Fray Martín* (1880); and the sentimental narratives *La pesca* (1884) and *Maruja* (1886). (H. B. Hl.)

NUORO, a province of central Sardinia, created in 1927 out of parts of Cagliari and Sassari provinces; it had been a province under Piedmontese rule from 1848 to 1860. Pop. (1961) 265,750; area 2,808 sq.mi. The headquarters town is Nuoro, lying on an east-west road linked with the east coast road and the western north-south highway. It was first recorded (as Nugorus) in the 12th century; the site was inhabited from remote antiquity. The province consists essentially of the highland backbone of Sardinia, including the massifs of Gennargentu, Albo, Monte Ferru and Catena del Marghine. It is the poorest region of the island, occupied largely by pastoralists, but after 1950 developments included 30 mi. of new road, improvement of more than 17,500 ha. of mountain pastures (Argosolo, Mamoiada, Fonni) and the grafting of 2,000,000 wild olive trees (Siniscola, Posada, Torpè). (J. M. Ho.)

NUPE. This Islamized kingdom in the heart of Nigeria (*q.v.*) lies at the confluence of the Niger and Kaduna rivers. About 360,000 people in the 1960s, they speak five main dialects of the Nupe language, which belongs to the Kwa language group (*see* African Languages). They are organized into a number of closely related subtribes, of which the Beni, the Zam, the Bataci (Batache) and the Kyedye (Kede) are the most important, although a dozen others can be named. The Kyedye and Bataci are river people, subsisting primarily by fishing and trading, while the other Nupe are primarily farmers, the staple crops being millet, sorghum and yams. There is a highly developed guild organization for craftsmen who specialize as blacksmiths, brass-smiths, weavers, beadworkers, glassmakers, tailors, matmakers, barbers and drummers. Either men or women may be specialist traders.

Nupe live in grass-thatched huts of mud brick built in villages or towns varying in size from a few families to towns such as Bida, Kutigi and Mokwa with populations of several thousand people. Villages were formerly surrounded by a wall, but today walls are seldom encountered. Indigenously the Nupe kingdom was divided into four zones for purposes of government, with a series of ranked officials who owed a feudallike allegiance to the king, called Etsu Nupe. The Beni and the Kyedye both are organized as kingdoms within the greater Nupe kingdom, their kings also owing fealty to the Etsu Nupe. The population is divided into nobility, commoners and clients. The office of Etsu Nupe rotates among three noble families.

Nupe are polygynous, and bridewealth (*q.v.*) changes hands at most marriages. The majority are now Muslim, but many pagan rituals are still performed. They are noted throughout Nigeria for glass beads, fine leather and matwork, as well as brass trays and fine cloth.

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NUREDDIN (Arab. Nur al-Din, "Light of the Faith"; Abu'l Qasim Mahmud) (1118–1174), a Muslim leader in Syria who by his achievements against the crusaders laid the foundations for the later triumph of Saladin (*q.v.*), was born in Feb. 1118. Succeeding his father, Zangi (*q.v.*), as ruler (atabeg) of Halab (Aleppo) in 1146, he speedily recaptured Edessa, which had been temporarily lost to the crusaders after his father's death. Apart from waging direct military campaigns against the crusaders Nureddin pursued a policy of the unification of the Muslim forces under his authority. After annexing Damascus (1154), he succeeded in submitting Egypt to his control (1168). As a result of this achievement Saladin, who participated in the conquest of Egypt, emerged as a powerful military commander. At the time of his death Nureddin's authority was recognized in Syria, Egypt and in parts of Iraq and Asia Minor.

Nureddin was a strict Muslim whose whole life was dedicated to the cause of Islam. Thus, while organizing the military effort of his kingdom, he also supported the religious and cultural activities of his subjects. He built many new mosques, schools, hospitals and caravanseries. But the greatest services were rendered by him in the struggle against the "infidels." His successes contributed to the popularity of the holy war against the crusaders and resulted in many defeats of the Christian enemy. His accomplishment in the field of the unification of Muslim forces proved to be fundamental for the subsequent victory of Saladin. Nureddin died at Damascus on May 15, 1174.

For a discussion of Arabic and western sources *see* C. Cahen, *La Syrie du nord à l'époque des Croisades* (1940). For a modern account of Nureddin's career *see* S. Runciman, *History of the Crusades*, vol. ii (1951); H. A. R. Gibb, "The Career of Nūrad-Dīn," in *A History of the Crusades*, vol. i, pp. 513–527 (1958). (A. S. Eh.)

NURHACHI (1559–1626), a tribal chieftain in Manchuria who organized an army of mounted archers during the 1590s and established military and political control over all of Manchuria. In the year 1616 he proclaimed himself emperor of China and was thus a forerunner of the Manchu or Ch'ing dynasty (1644–1912). He defeated a large Chinese army and captured several border cities but died before he was able to invade China.

See Ch'ing; Manchus; China: *History*.

NURI AS-SAID (Nuri al-Sa'id Pasha) (1888–1958), outstanding Iraqi statesman, was born in Baghdad in 1888, educated there and in Istanbul, and was commissioned in the Turkish army in 1909. He married, in 1910, the sister of Ja'far Pasha al 'Askari (*q.v.*). He saw service during 1912–13 against the Bulgarians. Thereafter, in Istanbul and later, during 1913–14, in Cairo and Basra, he became increasingly involved in Arab secret societies which envisaged home rule. In 1916, after a year's *résidence forcée* in India, he was helped by the British to join the (anti-Turkish) Arab revolt in the Hejaz, and reached Jidda in July. Thereafter for 26 months Nuri was a vigorous, competent, gallant and dynamic figure in the Arab army of Amir Faisal, to whom he came to stand in the closest personal relationship. He acted as staff officer, adviser and devoted supporter throughout the amir's rule in Syria (1920), and accompanied him to Versailles and on many journeys. When the Syrian kingship was lost, Nuri followed Faisal to his elected throne in Iraq (Aug. 1921). With integrity, ready accessibility and the highest contacts in neighbouring countries and in Europe, for the following 37 years he played a unique part in Iraqi constitutional, political and administrative life and was 14 times prime minister between 1930 and

1958. Standing for the monarchy and for a cordial relationship with Great Britain (not least in the critical mid-war period, 1940–41), the pasha suppressed extremism, Communism and the more effervescent forms of politics at home, opposed Zionism, and improved relations with Turkey and Iran. In wider Arab circles, in which by 1935 he had achieved a unique status, he urged all practicable forms of Arab unity and was an inspirer or founder of the Arab league (1945). Later, as pro-western creator of the Baghdad pact (1955), he lost popularity, and his somewhat autocratic regime at home offended the underemployed Iraqi intelligentsia. He was murdered in Baghdad during the military revolutionary *coup*, on July 16, 1958. *See* also IRAQ: *History*.

See Lord Birdwood, *Nuri as-Said* (1959); S. H. Longrigg, *Iraq 1900 to 1950* (1953). (S. H. Lo.)

NURISTAN (KAFIRISTAN), a region of eastern Afghanistan forming the northern part of the province of Nangrahar. Its area is approximately 5,000 sq.mi. and the population about 50,000. It comprises the upper parts of the three large north-south valleys of the Alinghar, Peech (Parun) and Bashgal. Its northern border follows the main range of the Hindu Kush, and on the east it is bounded by West Pakistan, west by the mountain ranges above the Nejrab and Panjshir valleys and southeast by the Kunar valley. Kafiristan ("land of the Kafirs," *i.e.*, infidels) came under Afghan rule in 1895 and after the forcible conversion of its people to Islam it was renamed Nuristan ("land of light or the enlightened").

The region is mountainous, forested and relatively rainy. The highest lying forests are dominated by conifers (deodar, pines) which grow from below 7,000 ft. to above 10,000 ft. Below 7,000 ft., mixed deciduous forest is prevalent with oak, maple, hawthorn and walnut. Below 5,000 ft. the deciduous forest becomes almost universal. The Asmar forest to the east produces a large part of Afghanistan's timber.

The people speak various Kafir languages (*see* DARDIC LANGUAGES) which are of unknown but very old Indo-European origin. They are light-skinned, of medium height, hardy and brave. Their record was one of pagan superstition, brigandage and plundering; they were, and still are, intensely loyal to their own people and strongly cherish their independence. They have a clan organization with village government, and are now settled agriculturists. The region as a whole has a most distinctive culture, and although it is possible to establish certain cultural differences between the three main valleys, yet they share a culture which gives them a unique position within Afghanistan.

The houses in the highest northern regions are built of stone or clay, but in the forested regions mainly of wood, and often (to save space) in several stories, stepwise above each other. They often have verandas and are richly carved. The small enclosed fields (often no bigger than an ordinary floor space), mostly lying in steep, narrow mountain valleys, are cultivated by the women, while the men hunt or tend livestock. The soil has to be fertilized and is sometimes irrigated by water brought for miles in wooden conduits along the mountainsides. Water mills for grinding grain are common. The usual Afghan wooden plow is used wherever possible, but is drawn by only one ox. The main crop is wheat, with barley, maize (corn), millet and peas. Grapes and mulberries are grown in the lower parts, and fruits are gathered—pomegranates, *Zizyphus* berries, blackberries and the fruits of conifers. Livestock consists mainly of goats, with some cattle, and a few sheep in the upper, wider valleys. There are no horses.

The whole of this recessive, very characteristic civilization is still partly preserved and marked by the strong geographical isolation and the paganism which prevailed until the 1890s, according to the descriptions of Sir George Scott Robertson, who visited Kafiristan at that time, and the Russian, Danish (1947–64) and German travelers who described it up to the mid-20th century. *See* also NANGRAHAR; AFGHANISTAN: *The People*.

See Sir G. S. Robertson, *Kafirs of the Hindu-Kush* (1896). (J. P. C. N. H.)

NÜRNBERG (NUREMBERG), the second largest town (pop. [1961] 454,520) in the *Land* (state) of Bavaria, which following the partition of the nation after World War II became part of the Federal Republic of Germany, and also administrative centre of the province of Mittelfranken (Middle Franconia), is situated on a sandy plain at the foot of the Franconian Jura, on both banks of the Pegnitz river 147 km. (92 mi.) N.N.W. of Munich. The Pegnitz flows into the Regnitz at the town of Fürth, 6 mi. to the northwest, and the Regnitz joins the Main at Bamberg (so connecting Nürnberg with the Rhine valley) and also makes possible communication eastward with Czechoslovakia. Nürnberg's wealth as a trading centre in the 12th and 13th centuries was devoted to building and to patronage of the arts. Its industrialization in the 19th century and its use as a war-production centre by the Nazis led to severe bombing during World War II. It was, however, reconstructed according to the original ground plan, and many of its damaged buildings were carefully restored. Its importance as a commercial and industrial centre has not destroyed its medieval character.

The older, central part of the city, the Altstadt, is still enclosed by the medieval walls (completed 1452), with their 128 towers and four main gates. It is divided by the Pegnitz river into the Lorenzer Seite (named after the Gothic St. Lorenzkirche) on the south and the older Sebalder Seite (named after the Romanesque-Gothic St. Sebalduskirche) on the north. The Sebalder Seite slopes up to the red sandstone castle rock on the northwest from which the gray-walled castle, with its five-cornered 11th-century tower and 12th–16th-century Kaiserburg (imperial castle), dominates the town. Just below is a perfectly preserved medieval square, near which is Albrecht Dürer's house (*c.* 1450, where he lived and died [1509–28]). St. Sebalduskirche (1225–73; east choir 1361–79) contains a magnificent bronze shrine by Peter Vischer and his sons Peter and Hermann (1508–19). Also on the Sebalder Seite are the Marktplatz, where stands the 14th-century Schöner Brunnen and the Gothic Frauenkirche (Church of Our Lady, 1352–61) on the west front of which is the Männleinlaufen, a mechanical clock made about 1509 to commemorate the Golden Bull of 1356, showing the seven electors moving round Charles IV; the gabled Fembohaus (1591–1600), the only surviving example of a burgher's house, which is now the old town's historical museum (founded 1953); and the Heiliggeistspital or Hospital of the Holy Ghost (founded 1331, expanded 1487–1527).

The two halves of the town are connected by the Königstrasse, a busy street containing modern shops as well as old buildings. It leads up to the St. Lorenzkirche (*c.* 1260–1360; choir 1439–77), containing the famous "Engelsgruss" (Annunciation) carved out of linden wood by Veit Stoss (1517–18), the stone sanctuary by Adam Kraft (1493–96) and an ornate rose window over the west door (1350–60). Also in the Königstrasse are the gabled market hall (built as the city granary, *c.* 1500) and the small churches of St. Klara (Gothic; choir 1273) and St. Martha (1360).

Among modern buildings worthy of mention (many built or rebuilt after World War II) are the school of economics and sociology, the school of music and the academy of art. The Germanic National museum (founded 1852) contains exhibits illustrating German art and culture from prehistoric times to the early 19th century. There are an industrial institute, a transport museum and an excellent municipal library, containing 3,000 manuscripts and 2,000 incunabula, in a modern building on the city's outskirts.

To the southeast of the city is Dutzendteich, which was used by the Nazis for their annual September rallies (1933–38). Some of its buildings have been dismantled. There is also a sports stadium (1923–28), and a national park on the slopes of the Schmausenbuck (1,276 ft.).

Nürnberg is an important south German railway junction, although the division of Germany after World War II severed many of its connections; *e.g.*, Halle-Leipzig-Berlin, Hof-Dresden-Warsaw, Eger-Prague. Nürnberg is on the Munich-Berlin *Autobahn* and the *Autobahn* to Frankfurt am Main, constructed in the 1960s, connects it to the Rhineland. The construction of the planned Rhine-Main-Danube canal would greatly aid its economy. An airport was opened to the north of the town in 1955.

Nürnberg is the centre of the great north Bavarian economic region. Its chief industries, in order of importance, are iron and metal production and manufacture, manufacture of business ma-

chines, cables, electrodes, telecommunications equipment, machinery and motor vehicles. Also characteristic are the toy industry (International Toy fair); the manufacture of gingerbread, chocolate, margarine and pharmaceutical goods; and brewing. Nürnberg is also important as a market for the export of Bavarian hops.

History.—Founded about 1040 as a stronghold by Henry III, duke of Bavaria and emperor of Germany, Nürnberg developed rapidly as a community of traders and artisans clustered around the castle. Destroyed in 1127, it was rapidly rebuilt, and in 1140–50 spread from the north to the south bank of the river. Its popularity with pilgrims because of miracles attributed to the tomb of St. Sebald, its position as a trading centre on the important trade route linking Germany with the Mediterranean and the patronage of the emperors caused it to flourish in the 12th and 13th centuries. In 1219 it received its great charter from Frederick II and after the middle of the century became a free imperial city, owning considerable land and ruled by a council of 42, most of whom belonged to wealthy patrician families. Alongside the development of wealth and influence went the development of learning and of crafts of all kinds. The names of the artists Michael Wohlgemuth and Albrecht Dürer, the sculptors Adam Kraft and Veit Stoss, the bronze founder Peter Vischer and his sons, and the scholars Martin Behaim, Johann Müller (Regiomontanus) and Willibald Pirkheimer testify to the quality of the city's artistic and academic life in the 16th century. The *Gymnasium Aegidianum*, founded in 1526 by Philipp Melanchthon, was among the first in Germany. The city also achieved fame as the nursery of German *Meistergesang* and home of Hans Sachs (*see* MEISTERSINGER). It was in Nürnberg that Peter Henlein invented (1500) the mainspring and possibly the first pocket watch, the "Nürnberg egg"; J. C. Denner invented the clarinet there in the early 18th century. In 1525 it was the first imperial city to adhere to the Reformation.

As a result of the change of direction of the great European trade routes after the discovery of the Americas and of the sea route to India, of the devastation of the Thirty Years' War during which Gustavus II Adolphus was besieged there, and of the customs policy of the great powers in the 17th century, Nürnberg gradually declined in importance. In 1806 the town and its lands were absorbed into the kingdom of Bavaria. The first German railway, the Ludwigs-Eisenbahn (1835–1922), ran from Nürnberg, and the city's industrialization in the 19th century gradually reestablished its position. In the 1930s it became a centre of the National Socialist party; in 1935 it gave its name to the anti-Semitic Nürnberg decrees. It was severely damaged in air raids in Jan.–Feb. 1945; 6,716 people lost their lives. It was captured by U.S. troops and was the scene of the Allied trials of German war criminals (*see* WAR CRIMES).

See also references under "Nürnberg" in the Index.

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NURSERY: *see* ARBORICULTURE.

NURSERY AND COUNTING-OUT RHYMES. A nursery rhyme may be understood to be any verse that is customarily said or sung to small children. From the point of view of definition, the source and age of the rhyme is immaterial, and it need not originally have been intended for children. It becomes a nursery rhyme through usage. It happens, however, that when a child has to be entertained, the rhymes and songs most readily recalled are those from an adult's own childhood, and this is the reason why the nursery repertoire remains moderately stable. Nevertheless a rhyme or song which was new when the adult was a child may occasionally come to mind along with the old verses, and thus enter the stream of tradition. It follows that the ages of nursery rhymes vary considerably, and the origin and history of each rhyme must be examined individually.

Some of the oldest rhymes are probably those which accompany simple babies' games, such as "Handy dandy prickly prandy, which hand will you have?" (recorded 1598), and the face-tapping formula "Brow bender, eye peeper, nose dropper, mouth eater, chin chopper" (recorded 1788). These formulas were almost certainly old when they were first recorded, as is shown by the existence of parallel formulas on the continent of Europe. For instance the German "Windle, wandle, in welchem Handle, oben oder unt" and "Kinnewippchen, Rotlippchen, Nuppelnäschen, Augenbräunchen, Zupp-Zupp-Härichen."

In a few cases—for example the verse addressed to the ladybird

> Ladybird, ladybird, fly away home,
> Your house is on fire and your children all gone;

the singing-game "London Bridge is falling down"; and the riddle rhyme popularized by Lewis Carroll, in *Through the Looking-Glass* (1872), "Humpty Dumpty sat on a wall"—numerous parallels are to be found half across Europe. The likelihood of direct translation can be discounted, and it is possible that these rhymes have come down from very early times. The ancient practice of incarcerating a human being in the foundations of a new bridge to serve as a guardian spirit may lie behind the stanza of "London Bridge is broken down" which begins "Set a man to watch all night." The watchman was thought necessary to overcome the supernatural opposition which kept destroying the bridge.

Counting-Out Rhymes.—Another type of rhyme which has European equivalents is the gibberish counting-out formula employed by children in their games to determine which one of them shall take some special role. The similarity of the sound of formulas repeated by children in different countries is sometimes remarkable. In Great Britain children may say:

> Eena, meena, mona, my,
> Barcelona, bona, stry,
> Air, ware, frum, dy,
> Araca, baraca, wee, wo, wack.

And in northern Germany:

> Ene, tene, mone, mei,
> Pastor, lone, bone, strei,
> Ene, fune, berke, berke,
> Wer? Wie? Wo? Was?

The refrain "Eena, meena, mina, mo" can also be compared (as can the refrain "Hickory, dickory, dock") with certain sets of numerals, reaching to 20, which have long been used in England by country folk in their work, for instance by shepherds counting their sheep and fishermen assessing their catch. An example from Yarmouth begins: "Ina, mina, tethera, methera, pin, sithera, lithera, cothra, hothra, dic." The origin of these scores is uncertain; they may be Celtic or Danish survivals, but there can be little doubt that when schoolchildren indulge in "Chinese counting" as they call it in England, or "Indian counting," as they call it in the United States, they are preserving, even if in a corrupted form, the sounds of very ancient numerals.

Sources.—Such relics of the far past are exceptional. The majority of nursery rhymes date back only to the 16th, 17th or more frequently, to the 18th century. Almost all of them appear to have been deliberate compositions rather than to have evolved over a course of years, and to have been primarily intended for adult entertainment. A number of them seem to have been popular ballads or songs. The original version of "The frog who would a-wooing go" was entered in the Stationers' Register as *A most Strange weddinge of the frogge and the mowse* in 1580. "Nose, nose, jolly red nose," which still flaunts its bacchanalian associations, was featured in *The Knight of the Burning Pestle* by Beaumont and Fletcher in 1607. A version of "Three blind mice" was printed, with tune, in Thomas Ravenscroft's *Deuteromelia* (1609). A verse of "There were three jovial Welshmen" appeared as "There were three men of Gotam" on a broadside of 1632, and may earlier have been known to Shakespeare (*The Two Noble Kinsmen* [1613], Act III, sc. v). "Lavender's green, diddle, diddle, lavender's blue" appeared on a broadside printed between 1672 and 1685. More recently, "If I had a donkey wot wouldn't go" was written by Jacob Beuler about 1822. "Oh where, or where has mine little dog gone?" was written in 1864 by Septimus Winner, and another song of his is still repeated in American nurseries:

> Ten little Injuns standin' in a line,
> One toddled home and then there were nine. . .

From this came the diminishing "Ten little nigger boys" of the

English nursery, written by Frank Green in 1869 for performance by the Christy minstrels.

There is no reason to think that many of these songs have a hidden significance, any more than have the popular songs of the present day. Some, naturally enough, were inspired by personalities of the time, and occasionally these can be identified. The original Elsie Marley who "is grown so fine, She won't get up to feed the swine" was almost certainly an attractive alewife living in county Durham in the 18th century; and "The brave old Duke of York" probably slanders Frederick, son of George III. Many political lampoons were brief doggerel verses, such as "Hector Protector was dressed all in green," "Little General Monk sat upon a trunk" and "William and Mary, George and Anne" (the daughters and sons-in-law of James II). "Jack Sprat could eat no fat" appears (at latest in 1659) to have been used to ridicule an Archdeacon Pratt, and local tradition in Somerset associates "Little Jack Horner" (recorded 1725) with a Thomas Horner of Mells who did well for himself during the dissolution of the monasteries.

Collections.—The earliest known collection of nursery rhymes, *Tommy Thumb's* (*Pretty*) *Song Book*, was published in London in two small volumes in 1744. Only a single copy of the second volume has survived, but it contains 39 rhymes including "Little Tom Tucker," "Bah, Bah, a black Sheep," "There was a little Man, and he had a little Gun," "Sing a Song of Sixpence," and "Who did kill Cock Robin?" The most influential collection in the 18th century was *Mother Goose's Melody: or, Sonnets for the Cradle*, printed *c.* 1780, but probably compiled earlier. This collection of 51 rhymes, including "Jack and Jill," "Ding dong bell," and "Hush-a-by baby on the tree top," was reprinted by Isaiah Thomas of Worcester, Mass., *c.* 1785, and it seems to be through this collection that the rhymes are frequently thought of as belonging to "Mother Goose." The name "Mother Goose" had been taken from *Mother Goose's Tales*, the familiar title of Charles Perrault's collection of fairy tales which had been translated into English in 1729. There is no verifiable evidence and little likelihood that a book called *Songs for the Nursery; or Mother Goose's Melodies for Children* was printed in Boston, Mass., in 1719; and the association of this legendary collection with one Elizabeth Goose (1665–1757) is merely delightful hey-diddle-diddle.

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NURSERY SCHOOL: *see* DAY NURSERY; PRE-ELEMENTARY EDUCATION.

NURSING as a profession is of comparatively recent origin, but the art of nursing in the form of nurturing the young, protecting the helpless and tending the sick and injured is at least as old as recorded history. The evolution of nursing in different countries has been extremely uneven. Historically, its development falls into four loosely defined periods: pre-Florence Nightingale, up to 1860; the pioneer Nightingale period, 1860 to about 1900; the period of expansion and professional organization, *c.* 1900–19; and the period of improved methods of nursing education, government recognition and growing international relationships, from about 1919 onward.

Before the Christian era, nurses, or attendants, are mentioned in the early medical records of China, India, Greece and Rome, but no reliable data about them exist. From the earliest Christian times nursing was regarded as a paramount duty of the church and with the rise of monasticism the care of the sick became the function of many religious orders of men and women. Among the earliest nursing records are those of the *hôtel Dieu* in Paris (early 7th century) and of the *hôtel Dieu* in Lyons (6th century). The military nursing orders, notably the Knights Hospitallers of St. John of Jerusalem (*c.* 1100), established well-equipped hospitals under rigorous quasi-military discipline. Many later nursing orders were important, *e.g.*, the Brothers of St. John of God in the 16th century and the world-famous Sisters of Charity, founded by St. Vincent de Paul, whose work began in 1633 under Mlle Le Gras (St. Louise de Marillac) and whose rule was confirmed in 1645.

The Reformation, with the suppression of monastic hospitals, left England without a system of hospital nursing and consequently nursing had no distinctive part in the colonial development of the United States. Hospitals built by the Spaniards in Latin America antedated those in the U.S. by about 300 years. The Jesuit missionaries in "New France" sent "relations," *i.e.*, reports, which aroused interest in France as to the needs of Canada's colonists. The first nursing sisters to cross the Atlantic ocean, in 1639, were Augustinians from Dieppe; they were established at the Quebec *hôtel Dieu* in 1658. Jeanne Mance (1606–73), the first white woman to arrive in Montreal, founded the *hôtel Dieu* there in 1644, assisted by nursing sisters of the order of St. Joseph de la Flèche, while herself remaining a lay woman. During the 18th century there was little development in Canada or elsewhere although Mme Marguerite d'Youville organized the Soeurs Grises at Montreal in 1755, and the Charity hospital, New Orleans, was staffed by Ursuline sisters from 1737 until Louisiana was purchased by the U.S. in 1803.

The early 19th century heralded the beginning of several nursing reforms. In Ireland, Catherine McAuley (1787–1841) started the Sisters of Mercy in 1831 and Mary Aikenhead (1787–1858) began the work of the Irish Sisters of Charity in 1834. In England two nursing sisterhoods of the Church of England, the Devonport sisters and St. John's House, began work in 1848; St. John's House undertook the nursing in King's College hospital in 1856 and later in several other London hospitals. In 1836 Pastor Theodor Fliedner and his wife established at Kaiserswerth, Ger., an institute for deaconesses in whose training nursing was included. At Lausanne, Switz., an independent school of nursing was opened, in 1859, in order to give young women theoretical and practical instruction in nursing. This school, La Source, was still active in the 1960s.

UNITED KINGDOM

The Birth of Modern Nursing.—Florence Nightingale (*q.v.*, 1820–1910) made outstanding contributions to the development of sanitation, medical statistics, military medicine and hospital administration, but she is best known as the founder of modern nursing. Although born to luxury and wealth, she was from her youth dissatisfied with a life of leisure. The administration of hospitals and the provision of proper nursing became her main interest. She visited several hospitals in Europe and in 1851 spent three months at the Deaconess institute at Kaiserswerth. In 1853 Miss Nightingale took charge of a small London hospital for gentlewomen, but a year later she undertook, at the request of the secretary at war, Sidney Herbert, the organizing and leading of a band of nurses for the British army hospitals in the Crimean War. This most difficult task was brilliantly accomplished and she returned to England a national heroine.

With a fund raised in her honour by public subscription, she established and financed the Nightingale training school at St. Thomas's hospital, London. The first 15 probationers entered the school on July 9, 1860, the date regarded as the birth of modern nursing. The basic principles of what came to be known as the Nightingale system of training, although subsequently often modified, included the following: (1) a trained matron (or superintendent) with undisputed authority over all members of the nursing staff, including those in training; (2) a planned course of theoretical and practical training, the latter to be given in the hospital with which the school was connected; (3) a home attached to the hospital in which carefully selected probationers were placed under a special sister responsible for their moral and spiritual character training.

The financial independence of the Nightingale school gave it the power to arrange for the practical training in the hospital, which should follow the course laid down by the school. The aims of the school were (1) to train the ordinary, or nurse, probationers as nurses for hospitals and for attending the sick poor at home, and (2) to qualify the pupils of superior education, *i.e.*, the lady,

or special, probationers, to become heads of new schools to train others. The Nightingale training was rooted in Christian ideals, based on strict discipline and imbued with a crusading spirit. It opened the door to a new profession for women.

Florence Nightingale's work and writings also emphasized the need for health teaching. In 1859 William Rathbone, in Liverpool, had introduced district nursing by employing a trained nurse to care for the sick poor in their own homes. In 1861 he wrote to Miss Nightingale for advice on how to establish a body of nurses trained for such work. In 1875 the Metropolitan and National Nursing association was established with her support. In 1887, to commemorate Queen Victoria's jubilee, a nationwide organization known later as the Queen's Institute of District Nursing was founded with the aim of preparing and maintaining nurses to care for the sick in their own homes.

By the end of the 19th century the Nightingale principles had been adopted by nurses' training schools connected with both voluntary and tax-supported hospitals in the English-speaking countries and had exerted some influence in continental Europe. The value to hospitals of nursing service by probationers, plus lack of endowments for independent schools, led to a type of apprenticeship training.

Professional Development.—Owing to the increasing demand for trained nurses in hospitals and elsewhere in the community, the need for a professional organization was apparent to some of the leading nurses in England before the end of the 19th century. The first such association was the British (later Royal) Nurses' association, founded in 1887 by Mrs. Bedford Fenwick, who before her marriage was matron of St. Bartholomew's hospital, London. One of the main objectives of the association was to obtain government registration for nurses and statutory control over standards of training. Several efforts were made without success to get a nurses' registration bill through parliament. The profession itself was divided on this issue: Mrs. Fenwick and her supporters believed that such a step was necessary in the interests of patients as well as of nurses; Miss Nightingale, on the other hand, was bitterly opposed to registration. She held that such action was premature and that examinations, which could never test the qualities of a nurse, would merely "standardize mediocrity." From 1887 to the end of World War I, the arguments for and against registration continued. In 1916 the College of Nursing, now the Royal college, was founded; one of its aims was to press for statutory recognition of the trained nurse. Finally, a nurses' bill was sponsored by the minister of health and the first Nurses act received the royal assent in Dec. 1919.

The State and Nursing.—The Nurses act, 1919, established the General Nursing council for England and Wales as the statutory body responsible for forming and maintaining a register of nurses. Similar acts established statutory bodies for Scotland (1919) and Northern Ireland (1922). The councils have the duties of approving hospitals as nurses' training schools, formulating the syllabus to be covered and conducting the examinations for admission to the register. Although the original intention was that this should be a register of general trained nurses, supplementary parts of the register were established, as a result of representation from special fields of nursing, for sick children's, fever (infectious disease) and mental nurses. There was a separate part for male general nurses, but this was later amalgamated with the general part of the register. The male nurse undergoes the same kind of training and largely performs the same duties as the female nurse, except that his study tends to specialize in genitourinary conditions in place of gynecology and midwifery.

The next legislation initiated was the Nurses act, 1943, which empowered the General Nursing council to form and maintain a roll of assistant nurses, to lay down the conditions for their training and to conduct the assessment for admission to the roll. This act also limited the right to use the title "nurse" to registered nurses, enrolled assistant nurses and those in training for admission to the register or the roll.

The National Health Service act, 1946, which was implemented in July 1948, brought all hospitals, with a few exceptions, under state ownership and in addition the community health services, including general medical practice, became part of the national service. The majority of nurses working in the United Kingdom are employed within the national health service, either in hospital, public health or midwifery. Salaries and conditions of service for all these nurses and training allowances for students and pupil nurses are nationally negotiated by the Nurses and Midwives Whitley council, composed jointly of a management and a staff side, this being one of the nine functional councils of the Whitley Councils for the Health Services.

In 1949 a further act enlarged the membership of the General Nursing council and gave it power to approve experimental programs of nurses' training and to allocate funds to hospital authorities for nurses' training. Regional committees were set up under the National Health Service act under the name of Area Nurse-Training committees to advise and assist nurses' training schools in their respective areas. The 1949 act also gave the council power to register nurses who had trained abroad. In 1957 a new act consolidated the previous 1919, 1943 and 1949 Nurses' acts.

The treatment and care of persons suffering from mental disorders was formerly largely limited to custodial care, which had as its main aim preventing the patient from harming himself or other people. The admission of patients and the administration of institutions for the mentally sick or the mentally subnormal were governed by the various acts relating to lunacy and mental treatment passed between 1890 and 1930 and the Mental Deficiency acts of 1913 to 1938. As knowledge of and interest in mental illnesses increased, the old idea of providing primarily custodial care gave way to the conception of the hospital as a therapeutic community. The Mental Health act, 1959, repealed the previous acts and hospitals for the mentally disordered are no longer differentiated by any legal or statutory requirements from hospitals admitting other types of patients. The act also envisaged considerable changes and progress in the treatment of mental illness in the hospital and in the community.

Nursing Education and Training.—The extension and development of the medical and health services, resulting from an increased knowledge and understanding of the causes and processes of disease and from the changed social pattern of modern life, have not only extended the scope of the nurse's work but also have made her responsibilities increasingly more complex and exacting. Furthermore, she is now expected to take part in the regular life of the community; no longer is she set apart by compulsory residence within the nurses' home of the hospital, nor is she isolated by long and inconvenient hours of work and a low level of remuneration, conditions that had made it difficult for her to participate in normal social and cultural pursuits. The basic preparation for nursing underwent many adjustments until it came to be considered a form of adult education as well as training for skilled professional service. Postcertificate education became increasingly necessary in order to prepare the nurse for work in a special field, or for community service, or to qualify her for teaching and administration.

The basic training course for the general part of the register (state-registered nurse, abbreviated S.R.N.) is undertaken in a hospital, or group of hospitals, approved by the General Nursing council for this purpose and, with the exception of certain experimental programs of training, covers a period of three years. Qualified nurse-teachers and medical lecturers are responsible for the theoretical side of the training; practical experience must include general medicine and training in surgical, sick children's and (except for men students) gynecological nursing. A variety of experience is gained under general medicine and surgical nursing in most training schools, such as ear, nose and throat, eye and orthopedic conditions. Many training schools include in addition one or more periods of specialized experience within the three-year training, for example, geriatric or psychiatric nursing, and obstetrical nursing for women students.

A few training schools have included some practical experience in home nursing and health teaching outside the hospital in their basic training, and some interesting experimental projects aim at preparing the nurse both for general nursing and for work in the

public health field and home nursing in a combined course of approximately four years' duration.

Training in psychiatric nursing for the qualification of registered mental nurse (R.M.N.) or registered nurse for the mentally subnormal (R.N.M.S.) also takes three years, but a nurse who is already admitted to one part of the register can qualify for admission to a second part in a shorter period. This is normally two years, but a number of training schools have been allowed, under the provision for experimental programs of training, to give an 18-month postregistration training to general trained nurses. Similarly the qualifying course for registration on the part of the register for sick children's nurses (R.S.C.N.) is of three years' duration. A number of training schools combine this course with preparation in general nursing; the dual qualification (*i.e.*, as S.R.N. and R.S.C.N.) can be obtained in four years' training. The training for admission to the part of the register for fever nurses (R.F.N.) is of two years' duration and again the training can be combined with general training to give the dual qualification. However, the diminution of the incidence of infectious diseases has reduced the number of hospitals required for this purpose, although there is a continuing need for isolation units.

The majority of training schools for the register set their own standards for admission in terms of general education. In July 1962 it became compulsory in England and Wales for all candidates who did not hold a recognized educational certificate to pass the General Nursing council's entrance test. The minimum age of entry to training under the council's rules is 18.

Training for the roll (see *The State and Nursing* above) is of two years' duration. In 1960 the term "assistant" was withdrawn from the title "state enrolled assistant nurse," and the qualification "state enrolled nurse" was authorized in parliament. The assessment (the type of examination used in this training) may be taken at the end of one year, although many training schools prefer to enter their pupils at the end of 18 months' preparation. This type of training is mainly practical, but a certain amount of relevant theoretical work is necessary and each approved training school must appoint a nurse to give this teaching. Any type of hospital that can meet the General Nursing council's requirements may be approved for this training, but the pupil nurse is required to have experience in the nursing of men, women and children (except in the case of male pupils) and to work in both long-stay wards and wards for acutely ill patients.

The many and varied courses available to nurses after registration are for the most part not the responsibility of the General Nursing council, with the exception of the training of nurses as teachers. The General Nursing council (for England and Wales) and the councils for Scotland and Northern Ireland have the duty however, of registering qualified teachers for schools of nursing. The regulations for such registrations are laid down in consultation with the university under whose aegis the course is conducted: in the case of the General Nursing council for England and Wales this is the University of London; in Scotland the course for nurse-teachers is conducted by the nursing studies unit in the University of Edinburgh. Courses are offered by professional nursing groups and other bodies and some courses, in addition to the teachers' course mentioned above, are associated with a university.

Apart from the combined experimental programs of training, additional qualification is required for public health nurses after they qualify for registration. District nurses' training under the Queen's Institute of District Nursing, Ranyard nurses or a local health authority is a four or six months' course, followed by examination for the national certificate of the ministry of health. Local health authorities have a statutory duty (under the National Health Service act, 1946) "to make provision for the visiting of persons in their homes by visitors to be called "health visitors" for the purpose of giving advice as to the care of young children, persons suffering from illness and expectant or nursing mothers, and as to the measures necessary to prevent the spread of infection."

The present function of the health visitor is primarily health education and the care of mothers and their young children. She also has responsibility for the prevention of illness both mental and physical, the care of the mentally subnormal, also the physically handicapped, the aged and infirm. She may be employed on general duties, or as a school nurse or in special projects or conditions such as tuberculosis. The examining body for the health visitor's certificate was the Royal Society for the Promotion of Health until the Council for the Training of Health Visitors was appointed in 1962 by the government. The course lasts one academic year, following registration as a general or sick children's nurse and successful completion of the first part of the midwifery course (six months).

Although the majority of midwives in England are also trained nurses, the training and control of midwives is conducted by a separate authority, the Central Midwives board. Statutory control of the practice of midwifery antedated similar control of nursing by 17 years, the Midwives act having been passed in 1902. For registered nurses midwifery training is a one-year course that may be taken in two parts. Part I is required for many nursing positions, part II for those intending to practise as midwives. The training is for two years for those without registration as a nurse, and the minimum age of entry is 20. (*See* also MIDWIFERY.)

Nursing Service.—The qualified nurse has a great range of opportunities from which to select the type of work best suited to her. As a staff nurse or ward sister in a hospital she may care for patients of any age from premature babies to the aged sick; she may work in medical or surgical units or in research wards where radioactive substances are used in diagnosis or treatment; in operating theatres she will be one of the surgical team carrying out operations of all kinds; she will assist in the treatment and investigation of all the varied conditions seen in the casualty (emergency) and outpatient departments. If specially suited to teaching or administration she may qualify as a tutor or matron after adequate nursing experience.

All local authority health services employ midwives, district nurses, school nurses and health visitors; many appoint specially prepared nurses with experience as supervisors and public health nurse tutors. Outside the health service nurses specially concerned with welfare and the prevention of illnesses or injury are employed in major industrial and commercial concerns as occupational health nurses. Private nurses, maternity nurses and private visiting nurses work independently or through a co-operation (*e.g.*, an employment register conducted by a nurses' association) or a private employment agency.

Hospitals in prisons are staffed by nurses appointed to the nursing service of the government prisons; these nurses also provide the maternal and infant welfare services required and nursing care in preventive detention institutes.

State-registered nurses serve as officers with the armed forces in Queen Alexandra's royal naval nursing service, Queen Alexandra's royal army nursing corps and Princess Mary's royal air force nursing service, each of which has a matron in chief. Nurse training is also offered in all three services to noncommissioned ranks, who thus qualify for registration by the General Nursing council.

Nursing appointments abroad are available, through Queen Elizabeth's overseas nursing service, in colonial and former colonial countries where rapid development increased the number of nursing schools with curricula and standards comparable with those in Britain. As the numbers qualifying from these schools increased, the new nurses were expected to staff the hospital and health services of the country, but there continued to be a great need for nursing administrators and teachers to help develop these services.

In the local, regional and national administration of the hospital and health services of the United Kingdom, nurses were being appointed in the 1960s as nursing officers or as members of advisory councils or boards of management. They also were appointed as members of special teams, research groups and planning commissions. Nurses are elected to the council responsible for nurses' training and registration; nurses appointed as chief nursing officers in government departments (*e.g.*, the ministry of

health) take part in the planning and administration of nursing and allied services at the national level.

The number of nurses practising in Britain cannot be stated with complete accuracy because of fluctuating conditions and the varied bases for making personnel returns. In the British national health services in Sept. 1962 there were the following: in hospitals, 54,902 full-time nurses and 18,470 part-time nurses (not including midwives); in local health services, 10,588 domiciliary nurses (including 352 male nurses), 7,884 midwives, 4,657 general health visitors, 367 health visitors who specialized in tuberculosis and 544 clinic nurses. Health visitors are also employed as school nurses (under the ministry of education) and occupational health nurses may be health visitors but neither they nor private nurses come under the health service, so that figures for them were not available.

OTHER COUNTRIES

In Canada, Australia, New Zealand and South Africa, the early development of the nursing service and of nurses' training followed, as might be expected, the British pattern as established by Florence Nightingale. Geographical and other factors influenced their later developments, as, for example, in Canada, where the close relationship between that country and the United States considerably influenced nurses' training and led to the increasing adoption of graduate courses leading to a degree in nursing. Also in Canada, especially in the French-speaking regions, there existed hospitals and nurses' training schools that had been under the direction of French religious orders from early days. In Australia and New Zealand nursing continued to develop along lines very similar to those in the United Kingdom.

In several European countries, notably in those of Scandinavia and of Finland and the Netherlands, professional nursing had achieved a high standard by the end of the 19th century. The schools were frequently attached to hospitals, following the English custom, but many were modeled on the motherhouse pattern, whether run by deaconesses or by the Red Cross. Other schools were organized by Roman Catholic orders, which in many countries (*e.g.*, France, Italy, Belgium and Germany) are actively concerned with hospital and public health nursing.

In the modern age of quick and easy transport, and with the increasing desire of professional people everywhere to have worldwide contacts with their colleagues, nurses from the United Kingdom, Canada, Australia, New Zealand and South Africa are finding many opportunities of visiting and working in each other's countries. Registered nurses from one country may be accepted as fully qualified professional nurses in other countries, although registration is not automatic.

Possibly nowhere has the development of the profession made more rapid strides than in such present or former British Commonwealth countries as those of east and west Africa, the Caribbean territories, the far east, India, Burma and Malaya. The government medical and nursing services formerly depended on the United Kingdom for their senior medical and nursing staff and the only nurses' training given locally was at first often necessarily of a simple type, partly on account of language difficulties, partly because of the lack of opportunities for general education. In a number of countries tradition or religious customs did not favour women's taking part in any kind of public activities and they particularly were against any form of nursing that required women to work in male wards. When such countries became independent, nurses and midwives boards or councils were established and were made responsible for registration and for the standards of training. Also established were schools of nursing that met or would soon meet the requirements for full professional training. Nursing progress in these countries was also greatly helped by the hospitals and schools established by religious bodies of many denominations and from many countries. It may be truly said that the missionary societies were, in many cases, the first authorities to provide education, and through their schools they materially aided the advances in both medical and nursing training, since progress in establishing such training depended on the attainment of a satisfactory level of general education. Full university education became available to an increasing number of persons in many of these countries, and where a faculty of medicine is included in the university program an undergraduate medical teaching hospital provides the spearhead for progress in both medicine and nursing.

An increasing number of nurses who receive their basic training in their own country in Asia, Africa and the Caribbean now travel abroad to Europe and elsewhere to take advanced nursing courses that prepare them for posts of the highest level in their own nursing service. At the same time, some of these countries need help from outside and a number of posts are open to nurses from the countries with established nursing services.

In many countries, including most European countries, the nursing service and the training of nurses is undertaken both by religious bodies and by the state or the national Red Cross society. In general, the duration and scope of the training is broadly comparable to the training of the registered nurses in the United Kingdom, although in some countries, such as Finland and France, considerably more emphasis is placed on the dual aim of the basic training of the student, *i.e.*, preparing her for work in the public health field and in the hospital. However, the need for closer contact between community and hospital nursing services is everywhere now recognized. Again, apart from language difficulties, very few barriers prevent nurses from profiting by contact with their colleagues in any part of the world. In some instances, regulation regarding work permits will not allow the paid employment of foreigners, but the exchange of nurses, particularly for study and visits of observation, is in most cases arranged without difficulty by the national nurses' associations through the exchange program of the International Council of Nurses.

INTERNATIONAL NURSING

As countries develop their health and hospital services the need for more and better qualified nurses becomes apparent. The World Health organization, after the First World Health council in 1948, adopted three gradually defined objectives concerning nursing in each country: enough nurses to assure the nursing service required for preventive and curative work; nurses capable of leadership in teaching and administration; and nurses able to participate in the planning of health services. The first teams sent to countries to tackle such problems as malaria, tuberculosis and venereal diseases, or to develop maternal and child health services, included a nurse member. Later, international teams included a senior nurse educator, a midwifery tutor and a public health nurse, all three of whom worked with the national staff in selected schools in order to form the qualified staff the country would continue to need for providing the necessary services.

Differences in nurse training in the rapidly developing countries include: combining the preventive with the curative aspects throughout training; including maternity nursing in the basic program; and introducing some preparation in teaching and administration.

The International Council of Nurses (I.C.N.), a federation of independent self-governing nurses' associations, was founded by Mrs. Bedford Fenwick of England in 1899. The first three member groups were the associations of the United Kingdom the United States and Germany. By 1961 national nurses' associations in 59 countries had joined the council and a nurse representative had been appointed in 12 other countries. The first international congress was held in Buffalo, N.Y., in 1901. The I.C.N. maintains contact with the World Health organization and other UN agencies such as the Economic and Social council, the International Labour organization and the United Nations Children's fund; in addition it belongs to the International Hospital federation and the World Federation for Mental Health. The objectives of the I.C.N. are the promotion of self-governing national nurses' associations in order to provide and maintain the highest standards of nursing service and nursing education, to promote the economic and social welfare of nurses and to encourage the interchange of knowledge and ideas on all matters relating to nursing as a professional service. *See* also HOSPITAL; RED CROSS.

(L. R. SE.; M. L. W.; MA. H.)

UNITED STATES

History.—The beginning of professional nursing in the United States dates from the early 1870s, when the first schools of nursing were established. Prior to that time the sick in hospitals were cared for by members of religious orders, both Roman Catholic and Protestant, or by untrained employees.

The first secular hospital was established on Manhattan Island by the Dutch West India company in 1658 as a pesthouse for soldiers and sailors. It later became a combination of city poorhouse, house of correction and penitentiary, orphan asylum and hospital for the pauper sick and insane. Much later, it became Bellevue hospital. Old Blockley, founded in 1713 in Philadelphia, had a similar history and characteristics—squalor, filth, high death rate, indifferent medical staff and ignorant, rough attendants. It was to become the Philadelphia General hospital many years later.

The Pennsylvania hospital, founded in Philadelphia in 1751, was the first secular hospital without workhouse qualities. The New York hospital was founded in 1771. Each of these employed a staff of nurses who were paid though they were still classed as domestics and had no training. Valentine Seaman, a physician at the New York hospital, developed in 1798 a course of 24 lectures for nurses, the first organized training for nurses in the U.S.

Nursing services for mothers and infants at home were first provided by the Ladies' Benevolent society of Charleston, S.C., in 1813 and by the Philadelphia Laying-in charity in 1828. Later, the "nurses" in these services were given small amounts of instruction.

When the American Civil War began, no trained nurses were available. Volunteer women in New York city organized the Women's Central Association of Relief, which later became the U.S. Sanitary commission. The commission organized volunteer groups, initiated intensive short training programs and disseminated literature on care of the sick and injured to government and other agencies and to some groups in the south. Its work could be considered similar to that of the modern American Red Cross. About 2,000 women volunteered in the south and the north. Most of the Civil War nursing for both armies was done by untrained volunteers and by orderlies drawn from enlisted men.

Dorothea Dix, who had organized the Western Sanitary commission, was designated by the U.S. government in June 1861 as superintendent of nurses. Clara Barton (*q.v.*), who in 1881 was to persuade the government to ratify the Geneva treaty of the Red Cross, served as a nursing volunteer during the Civil War.

After the war the reform movement in all health fields, including nursing, moved ahead rapidly. Louisa Lee Schuyler, who had served on the U.S. Sanitary commission and later in the State Charities Aid association (New York), organized hospital visits to study conditions in that state. At Bellevue the reformers found that patients were neglected and that nurses were vagrants or workhouse prisoners who terrorized the sick, accepted fees and could not be trusted with medicines or food. Action was taken at once to establish a school of nursing based on the Nightingale pattern. The school at Bellevue was established in 1873 along with two others in New Haven, Conn., and Boston. Opponents of this plan, among them physicians who did not approve of the school's independence and its direction by a nurse, were soon won over by the excellent nursing care given by the students and young graduates of the school.

The number of schools of nursing increased rapidly in the next 50 years, reaching more than 2,500 by 1925. The independence of schools from hospitals weakened markedly as the years passed, as did the idea that students were to receive selected educational experiences rather than to staff the hospital. Graduates found employment primarily with private patients at home, or sometimes in hospitals; only after 1930 did hospitals begin to employ graduate nurses to care for their patients and at the same time they began to decrease their dependence on student nurses to provide the major portion of their nursing services.

The first state law setting forth requirements for state examination and registration of nurses was passed in 1903 by North Carolina. All states had such laws within 20 years.

In 1886 visiting nurse societies began to expand. A new approach, a nurses' settlement on Henry street in New York city, was established by Lillian Wald in 1893. She coined the phrase "public health nurse." Miss Wald played a leading role in starting school nursing (in New York, 1902), helped establish home visiting by nurses to industrial holders of life insurance policies (1909), participated in the institution of a rural public health nursing service by the American Red Cross in 1912 and promoted the establishment of the Children's bureau in 1912.

Visiting nurse societies were established in large cities, often with financial support from community chests and philanthropic agencies. Many public health nursing methods received their initial trial in these societies, spreading later to official public health nursing agencies.

When tuberculosis was found to be a preventable disease, city health departments began about 1900 to employ nurses to visit patients in their homes, often at the insistence of and with help from tuberculosis associations. As public health movements expanded and government health agencies in states, cities and counties increased in number and scope, nurses were employed in greater numbers and for a wider variety of activities, first for special programs, later as generalists.

An unusual agency in a rural area was the Frontier nursing service, organized in 1925 by Mrs. Mary Breckinridge to carry out a nursing program among mountain families in southeastern Kentucky. The service began in a county without roads passable to motor traffic, and the nurses rode horseback. By the mid-1960s the service had been extended over a four-county area with a population of more than 9,000 and its facilities had been expanded to include a hospital directed by a physician, outpost clinics staffed by nurse-midwives and a school of midwifery.

The first national organization in nursing was founded after a conference on hospitals, dispensaries and nursing at the Chicago World's fair of 1893. At first it was called the American Society of Superintendents of Training Schools for Nurses, and in 1912 it became the National League of Nursing Education. Improvement of nursing education throughout the United States was its aim.

A second organization, called the Nurses Associated Alumnae of the United States and Canada, was founded in 1896. All nurses were eligible for membership. The organization, which became the American Nurses' association in 1911, focused its attention on problems of practice and legislation and the legal status of nurses. State and district associations were established throughout the nation.

In 1912 the National Organization for Public Health Nurses (later Nursing) was founded for the purpose of improving services in both government agencies and the growing number of voluntary visiting nurse services. It also carried on a program of improvement and standardization in the education of public health nurses.

The National Association of Colored Graduate Nurses was formed in 1908. It worked for higher standards of education and development of leaders among the group and against discrimination. While none of the other national organizations in nursing had excluded members on the basis of race, some state branches did so. The aggressive and successful efforts of the National Association of Colored Graduate Nurses, with support of the other organizations, culminated in the dissolution of this association in 1951 and the merging of memberships.

Just as the Civil War called national attention to the importance of nursing to the nation, so did subsequent wars. The Associated alumnae had pressed for use of qualified nurses in the Spanish-American War and the organization of a nurse corps in the military establishment. The army nurse corps was authorized in 1901 and the navy nurse corps in 1908. In 1909 the Associated alumnae volunteered to organize a Red Cross nursing reserve to act as a group of trained nurses to serve in disasters as well as in war. Jane Delano of the Red Cross led the combined planning so that by World War I this plan was in operation. After the war it provided both military and civilian nurses for work in former Spanish colonies and initiated the interests of American nursing in international health. During World War II, recruit-

ment to the military nurse corps became direct, with strong support of the Red Cross.

The first five nursing education programs in colleges or universities combining general and professional education and leading to the bachelor's degree were founded in 1916. The first university course for graduate nurses was given in 1899 and this expanded into programs at Teachers college, New York, in which nurses could qualify for the bachelor's degree and later for the master's and doctoral degrees. Other universities also developed both basic and advanced programs.

From the end of World War I through 1950, nursing experienced many studies and self-analyses. Among these was the Goldmark report in 1923, financed by the Rockefeller foundation, which revealed needs for an improved educational system. The Grading Committee study (1927–34) resulted in information needed for improvement and in many recommendations for improvement. The national organizations, with support from many sources, implemented many of these recommendations.

World War II greatly increased the demands for both civilian and military nurses. Congress authorized the Cadet Nurse corps program, in which nearly 170,000 students were recruited for schools of nursing. Nurses volunteered in large numbers for military service and at the peak period in 1945 there were more than 70,000 nurses in the U.S. armed forces. Nursing and related organizations and government nursing services worked together through the National Nursing Council for War Service.

Following the war, the national nursing associations were reorganized. Five associations—the American Nurses' association, the National Organization for Public Health Nursing, the National League of Nursing Education, the Association of Collegiate Schools of Nursing (founded 1933) and the National Association of Colored Graduate Nurses—became two groups in 1952, namely, the reconstituted American Nurses' association and the National League for Nursing. The former is composed solely of nurse practitioners and the latter is composed of nurses, practical nurses and aides, physicians, general educators, hospital and public health administrators and private citizens, as well as of institutional members—*e.g.*, schools of nursing and public health nursing agencies.

Current Situation.—More than 500,000 professional nurses were at work in the U.S. in the mid-1960s. They provided nursing services in more than 7,000 hospitals, 3,500 public health agencies, and in health programs in 4,000 public school systems. Some served in physicians' offices, nursing homes and in industrial plants. Nurses provided direct services in all these situations and also supervised and administered nursing services. They taught in schools of nursing and served as directors and deans of these schools. Some served as consultants with government and voluntary agencies. Some assisted in the conduct of research or carried on their own researches. Some wrote the literature of nursing. More than 60% of the 500,000 nurses worked in hospitals. About 1% of the nurses were men.

Another nearly 500,000 professional nurses in the U.S. are inactive in nursing. Most are married and in younger age groups. Beginning in 1950 an increasing number of these nurses returned to active status, many on a part-time basis. Nurses can usually resume active practice without additional training other than a refresher course, which usually is provided by the employing institution.

About 250,000 practical nurses work in hospitals, physicians' offices and nursing homes. In hospitals approximately 400,000 nursing aides, trained only on the job, assist nurses in caring for patients. The high ratio of untrained workers in hospitals underscores the shortage of professional and practical nurses.

The number of professional nurses was increasing more rapidly in the 1960s than the population of the United States. But the demand for services was increasing more rapidly than the supply of nurses. Factors creating the demand for nurses were: rapid scientific advance in medicine; expansion of hospitals and other health facilities and agencies; and an increase both in the population and in the proportion of it that seeks health care. Each medical discovery adds new ways in which nurses can serve; and more people were demanding the new benefits. Insurance plans for prepayment of hospital and medical expenses and widespread information about health and sickness bring more people to health facilities. New plans for care of the chronically ill and aged in their own homes require more nurses. Development of better community and institutional services for the mentally ill and mentally retarded was expected to increase the demands for nursing services still more.

The demands for nursing services increase qualitatively as well as quantitatively and bring changes in education for nursing. Deeper background in biological and physical sciences is required to understand and use the new diagnostic and therapeutic measures; greater knowledge of behavioural and social sciences is required to understand community relationships and health-related services as well as to gain insight into patients' feelings about illness and motives for recovery. For these reasons, collegiate education for nurses came to be emphasized.

The educational system for nursing is comprised of three major types of programs: (1) the collegiate program, four years in length, combining professional and general education and leading to the bachelor's degree; (2) the hospital school program, three years in length, leading to a diploma; and (3) the junior college program, two years in length, leading to an associate degree. Graduates of all these programs are eligible to take the state examination; after passing it, they are authorized to use the title registered nurse (R.N.).

There were approximately 175 collegiate programs, 850 hospital schools and 100 junior college programs in the U.S. in the mid-1960s, graduating about 32,000 nurses each year.

For advanced and special education, nurses undertake graduate study in universities. Thirty-four universities offered a variety of graduate programs in the mid-1960s. More than 1,000 nurses receive master's degrees annually and a small but growing number receive doctoral degrees. These nurses are qualified for administrative, teaching, supervisory, research, clinical specialist or consultative positions.

Practical nurses are prepared in one-year educational programs, some of which are operated by hospitals although most are conducted by vocational schools. The rapid expansion in practical nurses' schools after World War II was in large part attributable to federal financial aid under a vocational education program. There were more than 700 schools of practical nursing in the United States in the mid-1960s. After completing a state-approved program, graduates are eligible to take the state examination and, after passing it, to use the title licensed practical nurse (L.P.N.) or, in a few states, licensed vocational nurse (L.V.N.). A considerable number of practical nurses who achieved their skills through experience, not training, are licensed under a waiver of regulations. This number decreases each year.

The definitions of the practice of professional nursing and of practical nursing, and the legal control of practice, are established by the nurse practice acts of each state. The American Nurses' association has formulated items that it recommends for inclusion in such legislation; it seeks revisions of state laws so that standards of education and practice attain a uniformly high level.

The American Nurses' association formulates and promotes a code of ethics for members of the nursing profession, as does the National Federation of Licensed Practical Nurses for practical nurses. The American Nurses' association operates a program aimed at economic security for nurses. It also works to increase the clinical competence of its members. Through the association nurses of the United States are members of the International Council of Nurses.

The National League for Nursing operates a voluntary accreditation program for schools of nursing. About 60% of the U.S. nursing schools are so accredited. The league provides information for recruiting students to the schools and also maintains a program of school improvement; similarly, it works to improve public health nursing services through its member agencies.

The official organ of the American Nurses' association is the *American Journal of Nursing* (founded in 1900); *Nursing Outlook* is the official publication of the National League for Nursing.

A quarterly journal, *Nursing Research*, is sponsored by both.

The nursing councils of two regional organizations—the Southern Regional Education board and the Western Interstate Council on Higher Education—carry on programs aimed at improving nursing education in their regions.

Government Role in Nursing.—Several departments of the federal government carry on activities in nursing. The department of labour compiles and distributes manpower and salary data on nursing. The department of defense maintains three corps of nurses—army, navy and air force—totaling about 8,500 nurses who staff military hospitals and plan the nursing role in national defense. The Veterans administration is the largest single employer of nurses in the United States; about 15,000 nurses work in its hospitals.

The children's bureau of the department of health, education and welfare provides leadership to nursing in the care of mothers and babies; the office of vocational rehabilitation plays a similar role in restorative nursing. The office of education administers the program of federal aid for practical nurse education.

The public health service of the department of health, education and welfare employs 2,500 nurses. In addition to operating its hospitals, which include those for American Indians, this service conducts research in nursing and administers a research grant program. It also administers scholarship programs under which, by the mid-1960s, 11,000 nurses had completed graduate preparation for teaching and administration and 2,500 nurses had completed graduate study in mental health nursing. It also provides nursing consultation service to voluntary and official health agencies and institutions in a wide variety of public health fields.

Most states employ nurses in state hospitals, the state health department and other governmental agencies. County and local governments employ nurses in similar capacities. (L. P. LE.)

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NUSAYBIN (NISIBIN; ancient NISIBIS), a small frontier trading town of Mardin *il* (province), Turk., situated near the Syrian border about 130 mi. N.W. of Mosul, Iraq. Administratively, it is the centre of a *kaza* (district) of the same name. Pop. (1965) town 7,241, district (1960) 29,685. It lies at the point where the Gorgarbonizra river (Cagcaga, Jaghjagha; ancient Mygdonius) passes through a narrow canyon and enters the plain, and strategically, like Edessa, it commanded the entrance of the valley country from the mountains. During the Assyrian empire it formed a frontier fort against aggressions from the north and occupied a similar position in Seleucid times. From the middle of the 2nd century B.C. until the early years of the Christian era, it was the residence of the kings of Armenia. The fortress was important during the struggle between Rome and Parthia, and it became a Christian centre with a Nestorian (*see* NESTORIANS) and a Jacobite bishop. Under the caliphs it was a frontier stronghold and the scene of continuous fighting. It finally declined because of internal troubles and, according to the Arab chroniclers, the compulsory substitution of wheat for fruit crops. Nusaybin remains of some significance, however, because of its position on the upper trade route from Mosul to the west and its location on the Aleppo-Baghdad railway.

(N. TU.; S. ER.; E. TU.)

NUSKU, a light and fire god in the Sumero-Akkadian pantheon. Shulgi, second king of the 3rd dynasty of Ur, *c.* 1900 B.C., gives the god the title "exalted vizier of Enlil"—*i.e.*, of the second member of the cosmic triad of deities. On tablets of the same period from Drehem, near Nippur, Nusku is named together with Nergal, the god of the underworld, in lists of offerings. His father was Sin, the moon-god, whose cult centre was at Ur in Sumerian times and at Harran in Neo-Babylonian times. But while Sumerian tablets from Ur do not mention Nusku, a historical text relates how Nabonidus, the last Babylonian king, brought him from Babylon to Sin's temple at Harran (6th century B.C.).

Semitic texts describe Nusku as the king of the night, who illumines the darkness and repels the demons of the dark. On Babylonian boundary stones he is identified by a lamp. He is visible at the new moon, hence is called its son. The last day of the month is sacred to him, so that he is a lunar deity. He figures much in incantations and rituals as the fire. Without his firelight there would be no banquets for the gods, no sweet smell of incense, nor could Shamash, the sun-god, exercise judgment. In an Assyrian prayer Nusku is described as "counselor of the heart of the god Marduk."

A temple rubric of Seleucid date from Uruk (biblical Erech) in southern Babylonia directs that Nusku, "with the torch," shall proceed with other deities to the sanctuary of the goddess Antu, wife of Anu, god of heaven.

On stele of the 7th century B.C. from Nerab near Aleppo, Nusku, written Nushku, is named alongside the Aramaean moon-god Shahar.

For bibliography, *see* ADAD. (T. FH.)

NUT, generally any seed or fruit consisting of a kernel, usually oily, surrounded by a hard or brittle shell. Most edible nuts, *e.g.*, almond, walnut, Brazil nut, peanut, etc., are well known as dessert nuts. Not all nuts, however, are edible; some are used as sources of oil or fat and may be regarded as oil seeds (*see* OIL PLANTS); others are used for ornament. The botanical definition of a nut, based on morphological features, is more restrictive: a hard, dry, one-celled, one-seeded fruit that does not split open at maturity. Among the nuts that fit both the botanical and popular conception are the acorn, chestnut and filbert; other so-called nuts may be botanically seeds (Brazil nuts), legumes (peanuts) or drupes (almond, coconut, pecan and walnut). In this article the term nut will be used in its broadest sense unless otherwise indicated.

IMPORTANCE AND USES

Dietetic Value and Use as Food.—From the earliest times nuts have been food for man and are still of great importance in many parts of the world; *e.g.*, the coconut in the eastern tropics and the groundnut in China, India and Africa. In most western countries nuts do not constitute part of the staple diet, except perhaps of vegetarians, but they are popular for between-meal snacks and as dessert. Large quantities of nut kernels are also used in candies and in processed foods of various kinds.

The dietetic or food value of nuts is high; most dessert nuts are rich in protein and oil or fat, and also in mineral matter. Many nut kernels consist of more than 50% fat and average in excess of 20% protein, while vitamins may be present in appreciable quantities. Nuts are therefore a concentrated food.

Most nuts are eaten raw, though some nuts, such as the almond and the macadamia, are equally palatable raw or cooked and others, such as the peanut and chestnut, have a better flavour when cooked and salted. The flavour of nuts is largely dependent on the oils they contain and these may be modified in cooking.

Modern methods of processing, packing and storing nut kernels,

Common names	Scientific name	Original source	Principal use of nut
Almond (sweet)	*Prunus amygdalus*	Mediterranean basin	Food
Almond (bitter)	*P. amygdalus*, var. *amara*	Mediterranean basin	Flavouring extract; oil
Almond, Indian	*Terminalia catappa*	East Indies	Food
Almondette	*Buchanania lanzan*	India, Burma	Food
Araucarian pine nut (piñon, pinyonie)	*Araucaria araucana*	Chile	Food
Arnut (yer-nut, earth chestnut, hawk nut, lousy-nut)	*Bunium* species	W. Europe to Caucasus	Food
Australian nut, *see* Macadamia			
Babassu nut	*Orbignya oleifera*	Brazil	Food; fuel oil
Bambarra groundnut	*Voandzeia subterranea*	Tropical Africa	Food
Barbados nut (physic nut)	*Jatropha curcas*	Tropical America	Medicine
Baroba	*Dispoldiscus paniculatus*	Philippines	Starchy seeds boiled and eaten
Beech nut, American	*Fagus grandifolia*	E. United States	
Beech nut, European	*Fagus sylvatica*	Cent. Europe, S.W. Asia	Salad oil
Ben nut	*Moringa oleifera*	India, West Indies	Artists' oil; lubricant
Betel nut (areca nut, pinang)	*Areca catechu*	E. tropics	Masticatory
Bladder nut	*Staphylea* species	Temperate North America, S. Europe, S. Asia	Necklaces
Bomah nut	*Pycnocoma macrophylla*	Africa	Tanning; poison
Bonduc nut	*Caesalpinia bonduc*	Tropics	Medicine; beads
Brazil nut (castanea, creamnut, para nut)	*Bertholletia excelsa*	N. South America	Food (*see* BRAZIL NUT)
Breadfruit, African	*Treculia africana*	Tropical Africa	Seeds ground for meal
Bread nut	*Brosimum alicastrum*	Tropical America	Food
Butternut (long or white walnut)	*Juglans cinerea*	E. United States, S.E. Canada	Food (*see* BUTTERNUT)
Butter pit, *see* Naras nut			
Candle nut	*Aleurites moluccana*	Malaysia	Drying (*see* ALEURITES)
Cashew (acajou, caja, cajou)	*Anacardium occidentale*	West Indies, tropical America	Food (*see* CASHEW)
Castanopsis nut (golden chinquapin, wild chestnut)	*Castanopsis* species	S.E. Asia, California	Food
Chestnut	*Castanea* species	E. United States, S. Europe, N. Africa, Asia	Food (*see* CHESTNUT)
Chile hazel	*Gevuina avellana*	Chile	Food
Chile pine nut, *see* Araucarian pine nut			
Chinquapin	*Castanea* species	S.E. United States, China	Food (*see* CHESTNUT)
Chufa (rush nut, earthnut, ground almond)	*Cyperus esculentus*	S. Europe	Food
Cobnut, *see* Filbert			
Cobnut, Jamaican	*Omphalea diandra*	West Indies, tropical America	Food; oil
Coconut	*Cocos nucifera*	Tropics	Food; oil (*see* COCONUT PALM)
Cohune nut (cahoun nut)	*Attalea cohune*	Honduras	Oil
Cola nut, *see* Kola nut			
Coquilla nut	*Attalea funifera*	Brazil	Turnery
Coquita nut (coker nut)	*Jubaea spectabilis*	Chile	Oil; food
Coumara nut, *see* Tonka bean			
Dika nut	*Irvingia gabonensis*	W. Africa	Food; oil
Doum nut (dom nut)	*Hyphaene thebaica*	N. and central Africa	Turnery; vegetable ivory
Filbert (hazelnut)	*Corylus* species	E. North America	Food (*see* FILBERT)
Galo nut	*Anacolosa luzoniensis*	Philippines	Food
Gasso nut	*Manniophyton africanum*	W. Africa, Congo	Food
Gevuina nut, *see* Chile hazel			
Ginkgo nut	*Gingko biloba*	China, Japan	Food
Gnetum seed	*Gnetum gnemon*	Tropical Asia	Food
Goat nut, *see* Jojoba nut			
Groundnut (wild bean)	*Apios tuberosa*	North America	Tubers eaten
Grugru nut (corozo nut)	*Acrocomia aculeata*	Tropical South America	Beads; oil
Hazelnut, *see* Filbert			
Heartnut, *see* Japanese walnut			
Helicia nut	*Helicia diversifolia*	Queensland, Austr.	Food
Hickory nut	*Carya* species	North America, China	Food
Hodgsonia seed	*Hodgsonia macrocarpa*	Tropical Asia	Food
Hyphaene nut, *see* Doum nut			
Indian nut, *see* Pine nut			
Inoi nut	*Poga oleosa*	W. Africa	Food
Ivory nut, *see* Tagua nut			
Jack nut	*Artocarpus heterophyllus*	India	Food
Japanese walnut (heartnut, cordate walnut)	*Juglans cordiformis ailanthifolia*	Japan	Food (*see* WALNUT)
Java almond (Luzon or Philippine nut)	*Canarium commune*	Pacific tropics	Food
Jojoba nut (goat nut, sheep nut)	*Simmondsia californica*	California, Mexico	Food; hair oil
Karaka nut	*Corynocarpus laevigatus*	New Zealand	Food
Kola nut	*Cola acuminata*, *C. nitida*	W. tropical Africa	Masticatory; stimulant
Kubili nut	*Cubilia blancoi*	Philippines	Food
Ling (caltrop, lingko)	*Trapa bicornis*	China	Food
Litchi (lychee, Chinese nut)	*Litchi chinensis*	S. China	Food
Lotus seed	*Nelumbium nelumbo*	Asia	Food
Lunan nut	*Olophora fruticosa*	Pacific region	Food
Macadamia (Queensland nut, Australian nut)	*Macadamia* species	Australia, Hawaii	Food (*see* MACADAMIA)
Manketti nut	*Ricinodendron rautanenii*	S. Africa	Food

Common names	Scientific name	Original source	Principal use of nut
Marking nut	*Semecarpus anacardium*	India	Ink; varnish; food
Moreton Bay chestnut (black bean)	*Castanospermum australe*	Australia	Food
Naras nut (butter pit)	*Acanthosicyos horrida*	S.W. Africa	Food; oil
Nicuri Palm nut	*Cocos coronata*	Brazil	Food
Nitta nut (nete)	*Parkia biglobosa*	Tropical Africa	Food
Nutmeg	*Myristica fragrans*	East Indies	Spice
Nut pine, *see* Pine nut			
Olive nut	*Elaeocarpus ganitrus*	India	Beads; ornaments
Owusa nut	*Plukenetia conophora*	W. tropical Africa	Food
Oyster nut	*Telfairia pedata*	E. Africa	Food
Palm chestnut	*Guilielma gasipaes*	Tropical South America	Food
Palm nut	*Elaeis guineensis*	W. Africa	Oil (*see* PALM)
Paradise nut (sapucaia nut)	*Lecythis zabucajo*	Tropical South America	Food
Pascualito nut (pinonchillo)	*Garcia nutans*	Mexico to Venezuela	Quick-drying oil
Peanut (groundnut)	*Arachis hypogaea*	Brazil	Food (*see* PEANUT)
Peanut, hog	*Amphicarpa monoica*	North America	Food
Pecan (Illinois nut)	*Carya illinoensis*	S. United States	Food (*see* HICKORY)
Pekea nut, *see* Swarri nut			
Pili nut	*Canarium ovatum*	Pacific tropics	Food
Pine nut (piñon, pignolia)	*Pinus* species	S.W. United States, Europe, Asia	Food
Pistachio (pistache, green almond)	*Pistacia vera*	Mediterranean basin to S.W. Asia	Food (*see* PISTACHIO)
Poison nut	*Strychnos nuxvomica*	India	Medicine
Quandong nut	*Fusanus acuminatus*	Australia	Food
Queensland nut, *see* Macadamia			
Ravensara nut (clove nutmeg)	*Ravensara aromatica*	Madagascar	Spice
Rose nut (red nut)	*Hicksbeachia pinnatifolia*	Australia	Ornamental; food
Sapucaia nut, *see* Paradise nut			
Sassafras nut	*Ocotea* species	South America	Aromatic
Shea butter nut	*Butyrospermum parkii*	British Africa	Food; soap oil
Singhara nut (water nut)	*Trapa bispinosa*	India, Kashmir	Food
Snake nut	*Ophiocaryon paradoxum*	Guiana	Charm for snakebite
Soap nut	*Sapindus saponaria*	S. Florida to N. South America	Soap substitute
Soap nut, Indian	*Sapindus inocarpus*	India	Soap substitute
Sterculia nut	*Sterculia foetida*	Tropical Africa	Food
Swarri nut (souari nut, sawarri nut, pekea nut, butter nut, piki)	*Caryocar* species	Tropical America	Food
Taccy nut	*Caryodendron orinocense*	Colombia	Food
Tagua nut (ivory nut, vegetable ivory)	*Phytelephas macrocarpa*	Central America	Ornaments; buttons
Tahiti chestnut (South Sea chestnut)	*Inocarpus edulis*	South Seas	Food
Tallow nut (false sandalwood)	*Ximenia americana*	Tropical Africa	Food
Tallow nut, Chinese	*Sapium sebiferum*	China	Wax for soap and candles
Tiger nut, *see* Chufa			
Tonka bean (tonqua or tonquin bean, coumara nut)	*Dipteryx odorata*	Tropical South America	Perfume
Torreya nut (kaya nut)	*Torreya nucifera*	China, Japan	Food; oil
Tropical almond (myrobalan, tavola nut, Demerara almond)	*Terminalia catappa*	S.W. Asia	Food
Tung nut (wood-oil tree)	*Aleurites* species	S. China	Paint; varnish; oil (*see* ALEURITES)
Walnut, African	*Coula edulis*	W. tropical Africa, Congo	Food
Walnut, other	*Juglans* species	W. hemisphere, Iran, China, Korea	Food
Water chestnut (water caltrop)	*Trapa natans*	Europe, Asia	Food
Water chestnut, Chinese (matai)	*Eleocharis tuberosa*	S. China	Food
Yeheb nut	*Cordeauxia edulis*	Somaliland	Food

In particular the use of hermetically sealed vacuum or gas-filled containers, have done much to improve their condition and appearance on reaching the consumer. Nut kernels must be protected against insect (weevil) attack, to which they are very prone, and against rancidity.

Nuts, as human food, are used in a great variety of ways in different parts of the world. They are often ground up or grated in soups and stews (in West Africa groundnut chop, a kind of stew, is a national dish.) They are much favoured in salads and in stuffing for poultry. As ingredients of puddings, cakes and sweetmeats of many forms, nuts are in universal use. Nut butters and pastes of various kinds are popular. Nuts are a common ingredient in ice cream and extensively used, either whole or chopped, for nut chocolate and other sweets and candies; those generally used for these purposes are almonds, pecans, walnuts, Brazil or Barcelona nuts.

Dessert Nuts.—*Almond.*—This is the most universally popular dessert nut. Spain is one of the main producers, supplying the superior Jordan and Valencia varieties. The almond tree grows under a wide range of conditions, but a dry harvesting season is necessary for successful commercial production (*see* ALMOND).

Brazil Nut.—This nut, known also as para nut or creamnut and as *castanha* in Brazil, is one of the best-known and most generally liked of edible or dessert nuts. Like the almond, it is much used in confectionery (*see* BRAZIL NUT).

Cashew.—For dessert purposes the cashew kernel has come to the fore since World War II. Although the tree itself is a native of the Americas, it was carried to other countries by the early Portuguese explorers, and commercial production of the kernels is now centred in India (*see* CASHEW).

Chestnut.—Chestnuts are usually cooked, often roasted, before being eaten. The common European chestnut is often called sweet chestnut or, in Britain, Spanish chestnut. The best, large chestnuts (marron), of rich creamy flavour and definite aroma, are used for *marrons glacés*, the well-known French sweetmeat (*see* CHESTNUT).

Coconut.—The kernel or flesh of the coconut has numerous culinary uses, especially when grated, when it is used in salads, curries, etc. Dried or desiccated coconut, available in several forms and much used in confectionery and home cooking, is pre-

pared from fresh, selected nuts, mainly in Ceylon (*see* Coconut Palm; Copra).

Filbert.—Hazelnuts in the broad, botanical sense include such nuts as filberts, cobnuts, Barcelona and Turkish nuts (these are the small nuts of the nut trade). Their convenient size may account in part for their extensive use in nut foods and nut chocolate (*see* Filbert; Hazel).

Hickory.—There are several kinds of hickory nuts and all are American. Although some are difficult to crack, the better kinds have large plump kernels with a good flavour. These nuts keep well. They formed an important item in the diet of American Indians (*see* Hickory).

Macadamia.—The Macadamia or Queensland nut is native to Australia, as the latter name indicates, but is grown commercially in Hawaii. There are several different recognized varieties. The nuts are spherical in shape, 1½–2 cm. in diameter, with a white, pleasantly crisp kernel with an appetizing, slightly sweet flavour.

Oyster Nut.—It is mainly since World War II that this nut has been marketed as a dessert nut, although it has long been popular in east Africa, where it is indigenous. The nut, the seed of a large gourd, is flat, from 3–5 cm. in diameter, and covered with a fibrous layer that unfortunately prevents the use of mechanical crackers.

Paradise Nut.—This South American nut, also called sapucaia nut, resembles the Brazil nut, to which it is closely allied botanically, although it has a softer shell and softer kernel than the Brazil nut. The nuts are produced in a large woody fruit or "monkey pot."

Peanut.—The peanuts used as dessert nuts are usually specially selected or hand-picked nuts with large pods and large kernels. A light-coloured shell that does not darken unduly on roasting is desirable. These nuts are produced in various countries, notably in the United States, Spain and certain Asian and African countries (*see* Peanut).

Pecan.—This American nut, a member of the hickory family, is widespread in North America in the wild state. The nut somewhat resembles the walnut; there are many varieties.

Pine Nut.—Pine nuts, or pignolias, usually from the European stone pine (*Pinus pinea*), are relished by many people and much used in vegetarian cookery as a substitute for animal fat. As dessert they may be eaten raw, roasted, salted or made into sweetmeats. The kernels of many other pines are also eaten. In North America pine nuts are obtained from the so-called nut pines or piñons.

Pistachio.—This well-known nut, also called pistache, is a native of the Mediterranean region. It differs from all other nuts in the characteristic green colour of the kernel. It is popular, in grated form, for ornamenting dishes. Other features of the nut are its pleasant mild flavour and good keeping qualities (*see* Pistachio).

Swarri.—This little-known South American nut, also called the souari or butternut, from the Guianas, is sometimes imported into Europe and America. It is about four times the size of a Brazil nut with a thick (over 1 cm.) hard shell enclosing a soft white kernel with a good flavour (*see* Butternut).

Walnut.—The common walnut has been used in Europe from very early times as an article of food and in everyday cookery (*see* below). The green or immature nuts are often pickled. There are about half a dozen different species of walnut, the American black walnut and Japanese walnut being among them.

Nuts as Sources of Oil.—Oil for a variety of purposes can be obtained from nuts. At one time walnut oil was a much-used vegetable oil in France, although it is now little used. For centuries walnut oil has also been used for artists' colours, especially for mixing whites and delicate shades. Another nut oil, much used in Europe in the past for edible purposes and also for lamps, is beech nut oil. It is said to be a good frying oil that does not readily go rancid.

The tung nut, from a Chinese tree, yields a nonedible drying oil; it resembles linseed oil and is used for paints and varnishes. In west Africa the shea butter nut yields a fatty oil much used locally and suitable for soap making. The kernel of the babassu nut of Brazil, which grows on a palm, is also a source of oil. The Indian ben nut, the product of a small tree, yields an oil at one time used for lubricating watches. (*See* Oil Plants.)

Nuts as Sources of Starch or Carbohydrate.—A few nuts have kernels of a starchy nature, without the high oil and protein content of most edible nuts. The best-known of these are the chestnuts, notably the common European chestnut. In southern European countries it was an important food for man and his domestic animals for centuries, taking the place of bread or wheat flour in some areas. The closely related North American chestnut has been largely destroyed by disease The Chinese chestnut, now cultivated in other countries, is somewhat similar to the European although the nut is larger.

The so-called water chestnut of the orient and the chufa or tiger nut are not true nuts but the edible tubers of grasslike sedges; they are cultivated as a source of starchy food, especially in China The so-called Bambarra groundnut, a common legume crop in many parts of tropical Africa, may be cooked in various ways.

Nuts as Masticatories.—The betel or areca nut, produced by a palm, is chewed in the eastern tropics by all classes. It imparts a characteristic red colour to the spittle (*see* Betel Nut).

The kola nut is a well-known masticatory with stimulating properties and is widely chewed in west Africa and is also exported.

Other Uses for Nuts.—The finely-ground shells of various nuts may be added as bulk fillers in the manufacture of plastics. Some palms have very hard seeds, nuts or hard kernels that may be used in turnery and for making ornaments. The tagua or vegetable ivory nut, from Central America, which has also been used for making buttons, is the best-known of these. The African doum palm nut is somewhat similar although inferior, as it has a cavity in the centre. The thick, hard shell of the South American coquilla nut was used in the carving and turnery popular in the 19th century.

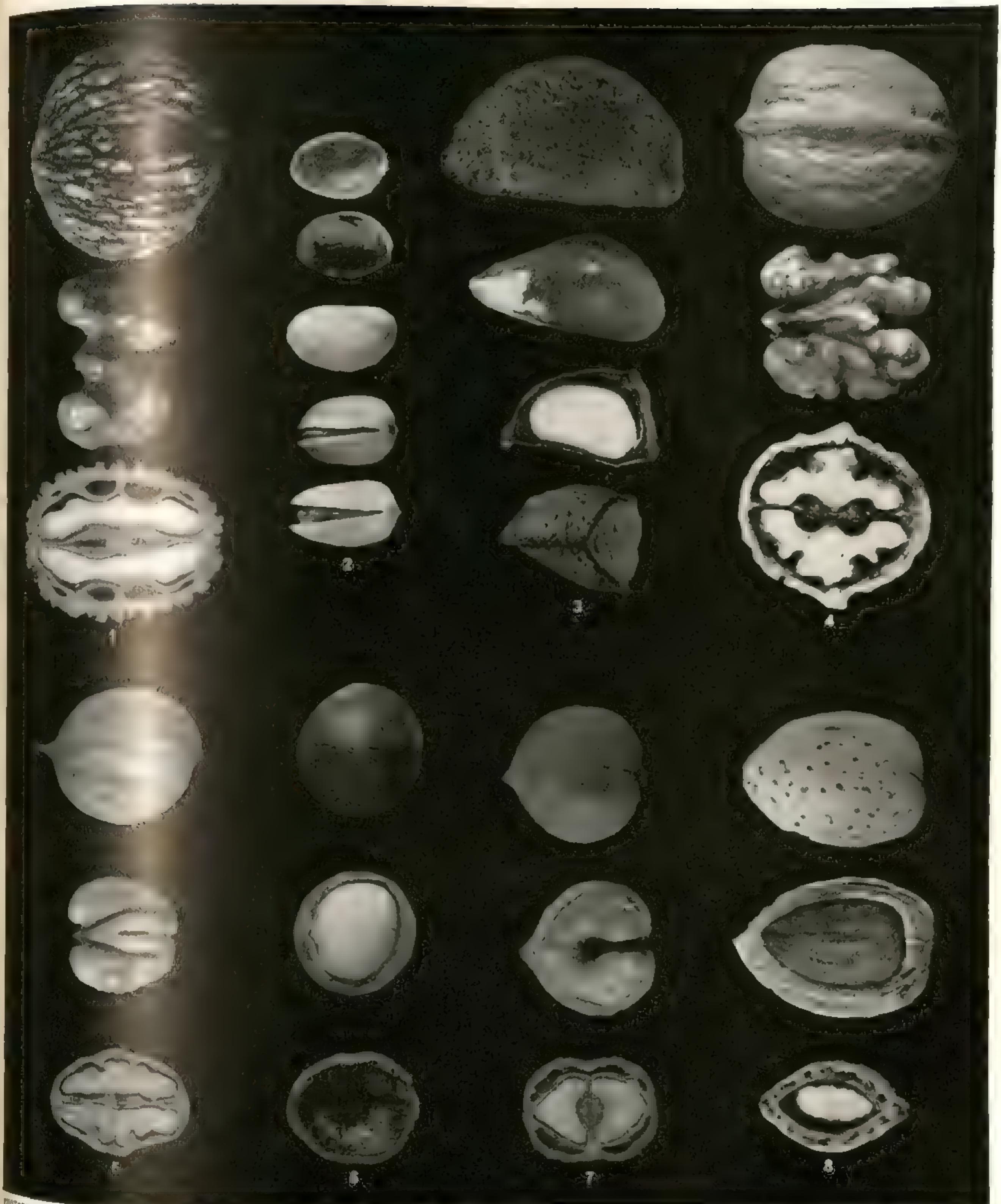
Marking ink for linen is prepared from the marking nut of India. The clearing nut is another unusual Indian nut. The seeds or nuts are cut open and rubbed round the inside of the rough earthenware vessels used for drinking water: the juice they contain thus impregnates the water and causes impurities to coagulate and sink.

The Chinese litchi nut is really a fruit, not a nut, but has a brittle, though thin, nutlike shell. The bonduc or nicker nut of the tropics is a hard marblelike seed, not edible but sometimes used as beads or as marbles by boys.

PRODUCTION

The world's trade in nuts varies a great deal from year to year as crops are often very dependent upon seasonal climatic conditions. For example, annual exports of the Brazil nut from the Amazon forests during the decade 1950–60 varied from 16,000 tons to 31,000 tons. (There is an increasing tendency to extract and pack the kernels in Brazil to save freight.) The related South American paradise nut is produced only in small quantities exports go mainly to the United States. The cashew is produced to some extent in the American tropics and West Indies but commercial production is mainly in India, annual production there exceeding 60,000 tons in the early 1960s. More than 100,000 tons (in the shell) of East African cashews may eventually go to Indian factories for kernel extraction and processing. The United States consumes more than 70% of India's cashew kernel production. The macadamia nut is produced commercially in Hawaii, where 100–200 tons of kernels annually (early 1960s) are exported in vacuum containers, chiefly to the United States.

Southern European countries, especially Spain and Majorca, are the main producers of almonds, but there is also considerable production in the southwestern United States and to some extent in Australia and South Africa. Walnuts are grown in the same regions as almonds, France being a notable producer. France Spain and Italy are important producers of chestnuts. Among small nuts of the filbert type, Spain is an important producer of Barcelona nuts, and Turkey of Turkish nuts. In Britain the county of Kent is noted for its filberts or cobnuts. Pistachio nuts are produced by various Mediterranean countries and in Asia



PHOTOGRAPHS, ROBERT TAYLOR

VARIOUS KINDS OF COMMERCIAL AND EDIBLE NUTS

1. Eastern black walnut (*Juglans nigra*), variety Thomas
2. Pistachio (*Pistacia vera*); top, half of shell removed from nut exposing kernel; below, three whole nuts
3. Brazil nut (*Bertholletia excelsa*)
4. Persian (English) walnut (*Juglans regia*), variety Placentia
5. Shagbark hickory (*Carya ovata*), variety Lingenfelter
6. Macadamia or Queensland nut (*Macadamia ternifolia*); top, whole nut; middle, kernel with half of shell removed; bottom, empty half-shell
7. Heartnut (*Juglans cordiformis*), variety Lancaster
8. Almond (*Prunus amygdalus*), variety Peerless

PHOTOGRAPHS, ROBERT TAYLOR

VARIOUS KINDS OF COMMERCIAL AND EDIBLE NUTS

1. Pecan (*Carya illinoensis*), variety Schley (Sly)
2. Peanut or groundnut (*Arachis hypogaea*)
3. Cashew (*Anacardium occidentale*)
4. European Filbert (*Corylus avellana*), variety Barcelona
5. European Filbert, variety DuChilly
6. Chinese Chestnut (*Castanea mollissima*): nuts in bur at maturity
7. Chinese Chestnut: top left, kernel with pellicle still attached; right, pellicle removed; below, outer and inner views of end nuts

Minor, and also to a small extent in California. The United States is the main producer of pecans. Italy is the chief commercial source of pine nuts. (F. N. H.)

NUT (Engineering): *see* BOLT.

NUTCRACKER, the name for species of the genus *Nucifraga*, foot-long birds of the crow family (Corvidae). They are found chiefly in evergreen woods of the northern hemisphere, and are known for their habit of storing nuts and other food for the winter. The common European nutcracker (*N. caryocatactes*), of which many races exist, is black-brown, brightly speckled with white, with conspicuous white under tail coverts and white-tipped tail feathers. The beak is blackish, long and thick. The nutcracker feeds mainly on conifer seeds but also takes fruits, insects and young birds. The nest, built about 20 ft. up in a tree, is a large structure of sticks lined with grass. The eggs are pale bluish-green, freckled with pale olive or ash.

Clark's nutcracker (*N. columbiana*), found in America, has a light gray body with white patches on black wings and tail.

NUTHATCH, the name for stubby, little tree-climbing birds, so called from their occasional habit of hacking nuts, which they fix, as though in a vise, in a chink or crevice in the bark of a tree, and then hammer with the bill till the shell is broken. Nuthatches, which constitute the subfamily Sittinae of the family Sittidae, are most numerous in the northern hemisphere; aberrant forms, however, are found in Africa and Australia. Smaller than sparrows, they have long dark bills, short tails, short legs and powerfully taloned feet, features associated with the nuthatches' remarkable adeptness at creeping jerkily about in all directions on the bark of trees. Nuthatches are the only tree climbers that habitually descend trees headfirst.

HENRY C. JOHNSON FROM NATIONAL AUDUBON SOCIETY

WHITE-BREASTED NUTHATCH (SITTA CAROLINENSIS) DESCENDING TREE TRUNK

Four species occur in North America. The best known is the white-breasted nuthatch (*Sitta carolinensis*), with gray or slate back and wings, a black cap, black eyes on a white face and chestnut under tail coverts. Its nasal song and familiar call of "yank, yank" may be heard at all seasons in woodlands and towns from southern Quebec and northern Minnesota to Florida and Mexico. (The treeless parts of the Great Plains and the deserts are devoid of nuthatches.) During most of the year it feeds on insects, which it seeks on the boles and larger limbs of old trees, but in autumn and winter it feeds on acorns and other nuts and on hard seeds. It makes its nest in a hole in a branch or stump of a tree, often in an empty nesting hole of a woodpecker. The interior contains a bed of dry leaves or the filmy flakes of the inner bark of a fir or cedar, on which the 5–8 whitish, brown-speckled eggs are laid. The red-breasted nuthatch (*S. canadensis*), slightly smaller and with rusty underparts and a black line through the eye, prefers conifer forests of both east and west coasts. The brown-headed nuthatch (*S. pusilla*) occurs in the southeastern U.S., and the pygmy nuthatch (*S. pygmaea*) is found along the middle California coast.

The common nuthatch of the old world (*S. europaea*) is widely distributed, with many local races from England to as far as Siberia and Japan. It has a blue-gray crown and back, buff underparts and chestnut flanks; the cheeks and throat are white and a black line passes through the eye. Like its American counterparts, it is a common visitor in gardens, orchards and parks. The rock nuthatches, *S. neumayeri* and its races and close relatives, nest and hunt among rocks rather than trees; they range from southeast Europe to Israel, Iran and Turkistan. Other less known species of *Sitta* occur in various parts of Asia. No nuthatches are found in South America, Africa from the Sahara southward or New Zealand.

A peculiar genus with a single species, *Hypositta corallirostris*, is confined to Madagascar. The Malay velvet-fronted nuthatch, pink and black, and the deep-blue nuthatch, with a beautiful blue belly, belong to an allied genus, *Dendrophila*, living in India and the Malay countries and islands. The genus *Neositta*, Australian tree runners, is also found in New Guinea, where also the single species of *Daphoenositta* is confined. (HT. FN.)

NUTLEY, a town of New Jersey, U.S., 5 mi. N. of Newark on the Passaic river, 13 mi. W. of New York city, adjoining Bloomfield and Belleville. Founded in 1680 by the Dutch as part of Newark, it was detached in 1812 to become part of Bloomfield. In 1874 it was separated as an independent township and renamed Franklin in honour of William, son of Benjamin Franklin, last royal governor of New Jersey. In 1902 it was renamed Nutley and incorporated as a town. Primarily residential, with many old colonial style homes, it has various industries: textiles, insulators, chemicals, pharmaceuticals, paints, machine tools, radar, telephone and electrical equipment and paper. In the late 19th century it was an authors' and artists' settlement; living there were Frank R. Stockton, author of "The Lady or the Tiger?" and *Rudder Grange*, and Henry C. Brunner. For comparative population figures *see* table in NEW JERSEY: *Population*.

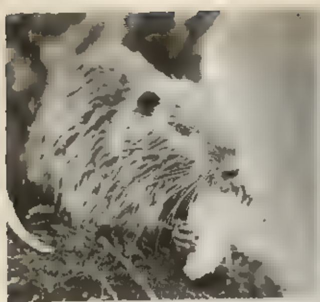
See E. S. Brown, *History of Nutley* (1907). (D. N. A.; M. P. M.)

NUTMEG, the commercial name of a spice representing the kernel of the seed of *Myristica fragrans*, a dioecious evergreen tree that may reach 70 ft. high, found wild in the Moluccas or Spice Islands and extending to New Guinea.

True Nutmeg and Mace.—Nutmeg and mace are mostly obtained from the Moluccas and the West Indies, although cultivation has been attempted with varying success elsewhere. The trees yield fruit in 8 years after sowing, reach their prime in 25 years and bear for 60 years or longer. The stands on the Moluccas thrive in the shade under groves of lofty trees. The fully ripe fruit is about two inches in diameter, of a rounded pear shape, and when mature splits into two, exposing a crimson aril surrounding a single shiny brown seed. When the fruit is collected the pericarp is first removed; then the aril is carefully stripped off and dried, in which state it forms the mace of commerce. The seed consists of a thin, hard shell, enclosing a wrinkled kernel, which, when dried, is the nutmeg. To prepare the nutmegs for use, the seeds are dried in the sun, gradually and with frequent turning, until the kernels will rattle in their shells when shaken. When thoroughly dried the shells are broken and the nutmegs picked out and sorted, the smaller and inferior ones being reserved for the expression of the fixed "oil of mace" that they contain. Oil of mace, or nutmeg butter, is a solid fatty substance of reddish-brown colour, obtained by grinding the refuse nutmegs to a fine powder, which is steamed and compressed while still warm, the brownish fluid that flows out being afterward allowed to solidify. Nutmegs yield about one-fourth of their weight of this substance. It is partly dissolved by cold alcohol, the remainder being soluble in ether. The latter portion, about 10% of the weight of the nutmegs, consists chiefly of myristin, which is a compound of myristic acid with glycerin. Nutmegs, maces and their oils are used as condiments and carminatives. A liniment or ointment made of nutmeg butter has been used as a counterirritant and in treatment of rheumatism. The oils are used to scent soaps and perfumes.

Other "Nutmegs."—The name nutmeg is also applied to other fruits or seeds in different countries. The Jamaica or calabash nutmeg is derived from *Monodora myristica*, the Brazilian from *Cryptocarya moschata*, the Peruvian from *Laurelia aromatica*, Madagascar or clove nutmeg from *Ravensara aromatica* and the California or stinking nutmeg from *Torreya californica*.

NUTRIA (COYPU), *Myocastor coypus*, a large aquatic rodent native to South America. Features that distinguish it from other members of the family Capromyidae are: size (up to 25 lb.); reddish-brown fur; long, round-tipped tail; partially webbed hind toes; short, round ears; and smooth, broad, orange-coloured incisor teeth. These traits have given it the misnomer "South Amer-



DOUGLAS FISHER

NUTRIA FEEDING (MYOCASTOR COYPUS)

ican beaver," but it more closely resembles a guinea pig or an agouti. The mammary glands are peculiarly placed along the sides of the back, an arrangement thought to be an advantage in permitting the young to suckle while the mother is surface swimming. The nutria lives in shallow burrows along the banks of rivers and edges of ponds; it subsists largely on aquatic plants, coming ashore to feed, especially in the evening. It is prolific, producing from two to eight young at a birth, and having as many as three litters a year.

Prime nutria pelts are of some commercial value but require expensive processing. In the late 19th century a high demand for pelts led to the near extermination of the species in Argentina. Raising nutrias in captivity in South America began in 1922 and spread to many other countries. High prices were paid for breeding stock, but the pelts from ranch-raised stock were generally inferior, and these ventures were disappointing. Some nutrias were turned loose, others escaped, and populations became established in the wild. In many countries to which they were imported, France, for example, nutrias became a distinct liability, feeding on cultivated crops, damaging dikes and irrigation ditches, destroying habitats of and competing with other wildlife. They are established in several other European countries and in Canada, and are a problem in parts of the southern U.S. (R. H. MA.)

NUTRITION. All forms of life, plant and animal alike, from simple single-cell organisms to complex mammals, require certain food materials in certain minimum amounts and proportions to ensure an active life and successful reproduction. Nutrition is concerned with what these materials are, how they function, what effects they have when absent or in too plentiful supply, what happens to them when ingested and other related problems. Nutrition might be defined as the science of food and the nutrients in food and their relation to health. Because of this wide scope there has been increasing overlapping with such sciences as biochemistry, enzymology and physiology. In spite of the enormous diversity of living things, each can be said to have two major nutritional requirements: (1) compounds which are sources of energy; and (2) substances whose primary purpose is to fill a structural or functional need. Some of course fulfill both needs. Often what is an absolute dietary essential for one species is without effect in another, for the latter may be able to synthesize it from other materials. In many instances knowledge of the nutrition of one species aids immeasurably in gaining nutritional information about another. For example, the requirement of a microorganism for a given nutrient may make possible the analysis of this compound in foods which are to be consumed by other living organisms.

General Requirements.—All living cells, whether existing as separate entities or as part of a complex tissue, require one or more inorganic substances and some form of carbon and nitrogen. On the other hand, the need for complex exogenous organic compounds is quite different for the various forms of life. Whereas vitamins and proteins are essential for many animal species, plants are without this requirement for they are able to make these out of simpler chemicals such as carbon dioxide, water and ammonia. This difference between forms of life has a tremendous importance, for continuous cycles exist in nature whereby simple compounds of the elements such as carbon and nitrogen are converted into complex molecules by some species; these in turn are used by higher forms where they are again eventually converted to simple compounds. Thus, in the long run, only energy has been expended. Were these cycles to be interrupted for long, life on earth as we know it would cease.

Plants.—Much is known of the requirements of plants for minerals, carbon and nitrogen. As is the case with animals, certain of the elements are required in extremely minute amounts for normal growth and reproduction. These are known as trace elements, a term not to be confused with the word tracers, which refers to isotopes incorporated into compounds to facilitate the tracing of a biochemical pathway. Boron and silicon are examples of trace elements which are needed by some plants but have not been shown to be required by animals. The nutrition of plants has a very important bearing upon nutrition of animals because the latter consume the plants and thereby gain proportionately to the nutritional status of the plants. The importance of this is shown by the fact that the analysis of plants for important nutrients is a constant facet of nutritional research. Furthermore, agricultural research is engaged in improving the food value of crops through plant breeding and nutrition.

Microorganisms.—A fascinating phase of nutritional investigation has been that dealing with the requirements of microorganisms: bacteria, molds and yeasts. As might be expected the diversity of microorganisms makes for a diversity of nutritional requirements which is reflected among species and also among strains within a given species. Some, like the plants, require no complex organic material whatsoever. Nitrogen (usually as an ammonium salt), carbon (as a simple salt such as carbonate) and minerals are sufficient to provide optimum growth and reproduction in such organisms. Others, however, have almost as complex requirements as human beings do. In these cases amino acids, vitamins, carbohydrates and minerals must be made available in chemical forms readily utilized by the organism. So exacting are the requirements of many organisms for certain nutrients that in the absence of any particular one there will be no growth. If inadequate amounts are provided, the growth will often be proportional to the amount present. This forms the basis of several important tools for biochemical and nutritional research. One of these is the microbiological assay developed by E. Snell and F. Strong. In this procedure all but one of the nutrients necessary for rapid growth are furnished to an organism such as *Lactobacillus casei*, found in cheese. When the missing factor is furnished in some suitably prepared extract of a natural product, the increased growth that results is a measure of the amount of the compound present in a readily available form. Comparison of this response with that obtained when known amounts of the factor are present give a fairly exact estimate of the amount of the substance in the natural product. Such assays came to have widespread use because of their simplicity, accuracy and rapidity.

Microorganisms also aid in the understanding of the nutrition and biochemistry of higher animals in another way. They readily lend themselves to investigations which deal with the actual pathways of synthesis and degradation of important nutrients and biologically important compounds. Extensive studies, notably by E. L. Tatum and co-workers, have been made on organisms which have been damaged by X-rays. Such organisms have lost the ability to carry out one step in a series of biochemical reactions. By proper techniques it is possible to isolate the affected ones and determine where such a metabolic lesion occurs and what its exact nature is. Such damage is usually reflected in the need for an additional nutrient not ordinarily required. In a sense an almost unlimited number of mutants of a given organism can be produced which differ only in that each has a special "dietary" requirement.

Although it is usual to think of higher animals in terms of the individual, such is not strictly possible from a nutritional standpoint. The reason is that the intestinal tract supports a flourishing population of microorganisms which have their own nutritional requirements, produce various important nutrients themselves and also degrade other nutrients. It is difficult to assess the importance of these uninvited guests on the nutritional status of the host, however, except in certain instances. For example, the use of antibiotics and sulfa drugs is known to have definite effects on the intestinal flora which may influence the amount of certain vitamins available to the patient. In studies with animals born and raised under germ-free conditions, J. A. Reyniers and co-workers showed that good growth and reproduction are not dependent upon the intestinal flora.

Human and Animal Nutrition.—The nutrition of the more

*Recommended Daily Dietary Allowances, 1964 Revision**

(for persons normally active in a temperate climate)

Person	Age† (years from–to)	Weight (kg., lb.)	Height (cm.; in.)	Calories	Protein (g.)	Calcium (g.)	Iron (mg.)	Vitamin A value (I.U.)	Thiamine (mg)	Riboflavin (mg.)	Niacin equiv.‡ (mg)	Ascorbic acid (mg.)	Vitamin D (I.U.)
Men	18–35	70 (154)	175 (69)	2,900	70	0.8	10	5,000§	1.2	1.7	19	70	
	35–55	70 (154)	175 (69)	2,600	70	0.8	10	5,000	1.0	1.6	17	70	
	55–75	70 (154)	175 (69)	2,200	70	0.8	10	5,000	0.9	1.3	15	70	
Women	18–35	58 (128)	163 (64)	2,100	58	0.8	15	5,000	0.8	1.3	14	70	
	35–55	58 (128)	163 (64)	1,900	58	0.8	15	5,000	0.8	1.2	13	70	
	55–75	58 (128)	163 (64)	1,600	58	0.8	10	5,000	0.8	1.2	13	70	
	Pregnant (2nd and 3rd trimester)			+ 200	+20	+0.5	+5	+1,000	+0.2	+0.3	+3	+30	400
	Lactating			+1,000	+40	+0.5	+5	+3,000	+0.4	+0.6	+7	+30	400
Infants‖	0–1	8 (18)		kg. x 115 ±15	kg. x 2.5 ±0.5	0.7	kg. x 1.0	1,500	0.4	0.6	6	30	400
Children	1–3	13 (29)	87 (34)	1,300	32	0.8	8	2,000	0.5	0.8	9	40	400
	3–6	18 (40)	107 (42)	1,600	40	0.8	10	2,500	0.6	1.0	11	50	400
	6–9	24 (53)	124 (49)	2,100	52	0.8	12	3,500	0.8	1.3	14	60	400
Boys	9–12	33 (72)	140 (55)	2,400	60	1.1	15	4,500	1.0	1.4	16	70	400
	12–15	45 (98)	156 (61)	3,000	75	1.4	15	5,000	1.2	1.8	20	80	400
	15–18	61 (134)	172 (68)	3,400	85	1.4	15	5,000	1.4	2.0	22	80	400
Girls	9–12	33 (72)	140 (55)	2,200	55	1.1	15	4,500	0.9	1.3	15	80	400
	12–15	47 (103)	158 (62)	2,500	62	1.3	15	5,000	1.0	1.5	17	80	400
	15–18	53 (117)	163 (64)	2,300	58	1.3	15	5,000	0.9	1.3	15	70	400

*The allowance levels are intended to cover individual variations among most normal persons as they live in the United States under usual environmental stresses. The recommended allowances can be attained with a variety of common foods, providing other nutrients for which human requirements have been less well defined.

†Entries on lines for age range 18–35 years represent the 25-year age. All other entries represent allowances for the midpoint of the specified age periods, *i.e.*, line for children 1–3 is for age 2 years (24 months); 3–6 is for age 4½ years (54 months), etc.

‡Niacin equivalents include dietary sources of the preformed vitamin and the precursor, tryptophan. 60 mg tryptophan represents 1 mg niacin

§1,000 international units from preformed Vitamin A and 4,000 international units from beta-carotene.

‖The calorie and protein allowances per kg. for infants are considered to decrease progressively from birth. Allowances for calcium, thiamine, riboflavin and niacin increase proportionately with calories to the maximum values shown.

Source: Food and Nutrition Board, National Academy of Sciences—National Research Council (United States).

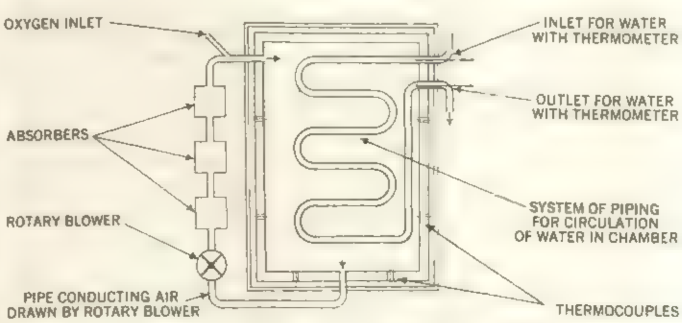
complex forms of life, the higher animals and humans, differs from that of the plants and microorganisms in several important aspects: First, all higher animals require a number of preformed complex organic compounds in their diet for bare survival, let alone optimum development and reproduction. Second, the requirements that must be met are not only those of a diversity of cells but also those of complicated tissues. Third, there is absolute dependency upon plants and microorganisms for dietary requirements. Fourth, higher animals have a greatly added caloric requirement to meet the needs imposed by muscular activity. In addition to these and other differences, the higher animals possess such additional traits as appetite, habits and idiosyncrasies that influence not so much their requirements as the problems of meeting those requirements adequately.

Caloric Requirements.—The fundamental requirement of the cell, and therefore of the animal as a whole, is for calories. Without a source of energy, the capacity to do work would be lacking and life would stop. Ordinarily, this need is satisfied by the consumption of sufficient caloric foodstuffs. In conditions such as starvation, the need for calories continues but the source now is the body's own reserves of fats, carbohydrates and, to some extent, proteins. Obviously, there comes a time when these sources are exhausted and death ensues. During the period immediately prior to death, it is found that the animal becomes progressively less active in order to economize on the expenditure of calories.

Energy must be provided to satisfy a number of different needs. In the adult the most basic one is for maintenance of the *status quo* of the body exclusive of voluntary muscular work and other additional energy-consuming functions. Many of the processes which contribute to this basic need are easily overlooked, for they include the maintenance of body temperature, breathing, heart action, gastrointestinal activity, muscle tone and many reactions which are involved in the chemical syntheses and degradations constantly going on in the tissues. One of the most important of the nonbasic functions is that of voluntary muscular work. The size of the caloric demand for this function is governed by the activity of the individual. Energy must also be supplied for growth in children and for women during pregnancy and lactation. The recommended caloric intakes for men, women and children under various conditions and the recommended intakes of certain other nutrients have been tabulated by the Food and Nutrition board of the National Academy of Sciences–National Research council (*see* Table).

In order to determine either the caloric requirement or the amount of food necessary to meet this need, it is essential to know the caloric value of the energy-yielding components of food. This value can be established by completely burning a pure sample of fat, carbohydrate or protein in a device known as a bomb calorimeter. During this process all organic matter is converted to carbon dioxide, water and nitrogen oxides, and the energy liberated is calculated from the amount of heat evolved. The number of calories per gram of material obtained by this method, however, is above that available to the animal because of incomplete absorption of the compounds from the intestine and also because of incomplete metabolism of the protein which results in the loss of calories through the urinary excretion of urea, uric acid and related compounds. The losses can be measured and subtracted from the values derived in the bomb calorimeter. When this is done it is found that the caloric values of fat, carbohydrate and protein are nine, four and four calories per gram respectively. To calculate the caloric content of a food it is only necessary to multiply the per cent of each of the proximate principles (fat, carbohydrate and protein) by its respective caloric value and add the products together.

The use of a direct animal calorimeter enables the determination of not only the caloric values of foods, but the extent and degree of metabolic activity of the subject as well. The subject is enclosed in a special chamber or calorimeter so devised that all the heat given off by the subject can be directly collected and measured (*see* figure). In order that there be no escape of the body heat to the environment, the double copper walls of the chamber are fitted with elaborate electrical equipment that permits such a delicate balance that heat can neither pass out of nor into the chamber. In order to measure the heat given off by the subject, a current of cold water is circulated within the box in continuous piping. If the temperature of the incoming and outgoing water is carefully measured and if the quantity of water passing through



DEVISED BY W. O. ATWATER, F. B. ROSA AND F. G. BENEDICT

SCHEMATIC DRAWING OF RESPIRATION CALORIMETER

also is known, the heat lost by radiation and conduction by the subject in a given time can be determined. As part of the heat lost, amounting to about one-fourth of the whole, is eliminated by the subject in the form of water vapour, this loss is determined by absorbing the lost water in sulfuric acid and weighing the acid to measure its gain in weight.

This method of direct calorimetry is very accurate and reliable, but the method is difficult and the apparatus is very liable to get out of order. In addition to this direct measurement of the heat output, the metabolic activity of the subject can be calculated from a determination of the amount of carbon dioxide given off and the amount of oxygen utilized by the subject in a given period. This method of indirect calorimetry can be carried out simultaneously with the direct method and serve as a check upon it. The calorimeter chamber in which the subject is enclosed is gastight and the air is circulated through a gastight absorbing system by means of a rotary blower. The carbon dioxide given off is absorbed by means of soda lime, the amount absorbed being determined by weighing the soda lime at the beginning and the end of the experiment. The carbon dioxide-free air is returned to the chamber after the deficiency in oxygen, which is approximately determined by reduction in volume, has been corrected by adding oxygen from a cylinder. The amount of oxygen used during the experiment is determined either by metering the amount of oxygen passed in or by weighing the cylinder before and after the experiment. The heat lost by the subject can be determined from the amount of oxygen used. The caloric value of a litre of oxygen used in tissue combustion has been determined. This value varies with the carbon dioxide-oxygen ratio, called also the respiratory quotient (R.Q.), from 4.795 cal. with an R.Q. of .713, which is held to represent the combustion of fat alone, to 5.058 cal. with an R.Q. of 1.00, which is accepted as representing the combustion of pure carbohydrate by the tissues. The two methods of direct and indirect calorimetry have been found to give almost identical results.

A portable apparatus that measures the energy expenditure of subjects engaged in work was designed by N. Zuntz and later much simplified by C. Douglas. When using the simplified apparatus, the subject, wearing either a mask or special mouthpiece (with nose clip) fitted with two one-way valves, breathes into a gastight bag carried on his back. At the end of the experiment the air collected in the bag is measured by passage through a meter, a sample of the expired air is analyzed in the Haldane gas analysis apparatus, and the amount of carbon dioxide and oxygen present is determined. As the composition of the atmospheric air is known, it is easy to calculate how much carbon dioxide the subject excreted and how much oxygen he utilized in a given time; the caloric values can be determined as above. In order to relate the carbon dioxide output and oxygen utilization to the nonprotein moiety of the food the protein metabolized during the period of the experiment is determined from the nitrogen output in the urine. For every gram of urinary nitrogen derived from protein 8.45 g. of oxygen are required and 9.35 g. of carbon dioxide are given off. Hence, to determine the nonprotein utilization the appropriate amounts of carbon dioxide and oxygen are deducted from the total amounts. As the amount of nitrogen excreted during the period of examination is minute, it is usually ignored in practice. (*See* also CALORIMETRY.)

When the alterations of the gaseous metabolism are considered they are commonly referred to variations from the so-called basal metabolism. The basal metabolism may be defined as that of a subject lying comfortably at rest in a warm bed and in the postabsorptive condition; *i.e.*, about 12 to 15 hours after the last meal. With the subject in such a condition the metabolism reaches its lowest level. It has been estimated that functional activities of the various organs may account for about 25% of the resting metabolism (thus the activity of the heart for about 3.6%, respiratory movements for about 10% and the kidneys for about 5%).

This basal metabolism is shown to be high in childhood; as adolescence is reached it falls to a level which is more or less uniformly maintained until about the age of 50. Thereafter the decline is steady although small. The basal metabolism is also influenced by the sex of the subject, the nature of the food consumed and environmental conditions like temperature, climate, etc.

Differences in human weight, height and sex also complicate calculations of energy assessments. As a means of overcoming this difficulty, E. F. and D. Du Bois proposed the extensively used formula (height × weight × a constant) to obtain basal metabolism values in terms of caloric output per square metre of body surface area. In the early 1960s the caloric allowance for differences in size given by the Food and Nutrition board for persons neither over- nor underweight was calculated on the basis of weight. The assumption was made that 25% of the energy expenditure was independent of body weight and 75% was directly proportional to body weight.

Components of Nutrition.—Carbohydrates, fats and proteins form the major portion of the diet, while minerals and vitamins are present in smaller quantities. All are important and many have special functions as will be seen below. (*See* CARBOHYDRATES; OILS, FATS AND WAXES; PROTEINS; VITAMINS).

Until R. Schoenheimer and D. Rittenberg demonstrated otherwise, most of the body constituents such as proteins and fats were considered to be stable in the sense that they were not in equilibrium with ingested food components. The latter were thought either to undergo degradation or, if incorporated in body constituents, to remain there indefinitely. There was no adequate way to study this problem before the advent of isotopes, because there was no way of distinguishing an ingested compound or its parts from like ones already present in the body. By synthesizing compounds which contained an isotope of one of the atoms in the molecule, it was possible to follow the exact fate of the compound by making suitable isotope measurements. Such experiments have shown beyond doubt that there is a constant equilibrium between ingested substances and identical ones which have been incorporated into the body. This concept of a "dynamic state of body constituents" had profound effects on the understanding of biochemistry and nutrition.

Enzymes.—Many enzymes are involved in biochemical reactions that are concerned with the removal or addition of water between molecules while others are concerned with joining or splitting the bonds between atoms within a molecule. (*See* ENZYMES.) The process of digestion, for example, involves the addition of water (hydrolysis) to complex molecules with the formation of their simple integral parts. On the other hand, the metabolism of these simpler molecules may involve either their reincorporation into other complex compounds or their conversion to other simple molecules. It is believed that almost every reaction in the body is mediated by an enzyme which is specific for that particular reaction. Many of the enzymes had been isolated by the 1960s and in many cases had also been crystallized. One of the most interesting properties of enzymes is their high degree of activity under very mild conditions. Similar reactions carried out by chemical means alone would require in many instances drastic conditions and long reaction times. All enzymes discovered had been found to contain mainly protein, and it was also shown that they are not immune from the "dynamic status" referred to previously. Many toxic materials are known to inactivate enzymes, and this action is believed to be the basis of their toxicity. Numerous modern drugs also function by virtue of some effect on one or more enzyme systems. Indeed, such sought-for activity forms the basis of research in many fields such as cancer where the arrest of specific processes is essential.

Carbohydrates.—These compounds are present in most foods in the form of sugars known as disaccharides, such as cane sugar, and polysaccharides, such as starch. When ingested, they must be converted into monosaccharides, or simple sugars, before they can be absorbed. Ptyalin, an enzyme found in saliva, is able to effect some hydrolysis of starches, but the main agents which cause the hydrolytic breakdown of the carbohydrates are amylase, maltase, sucrase and lactase, which attack starches, maltose, sucrose and lactose (milk sugar), respectively. The nutritionally important simple sugars—fructose, glucose and galactose—which are thereby formed are absorbed and are made available via the blood stream to the cells of the various tissues. Here the first step in their

utilization involves enzymatic reactions which result in the formation of phosphorylated sugar. The sugar phosphates then either are converted to glycogen or undergo a series of reactions which lead eventually to the formation of carbon dioxide and water. The elucidation of these reactions by such workers as A. Harden and W. Young, C. F. and G. T. Cori, G. Embden, O. Meyerhof, H. Krebs and A. Szent-Györgyi was of tremendous importance to the fields of biochemistry and nutrition. (*See* also KREBS CYCLE.) It was absolutely established through isotope studies that some of the carbon present in the sugars can be recovered in the fat, protein and other important compounds in the body.

The proper utilization of carbohydrate is essential for health. Insulin (*q.v.*) is necessary to carry out the initial phosphorylation of glucose. When insulin is deficient, as in diabetes mellitus, the glucose concentration in the blood rises and some of the sugar is lost in the urine. Another hormone, adrenaline (epinephrine), which is produced by the adrenals, causes the breakdown of carbohydrate stored in the liver and muscles as glycogen. It is this source of energy which is called upon for immediate needs. About 100 g. of carbohydrate per day are necessary for the prevention of ketosis in human adults.

Fats.—When fats are eaten, relatively little happens until they reach the intestine. There they are emulsified and undergo extensive enzymatic hydrolysis by lipase to form mono- and diglycerides and fatty acids. The precise manner in which these products are absorbed was still undetermined in the 1960s. Ordinarily most of the fat upon being absorbed enters the lymphatic system and is present as an extremely fine emulsion known as chyle, which enters the blood stream through the thoracic duct. The small droplets of fat (chylomicrons) then appear to undergo a process of partial dissolution brought about by the action of an enzyme, lipoprotein lipase, found in blood and tissues. Further metabolism occurs within the cells.

Since the early studies of F. Knoop the mechanism by which fatty acids are degraded had been postulated to proceed by removal of two carbons at a time, but definitive proof of this was not obtained until much later. Through the research of A. L. Lehninger, F. A. Lipmann, F. Lynen, D. Green and others it became known that the fatty acids react to form phosphate esters which in turn react with coenzyme A (a derivative of the vitamin pantothenic acid) to form coenzyme A derivatives. In this form they undergo a series of enzymatic transformations to yield at intervals the coenzyme A derivatives of the next lower fatty acid and of acetic acid. This continues until the acid is degraded. The acetic acid-coenzyme A molecules may react with a carbohydrate derivative, oxaloacetate, and be converted to carbon dioxide and water, or form "ketone bodies." The latter are greatly increased in diabetes. By means of fats labeled with radioactive carbon it was definitely shown that fats can be converted to carbohydrates and proteins. Aside from serving as a source of energy, fats act as insulating material against cold and mechanical shock. They also serve as carriers for fat-soluble vitamins. The normal adult human male consumes about 150 g. of fat per day. As far as is known this amount is not necessary; however, it is easy to obtain part of the daily caloric requirement in the form of fat because of its higher caloric value per gram.

Essential Fatty Acids.—Historically, this group of nutrients is comprised of linoleic, linolenic and arachidonic acids, all of which are polyunsaturated. George O. Burr and M. M. Burr first demonstrated that without at least one of these acids in the diet the rat failed to grow, developed scaly skin and necrosis of the tail, and eventually died. Considerable study has shown that these acids may be of importance in atherosclerosis because they are effective in lowering the cholesterol concentration in the serum of man and animals. Such an effect often can be achieved by the inclusion in the diet of liberal quantities of maize, safflower or similar vegetable oils that are rich in essential fatty acids, mainly linoleic. An appreciable portion of the cholesterol of blood serum occurs as the ester of this acid. In the early 1960s linoleic and arachidonic acids were shown to be necessary in animals and human infants. (*See* also CARBOXYLIC ACIDS; CHOLESTEROL.)

Proteins.—Although available as a source of calories, dietary protein functions chiefly by supplying amino acids for the maintenance and synthesis of body proteins. When ingested, protein is not absorbed as such but is first converted to peptides and then amino acids. This conversion begins in the stomach through the action of the enzyme pepsin (*q.v.*), which is effective in the acidic condition found there. The rest of this degradation is carried out in the intestine by the enzyme trypsin. Both of these enzymes also occur in an inactive form or zymogen and are converted to the active form when the need arises. Once the amino acids are formed they are absorbed and transported via the blood stream to the various tissues. Here they may be incorporated into tissue proteins or undergo various metabolic degradations. Since the structures of the amino acids are on the whole dissimilar, these reactions are multifold and usually quite specific. The amino group of the acid may be transferred to a nonamino acid by means of an enzyme of the class known as transaminases. One of the B-complex vitamins, pyridoxine, plays a role in this type of transformation. The ultimate fate of the amino acids is metabolism to water, carbon dioxide, ammonia, urea, uric acid and related compounds. In species which have access to an abundant water supply, urea is the chief urinary nitrogenous excretory product, while in those with limited water supplies, uric acid is more important. When the amount of nitrogen excreted in the urine, feces and other excretory products such as perspiration equals the amount of nitrogen ingested, the subject is in nitrogen equilibrium. During growth, the output of nitrogen is smaller than the input; the reverse is true in starvation. The amount of protein ingested has an important bearing on the nitrogen balance.

Not all proteins are adequate for normal nutrition. This stems from the fact, as found notably by W. C. Rose, that of the approximately 20 naturally occurring amino acids, only eight are necessary in the human diet since the others can be synthesized by the body. This means that if a protein contains the essential amino acids in adequate amounts it is a complete protein and can satisfy the needs of the body when consumed in normal quantities. Incomplete proteins may be used to fortify one another in such proportions that they supply sufficient quantities of the amino acids. H. Borsook found that for optimum utilization the amino acids should be ingested simultaneously. An interesting interrelationship between tryptophan, one of the essential amino acids, and nicotinic acid, the pellagra-preventing vitamin, was uncovered. Many of the details were known by the mid-1960s, and it was definitely established that an interconversion between these compounds can take place in the body and as a result the intake of one can affect the apparent effectiveness of the other when the latter is in short supply. Thus, in the normal adult human 60 mg. of tryptophan furnishes the equivalent of 1 mg. of niacin.

Inorganic Materials.—The body requires a constant replenishing of the minerals and electrolytes that are excreted from the body in various forms. Among those that are needed by most species are calcium, magnesium, iron, iodine, phosphorus, sodium, potassium and chlorine. Whereas it is recommended that the adult male take in 0.8 g. of calcium per day, 10 mg. of iron are sufficient. In many instances with animals the need for trace elements has been shown. These include zinc, copper, cobalt and manganese, and the amounts required per day when calculated on the basis of humans is far below that of iron. Of interest is the fact that less than 0.0001 mg. of cobalt in the form of vitamin B_{12} is necessary to keep pernicious anemia patients normal. This vitamin is the only one known to have a metal as part of its molecule. On the other hand, metals are known to play a role in many enzyme reactions. Copper, for example, is necessary for the oxidation of ascorbic acid (vitamin C) by the enzyme ascorbic acid oxidase, while magnesium is essential for several enzymatic steps in the metabolism of carbohydrate. Phosphorus plays an important role in the metabolism of many compounds. In addition it is a major constituent of bone and teeth.

As a result of the different metabolic processes that take place in the tissues there is a constant production of acid, chiefly from sulfur and phosphorus, which must be neutralized by basic ions containing sodium and potassium and probably also calcium and magnesium. The kidney for the most part regulates in a very

selective fashion the output of these various inorganic constituents. It must not be imagined, however, that the body can completely protect itself from excessive salt loss, a loss so great that it may give rise to symptoms of a serious character. Thus it has been shown that men who, in the course of their work, are exposed to high environmental temperatures with consequently much sweating are very liable to a form of cramp. Further the cramp is frequently exacerbated where the men drink freely of water to allay their thirst. It has been found that the condition is due to an excessive loss of sodium chloride from the body carried away in the sweat and that the condition may be cured or prevented by taking salt tablets.

Although five-sixths of the total mineral matter of the body is found in bone, and in spite of the fact that bone has all the appearance of being firm and resistant, the evidence available shows that the bony structures must be regarded as active storehouses of mineral matter. When the need arises the body as a whole can draw upon the bones for constituents such as lime and phosphates. Under certain conditions the bones may give up so much of their mineral matter that they become soft and can no longer function as an effective framework.

The other one-sixth of the mineral constituents found in the body are not distributed uniformly throughout the remainder of the tissues. As regards this varying distribution of salts in the tissues and the blood, A. B. Macallum, in his study of paleochemistry, produced some interesting evidence in favour of his view that the present composition of the blood plasma, insofar as its inorganic constituents are concerned, is probably identical with that of the sea water just before the Cambrian period and that the salt concentration in protoplasm represents conceivably the salt concentration of the primeval ocean in which life first appeared. At any rate the curious ratio of potassium and calcium to sodium that is characteristic of protoplasm is reflected in the salt relationship in water drawn from Pre-Cambrian formations.

Water.—Because water forms about 60% of the body weight of man, it obviously plays an important part in metabolism. The whole series of chemical actions that are intimately related to the life of the living organism, animal or vegetable, are ultimately referable to changes that take place in solution. It has been conclusively shown that the younger the animal the richer it is in water. It has also been found that the fatter the animal the smaller the percentage amount of water present.

Studies with heavy and radioactive water have shown that exchange occurs between ingested water and metabolically derived water in the cells; much information concerning the extent and rate of exchange has been derived from these studies. Some water in cells is tightly associated with proteins and other cellular constituents and is referred to as bound water. Although some forms of life require little water, none can exist without any.

Vitamins.—These organic compounds are important components of nutrition. For detailed information about vitamins, *see* the article under that title.

See also BIOCHEMISTRY; DIGESTION. Daily food allowances and diet planning are discussed in DIET AND DIETETICS. Deficiency diseases and other problems are discussed in MALNUTRITION. *See* also references under "Nutrition" in the Index.

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(E. P. C.; F. J. SE.; R. P. G.)

NUTTALL, GEORGE HENRY FALKINER (1862–1937), biologist and founder of the Molteno institute for research in parasitology at Cambridge, Eng., was born in San Francisco, Calif., on July 5, 1862. Graduating M.D. at the University of California, Berkeley, in 1884, he joined Johns Hopkins university, Baltimore, Md., in 1885. During 1886–99 he studied zoology, botany and hygiene, mostly in Germany, developing his eventual interest in parasitology. He was appointed lecturer in bacteriology and preventive medicine at Cambridge university in 1900, and elected in 1906 to the newly founded Quick professorship of biology, holding this until 1931. He founded the *Journal of Hygiene* in 1901 and remained editor until his death; in 1908 he founded *Parasitology* and was chief editor until 1933. In 1919 he raised funds for the erection of an institute of parasitological research in Cambridge—the Molteno institute. Nuttall's work covered a very wide field; he wrote almost 200 papers on bacteriology, serology, hygiene, tropical medicine and parasitology. He made pioneer experiments on life under aseptic conditions, founded the study of humoral immunity and work on precipitin reactions. He acquired British nationality on going to Cambridge.

His classical monograph, *Blood Immunity and Blood Relationship*, appeared in 1904. Later he studied diseases transmitted by ticks and with W. R. Hadwen discovered the curative properties of trypan blue for piroplasmosis. *Ticks, a Monograph of the Ixodoidea* (with C. Warburton and L. Robinson) appeared in parts from 1908. He died in London Dec. 16, 1937. (ED. HE.)

NUTTALL, THOMAS (1786–1859), British-U.S. naturalist, was an expert on North American flora and described many new genera and species of plants. He was born on Jan. 5, 1786, at Long Preston, Yorkshire. After serving seven years as an apprentice printer, he emigrated to the United States in 1808. Benjamin S. Barton (*q.v.*) encouraged and assisted him in his scientific career. Nuttall's expeditions included those to the Missouri river (1810–11), Arkansas territory (1818–20), and the Columbia river and Hawaii (1834–36). He was lecturer on natural history and curator of the botanic garden at Harvard university from 1825 to 1834. His publications include *Genera of North American Plants, and a Catalogue of the Species, to the Year 1817* (1818), describing genera and enumerating species; and *The North American Sylva* (1842–49). Nuttall's *A Manual of the Ornithology of the United States and of Canada* (1832–34; further editions in 1840, 1891, 1896 and 1903) was the first work of moderate size and price on American birds. In 1842 Nuttall returned to England. On Sept. 10, 1859, he died at Nut Grove hall, Lancashire.

See biography and list of works in *Leaflets of Western Botany*, vol. ix, pp. 32–42 (1959). (J. W. TT.)

NUWARA ELIYA, a town and district of Central province, Ceylon. The town, administrative centre of the district, is situated about 6,200 ft. above sea level in the heart of the picturesque central highlands, 48 mi. S.S.E. of Kandy and 110 mi. E. of Colombo by road. Pop. (1953) 14,405. It lies in a pleasant hollow only 2 mi. S. of Ceylon's highest mountain, Pidurutalagala (8,281 ft.). Nuwara Eliya is a hill station with a refreshing climate. It is the headquarters of the Ceylon Fishing club and has a beautiful setting. The mean monthly temperature varies from 13° C. (56° F.) in February to 16° C. (61° F.) in May; these figures, however, conceal a considerable daily range, and frost is not unknown at night.

NUWARA ELIYA DISTRICT (area 474 sq.mi.) had a population (1953) of 325,254. Much of it is under tea plantations. Indian Tamils form the main population group. (B. H. F.)

NUX VOMICA, a poisonous drug, consisting of the dried ripe seed of *Strychnos nux-vomica*, a tree (family Loganiaceae) indigenous to most parts of India and found also in Burma, Thailand, Indochina and north Australia. The drug was once used as a bitter tonic and stimulant in humans and is still employed in this way in animals.

The tree is of moderate size, with a short, thick, often crooked stem and ovate entire leaves, marked with three to five veins radiating from the base of the leaf. The flowers are small, greenish-white, tubular and arranged in terminal clusters. The fruit is the size of a small orange and has a thin hard shell, enclosing a bitter, gelatinous white pulp in which from one to five seeds are vertically embedded. The seed is disk shaped, about one inch in diameter, and one-fourth inch thick, slightly depressed toward the centre, and in some varieties furnished with an acute keellike ridge at the margin. Externally, it is grayish-green and satiny from a coating of appressed silky hairs. Internally it consists chiefly of horny albumen, which is easily divided along its

outer edge into halves by a fissure, in which lies the embryo. The latter is about three-tenths inch long and has a pair of heart-shaped membranous cotyledons.

The chief constituents of the seeds are the alkaloids strychnine (*q.v.*) and brucine, each of which constitutes from 1% to 2% of the dried seeds. The two have similar pharmacological actions, though brucine is much less active.

NUYTSIA, a genus of the mistletoe family (Loranthaceae) named after an early Dutch voyager, Peter Nuyts. Its single species, *N. floribunda*, is the Western Australian Christmas tree. It grows to a height of about 30 ft. and in December (summer in Australia) the massed golden-orange flowers make it a conspicuous feature of the sand heaths and eucalyptus forests of southwestern Australia from the Murchison river to King George's sound. *Nuytsia* is a semiparasite on the roots of native trees and shrubs, depending on its host only for mineral elements; containing chlorophyll, it is able to manufacture its organic food by photosynthesis. Around Perth many trees have been spared and are to be found in suburban parks and gardens. Cultivation is difficult, but some gardeners have grown seedlings successfully by allowing the roots to parasitize those of a grass such as Bermuda grass (*Cynodon dactylon;* in Australia called couch grass) in the early stages of growth. (J. W. Gr.)

NUZI. The city of Nuzi was located at present-day Yorgan Tepe, 13 km. S.W. of Kirkuk in the Kirkuk *liwa* of Iraq. It lies in the plain between the mountains of Kurdistan and the Little Zab and Khassa Shai rivers. Twelve levels of habitation were found at Yorgan Tepe during the excavations undertaken by the American Schools for Oriental Research, Harvard University museum and the University of Pennsylvania museum in the years 1925–31. Levels xii–vii contained material of the "protohistoric" and "protoliterate" periods; level ii, the Isin-Larsa period; and level i, the Nuzi period proper. The remains on the surface of the mound were of the Roman, Parthian and Sasanian periods. During the Akkadian period the site was known as Gasur. During the 15th and 16th centuries B.C., Nuzi was an important administrative centre.

The site has produced many specimens of great value for the study of Hurrian ceramics and glyptic art. The palace, rebuilt over the centuries, and private homes contained over 4,000 cuneiform tablets. The tablets are written mostly in Akkadian, the *lingua franca* of the period, but most of the personal names are Hurrian and the Akkadian used often contains Hurrian loanwords and shows strong Hurrian influence. From these tablets and those of nearby Kirkuk, an insight into specific Hurrian family law and societal institutions has been possible. Among these may be noted: fratriarchy; the adoption of a son-in-law when the only child is a daughter; inheritance by possession of the testator's house gods; inalienability of property and consequent fictive adoption; providing of a concubine to the husband by the childless wife without sacrifice of her position, etc. This Nuzi material has clarified many difficult passages in the contemporary patriarchal narratives of Genesis. The Hapiru (identified by many with the Hebrews) are mentioned in Nuzi texts in a servile role. After the Nuzi period, the site remained essentially uninhabited for over a millennium. *See* also HURRIANS.

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(J. C. Gr.)

NYACK, a village of Rockland County, New York, U.S., on the west bank of the Hudson River (which there expands into Tappan Zee, 3 mi. [5 km.] wide), 14 mi. (23 km.) above New York City. There is a ferry to Tarrytown, nearly opposite. With the adjacent villages of Upper Nyack, South Nyack, Central Nyack, and West Nyack, the population exceeded 11,000 in 1960. The industries include shipyards, machine shops, and factories. Permanent settlement dates from around 1700. Nyack was incorporated in 1833 and named after a tribe of Algonkin Indians. For comparative population figures *see* table in NEW YORK: *Population.*

NYAKYUSA, a Bantu-speaking people of Rungwe district, Tanganyika (Tanzania), immediately north of Lake Nyasa. Their country comprises alluvial flats near the lake and the mountainous country beyond for about 40 mi. In the 1960s their growing population was more than 230,000. Formerly consisting of six groups of chiefdoms of basically similar culture, they are now invariably known as Nyakyusa (the name of the group inhabiting the lake plains) as a result of modern administrative unification. Bananas are the traditional staple food, augmented with corn, millet, beans and some milk. Rice and coffee have become the principal market crops and, combined with the earnings of labour migrants, are the basis of the modern economy.

Traditionally the Nyakyusa lived in age-villages that may be unique human phenomena. Each village comprised men of about the same age with their wives and children. Boys left home at about the age of ten and lived in a new hamlet apart from their fathers and elder brothers. In due course, the new hamlet became an autonomous village with its own headman, and area of arable land and pasture. A village died as its founders died in old age. A number of villages comprised an independent chiefdom of a few thousand people. The chief had two senior wives and the eldest son of each succeeded to a half of the chiefdom. Succession occurred when the sons were about 30 years old and before their father reached old age. At that time their commoner contemporaries established their hamlets as new villages and chose their headmen. The old chief retired, his old headmen became mainly ritual leaders and the old villages might even shift off their land to make room for the villages of their sons. With modern land shortage the older men are no longer willing to shift and new age-villages seldom become established now.

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NYAMWEZI, the Bantu-speaking inhabitants of a wide area of the western region of Tanganyika (Tanzania); their growing population was estimated at 400,000 in the 1960s. They form (together with the Sukuma people, who numbered about 1,000,000) the Sukuma-Nyamwezi language group. Several other peoples, although differing somewhat from the Nyamwezi in language, customs and way of life, have sufficient in common to be included in this group of tribes. The Nyamwezi live mainly in the Tabora, Nzega and Kahama districts.

Other tribes in the group include the Sumbwa (about 70,000, mainly in Kahama), the Kimbu (about 16,000) and the Bende (about 10,000). In some regions animal husbandry is limited by tsetse fly infestation, but these peoples have more than 700,000 cattle; there are also about 425,000 smaller livestock. In addition, the Nyamwezi grow rice, peanuts and sunflower seeds as their main cash crops. These mixed farmers also raise cotton for trade, but not in important quantities.

Tabora, capital town of the Nyamwezi, was the most important pre-European centre in this part of Africa. Arab traders settled there and explorers passed through; as porters, the Nyamwezi became the best-known tribe of east Africa. Although most tribes in the Nyamwezi cluster are matrilineal, the Sukuma follow patrilineal succession and practise leviratic marriage (*see* MATRILINY; LEVIRATE); their clan system has lost much in importance and the rules of exogamy are based on blood relationships rather than on clan tabus. The people of this tribal group have an extensive folklore and are enthusiastic and versatile musicians, singers and dancers. They are famous as practitioners of these arts and have formed a great number of secret societies, many of them relatively harmless (*e.g.*, snake charmers, porcupine hunters) and a few not so harmless. Ceremonies are performed to initiate novices into these societies, but puberty initiations and circumcision are not performed. *See* also TANZANIA, UNITED REPUBLIC OF; BANTU (INTERLACUSTRINE).

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NYASA, LAKE, the southernmost and third largest of the Great Rift Valley lakes of east Africa, lies in a deep trough en-

tirely within Nyasaland, its northern and eastern shores forming much of the boundary with Tanganyika and Portuguese East Africa (Mozambique). With a length, in a general north-south direction, of 360 mi., and a width varying from 10 to 50 mi., its area is 11,600 sq.mi. The surface is 1,550 ft. above sea level, and the depth increases to 2,220 ft. toward the northern end, where the forested Livingstone mountains to the east and the Nyika plateau and Vipya mountains to the west (all between 6,000 and 8,000 ft.) fall steeply down to the lakeshore.

Away from the influence of coastal features, which continue beneath the surface, the bottom of the lake is regular and consists of mud. A fresh southeasterly wind (the *mwera*) prevails from May to August, causing steep, short seas, and the coastline offers little shelter. In 1946 a 370-ton vessel, the "Vipya," was overwhelmed in a storm with heavy loss of life. There are few settlements on the eastern shore but near it, halfway up the lake, is Likoma Island, a mission headquarters and site of an imposing Anglican cathedral (completed 1911). On the heavily populated Malawi shore there are government stations at Fort Johnston, Kota Kota, Nkata Bay and Karonga.

The water, fresh and potable, is derived largely from the area of high rainfall in the north. There are 14 perennial rivers feeding the lake, the largest being the Ruhuhu, but the sole outlet is the Shire river (*q.v.*) in the south, a tributary of the Zambezi. The lake has a seasonal rise and fall of about 3 ft., and also a long-period variation. Between 1915 and 1935 outflow was negligible and the lake rose 18 ft. A degree of stabilization of the lake, as well as hydroelectric power and irrigation, was envisaged in the Shire Valley scheme (1955), but this fell into abeyance. A feature of Lake Nyasa is the lake fly, which hatches in clouds large enough to obscure the horizon.

A passenger and cargo vessel "Ilala II," operated by the Nyasaland Railway company, makes three round voyages a month, leaving from Monkey bay, headquarters of the lake services. Cargo is also carried by two other vessels and by tugs with barges. Cotton, rice, rubber, tung oil and peanuts (groundnuts) are shipped to the only railhead at Chipoka, in the south, whence the railway connects through Limbe to Beira, Mozambique. Passenger and cargo traffic increased after World War II, and the former federal government of Rhodesia and Nyasaland improved navigation and harbour facilities.

Commercial fisheries exist at the southern end of the lake, thriving chiefly on *Tilapia*, which is sun dried for African consumption. African fishing is on a subsistence basis. The total annual yield is estimated at 7,000 tons. Of about 200 species of fish recorded by the Fisheries Research laboratory at Nkata Bay, about four-fifths are endemic, being isolated from the Zambezi fauna by the Murchison falls.

The existence of Lake Nyasa was first reported by a Portuguese, Caspar Boccaro, in 1616. David Livingstone (*q.v.*), with John Kirk, reached it from the south in 1859 and was told by the Yao people that its name was "Nyasa" (Nyanja), which describes any mass of water. The first steamer on the lake was the "Ilala I," carried in pieces and reassembled on the shore in 1875 by Scottish missionaries.

Until the end of the 19th century the lake was infested with Arab slave traders, whose influences are seen in the fleet of Arab-type dhows. Three small gunboats, brought to the lake in 1893, helped to establish order. The first shot of World War I between British and German forces was fired on Lake Nyasa when the S.S. "Guendolen" disabled beyond repair the German gunboat "Hermann von Wissmann" on her slipway at Sphinxhaven (Liuli) on the Tanganyika side. (R. T. BA.)

NYASALAND was the name of a British protectorate in east-central Africa, which on becoming an independent member of the Commonwealth of Nations in 1964 was renamed Malawi (*q.v.*). The present article deals with the history of this country up to independence.

The first foreigners known to have discovered Lake Nyasa (Malawi) and to make firm contact with the Bantu peoples on its shores were Arab slave traders who established a base on the lake in the early 19th century and carried the slave trade westward into central Africa. When David Livingstone reached Nyasaland in 1859 he was horrified by the barbarities of the trade, stirred the conscience of his fellow countrymen with his descriptions, and urged the churches to send out missionaries to heal what he called the "open sore of the world." The first of these arrived in 1861 but it was not until 1875 that missionaries of Scottish Churches were able to establish themselves in the country. At their request the African Lakes Company was formed, supplying the missions and providing "legitimate commerce" as an alternative to the slave trade. Both the missionaries and the company came into conflict with the slave traders. The British government was reluctant to take on more responsibilities, though in 1883 a British consul was sent out to the area, accredited to "the kings and chiefs of central Africa." In 1891, following an attempt by the Portuguese to extend their power inland, the area was proclaimed a protectorate. In 1904 responsibility for its administration was transferred from the Foreign Office to the Colonial Office. In 1907 the protectorate (known as the British Central Africa Protectorate after 1893) was named Nyasaland. Henceforth, for more than 50 years, its problems were mainly economic. With a crowded and growing African population and no exploitable mineral resources, Nyasaland remained poor and its chief export was manpower. In the 1930s it was realized that it would be difficult for the country to solve its economic problems in isolation and after World War II the idea of closer association with Southern Rhodesia was pursued.

In 1953 the protectorate of Nyasaland was included in a federation with two other British territories, Northern Rhodesia, also a protectorate, and Southern Rhodesia, a self-governing colony. The federal capital was located at Salisbury in Southern Rhodesia and the federal prime minister was Sir Godfrey Huggins. There were some disturbances in Nyasaland the same year, instigated by African opponents of federation. Political advancement continued and in 1955 the Legislative Council was reconstituted to include five Africans. In 1959 large-scale disorders broke out, a state of emergency was declared, Hastings Banda and other members of the Nyasaland African Congress were arrested, and a number of Africans were killed in clashes with security forces. In 1960 the report of the Monckton Commission indicated the strength of African opposition to the idea of federation. When, in 1961, elections were held under a new constitution, Banda's Malawi Congress Party gained control of the Legislative Council. In February 1963 Nyasaland achieved internal self-government and Banda took office as prime minister. The federation was dissolved at the end of 1963 and in July 1964 Nyasaland achieved independence under the name of Malawi. (K. G. B.; X.)

NYAYA, one of the six systems of thought into which ancient Indian philosophy divided itself in the centuries following the Epic period (*see* INDIAN PHILOSOPHY). For its outstanding achievement *see* LOGIC, HISTORY OF.

NYCTEUS, in Greek legend, father of Antiope, whose sons Zethus and Amphion were to build the walls of Thebes; brother of Orion, the giant hunter. Nycteus' father, Hyrieus, the founder and eponymous hero of the Boeotian town of Hyria, had been long childless until Zeus, Poseidon and Hermes on a visit remedied this. Nycteus and his brother Lycus, in what may be a later tradition, intrude into the Cadmeian dynasty of Thebes by acting in turn as guardians of the infant Laius, who was to be the father of Oedipus. (H. W. PA.)

NYE, EDGAR WILSON (BILL NYE) (1850–1896), U.S. journalist, humorist and lecturer, was born in Shirley, Me., on Aug. 25, 1850. In 1852 the family moved to Wisconsin, where Nye attended River Falls academy, taught school and read law. Settling in Laramie, Wyo., in 1876, he served as postmaster and justice of the peace, and contributed to the *Denver Tribune* and *Cheyenne Sun*. His humorous squibs and tales in the *Laramie Boomerang*, which he helped found in 1881, were widely read and reprinted. Collected, they form the substance of several published volumes. Later Nye returned to Wisconsin, and for several years wrote for the *New York World*. In 1886 he lectured with James Whitcomb Riley, the combination of Nye's wit and Riley's sentiment proving extremely popular. He continued writing, but

he suffered from poor health, and spent his last days in Arden, N.C., where he died on Feb. 22, 1896.

Nye is associated with Charles F. Browne ("Artemus Ward" [*q.v.*]), David R. Locke ("Petroleum V. Nasby" [*q.v.*]), Henry W. Shaw ("Josh Billings" [*q.v.*]) and other professional humorists who flourished after the Civil War. But he avoids their political satire and their tricks of faulty spelling, grammar and diction. Writing in his own person, rather than in the guise of a foolish character, Nye reveals his own kindly but droll nature. Possibly for these reasons he has worn better than some of his humorous contemporaries.

See F. W. Nye, *Bill Nye: His Own Life Story* (1926). (L. T. D.)

NYERERE, JULIUS KAMBERAGE (1922–), president of Tanzania and an important figure in the Organization of African Unity, was born in March 1922, the son of a chief, at Butiama, Musoma district, Tanganyika. First educated locally, he went to Makerere College, Uganda, in 1943, in which year also he became a convert to Roman Catholicism. At Makerere College he joined a branch of the Tanganyika African Association (the TAA), a moribund organization of African civil servants. On leaving Makerere in 1945, Nyerere went to teach at St. Mary's Roman Catholic school at Tabora. In 1949 he went to Edinburgh University, where he took an arts degree, returning afterward to teach in Tanganyika. In 1953 he was elected president of the TAA, which he soon converted into a lively political organization with the title Tanganyika African National Union. In 1954 and 1957 he served briefly as a member of the Legislative Council and became an elected member in 1958. In 1957 he addressed the UN Trusteeship Council in support of ultimate independence for Tanganyika with an African majority government. In September 1960, when Tanganyika gained responsible self-government, Nyerere became chief minister, and he was the first prime minister of independent Tanganyika from December 1961. When Tanganyika became a republic a year later he was elected president, and in 1964 he became president of the United Republic of Tanzania (Tanganyika and Zanzibar). His policy was consistently one of nonracialism inside Tanganyika and of nonalignment outside. (K. I.)

NYIKA, the Northeast Coastal Bantu tribes, including the Digo, who live along the Kenya and Tanganyika coast south from Mombasa to Pangani; the Giryama, who live north of Mombasa; and the Duruma, Jibana, Rabai, Ribe, Chonyi, Kauma and Kambe, who live in the arid bush steppe (*nyika* in Swahili) west of the Digo and Giryama. In the 1960s they were estimated to number 300,000. Most Nyika are of medium height, muscular, broad-headed and dark brown in complexion. Some, because of intermarriage with Arabs and Cushites, are slender, lighter brown and have narrow faces. Modern Nyika wear loincloths and pleated kilts or Swahili and western garments. They build rectangular mud, wattle and thatch houses or loaf-shaped grass huts and live in dispersed homesteads or compact villages. Before European rule ended tribal war they lived in fortified villages known as *kaya*.

Many Nyika are Muslims, some are Christians, and perhaps a quarter retain the traditional native faith. There is widespread belief in Islamic, pagan and ancestral spirits thought to require ritual placation. Nyika are governed by officials appointed by the Kenya and Tanganyika governments. Traditionally they were ruled by elders deriving authority from age grade (*see* AGE SET) and rank in secret societies. Digo social organization is bilateral, Duruma is double unilineal and the others are patrilineal. Nyika are cultivators and keepers of livestock. Some work in urban centres and on plantations. Many are traders, hunters, and fishermen. *See* AFRICA: *Ethnography* (*Anthropology*): *East Africa.*

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NYÍREGYHÁZA, a town of northeast Hungary in Szabolcs-Szatmár *megye* (county), 169 mi. (272 km.) E.N.E. of Budapest by rail, is the main urban settlement of the Nyírség region. Pop. (1960) 56,834 (mun.). Nyírség was for centuries a spectacular wilderness of dune and fen, but it has been gradually reclaimed for farming, and its sandy soils are well cultivated. The countryside is noted for its *tanya* settlements (small isolated farms or groups of farmsteads). There are 73 identifiable separate hamlets round the town, originating from family colonies, each of which once had its own small school. The town is now an important road and rail intersection point. Since World War II light industry (hosiery) has developed, but Nyíregyháza remains chiefly a market for farm products, especially tobacco, potatoes and vegetables.

The history of Nyíregyháza as a town really begins with the determined effort of Count Ferenc Károlyi in the mid-18th century to colonize the region. The settlement of Slovak immigrants was conspicuous; they were known as *Tirpaken* ("without possessions") and their descendants, although more prosperous, still often bear the nickname. (H. G. S.)

NYLON: *see* FIBRE.

NYMPH, in Greek mythology the generic name of a large class of inferior female divinities. The word nymph is of uncertain etymology and means simply a marriageable woman; this is appropriate, for the nymphs are mostly associated with fertile, growing things, such as trees, or with water. Superior deities especially associated with them are Artemis, Apollo, Dionysus, Pan and Hermes. The nymphs were not immortal but were extremely long-lived; they were on the whole kindly disposed toward men. They were distinguished according to the sphere of nature with which they were connected. The Oceanids, for example, were sea nymphs, daughters of Oceanus and Tethys; the Nereids (*q.v.*), daughters of Nereus and Doris, inhabited both salt and fresh water; the Naiads (*q.v.*) presided over springs, rivers and lakes. The Oreads (*oros*, "mountain") were nymphs of mountains and grottoes; one of the most famous of these was Echo (*q.v.*), who either was vainly loved by Pan or herself vainly loved the fair youth Narcissus. The Napaeae (*nape*, "dell") and the Alseids (*alsos*, "grove") were nymphs of glens and groves; the Dryads (*q.v.*) or Hamadryads presided over forests and trees.

Italy had native divinities of springs and streams (Juturna, Egeria [*qq.v.*], Carmentis, Fons) and water-goddesses called Lymphae (originally Lumpae) with whom the Greek nymphs tended to become identified.

NYMPHAEUM, a monument consecrated to the nymphs (*q.v.*), especially those of springs. These monuments were originally natural grottoes, which were traditionally considered the habitations of the nymphs. They were arranged to furnish a supply of water. Subsequently, artificial grottoes took the place of natural. The nymphaea of the Roman period were borrowed from the Hellenistic east (*e.g.*, the Great Nymphaeum of Ephesus). The majority were rotundas, adorned with statues and paintings. They served the threefold purpose of sanctuaries, reservoirs and assembly rooms. A special feature was their use for the celebration of marriages. Such nymphaea existed at Corinth, Antioch and Constantinople; the remains of about 20 have been found at Rome and of many in Asia Minor, Syria and Africa. The term nymphaeum was also applied to the fountain in the atrium of the Christian basilica. *See* FOUNTAIN.

NYORO (Banyoro, Wanyoro, Kitara, Bakitara), a Bantu-speaking people of Uganda (*q.v.*) inhabiting the area east of Lake Albert between the Victoria Nile and the Kafu (*see* BANTU [INTERLACUSTRINE]). Before the growth of Ganda power in the 19th century, the Nyoro kingdom was the political focus of the region, controlling the now-independent Toro and the present Mubende district of the Ganda kingdom. The Haya, Nkole and northern Soga states also have traditional links with the Nyoro kingship, as also have some of the Nilotic Lango and Acholi. Including those living in areas presently controlled by the Ganda, but not including Toro, the Nyoro numbered about 200,000 in the 1960s.

Nyoro society was traditionally divided into two main categories which, however, are no longer distinct: the Iru (Bairu),

settled agriculturalists who grew millet and sweet potatoes; and the Huma (Bahuma), who were mainly transhumant cattle-keepers. A third category, the Bito (Babito), were of Nilotic origin and provided the ruler of the state, the *Mukama*. Chiefs of districts were appointed by the *Mukama* from all sections of the population. Nyoro religion was centred upon communication (through mediums) with the spirits of ancestors, natural phenomena and a pantheon of god-kings (*bacwezi*) who were believed to have formed a dynasty that ruled prior to the Bito.

See also AFRICA: *Ethnography (Anthropology)*: *East Africa.*

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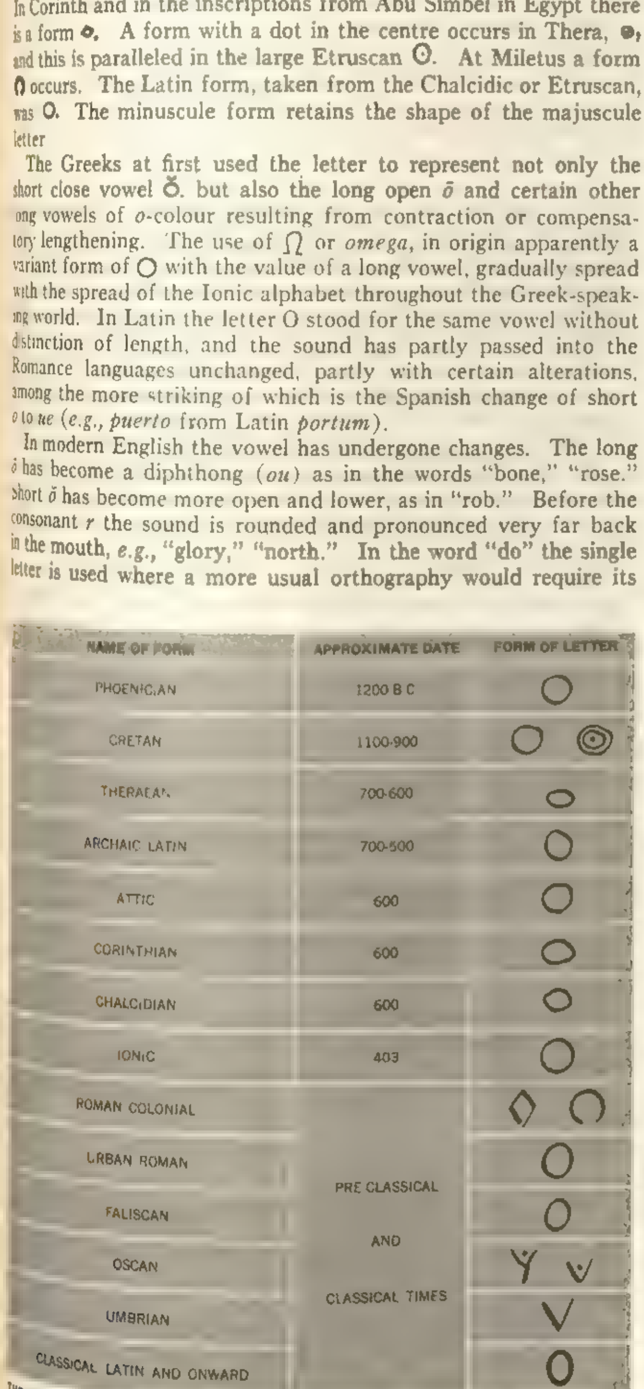
NYX, "Night," in Hesiod, daughter of Chaos and mother of numerous primordial powers including Sleep and Death. Orphic myth makes her rule the gods after her father, Phanes, and dominate her successors (Uranus, her son by Phanes; Cronus and Zeus) by her oracular gifts. Throughout antiquity she caught the imagination of poets and artists but was seldom worshiped.

(D. E. W. W.)

O THIS letter, the fourth vowel of the modern alphabet, corresponds to the Semitic *ayin*, which represented a breathing and not a vowel. The Semitic form may derive from an earlier sign representing an eye. The Greeks in adapting the Semitic alphabet to their own use used this letter (*omicron*) to express the vowel O, as the letters *aleph, he, cheth* and *yodh* were used to express vowels. Vowels were not expressed alphabetically in Semitic. The form of the letter on the Moabite stone was small O, and this small form appears in early Greek inscriptions from Thera and Corinth. In Corinth and in the inscriptions from Abu Simbel in Egypt there is a form ◇. A form with a dot in the centre occurs in Thera, ⊙, and this is paralleled in the large Etruscan ʘ. At Miletus a form Ο occurs. The Latin form, taken from the Chalcidic or Etruscan, was O. The minuscule form retains the shape of the majuscule letter

The Greeks at first used the letter to represent not only the short close vowel ŏ. but also the long open ō and certain other long vowels of *o*-colour resulting from contraction or compensatory lengthening. The use of Ω or *omega*, in origin apparently a variant form of O with the value of a long vowel, gradually spread with the spread of the Ionic alphabet throughout the Greek-speaking world. In Latin the letter O stood for the same vowel without distinction of length, and the sound has partly passed into the Romance languages unchanged, partly with certain alterations, among the more striking of which is the Spanish change of short *o* to *ue* (*e.g., puerto* from Latin *portum*).

In modern English the vowel has undergone changes. The long *ō* has become a diphthong (*ou*) as in the words "bone," "rose." Short *ŏ* has become more open and lower, as in "rob." Before the consonant *r* the sound is rounded and pronounced very far back in the mouth, *e.g.,* "glory," "north." In the word "do" the single letter is used where a more usual orthography would require its doubling. Again in the word "son" one would expect the vowel *u*. In words such as "word," "work," "world" the sound has been affected by the preceding bilabial. The short sound is the descendant of Middle English short *ŏ* in which both the close and open short *ŏ*, which were distinguished in Old English, met. The long *ō*, now a diphthong, descends from Middle English long *ō*, an open sound, which was derived from Old English long *ā*. In Middle English this was a rounded back vowel akin to the modern vowel in "shore," "north." Old English close long *ō* became in Middle English *oo* (*ū*). *See* also ALPHABET. (B. F. C. A.; J. W. P.)



THE DEVELOPMENT OF THE LETTER "O" FROM THE PHOENICIAN THROUGH CLASSICAL LATIN TO THE PRESENT FORM

OAK is the common name for more than 300 species of trees and a few shrubs belonging to the genus *Quercus* of the beech family (Fagaceae).

True Oaks.—Oaks are widely distributed throughout the temperate regions of the northern hemisphere and are quite abundant at high elevations in many parts of the tropics. A few are found below the equator, in the new world as far south as Colombia and in the old to the Indian archipelago. Their greatest concentration occurs in the highlands of Mexico, especially in the Sierra Madre range where they are the principal components of vast mixed hardwood forests. Several of the oaks indigenous to the eastern United States are productive of some of the world's finest cabinet and structural timbers. The forests of Japan, India, the U.S.S.R., Czechoslovakia and Poland also include valuable timber-producing species.

As a group the oaks are characterized by alternately disposed, simple, deciduous or evergreen leaves with lobed, toothed or entire margins and a featherlike arrangement of their principal veins. Their small inconspicuous unisexual flowers are borne in separate inflorescences on the same plant (monoecious). The male or staminate flowers are borne in many-flowered, sulfurous-yellow, pendent catkins that appear with or after the leaves, each being comprised of a 4- to 7-lobed calyx and 4 to 12 (mostly 6) stamens. The female or pistillate flowers; by contrast, appear in few-flowered spikes or are solitary. Each flower consists of a 6-lobed calyx and 3- to 5-celled pistil, the whole partially enveloped by many involucral bracts. The fruit of the oak is the distinctive acorn, a nut that is partially (rarely wholly) encased in a "cup" composed of the greatly enlarged involucral bracts that attended the pistillate flower. The bark pattern of oak trees varies greatly not only among species but often within a species of different age classes. The bole of several species features transverse and longitudinal fissures resulting in a blocklike configuration reminiscent of alligator leather. Barks of other trees are often smooth, superficially scaly, plated or irregularly ridged between deep longitudinal and often anastomosing furrows.

On the basis of certain common botanical features the genus *Quercus* is readily divided into three very distinctive subgeneric groups known as the *Cyclobalanus, Leucobalanus* and *Erythrobalanus* oaks. *Cyclobalanus* oaks feature fruits in which the involucral bracts of the acorn cups are fused together into several concentric rings. In the other two groups the bracts are spirally arranged. *Leucobalanus* oaks, commonly known as the white oaks, feature leaves with smooth or occasionally glandular margins but are never bristle tipped. Their acorns, which mature at the end of a single growing season, are usually sweet meated and germinate within a few days following their fall. *Erythrobalanus* oaks, the red or black oaks of commerce, in contrast, are characterized by leaves with bristle-tipped lobes and apices, and astringent fruits that not only mature at the end of two growing seasons but also winter over and germinate the following spring. The term "live" oak is applied to any of the oaks that feature persistent, evergreen foliage.

Of the more than 85 species of *Quercus* indigenous to the United States, more than 50 attain the stature of large trees, and fully half of these are of primary importance in the timber industry.

Many of them attain heights in excess of 100 ft., and diameters of from 4 to 7 ft. are not at all uncommon. While oaks are found in every forested region in the United States, the chief centres of oak lumber production lie in the southeast.

Among the most valuable of the eastern leucobalanus oaks are the white oak (*Q. alba*), a tree 80 to 100 ft. tall with a trunk 3 to 5 ft. in diameter, productive of some of the world's finest white oak lumber; the massive bur oak (*Q. macrocarpa*), often 150 to 170 ft. high and 4 to 7 ft. in diameter, easily recognized by its corky twigs, obovate leaves with deep central sinuses and large fruits, the fringed cups of which nearly enclose the nut; the post oak (*Q. stellata*) with its leaves in the form of a cross; the chestnut oak (*Q. prinus*) and swamp chestnut oak (*Q. michauxii*), two species with chestnutlike leaves, the former an upland form, the latter largely restricted to permanently wet sites on the coastal plains; and the overcup oak (*Q. lyrata*), another denizen of southern coastal swamps, readily recognized by its irregularly lobed leaves and large nuts completely enclosed in thin scaly cups. The eastern red oaks of primary importance to the lumber industry include the northern red oak (*Q. rubra*), the fastest growing of the eastern oaks which at maturity often attain a height of 150 ft.; the black oak (*Q. velutina*) another equally large tree, whose bark is the source of a yellow dye principle, quercitron (*see* QUERCITRON BARK); the Shumard oak (*Q. shumardii*); the scarlet oak (*Q. coccinea*); and the willow oak (*Q. phellos*) a large tree of the southern coastal plains with willowlike leaves, commonly used as a street and shade tree throughout many of the southern states. The live oak (*Q. virginiana*), the only evergreen oak in eastern United States, was once highly prized by both British and American shipbuilders.

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LEAVES AND ACORNS OF THE WHITE OAK (QUERCUS ALBA)

The oaks of the Rocky mountain region are mostly small trees that at high elevations are little more than shrubs. The Gambel oak (*Q. gambelii*), rarely 45 ft. tall, is the largest oak in Colorado, and the somewhat larger Arizona white oak (*Q. arizonica*), is the principal oak of Arizona and New Mexico.

A number of deciduous and evergreen oaks are indigenous to the Pacific slope. The most important of these is the Oregon white oak (*Q. garryana*), found from British Columbia to San Francisco bay, commonly used locally in the production of furniture and flooring. Two other deciduous species, the California white oak (*Q. lobata*), a massive tree with a crown spread of 150 or more feet, and California black oak (*Q. kelloggii*), are trees of secondary importance. Among the evergreen species are the interior live oak (*Q. wislizenii*) with hollylike leaves; canyon live oak (*Q. chrysolepis*) with small, thick, unlobed leaves and woolly twigs, the California live oak (*Q. agrifolia*) and the small shrublike California scrub oak (*Q. dumosa*).

The timber of both the American red and white oaks is put to many diverse uses. The better grades of lumber are used for flooring, furniture, paneling and millwork. The white oaks are admirably suited for staves and headings for tight cooperage. Large quantities are also consumed in the production of crossties, structural timbers and mine props, stulls and sills.

Among other important oaks of the world particular mention should be made of the cork oak (*Q. suber*), a small- to medium-sized tree of the Mediterranean basin, the bark of which is the principal source of the world's supply of commercial cork (*q.v.*).

The brown oak (*Q. robur*), the only oak indigenous to England, is a cosmopolitan tree of wide distribution through most of the milder parts of Europe and the Caucasus mountains in Asia. At least 40 varieties are known in cultivation. Long noted for its heavy, fine-grained, rich brown heartwood, it was once used in the construction of British merchant shipping. At one time it was also a favourite of wood carvers, and the shrine of Edward the Confessor in the abbey at Westminster was fabricated of this handsome wood. This species, also known as English oak, attains great longevity, and many of the largest trees still standing in the British Isles are believed to date from Saxon times. One venerable old forest giant, the celebrated Newland oak in Gloucestershire, known for centuries as "the great oak," was 47.5 ft. in diameter 5 ft. from the ground at the time of its destruction.

The Turkey oak (*Q. cerris*) abounds over the Taurus ranges along the Turkish peninsula and in many other parts of southern Europe. It is also a common ornamental plant in England and in several of the older cities of eastern United States.

The evergreen holly oak (*Q. ilex*) is indigenous to southern Europe and northern Africa. In its native lands it attains great age. Pliny attributed to several trees growing in Rome a greater antiquity than the city itself.

While the oaks are principally known for the many fine timbers they produce, several of them are also important sources of other valuable forest products. The kermes oak (*Q. coccifera*), a small bushy tree of the Mediterranean basin, is heavily preyed upon by kermes, small insects whose body juices are bright red and which are used as a source of dye. Tannin (*q.v.*), a chemical complex used in converting raw hides to leather, is obtained in commercial quantities from the barks of several oaks. Valonia tannin is traceable to the acorn cups of *Q. aegilops*, a small tree indigenous to Greece and the coasts of the Levant, while Aleppo tannin is derived from insect galls commonly found on the twigs of the Aleppo oak (*Q. infectoria*), a Turkish tree. The acorns of several oaks are a common article of diet of small game, and because of their high nutritive value have been used to fatten swine.

Leaf-eating organisms (tent caterpillars; larvae of gypsy, Luna, browntail, Cecropia and buck moths; striped oak, American silk and canker worms) commonly denude several species of oak but seldom bring about their death. Other insects cause unsightly twig and leaf galls. Oak wilt fungus causes severe loss in several areas, threatening extinction of some species.

Other Trees Bearing the Name of Oak.—Several other unrelated groups of trees, the timbers of which also display large prominent wood rays that on the quarter section of boards give rise to a spangled figure, are likewise known in the lumber trade as oaks. Notable among these are the Australian silky and satin oaks, a group of highly prized ornamental woods traceable to the genera *Cardwellia, Grevillea, Embothrium* and *Orites* of the Proteaceae. The tulip oaks, another group of Australian trees, belong to the genus *Tarrietia* of the cocoa family (Sterculiaceae; *q.v.*). The she (or shee) oaks, including beef oak and flame oak are members of the genus *Casuarina* of the Casuariniaceae, a monotypic family widely distributed through the southern hemisphere but most abundant in Australia. African oak timber is the product of two unrelated species from the Ivory Coast, *Oldfieldia africana* and *Lophira alata*. Wood of the former has been used in marine construction by the British navy but is virtually unknown in the United States.

Tanoaks belong to the genus *Lithocarpus*, also a member of the Fagaceae and may be distinguished from the true oaks on the basis of their unisexual flowers, which appear in bisexual catkins.

See also TREE; FAGACEAE; WOOD; and references under "Oak" in the Index.

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(F. W. J.; E. S HR.)

OAKHAM, a market town and urban district in the Rutland and Stamford parliamentary division, and the county town of Rutland, 17 mi. E. of Leicester. Pop. (1961) 4,571. It is an ancient market town in the fertile Vale of Catmose and the headquarters of the Cottesmore hunt. By the market place with its old octagonal Butter cross stands the Norman castle, originally a fortified manor house, which has a banquet hall hung with a collection of the horseshoes presented by custom since the time

of Elizabeth I to the lord of the manor by royalties and peers passing through the lordship for the first time. All Saints parish church, dating from *c.* 1190, is mainly Perpendicular. The grammar school was founded in 1584. Light industries include the manufacture of hosiery and shoes.

OAKLAND, a city of California, U.S., is the county seat of Alameda county and part of a metropolitan area surrounding San Francisco bay in central California. The city land area covers 53 sq.mi. in the centre of a continuously built-up plain between the east shore of the bay and parallel ranges of hills. The east bay also includes the cities of Richmond and Berkeley on the north, Alameda across a narrow estuary to the west and San Leandro and Hayward (*qq.v.*) to the south, together with the smaller communities of Albany, El Cerrito, Emeryville and Piedmont. Residential areas rise into the hills, and extend beyond them where the Broadway tunnel opens a way into the valleys of Contra Costa county.

The population in 1950 was 384,575 and in 1960, 367,548 by federal census. The population of the San Francisco-Oakland standard metropolitan statistical area, which includes Alameda, Contra Costa, Marin, San Francisco, San Mateo and Solano counties, was 2,783,359 in 1960. In 1963, Solano county (1960 pop., 134,597) was deleted. (For comparative city population figures *see* table in CALIFORNIA: *Population.*)

History.—The east bay was settled by the Spanish in 1820, when Luis Maria Peralta received a royal grant of about 48,000 ac. and established the Rancho San Antonio. In 1849 Moses Chase leased land for farming and laid out a town named Clinton in the area of east Oakland. In 1851 Horace W. Carpentier gained control of a large section of waterfront and started a ferry to San Francisco. The following year he secured a town site and named it Oakland after the live oaks on the grassy plain. In 1854 Carpentier and his associates extended the area and reincorporated it as a city. In spite of bitter competition, Carpentier and the railroads which later took over his interests maintained control of access to San Francisco through the old waterfront claims. By 1885 the Southern Pacific railroad had established its western terminus on the Oakland mole and was operating numerous ferries. In 1903 the Key system, formed out of a small railroad and local electric lines, began another system of ferries. The 1906 earthquake and fire in San Francisco caused a shift of population to Oakland, and regular commuter traffic across the bay increased rapidly.

Under Frank K. Mott, mayor from 1906 to 1915, a new city hall and auditorium were constructed, large areas to the south annexed and a new charter adopted. Most important of all, the city secured court decisions breaking the railroad monopoly on the waterfront and gained control of the tidelands in 1911.

Thereafter, the commercial and industrial growth of the east bay was rapid, and it ceased to be primarily a "bedroom" for San Francisco. World War II brought tremendous military and naval activity, and the construction of extensive shipyards. This expansion continued in the postwar years, until the whole area from the refineries of Richmond to the orchards of Hayward became a continuous urban complex.

Administration.—Oakland is governed under a charter adopted in 1911 and amended in 1931 and 1951 to provide for a council elected by a city-wide vote, a city manager appointed by the council and a popularly elected mayor. The council appoints commissioners for the port, the parks, recreation, city planning and civil service.

Since 1923 water has been supplied through the East Bay Municipal Utility district, which received rights to the water of the Mokelumne river in the Sierra Nevada. Construction of the Pardee dam and aqueducts across the San Joaquin valley provided enough water to expand the district to include 225 sq.mi. of the east bay. In 1944 Oakland and six neighbouring municipalities placed their common problems of sewage treatment and disposal in the hands of the district.

The state of California bridge authority operates all toll bridges crossing the bay. It built the tremendous double-deck bay bridge from Oakland to San Francisco, which is 8¼ mi. long, including the approaches. The bridge was an immediate success when it was opened in 1936, but was already inadequate ten years later. Controversies regarding the location of a second bridge to San Francisco were not resolved, but a new bridge from Richmond across the northern arm of the bay was completed in 1956. In 1957 a San Francisco Bay Area Rapid Transit district was created by the state to plan an integrated system of public transportation for the region. The same procedure of creating special districts in the bay area has been used to deal with the problems of water pollution and smog control.

Commerce and Industry.—The port of Oakland covers 19 mi. of waterfront in the outer, middle and inner harbours. Including the Alameda side of the inner harbour, it handles 4,000,000 tons of cargo annually. There are large terminals and warehouses, shipbuilding and repair yards, dry docks, small-boat harbours, various industries, an international airport and Jack London square, a restaurant area developed by the port commissioners. The Oakland army base, the Oakland naval supply centre, and the naval air station in Alameda across the estuary are tremendous installations, covering over 3,000 ac. of filled land. Large areas in the north harbour and around San Leandro bay are held by the port for further development, as well as 8,000 ac. of submerged land annexed in 1955 to provide for the expanding airport.

The principal industries of Oakland and the east bay include food processing and milling, oil refining, manufacture of automobiles, calculating machines, electrical equipment, containers of all kinds, steel fabrication, chemicals and drugs. Oakland is headquarters for Kaiser Industries Corp. and the related Kaiser enterprises, which have built a large and strikingly beautiful office building overlooking Lake Merritt.

Education.—Public education is in the hands of an elected school board, which maintains a junior college and 5 senior high schools as well as more than 75 junior high schools and elementary schools. Mills college, founded in 1852, the oldest college for women in the far west, occupies a 136 ac. campus in east Oakland. The College of the Holy Names (for women) and the California College of Arts and Crafts are inside the city, and St. Mary's college (for men) is in the Moraga valley to the east. The University of California is in Berkeley, about a mile from the city line.

Oakland maintains a public library system, an art gallery, a public museum, the Woodminster outdoor theatre and the Chabot observatory.

Parks.—The park system includes Lake Merritt, a large salt water inlet from the estuary near the heart of the city. In the park around its shores are the children's fairyland and the waterfowl sanctuary, established in 1867, the first public wild fowl refuge in the United States.

Oakland includes the Knowland state park and arboretum, and is adjacent to large areas in the Contra Costa hills maintained by a regional park district. (F. H. HK.)

OAKLEY, ANNIE (in full PHOEBE ANNE OAKLEY MOZEE) (1860–1926), U.S. markswoman best known as "Little Missy" of Buffalo Bill's Wild West show, was born on a farm in Darke county, O., Aug. 13, 1860. As a youngster she won local acclaim for marksmanship and after winning a shooting match at Cincinnati with ranking marksman Frank E. Butler became a nationally known figure. Later Butler and Annie were married and together they successfully toured the vaudeville circuits and circuses until 1885 when the "Butler and Oakley" team joined the Buffalo Bill (William F. Cody) show and remained with it for 17 years. So startling were "Little Missy's" performances and so enthusiastic her audience response that she was given main billing as "Miss Annie Oakley, the Peerless Lady Wing-Shot," while her husband served as manager and attendant. Annie's was always the opening act in the Wild West show, and the performances were incredible. Her most spectacular feats were, at 30 paces, to hit the thin edge of a playing card, a dime tossed in the air and the end of a cigarette held in Butler's lips. Once while performing at Berlin she obliged Crown Prince Wilhelm (later Kaiser Wilhelm II) by performing the cigarette act while the prince held the cigarette. Everywhere that the Buffalo Bill show traveled—at home and abroad—the

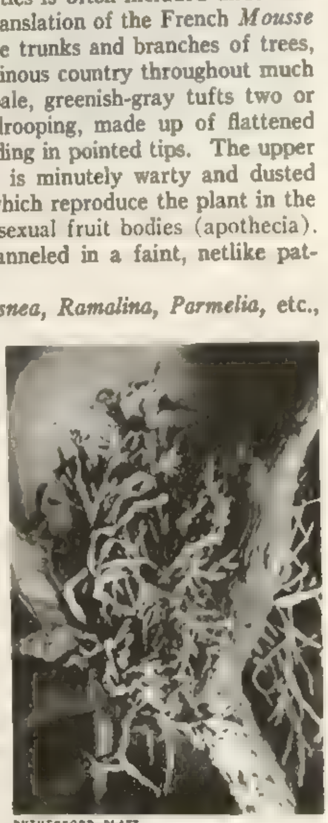
acclaim for Annie Oakley was spontaneous and great. In 1901 she was severely injured in a train wreck but recovered and continued her performances. She died at Greenville, O., on Nov. 3, 1926, and was buried at Brock, near her Ohio birthplace. Her husband died three weeks later.

One of many reminders of this remarkable woman is the use of her name to denote a complimentary ticket. The hole customarily punched in such a free pass recalls the bullet holes that she shot in small cards during her theatrical performances. A free ticket thus came to be known as an "Annie Oakley."

See Walter Havighurst, ***Annie Oakley of the Wild West*** (1954).
(O. O. W.)

OAK MOSS (*Evernia prunastri*), a lichen containing an oleoresin valued in perfumery both for its own fragrance of a heavy, oriental type and as a fixative base. Another species (*E. furfuracea*) having similar properties is often included under the same common name, which is a translation of the French *Mousse de chêne.* Oak moss grows on the trunks and branches of trees, also on poles and rails, in mountainous country throughout much of the northern hemisphere, in pale, greenish-gray tufts two or three inches long, extending or drooping, made up of flattened strands which fork repeatedly, ending in pointed tips. The upper or outer surface of these strands is minutely warty and dusted with pale-gray soredia, particles which reproduce the plant in the absence of the rare, disk-shaped, sexual fruit bodies (apothecia). The under surface is whitish, channeled in a faint, netlike pattern.

Other lichens of the genera *Usnea, Ramalina, Parmelia,* etc., which grow intermingled with the *Evernia,* frequently gathered with it in the commercial product, have little fragrance, but may contribute to the value of the oleoresin as a base. Chief sources of oak moss from about 1900, when the perfume first came into general use, until 1940, were Yugoslavia and France, large quantities being shipped for distillation in northern Europe. After the disruption of trade by World War II, investigation showed the lichens to exist in Canada and northern United States, and they have been distilled in America to a limited extent.


RUTHERFORD PLATT

OAK MOSS (EVERNIA PRUNASTRI) GROWING ON THE BRANCH OF AN INCENSE CEDAR TREE

Oak moss was used in perfumery as early as the 16th century and later forgotten. Baskets filled with it have been found in the ancient royal tombs of Egypt, but whether intended for perfume or, as some suggest, for making bread, is not known. It contains a starchy edible substance.

See also LICHENS.

OAK PARK, a village of Illinois, U.S., in Cook county, west of and adjacent to Chicago. Oak Park was first settled in 1833 and served as a stopping place for farmers taking their produce into Chicago. In 1871 after the Chicago fire the population grew rapidly, and in 1901 the village was incorporated. Primarily a residential community, Oak Park has an extensive retail trade, little light industry and no heavy industry. Oak Park is unusual in possessing 24 homes designed by Frank Lloyd Wright. It has a number of public and parochial schools and a Catholic military academy. In 1953 Oak Park adopted a village manager-council form of government. For comparative population figures *see* table in ILLINOIS: *Population.* (J. ZA.)

OAK RIDGE, a city of Tennessee, U.S., is about 20 mi. N.W. of Knoxville, at the eastern end of a remote 58,800-ac. tract selected in 1942 as headquarters site for the U.S. wartime atomic energy program, the Manhattan project. Originally known as the Clinton Engineer works, Oak Ridge was picked for the vital government installation because it was isolated, yet accessible to power, water, transportation and manpower. Army engineers began work in early 1943 on the community to house project personnel. The town, built in 2½ years behind security fences, reached a peak population of 75,000 in 1945. Maximum wartime employment was 82,000. After World War II, Oak Ridge's population declined, so that in 1960 the population was 27,169. For comparative population figures *see* table in TENNESSEE: *Population.*

In the latter 1950s the internationally known community, by then headquarters for a major Atomic Energy commission field office, was still centred about a single industry, atomic energy. The government investment at Oak Ridge totaled $1,500,000,000 in two huge uranium processing plants and Oak Ridge National laboratory.

Oak Ridge bears slight resemblance to the temporary wartime boom town. In 1949 fences were removed from the community area. In 1953, roads through the plant areas were opened, and for the first time land was leased for private construction. New churches and schools were built as were many homes.

In 1955 congress provided for the sale of property in Oak Ridge, and in Sept. 1956, the first government-owned house was sold. In less than a year, Oak Ridge became the city with the largest percentage of individual home ownership in the U.S. The resulting renovation and remodeling effected a major face-lifting in the community.

Oak Ridge, which from its inception depended upon the federal government for services normally rendered by municipal government, was incorporated in 1959. (J. A. Hs.)

OANNES, in Babylonian mythology an amphibious being who taught mankind wisdom. He was called thus by the Babylonian priest Berossus, writing in Greek in the 3rd century B.C. (Oannes' name is sometimes also found in the forms Iannes, Euhanes. Fragments of Berossus' writings are preserved by the Jewish historian Flavius Josephus (1st century A.D.) and by the Christian historian Eusebius of Caesarea (3rd–4th century A.D.), the latter transmitting the Oannes legend from earlier Greek sources. Berossus describes Oannes as having the form of a fish, but with under his fish's head, the head of a man and, under his fish's tail the feet of a man. He rose in the daytime from the waters of the Persian gulf and, upon the seashore, instructed mankind in writing, the arts and the sciences. Likewise upon the seashore was the city Eridu, sacred to Ea (*q.v.*), god of the freshwater deep and of wisdom and symbolized as a "goat fish." But the possibility that Oannes and Ea were identical is remote. Oannes is more likely to have been Ea's emissary, sent by him to educate mankind. (T. FH.)

OARFISH, any oceanic fish of the family Regalecidae (a group sometimes included in the closely related dealfish family, Trachypteridae), characterized by a long, compressed silvery body; short head; large eyes; and long, coral red dorsal fin that forms a crest on the top of the head. Oarfishes and their relatives are fragile, usually deepwater species that are rarely seen alive dead or dying specimens being beached occasionally. The long filamentous pelvic fins ending in oarlike expansions give the family its common name. Oarfishes, especially the widely distributed giant oarfish or king of the herrings (*Regalecus glesne*), may reach a length of about 30 ft.; such large individuals are undoubtedly the basis for some of the reports of undulating sea serpents. *See* also FISH; SEA SERPENT.

OASIS, a fertile tract occurring in a desert wherever a perennial supply of fresh water is available. Oases vary in size from a few acres around small springs to vast areas of naturally watered or irrigated land. The largest occur along rivers traversing deserts from headwaters in distant rainy regions; in Egypt, for example, most of the population is concentrated within the nearly 14,000 sq.mi. of the intensively cultivated, irrigated land along the Nile river.

Underground water sources account for large numbers of oases, where springs and wells, many of them artesian, are supplied from sandstone and limestone aquifers. (*See* also GROUND WATER.) The oases of Kharga and Dakhla, northwest of Aswan in the Libyan desert, are watered by an aquifer whose area of water ac-

cumulation lies more than 500 mi. to the south in the Sudan. Water from the deep Artesian basin underlying much of southwestern Queensland, Austr., is widely used for watering livestock but is too saline for crop irrigation.

Desert oases are almost invariably under cultivation. In the Sahara the date palm is characteristic and cotton, olives, figs, citrus, tomatoes, gourds, onions, mint, fennel and numerous other fruits, vegetables and herbs are cultivated. Barley, wheat, maize, millets, rice and other grains are economically important crops.

Heat oases occur in the cold arctic tundra (*q.v.*) where dark-coloured soil materials, which absorb solar radiation with greatest efficiency, are in a topographic position providing both protection from cold winds and exposure of the ground to the most direct angle with the sun. Greater variety of plant species and increased vegetative growth, flowering, intensity of flower coloration and seed maturation characterize these bright spots on the usually drab landscape. (M. E. B.)

OASTLER, RICHARD (1789–1861), English factory reformer, one of the instigators of the Ten Hours bill (1847), was born at Leeds on Dec. 20, 1789. In 1820 he became steward of Thomas Thornhill's estate at Fixby, near Huddersfield, Yorkshire. A Wesleyan family background and a Moravian schooling directed Oastler's attention to practical philanthropy as well as business. In 1830 John Wood, a Bradford worsted manufacturer, revealed to him some of the evils of child employment in the local factories. Oastler was shocked and wrote a vigorous letter, entitled "Yorkshire Slavery," to the *Leeds Mercury*, thereby starting an agitation which soon passed from philanthropy to politics.

During the next ten years Oastler was the most prominent of a band of Tory-Radicals who attacked the "factory system" and the poor law of 1834 and pleaded for a stable social order, based on the principle that "every man born in England has a natural right to live well." Although not a Chartist, he was just as prepared as the Chartists were to agitate when parliament seemed insensitive to operatives' pressure. For his efforts in the West Riding he began to be called the "Factory King," and at last, after many rebuffs, in 1847 a Ten Hours bill was passed by parliament, which appeared to secure the objectives he and his parliamentary colleagues, particularly Lord Shaftesbury, had demanded. A further act of 1850 was necessary to enforce the ten-hour law; by that time the factory reform movement was divided into hostile sections and Oastler was still dissatisfied with results.

His opposition to the poor law of 1834 had led to his dismissal from his stewardship, and being unable to pay an outstanding debt to Thornhill he was sent in 1840 to the Fleet prison where he spent more than three years. From prison he published the *Fleet Papers*, which summarize his philosophy. In 1844 his friends paid his debt, and after his release he was given a triumphal entry into Huddersfield. He died at Harrogate on Aug. 22, 1861.

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OATES, TITUS (1648–1705), renegade Anglican priest who, with Israel Tonge, invented the "popish plot" in 1678. He was born on Sept. 15, 1648, at Oakham, Rutland, the second son of Samuel Oates, an Anabaptist preacher, who was for some time chaplain in Col. Thomas Pride's regiment of foot. From his earliest years he seemed destined to a career of villainy. Expelled from Merchant Taylors' school, London, within a year of his admission, and sent down from both Caius and St. John's colleges, Cambridge, he yet secured admission to orders in the Church of England. He became successively vicar of Bobbing, Kent, in 1673, and curate to his father, who had conformed after the Restoration, at All Saints, Hastings, in 1674. While serving in the latter position, he made his first serious essay in the art of perjury by uniting with his father to bring scandalous and quite unfounded charges against a local schoolmaster whose place he coveted. He sought refuge from prosecution in the navy and in the summer of 1675 visited Tangier as chaplain to the "Adventure" man-of-war. From this post also he was dismissed on the return of the "Adventure" to England, yet early in 1677 he contrived to secure appointment to the position of chaplain to the Protestants in the household of the Roman Catholic duke of Norfolk.

There for the first time he came into intimate and extensive contact with Catholic circles, and was inspired by the association he had formed with Israel Tonge, a fanatical anti-Jesuit, to see what profit could be derived from them. He joined the Roman Catholic Church on March 3, 1677, and in the summer of the same year was sent to Spain to study for the priesthood at the English college at Valladolid; he later claimed to have received the degree of doctor of divinity from the University of Salamanca. His stay at Valladolid was short, however, for he was expelled within five months, only to secure admission instead to the English seminary at St. Omer, from which in turn he was expelled on June 23, 1678. Making his way back to London with a mass of miscellaneous information about the Catholics, he rejoined his ally Tonge, and on the basis of that information and Tonge's imagination the pair proceeded to draw up their account of a vast Jesuit conspiracy to assassinate Charles II, place James, duke of York, on the throne and recover England for the Roman Catholic Church. Tonge, with the utmost affectation of secrecy, took the first step toward making a disclosure of these designs to Charles II and the government on Aug. 12, 1678; and on Sept. 28, Oates, dissatisfied with the progress that had been made, deposited a written account of the plot with a prominent justice of the peace, Sir Edmund Berry Godfrey (*q.v.*), and swore to the truth of its contents.

The tale told by Oates was a clumsy fabrication, but unfortunately it contained just sufficient truth to enlist the support of the ignorant. It was welcomed by several of the contending factions at court, who imagined they could turn it to their own advantage; and it received immediate apparent confirmation with the discovery of Godfrey's corpse under circumstances never satisfactorily explained. A wave of terror swept over England which carried Oates to the summit of power. Hailed as the saviour of his country, rewarded with a pension, and provided with a guard, he found himself in a position to send to the scaffold almost anyone whom he cared to accuse, and did in actual fact bring about the death of about 35 more or less innocent persons. But as the frenzy died down, and too many imitators came forward with additions to his story, discrepancies became apparent which even his brazen assurance could scarcely brush aside, and his credit steadily declined. The queen's physician, Sir George Wakeman, against whom he had given evidence, was acquitted on July 18, 1679. In the following October, Oates was refused the degree of doctor of divinity by the University of Oxford. During the years 1681 and 1682 his pension was first reduced and then withdrawn altogether. In June 1684 damages to the enormous amount of £100,000 were awarded against him at the suit of the duke of York. Finally, in May 1685, he was convicted of perjury, subjected to a flogging from which he barely escaped alive and committed to prison for the remainder of his life.

After the revolution of 1688, Oates was released and once more granted a pension; but the refusal of the house of lords to reverse the sentence passed upon him precluded him from giving evidence in a court of law and so deprived him of his former means of livelihood. His efforts to train others to follow in his footsteps proved unsuccessful, and his marriage on Aug. 17, 1693, to Rebeccah Weld, daughter of a wealthy draper, followed shortly afterward by his admission to and expulsion from the Baptist Church, provoked little but mirth. By the time of Anne's accession in 1702 he had been practically forgotten, and his death in London on July 12 or 13, 1705, passed almost unnoticed.

BIBLIOGRAPHY.—Contemporary accounts of Titus Oates are largely the product of party passion, and cannot be relied upon. The only full-scale modern account is Jane Lane, *Titus Oates* (1949), which combines much accuracy in detail with a less satisfactory presentation of the general background against which Oates's career has to be considered. *See* also Sir John Pollock, *The Popish Plot*, new ed. (1944). (A. BG.)

OATH AND AFFIDAVIT. An oath is a statement or assertion made under penalty of divine retribution for intentional falsity; an affidavit is a formal written statement executed under oath. Both are employed throughout the Anglo-American world.

Oath.—Fealty to a sovereign, the obligations of public office and the ethical obligations of learned professions are all assumed by oath. The most frequent use, however, occurs when a witness in an authorized inquiry states his intention to give his pertinent knowledge and to tell only the truth in relating that knowledge. The precise formula varies, usually being prescribed by statute. A common formulation of the witness oath is: "I do solemnly swear that the testimony I am about to give will be the truth, the whole truth, and nothing but the truth. So help me God." In Anglo-American legal practice testimony will not be received unless the witness is subject to some sanction for falsity, the oath being the usual form. Civil-law nations use it more sparingly; they generally do not permit parties to the case to testify under oath and they make the oath voluntary with many others. In these countries the oath is often administered after rather than before the testimony is given.

Moral consequences may not vary with the manner of assuming the oath but temporal consequences do turn upon whether the administering officer was validly empowered and whether the proceeding was properly authorized. Judges, court officials and some other public officers have statutory power to administer oaths; normally consular officials and commissioned officers of the armed forces have the same power. One of the principal functions of the notary public is administering the oath. The low estate of that office in the United States, contrasted with its dignity in Europe, is a product of indiscriminate resort to the oath. Although so cheapened that it gives little assurance against false testimony, the law nevertheless provides that false testimony under oath constitutes the crime of perjury (*q.v.*).

Affirmation.—The principal alternative to the oath as a safeguard against false testimony is the affirmation—the witness declares his intention to tell the truth, under the pains and penalties of perjury. Affirmation was originally a concession to those whose religious scruples prevented the swearing of oaths. It has been extended in Great Britain and in many states of the United States to nonbelievers as well. Members of nonmonotheistic religions are frequently sworn according to the forms of their own faith. Persons of immature understanding may testify without either oath or affirmation if they display understanding of the duty to tell the truth.

Affidavit.—An affidavit is used in judicial proceedings and in perfecting records of factual events. It recites the place in which it is made; that the affiant (or, commonly, deponent), having been first duly sworn, "deposes and says" certain facts; and, in appropriate cases, that he knows nothing further of the matter—"further deponent sayeth not." It must then be signed by the deponent in the presence of the administering official, who executes thereon his jurat. In the jurat he recites that the instrument was executed before him, under oath, giving the date thereof; he states his authority to administer oaths; and he impresses thereon the seal of his office. The purposes are two: the formalities give some assurance that the instrument is genuine; and the oath gives some assurance that the statement is true as well as genuine. Because not made subject to cross-examination, however, the law courts normally decline to receive it in lieu of oral testimony except in interlocutory proceedings. Were the affidavit made subject to cross-examination, however, it would in the United States be called a deposition and would be more freely receivable. Depositions are now freely used in the U.S. when the deponent is unavailable. In Britain the Evidence act, 1938, permits freer use of various kinds of written evidence, including affidavits, in proper cases, by leave of the court. *See* also EVIDENCE; LOYALTY.

See H. Silving, "The Oath," *Yale Law Journal*, 68:1329–1390 and 1527–1577 (June and July 1959). (R. E. DE.)

OATS. The oat plant belongs to the genus *Avena* and is one of the important cereal crops. The grain is used largely as feed for livestock, although some is processed directly into food for human beings.

Origin.—Wild oats were first found growing in different regions of western Europe. Early writers stated that oats were found as a weed mixed with barley and therefore may have been distributed as a mixture in barley. From western Europe oats spread to other temperate parts of the world and are produced under a wide range of conditions. It was previously thought that cultivated oats were derived chiefly from two species, the common wild oat (*Avena fatua*) and the wild red oat (*A. sterilis*). Some cereal workers held that common white oats (*A. sativa*) were derived from *A. fatua* with a spreading panicle and that red oats (*A. byzantina*) came from *A. sterilis*. Later some workers believed that *A. sterilis* was the progenitor of both the red oats and white oats.

Botanical Description.—The flowering and fruiting structure of the oat is a terminal panicle that is usually lax or spreading. In some rare types, the panicle is reduced so that it approaches the spikes or heads of other small grains. The panicles may be either approximately symmetrical or with a preponderance of branches and their terminal spikelets hanging to one side, producing what is called side oats. The panicle is made up of numerous branches and spikelets, which in turn are composed of two papery glumes and usually two florets. The primary and secondary florets are held together by a short, thin rachilla. The individual floret has a lemma and palea that enclose three stamens, a pistil and two lodicules.

After fertilization the pistil develops into a one-seeded fruit called a caryopsis. The fruit, also called the groat, is closely clasped by the lemma and palea except in hull-less types where it is freed upon threshing. In *Avena nuda*, a naked species, spikelets may have five to ten florets, borne on long rachillas.

The lemma and palea, the covering or hulls containing the groat are usually without hairs in most cultivated oats (*Avena sativa*). In a large number of the wild forms, however, the lemma is covered with numerous hairs. The lemma has a weak awn in many cultivated varieties and sometimes a large and twisted awn in wild types. The hull colour at maturity may vary considerably from yellow to white, black, brown or red. In some wild species of oats, empty glumes remain attached to the panicle branches after the kernels have fallen to the ground. In cultivated species, however, most of the kernels remain attached until threshed. The basal articulation of the spikelet is useful in species classification. Sometimes the secondary kernel is tightly clasped by the lemma of the primary kernel; this is known as doubling or bosom kernels. Sometimes the first flower may be sterile and yet not doubled. The caryopsis or groat weighs about 20 mg. and the lemma and palea about 6 mg. in cultivated oats. The oat panicle usually is from 4 to 21 in. long and may have as few as 8 to 10 kernels or as many as 200, and averages about 45 kernels. When an oat seed germinates, the scutellum (part of the germ adjacent to the endosperm) elongates; this is in contrast to other cereals.

The leaves of the oat plant are thin, narrow and long. They are very prominent in the early phases of growth, but become less prominent upon maturity, at which time the culms elongate and produce the stalk or culm of the plant. The base of the leaf blade has no auricle, this being in contrast to other small grains. The

PANICLES OF OATS

Stems are usually hollow except at the nodes. Culms are from two to five feet tall and the number per plant depends largely upon the rate of sowing, the fertility of the soil and growth conditions. Roots are fibrous and numerous, and penetrate the soil to various depths.

Classification.—The genus *Avena* is composed of a polyploid series, as is true of *Triticum* (wheat), the haploid (*n*) chromosomes numbering 7, 14 and 21 in the sex cells, or 14, 28 and 42 in the vegetative or diploid (*2n*) cells. These are called diploid, tetraploid and hexaploid groups respectively. Several diploid species are recognized and at least two tetraploid species. The hexaploid group contains the commonly cultivated varieties including *Avena byzantina*, red oats. Hull-less and wild forms are in this series. I. Nishiyama has experimentally produced stable octaploid types with 56 (*2n*) chromosomes.

The common wild oat is distributed in cooler areas of the world as well as warmer sections like Mexico. Hexaploid and tetraploid wild species are sometimes grazed or cut for hay. Because the seeds may lie dormant for long periods wild oats are difficult to eradicate. Kernels at the top of the panicle mature sooner and drop to the ground as they ripen, even though the culm may still be green. The panicle of the wild oat is usually longer and more lax than that of the ordinary cultivated sorts.

Fatuoids or false wild oats have been observed in nearly all cultivated varieties. Fatuoid kernels also drop to the ground as do wild oats. However, false wild types do not constitute a weed hazard.

The various common oats are grown in cooler and more temperate regions of the world. Side and late-maturing common oats occur in northwestern Europe, northern sections of the United States and southern Canada. The smaller yellow-kerneled varieties occur in southwestern U.S.S.R. and to a lesser extent in the corn belt of the United States. Red oats are grown principally in warmer climates, including the southern sections of the United States, the Mediterranean region and areas of South America and Australia. These are considerably more heat-tolerant than are the common types. Hull-less (*A. nuda*) forms are found in the highlands of Tibet, northern India, Turkestan and western China.

Some of the older agricultural varieties of oats in North America are Kherson, Silvermine, Victory, Fulghum, Red Rustproof, Markton, Columbia, Ajax, the "Victoria-Richland" group and the Bond varieties including Clinton, Cherokee and Nemaha. Some of the newer varieties are Alamo, Beedee, Clintland 60, Garry, Goodfield, Mo. 0-205, Radar, Rodney, Suregrain, and Victorgrain 48-93. Varieties from other sections of the world are Abed Minor, Algerian, Astra, Avon, Ballidu, Belar, Blenda, Eagle, Flamingstreue, Heilshafer, Golden Rain II, Landhafer, La Prevision, Lyallpur No. ..., Maldwyn, Marne, Mauerner Weiss, Minor, Orion III, Red Algerian, Rex, Santa Fe, S. 147, S. 172, Sisu, Stål, Sun II, Victoria and Victory.

Cultivation and Use.—A large part of the oats produced in the United States are sown in the spring. There are three groups of spring-sown oats: those that are midseason to late in maturity; early white and yellow types; and the spring-sown red types that are grown principally in the Great Plains of the United States. There is also a large area of fall-sown oats in the southern section of the United States. Seeding is done in practically all months of the year in various areas of the world.

Oats are less exacting in their soil requirements than are other cereals with the exception of rye. They seem to be able to extract elements from the soil that would not be available for wheat and barley. In the presence of sufficient moisture, oats do comparatively well on soils that are sandy and low in fertility and on soils high in acidity, but will also do well under fertile conditions. The however, will produce crops on soils that are too poor for satisfactory oat production. In the corn belt of the U.S. oats are grown widely in rotation with corn and forage crops. Oats are used as a nurse crop with grasses and legumes that are to be used later for forage purposes. Since oat culture is relatively simple, a good crop may be obtained by either disking or plowing in the fall or spring, followed by sowing seed with a grain drill or a broadcast seeder. The rate of seeding is about ten pecks to the acre.

Production in the spring-sown area is usually greater when seed is sown soon after frost has left the ground. The combine is widely used for harvesting the crop. Another method is the use of a binder followed by shocking the bundles and then threshing by means of a separator. In some countries harvesting is done by more primitive means.

About 90% of the U.S. oat crop is used for feed. It is fed to all classes of livestock as grain in pure form or in feed mixtures. The straw is used for animal feed and is excellent for animal bedding. Oats make palatable hay, furnish excellent grazing and make good silage under proper conditions. Oats have long been a favourite source of breakfast food. Rolled oats or oatmeal is used mostly for porridge, although other kinds of breakfast foods are manufactured from the groats. Oat flour is also used in cookies, breads and puddings. The flour contains an antioxidant that retards development of rancidity in fat-containing foods.

The oat grain is high in protein and fat content. It is also a very good source of vitamin B_1 and has appreciable amounts of the other B vitamins including riboflavin, niacin, choline, pantothenic acid and vitamin E. It is practically devoid of vitamins C and D. Leaves of growing young plants are high in a large number of nutritional elements that add to its value as fodder.

The oat crop enters industrial usage to a small extent. One of the principal industrial products is the liquid aldehyde called furfural (*q.v.*). This is made by the destructive distillation of oat hulls, corncobs and other agricultural residues in the presence of acid and steam under regulated conditions. Furfural is used in selective solvents for various purification purposes, in paint remover, lacquer solvents and in adiponitrile, which in turn is used in developing nylon. Limited medical products come from oats.

In most regions of the world, oat culture faces the hazards of rust, smut, viruses, fungal rot (that is, *Septoria*) and other diseases that may greatly reduce yield and quality. Plant breeders try to develop oats that are resistant to these major diseases and that are high in quality and yield. In certain areas drought resistance and the survival of fall-sown varieties are much-needed characteristics sought by the plant breeder. Inasmuch as oats are self-pollinated and breed true after pure lining, improvements are easily utilized in production increase. New and superior varieties are developed by means of hybridization followed by purification and testing against standard varieties.

One of the main problems in breeding is the selection of plant progenies in early generations that will resist disease and have high productive capacity. Specialized races of pests including viruses and pathogenic fungi complicate the problem of breeding for disease resistance. Much progress was made, especially after about 1930, in breeding oats with smut and rust resistance. In addition better grain quality and much stiffer straw was obtained. Lodging-resistant varieties enabled farmers to obtain greater yields with higher soil fertility levels and with less trouble at harvest. Breeders have induced genetic variability with chemicals and irradiation. Florad was the first variety resulting from irradiation breeding to be distributed, by the Florida Agricultural Experiment station.

Production.—The estimated annual world production of oats in the 1960s was more than 4,000,000,000 bu. on about 80,000,000 ac. Production has remained fairly steady, while acreage has declined. The leading producing countries are the United States, U.S.S.R., Canada, France, Poland, the United Kingdom and West Germany. Substantial quantities also are grown in Australia and New Zealand.

Improved varieties have permitted increased yields per acre. In the United States, for example, production averaged 35.7 per acre for the period 1949–58. In the 1960s yields averaged more than 40 bu. per acre, with some farmers growing 80–100 bu. per acre in cool seasons and more than 150 bu. per acre with irrigation. The competition of hybrid corn and longer-lived alfalfa has tended to reduce the demand for oats.

See also references under "Oats" in the Index.

Bibliography.—For further reading and comprehensive treatment of oats *see* F. A. Coffman (ed.), *Oats and Oat Improvement;* Monograph of the American Society of Agronomy, Madison, Wis. (1961),

which contains discussions of world importance and distribution, breeding accomplishments, diseases, culture in North America and processing and composition. For oat species and variety description *see* T. R. Stanton, "Oat Identification and Classification," U.S. Department of Agriculture *Technical Bulletin 1100* (1955). (H. L. Ss.)

OAXACA, a southern state of Mexico that includes the greater part of the Isthmus of Tehuantepec (*q.v.*) on its Pacific side. Pop. (1960) 1,727,266, the majority of whom are Indians divided into more than 15 major tribes. Area 36,820 sq.mi. The capital city, also named Oaxaca (*q.v.*), is near the centre of the state on a high plateau surrounded by mountains. The Sierra Madre del Sur ends at the Isthmus of Tehuantepec, which is low, hot and arid. The Atlantic lowlands near Veracruz are hot and humid, but most of the state enjoys mild, healthful conditions in its broad valleys and fertile uplands. The Pan-American highway from Mexico City traverses the state southeasterly, while rail lines from Coatzacoalcos on the Gulf of Mexico to the Pacific port of Salina Cruz and trunk lines from Puebla and Veracruz form an incomplete rail net within the state. There are good air connections, and the free port of Salina Cruz has large dry docks.

Oaxaca is an agricultural and mining area, with a broad range of products, chief among which are maize, wheat, coffee, sugar, tobacco, fibres and tropical fruits. It manufactures for local consumption cigarettes, soap and Indian blankets, or serapes, from wool. Its mountains are veined with gold, silver, uranium, diamonds, onyx and other deposits. During colonial days Oaxaca was a notable producer of silk and of cochineal for dyestuffs.

In pre-Columbian times the Zapotecas and Mixtecas constructed stone edifices, the remains of which are found at Mitla and Monte Albán; the descendants of these Indians form the majority of the population. *See* also MIXTEC. (J. A. Cw.)

OAXACA (OAXACA DE JUÁREZ), capital city of the state of the same name in Mexico, stands in the fertile valley of Oaxaca at an altitude of 5,070 ft. Pop. (1960) 72,370. The Pan-American highway, continuing south from Mexico City, passes through Oaxaca on the route to Guatemala. A beautiful colonial city, Oaxaca is noted for its 16th-century art and architecture as well as for the delicately coloured green stone used in many buildings. Nearby are the Mixtec ruins of Mitla and the Zapotec ruins of Monte Albán. Oaxaca has one of the most colourful handicraft markets in Mexico, selling multicoloured glazed pottery, black pottery ware, leather goods, fine steel knives, gold filigree jewelry and hand-woven wool and cotton textiles. Founded in 1486 as an Aztec garrison post and conquered by the Spanish in 1521, Oaxaca has played an important part in Mexican history and was the home of two of Mexico's most famous presidents, Benito Juárez and Porfirio Díaz. (H. R. Hy.)

OB, a river of Siberia, U.S.S.R., is one of the largest in the world. The Ob from the confluence of the Biya and Katun is 2,287 mi. long. With its largest tributary the Irtysh (*q.v.*), itself 2,640 mi. long, it forms a river 3,461 mi. in length. Its basin covers an area of about 1,131,000 sq.mi., within which are several basins of inland drainage, forming more than 15% of the total area. The Biya and Katun rivers, which form the Ob, drain from the Altai mountains and meet at Bisk. Thereafter the Ob flows west and then north to Barnaul. This part of its course is highly braided, with many sand and shingle banks. Below Barnaul the Ob again flows west and north through the Novosibirsk reservoir to Novosibirsk. After 1962 a second great barrage and power plant was constructed at Kamen-na-Obi on this stretch. At Novosibirsk, the largest city of Siberia and the crossing point of the Trans-Siberian railway, the Ob leaves the low Altai foothill zone and enters the vast west Siberian lowland. It flows in a highly sinuous course over a wide floodplain with innumerable channels, cutoffs and oxbow lakes, in a general northwesterly and westerly direction to the confluence with its giant tributary, the Irtysh, at Khanty-Mansisk. The river itself in this section is up to 2 mi. wide. Below Khanty-Mansisk the Ob flows in a general northerly direction to Salekhard, where it swings east to enter the head of the Ob gulf of the Kara sea, by a delta. From Peregrebnoye to just above Salekhard, the river divides into the Great and Little Ob, with innumerable connecting channels. At Salekhard the river is about 2½ mi. wide. The Ob gulf (Obskaya Guba), more than 500 mi. long and about 50 mi. wide, represents the drowned lower course of the Ob.

The greater part of the Ob basin is extremely level lowland and below the Tom confluence the fall of the Ob is about 1 in 40,000. The rate of flow is thus very sluggish. The annual average discharge is 441,434 cu.ft. per second with a maximum at Salekhard of 1,292,420 cu.ft. and a minimum of 79,458 cu.ft. Maximum flow comes in March–May in the upper reaches and April–June in the lower. Ice first appears about mid-October in the lower course and late October in the upper, with a firm ice cover established 8–10 days later, although shallows often take longer to freeze over. The spring breakup of ice begins first in late April, in the upper reaches, causing huge ice jams and widespread flooding. Navigation is possible along the entire river, and north of Tomsk it is the only important means of communication. Until the building of the Trans-Siberian railway the Ob and Irtysh formed the main route across western Siberia. The main tributaries are the Irtysh, Vasyugan (457 mi. long) and Severnaya (Northern) Sosva (447 mi.) on the left, and the Chulym (1,077 mi.), Ket (845 mi.) and Tom (522 mi.) on the right. (R. A. F.)

OBADIAH, BOOK OF, in the Old Testament, the fourth of the Minor Prophets in the Hebrew, Latin and English order and the fifth in the Septuagint Greek. The name, which means "worshiper of Yahweh," is transliterated OBDEIOU in Codex Vaticanus and ABDIOU in Codex Sinaiticus of the Septuagint and ABDIAS in the Vulgate.

Contents.—The book, which consists of only one chapter, may be outlined as follows:

1–14:	judgment of Edom
1a:	title
1b–4:	warning of Edom's downfall
5–9:	complete destruction of Edom
10–14:	reasons for judgment of Edom
15–16:	judgment of all nations
17–21:	restoration of Israel

Main Themes.—*Revelation.*—The phrase "says the Lord" or its equivalent occurs four times (1, 4, 8, 18). Belief in a living God who reveals his will is a basic tenet of prophetic religion.

Judgment.—The main message of this book is God's moral judgment through the events of history. Despite its vaunted fortresses and wisdom, Edom has been pushed out of its original land and will be destroyed because of cruelty to its brother-nation Israel. Israel also has been punished by conquest and captivity. Finally on the day of the Lord all nations will be judged.

Nationalism.—Obadiah has been accused of nationalism because he pronounces doom on Edom, Israel's enemy, and looks forward to the restoration of his own people. His primary loyalties, however, are not to land or race but to moral principles and to God.

The Kingdom of God.—The ultimate hope of Obadiah is that "the kingdom shall be the Lord's" (21; *cf.* Rev. xi, 15). Two aspects of this kingdom are "deliverance" ("escape") and "holiness" (17), concepts which are spiritualized in the New Testament (*e.g.*, Luke xxi, 36; Rev. xxi, 2–8).

Form and Style.—In form Obadiah follows a common prophetic pattern in dealing first with present sin and judgment (1–14) and then with future judgment and hope (15–21). The vigorous style of Obadiah is marked by varied poetic rhythms and striking comparisons, and contrasts between doom (1–16) and hope (17–21). In much of this brief prophecy God himself is addressing personified Edom (2–15), and this gives a direct and arresting quality to the book.

Date and Authorship.—The compilers of the Hebrew canon placed Obadiah among the pre-exilic prophets. Some scholars have proposed that the background for the whole book was the attack of the Arabians and Philistines on Judah in the 9th century B.C. (II Chron. xxi, 16–17). Many commentators think that only the old oracle against Edom (1–6, 8–9) is pre-exilic. But the calamity to Jerusalem in 11–14 is probably its capture in 587 B.C. by the Chaldeans, assisted by the Edomites (*cf.* Ps. cxxxvii, 7; I Esdras iv, 45). In the later 6th or early 5th century B.C., Arabs pushed Edomites into the Negev, as implied in Obad. 7, Mal. i, 3–4 and I Esdras iv, 50. According to Obad. 19–20, the returned Jews occupy the area around Jerusalem, as in the mid-5th century B.C. (

Neh. xi, 25–36), which is the probable date of the prophecy in substantially its present form. If, then, the prophet Obadiah lived in Judah in the 5th century B.C., he cannot be identified with Ahab's steward called Obadiah (I Kings xviii, 3–16) as in the Babylonian Talmud (*Sanhedrin* 39b), nor with Ahaziah's unnamed captain (II Kings i, 13–15) as in *The Lives of the Prophets* wrongly attributed to the Church Father Epiphanius. Apart from 1–6 and 8–9, where most scholars believe that he adapted an older oracle, the prophecy may well come from Obadiah in its entirety, although some wish to divide 10–21 among various authors. The many identical phrases in different order in Obad. 1–9 and Jer. xlix, 7–22 probably indicate that both prophets are using some earlier oracle against Edom. Several phrases are common to both Obadiah and Joel, and Joel ii, 32 seems to quote Obad. 17 directly.

Geographical References.—Rabbinic commentators sometimes interpret Edom as Rome or Christendom. "The rock" (3) probably refers in general to the mountainous home of the Edomites and also in particular to the Edomite capital Sela ("rock"), called in Greek Petra, where the Nabataeans later carved splendid tombs and temples out of the variegated rock. Teman (9) may be modern Tawilan, 5 mi. E. of Petra. Verse 19 foresees a Jewish expansion toward the south, the west, the north and the east, which actually occurred under the Maccabees. Sepharad (20) was interpreted as Spain by the Syriac Peshitta and Aramaic Targum, and hence Spanish and Portuguese Jews are called Sephardim. It is probably, however, Sardis in Asia Minor, where there was a Jewish colony in the 5th century B.C.

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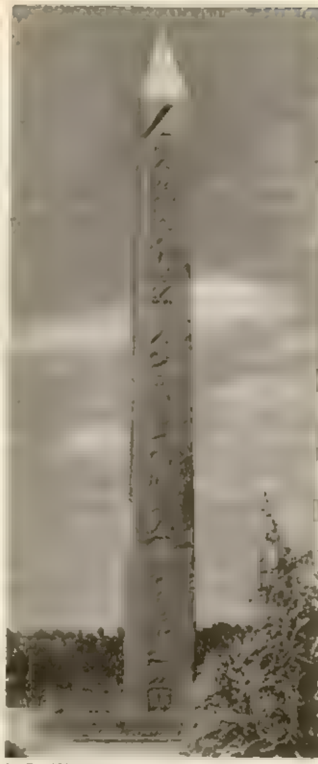
OBANDO, JOSÉ MARIA (1795–1861), president and *caudillo* (military-political leader) of Colombia, was born in the Cauca region of that country. He fought for the Spanish crown during most of the Latin-American war for independence, but finally joined the revolutionary forces under Simón Bolívar. In the turbulent new republic of Gran Colombia, Obando opposed Bolívar's centralist government. A key event in the struggle for power was the assassination of Marshal Antonio de Sucre (*q.v.*), a deed for which many persons have held Obando responsible. Sucre's death helped clear the way for Obando's rise in the 1830s to the vice-presidency and ministry of war in New Granada, as Colombia was then called. In 1838–40, Obando led a revolution against the Conservative party government of New Granada, but he was defeated and fled to Peru. He returned after the election victory of the Liberal party in 1849 and became president of the country in 1853. His regime was marked by the adoption of the liberal constitution of 1853, but he was overthrown the next year by the Conservatives. After a period of exile, Obando returned to Colombia in 1860 and was killed fighting in a civil war. His character and career may be considered representative of the political and military leaders and of the strife which marked the history of Colombia during the 19th century. (T. F. McG.)

OBEID, EL, the chief town of the province of Kordofan, Republic of the Sudan, lies 230 mi. S.W. of Khartoum on a sandy scrub-covered plateau at an elevation of 1,869 ft. Pop. (1965 est.) 62,500. With an encircling forest reserve to mitigate dust storms, El Obeid is laid out on either side of a watercourse in wide straight streets intersecting at right angles. Modern waterworks lie about 10 mi. S. Commerce depends on the railway link eastward (completed 1911), on the more recent extension westward to Nyala and on more than 1,000 trucks operated by local merchants over rough tracks. Commodities of trade are gum arabic, millet, peanuts, melon seeds, cattle and sheep. El Obeid is linked by air services with Khartoum and places in Darfur. Founded by the Turko-Egyptian regime in 1821, El Obeid was captured and largely destroyed by Mahdist rebels in 1882. It was refounded at the beginning of the Anglo-Egyptian condominium in 1899. (J. H. G. L.)



A. F. KERSTING

OBELISK AT AL MATARIYAH, EGYPT

OBELISK, usually a pillar of stone, square in section, tapering upward to an offset pyramidal top. Obelisks seem to have originated in the Egyptian Old Kingdom as grave monuments. In the 6th dynasty a pair was placed at the entrance of the tomb of Sabui at Elephantine and in the 11th dynasty single examples marked the graves of kings at Thebes. These earliest obelisks, which were also used in gardens and in front of palaces, were short (about ten feet at Thebes) and tapered little. The earliest surviving obelisk still in its original position is that of Senusret I (12th dynasty) at Al Matariyah, ancient Heliopolis. It is 68 ft. high and does not taper sharply as do later examples.

Under the New Kingdom, obelisks occupied an important position in temple planning. The 18th-dynasty temple was composed of three main elements: pylon, portico yard and shrine. Such was the plan of the Temple of Amon at Karnak, in which the largest surviving examples still stand. The earliest pair was placed in front of the pylon built by Thutmose I. Of these, one remains in place, over 80 ft. high, 6 ft. square at the base and weighing 143 tons. It celebrates the 30th anniversary of his accession. Queen Hatshepsut added a second, larger pylon and two obelisks 96 ft. high, 5 ft. 4 in. square at the base and weighing 325 tons.

While most of the old obelisks were erected to commemorate jubilees, their real purpose seems to have been connected with sun worship. In a sun temple discovered at Abousir near Giza, the central shrine consisted of a raised platform in the form of a truncated pyramid surmounted by an obelisk. Such obelisks were not monolithic but built up of limestone blocks, and they had sacrificial altars placed in front of them. The Egyptian word for obelisk, *téhen*, is philologically connected with the word for sunbeam. It is known that the pyramidal summits were covered with sun-reflecting electrum (an alloy of silver and gold), and the hieroglyphic sign for obelisk suggests that a golden ball was placed on top of them. A considerable number of small obelisks found at Elephantine originated in the temple of the god Khnum, who by his assimilation as Khnum-Re to the sun-god could display obelisks as symbols of solar religion. Other obelisk dedications are to sun-assimilated gods—Harakhti (at Heliopolis), Amon (at Thebes)—and an obelisk erected by Augustus in Rome bore the dedication "*Soli donum dedit.*"

The sole material for making larger obelisks was the granite of Aswan, where the quarries still hold a large unfinished example. Lesser obelisks were made of basalt or quartzite. Special boats were built for their transport down the Nile.

Close relations between Egypt (*q.v.*) and Canaan in the 12th dynasty led to the adoption of obelisks by Canaanites and Phoenicians. A row of them was found in the temple at Byblos (ancient Gebal), Lebanon, of the early 2nd millennium B.C., and Theophrastus states that at a later date an obelisk of solid turquoise was set up in the temple at Tyre. Obelisks in use by the Assyrians were short and step-topped and designed to bear horizontal reliefs of historical content around the four sides. The most complete example is the "Black Obelisk" of Shalmaneser III (British museum), showing the submission of King Jehu of Israel in the 9th century B.C. (*See* also EGYPTIAN ARCHITECTURE.)

In Greco-Roman Egypt obelisks (*obeliskos*, a "peg" or "needle") were still made. Many were transported to Italy in imperial times

and one to Constantinople by Theodosius I. Copies of obelisks inserted into architectural schemes were already popular in Britain and France in the 18th century. In the 19th century obelisks were taken to London and New York (the two "Cleopatra's Needles," *q.v.*), Paris, Arles, Vincennes and Fontainebleau. The latest obelisks to be constructed in the ancient world were fan-topped monuments at Aksum in Ethiopia. The Washington monument in Washington, D.C., a modern obelisk over 555 ft. high, has an observatory at the 500-ft. level which is reached by interior elevator and stairs. *See* also MONUMENTS AND MEMORIALS.

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OBERAMMERGAU, a village in Bavaria, Germany, 42 mi. S.S.W. of Munich. Pop. (1961) 4,603. The village is famous for its wood-carving industry and the performance of the Passion play every ten years.

In 1633 Oberammergau was stricken by the plague. As an expression of their gratitude for the end of the scourge, the villagers vowed to enact the Passion of Christ every ten years. In 1634 the first performance of the Passion play took place. After 1674 the dates were changed so as to fall on decimal years. From 1680 on, the play was given regularly every ten years. In the 1770s a crisis arose when the performance of religious plays was forbidden throughout the electorate. An appeal of the players to the elector Karl Theodor brought about the lifting of the ban. After World War I the production that should have been mounted in 1920 was postponed until 1922. During World War II no performances could take place: most of the villagers were in the German army, and the Nazi regime frowned upon the staging of religious plays. Performances were resumed in 1950.

It takes almost eight hours to perform the play, which is divided into episodes. After a prologue the action begins with Christ's entry into Jerusalem. After Christ's capture on the Mount of Olives falls the intermission. The second part begins with Christ's appearance before the high priest Annas and ends with the Resurrection. Each episode is introduced by a song of the Passion chorus of 50 singers. Moreover, a pantomime tableau presenting the Old Testament prefigurations precedes each episode. Thus the scene with Christ before Pilate is introduced by a tableau showing Daniel before King Darius.

The text of the original Passion play as it was produced in 1634 seems to have been a conflation of two earlier versions of the sacred story, of the so-called Augsburg Passion and of the Passion written by the Augsburg Meistersinger Sebastian Wild. In 1680, however, the text was altered by Johann Aelbl. A new version made by Father Ferdinand Rosner was used in 1750 and 1760. For 1780 Magnus Kipfelberger made alterations. In 1811 a new version was ready, this time prepared by Othmar Weiss. For the performance of 1860 Alois Daisenberger served as play doctor. The text as it stands today has no traceable relation to any authentic medieval text and may well be lacking in literary merits.

Nor is medievalism a feature pronounced in any of the productional aspects. The vast forestage is an open-air platform on which permanent architectural elements are set up. In central position rises a curtained picture-frame stage with wings and backdrops. Next to this inner stage of shifting scenes there are, on either side, gates through which the spectator looks into the streets of Jerusalem. Both gates are flanked by palaces, that of Annas at stage left, and Pilate's at stage right. In extreme downstage position there are smaller gates for side entrances on either side. An orchestra pit accommodates the musicians. The audience is seated in a roofed auditorium which holds 5,200 spectators.

Both the text and the stage are hybrid forms and far removed from medieval prototypes. But the spirit in which the Passion of Oberammergau is presented is still in the medieval tradition which demands that an entire community become involved in the undertaking for the glory of God and the edification of the faithful. A Passion play committee supervises the preparations for the production. The amateur actors are chosen from among the inhabitants of the village, and it is a task of some magnitude to select suitable performers for the 124 speaking parts. Hundreds of villagers are employed in the crowd scenes.

The most famous interpreters of Christ were Josef Mayr, from 1870 to 1890; Anton Lang, in 1900, 1910 and 1922; and Alois Lang (no relation to Anton) in 1930 and 1934. (A. M. N.)

OBERHAUSEN, a city of Germany in the *Land* (state) of North Rhine-Westphalia which after partition of the nation following World War II became part of the Federal Republic of Germany. Pop. (1961) 256,773. It is on the Rhine-Herne canal and is part of the Ruhr industrial belt. Oberhausen, an important rail junction on the main line between Hanover and Berlin, also has good *Autobahn* communications with the Netherlands. It is the centre of a network of lines radiating into the Westphalian coal and limonite iron-ore fields which were the foundation for its rapid industrial development; this began in the mid-19th century with the establishment of a railway station (named after the old castle Oberhaus on the banks of the Emscher) on the uninhabited but mineral-rich Lipperheide.

Oberhausen became a city in 1874 and in 1929 it incorporated the neighbouring towns of Sterkrade and Osterfeld. Economic activities are governed by heavy industry based on the production of pig iron, steel and bituminous coal. The St. Antony ironworks (1758–1876) was the first to be built in the Ruhr. There are also zinc smelting refineries, dye works, railway workshops and a large thermoelectric plant, and manufactures include steam boilers, wire rope, glass, chemicals, sugar, porcelain and soap.

Historic sights include Sterkrade abbey (1150), Holten fortress (1307) and the 16th-century moated castle of Vondern. Among the notable modern buildings are the Rathaus (1930), the main railway station (1938), Euripahaus (1956–57) and a notable modern Stadthalle (city hall; 1962), used for conferences, concerts, exhibitions, etc. Oberhausen is well endowed with schools and has a civic theatre and several art galleries. It is the scene of the annual West German International Short Film festival.

OBERLIN, JOHANN FRIEDRICH (1740–1826), Alsatian Lutheran pastor and philanthropist, devoted his life to transforming his desperately poor parish of Waldersbach and neighbouring villages in the Steintal (Ban de la Roche, Vosges, France) into a materially as well as spiritually flourishing community. He was born of middle-class family at Strasbourg on Aug. 31, 1740, studied theology at Strasbourg university and became pastor of Waldersbach in 1767.

To raise the standard of living in the Steintal, Oberlin first of all started schools in the villages and provided one of the earliest systems of supervision and instruction for very small children while their parents were working. His teaching methods related instruction closely to practical needs and in many ways foreshadowed Pestalozzi and Froebel. He maintained close personal contact with all his parishioners, and his success with the young gradually won the interest of the older generations, who also began to come to him for instruction. Thus Oberlin found men to build roads and bridges, to end the isolation of the Steintal. He encouraged experiments in improving crops and started regular meetings for the discussion and exchange of agricultural information. Better implements were bought in bulk and sold at cost price while a saving and lending bank was founded to help with the initial cost. At his own expense Oberlin sent young men to Strasbourg to learn crafts and had one of his assistants trained as a doctor. Finally, with the help of J. L. Legrand, he started up a small local industry. He died at Waldersbach on June 1, 1826.

Oberlin was strongly influenced by pietist and philanthropist thought, and he admired Rousseau and Swedenborg. His preaching combined rationalism with apocalyptic mysticism. He welcomed the French Revolution and maintained his religious teaching by turning church services into club meetings. Both Revolutionary and imperial governments of France honoured him for his work

Oberlin gave his name to the town and college in Ohio (*see* OBERLIN) and to the Oberlinhaus, a German home famous for its treatment of the deaf, dumb and blind.

See H. Strohl, "Études sur J. F. Oberlin," *Cahiers de la Revue d'histoire et de philosophie religieuses* (1926); W. Heinsius, "Johann Friedrich Oberlin," *Alemannisches Jahrbuch* (1955).

OBERLIN, a city of Lorain county, O., U.S., is located 34 mi. W.S.W. of Cleveland; the seat of Oberlin college. The community was founded in 1833 by the Rev. John Jay Shipherd, a Presbyterian minister, and Philo Penfield Stewart, a former missionary to the Choctaw Indians. In 1834 they also established the Oberlin Collegiate institute to educate ministers and schoolteachers for the west; the name was taken from Johann Friedrich Oberlin, the Alsatian pastor and philanthropist. In the antislavery agitation then current in the North a group of students at the Lane Theological seminary in Cincinnati left that institution in protest against its lack of support of antislavery; the Tappan brothers, merchants in New York, promised to finance their later education under the instruction of Charles G. Finney (*q.v.*), by that time a well-known evangelist, in a college which would appoint him to its faculty. He was given a professorship at Oberlin in 1835 and also served as president from 1851 to 1866. The institute (officially designated a college after 1850) was identified with various innovations: it was coeducational, it admitted Negroes on an equal footing with whites and it became a station on the Underground Railroad by which fugitive slaves escaped to freedom in Canada. In 1858 students and townspeople rescued a Negro at Wellington, 8 mi. S., from law officers who were returning him to his legal owners. As a result some of the "rescuers" were imprisoned in the county jail in Cleveland and the case attracted nationwide attention. The seminary became the graduate school of theology in 1915. Charles Martin Hall, an alumnus who had developed a cheap method of making aluminum commercially, bequeathed to the college several million dollars for the endowment and the construction of Hall auditorium.

Oberlin college includes a college of arts and sciences and a conservatory of music (1867) which maintains a branch in Salzburg, Aus. Discontinuance of the graduate school of theology was announced in 1965. The community, which continues to be primarily a home for the college, was incorporated as a village in 1846 and as a city in 1950. It established a council-manager form of government in 1926. For comparative population figures *see* table in OHIO: *Population*. (R. S. FR.)

OBERMAIER, HUGO (1877–1946), German archaeologist and Roman Catholic priest whose work in Spanish prehistory is especially notable, was born in Regensburg on Jan. 29, 1877. At the University of Vienna he published monographs on central European prehistoric sites, leaving (1910) to take the chair of geology and paleontology at the Institut de Paléontologie Humaine in Paris. He excavated in Bavaria and undertook cave explorations and excavations in Spain, with such men as H. E. P. Breuil (*q.v.*). In 1922 Obermaier became professor at the University of Fribourg, Switz., where he died on Nov. 12, 1946.

He published *Der Mensch der Vorzeit* (1912), *El Hombre fosil* 1916; Eng. trans., *Fossil Man in Spain*, 1924), *The Cave of Altamira* with Breuil in 1935 and many monographs on Spanish prehistory. He also collaborated in publications of African prehistoric art, notably *Hadschra Maktouba* (1925) with L. Frobenius.

See H. Breuil, "Hugo Obermaier (1877–1946)," *Revue Archéologique*, vol. 35 (1950). (H. KE.)

OBERON, the name given to the "king of faërie" in the French medieval poem *Huon de Bordeaux* (*q.v.*), and introduced into English literature by the prose translation (*c.* 1534) by Lord Berners (*see* BERNERS, JOHN BOURCHIER). In the French poem, Oberon is a dwarf-king, living in the woodland, who by magic powers helps the hero to accomplish a seemingly impossible task—a common theme in folklore, from which Oberon (though not under that name) ultimately derives. He can be equated with Alberich, the dwarf who guards the underground treasure in the Germanic Siegfried legend, only in that both probably originated in prehistoric belief in a powerful spirit guarding the burial mounds in which, with the bodies of the dead, their valuable possessions were interred.

The first English writer to mention Oberon was Robert Greene, in his play *The Scottish Historie of James the fourth* (*c.* 1590–91; publ. 1598). Shakespeare's Oberon in *A Midsummer Night's Dream* (*c.* 1593–96) derives many elements from the French, via Lord Berners. His fairy queen, Titania, however, is taken direct from Ovid's *Metamorphoses* (book III, line 173), where the goddess Diana is called Titania; *i.e.*, daughter of the Titans. Among later poets to describe Oberon as a fairy king or prince were Ben Jonson (*q.v.*), in his court masque *Oberon, the Faery Prince* (performed Jan. 1, 1611), and Michael Drayton in his charming fairy poem *Nymphidia* (1627). Shakespeare's Oberon inspired the German poet Christoph Wieland, whose romantic epic *Oberon* (1780), in the English translation of 1798, formed the basis of J. R. Planché's libretto for Carl von Weber's opera *Oberon* (Covent Garden, 1826).

OBERTH, HERMANN JULIUS (1894–), a founder of modern astronautics, was born June 25, 1894, in Hermannstadt, Transylvania, then a part of the Austro-Hungarian empire. The son of a prosperous village physician, he early displayed an interest in mechanical and scientific subjects. In 1913, bowing to his father's desires, he enrolled in medicine at the university in Munich but managed to continue taking courses in mathematics and astronomy. His university career was cut short by World War I, and Oberth enlisted in the Austro-Hungarian Army. After being wounded in battle, he was transferred to the Medical Corps, in which he had time to continue his studies in astronautics. He performed experiments to simulate the feeling of weightlessness and also worked out a design for a long-range, liquid-propellant rocket that his commanding officer sent to the War Ministry, which rejected it as a fantasy.

After the end of the war, Oberth spent several years at universities studying science and mathematics. At Heidelberg, he sought a Ph.D. degree with a dissertation based on his rocket design of World War I. The dissertation was rejected by the university in 1922, and Oberth submitted it to a series of publishers. It was published in 1923 but only after Oberth had partially underwritten the expenses.

The book, which explained mathematically how rockets could achieve a speed that would allow them to escape the earth's gravitational pull, was an immediate success, and Oberth gained widespread recognition. He did not become familiar with the work of Robert Goddard in the United States until 1922 and Konstantin Tsiolkovski in the U.S.S.R. until 1925. Corresponding with these two pioneers in rocketry and astronautics, he acknowledged their precedence in deriving the mathematical equations associated with space flight.

In 1929 Oberth's book *Wege zur Raumschiffahrt* ("Way to Space Travel") won the first annual Robert Esnault-Pelterie–André Hirsch Prize of 10,000 francs, which helped him to finance his research in liquid-propellant rocket motors. The book was remarkable for its discussion of electric propulsion and the ion rocket, anticipating the efforts to develop them by 30 years. With little encouragement from government or industry but with the enthusiastic support of space travel enthusiasts, Oberth continued to develop his theories of manned space travel as World War II approached. In 1938 he joined the faculty of the Technical University of Vienna and in 1940 he moved to the Technical University of Dresden. During that year he became a German citizen and in 1941 he transferred to the German rocket development centre at Peenemünde, to work for his one-time assistant, Wernher von Braun. However, his talents were little used, and in 1943 he was sent to another location to work on solid-propellant antiaircraft rockets.

After the war Oberth spent a year in Switzerland as a rocket consultant, and in 1950 moved to Italy, where he worked on solid-propellant antiaircraft rockets for the Italian Navy. In 1955 he moved to the United States, where he engaged in advanced space research for the U.S. Army. He returned to Germany in 1958 to spend his retirement writing and lecturing. (M. R. S.)

OBESITY is that physical state in which excessive fat is

stored in the body. Though it is often considered primarily a cosmetic defect, making the obese person less attractive than the person of normal weight, obesity deserves the consideration accorded to serious disease. The disorder indicated by obesity is a prolonged positive energy balance, with resultant excess accumulation of fat and formation of superfluous adipose tissue.

In obesity there is excess deposit of fat in both normal and abnormal sites. In extreme cases the subcutaneous fat may exceed ten centimetres in thickness. Large amounts of fat may be found in the membranous tissues that enclose the abdomen (retroperitoneal space, omentum and mesentery), in the tissues surrounding the kidney, in the space between the lungs and in the pericardium (the membranous sac that contains the heart). Fatty infiltration may occur in the pancreas, in skeletal muscles and in the heart muscle. The liver may be greatly enlarged, and many of its cells may be filled with fat.

Diagnosis.—Although adiposity is usually evident from appearance alone, appearances may be deceptive. Some persons who are overweight by the usual standards have exceptionally heavy muscle development and are not fat. Others may be within the normal weight limits, but their bodies may contain excessive fat and be deficient in muscle. The diagnosis of obesity is simply the first step; it is necessary to establish also the ideal weight of the subject and the degree of obesity. Approximate optimal weights according to height, sex, age and type of body frame may be found in tables (see *Bibliography*). Weights given in such tables, however, are approximations and are not necessarily applicable to any single person; they give mean or average weights. More accurate optimal weights for each person can be determined by individual application of one or more methods:

1. Skeletal measurements of wrist circumference, knee circumference, shoulder width, hip width, etc. Such measurements permit calculations based upon the width and depth of the body and the size of the skeletal framework.

2. Densitometry, a more exact method of measuring fat storage as compared with normal, requires the determination of the specific gravity of the whole body by weighing the person under water. Since human fat has a density of 0.92 whereas the rest of the body has an average density of 1.1, the percentage of body fat may be calculated when the total body density is known, correction being made for residual air in the lungs. This is the most accurate method of calculating body fat content, but the difficulties involved limit its use to research laboratories.

3. Measurements of total body water (by dye dilution and other chemical techniques). Under normal conditions total body water maintains a constant relationship to lean body mass. When total body water is known, lean body mass can be calculated and the fat content of the body determined by subtracting lean body mass from total body weight.

4. Skin-fold thickness. Formulas have been devised for estimating body fat content by calculating from careful caliper measurements of skin-fold thickness at several specified points on the body.

Many useful data have been developed from studies utilizing these methods. In an average healthy young man, fat constitutes about 15% of the total body weight, extracellular water about 23%, cells or active tissue 58% and bone mineral 4%. In obesity of extreme degree the percentage of fat may exceed 50 and even reach 70. In extreme leanness, the percentage of body weight made up of fat may be lower than 10, even as low as 2. Normal young men of the same heights and ages as a group of young women had average body fat content of 9.8% as compared with 17% for the women. Even when weights are the same, normal middle-aged men are much fatter than normal young men if body content of fat is used as the criterion rather than height-weight-age tables. The trend for older as compared with younger females is similar, but females are fatter than males at all ages.

Computation of actual individual body fat content can be very helpful, but for practical purposes in most cases, accurate weighing of the unclothed fasting person (before breakfast), careful physical examination and comparison with ideal weight figures from the standard tables suffice to establish the diagnosis of obesity and its degree. Tables giving average rather than desirable weights at various ages and heights are misleading, for the optimal weight of an adult remains unchanged but average weights increase in the middle decades. Even minor degrees of corpulence (*i.e.*, 10% to 15% above optimal weight) are accompanied by higher mortality rates.

Incidence.—Obesity occurs frequently even among children and adolescents, but it is commoner among adults. Moderate corpulence affects about one-fifth of the adult population of the United States, occurs most frequently between ages 30 to 50 years, and is somewhat commoner in women than in men. In the United States it is estimated that about 9% of the population is 10% overweight and 3% is 20% overweight.

Consequences.—Obese persons suffer more often from a number of illnesses than do persons of normal weight, and they also have a shorter life expectancy. The hazard of obesity increases with age, so that persons 45 to 50 years old who are 10 lb. overweight have an increase above the average death rate of 8%; those 20 lb. overweight, 18%; and so on. Analysis of the causes of death among obese persons as compared with those among persons of normal weight reveals that deaths from degenerative diseases of the heart, the arteries and the kidneys account for the greatest proportion of the higher mortality. All types of cardiovascular-renal conditions appear to occur more frequently and with greater severity among overweight persons, including, in particular, heart failure, cerebral hemorrhage and thrombosis, coronary thrombosis and nephritis. More of the obese die of accident, probably because fat people are less agile than thin people. The death rate from diabetes is almost four times as great among obese persons as compared with those of normal weight. Other diseases that occur more frequently in the obese are cirrhosis of the liver, gallstones, cancer of the liver and gall bladder, cancer of the uterus, appendicitis, complications of pregnancy and the postpartum period, diaphragmatic hernia, degenerative arthritis and flat feet. High blood pressure, varicose veins and venous thrombosis and embolism affect obese persons more severely and appear to occur more often among them. The greater the adiposity, the poorer the chances of success in and survival after surgery.

Because obesity is so common and affects health and life expectancy in such a variety of ways and in such severe and definite manifestations, it has been called the greatest single health hazard.

Causes.—Investigation of developing obesity in its early stages offers hope of discovering specific causative factors. There is of course only one ultimate cause of obesity: a caloric intake persistently exceeding the caloric output. There are, however, many ways in which the energy balance may be tilted to the positive side. Maintenance of normal body weight and of normal fat stores depends upon an outflow of heat and energy equal to the inflow provided by food. Excess food, whether taken as protein, carbohydrate or fat, is chiefly converted into and stored as body fat. In children, when the body is growing and physical activity is high, protein intake and total caloric intake must be high to provide for tissue growth and muscular energy. After body growth is complete, and muscular activity diminishes (as it does in most persons in the middle decades), excess calories taken as food produce not useful body tissue but detrimental fat. Perhaps in the least complex cases of obesity the commonest causes are either simple overeating or lack of exercise or both.

Physiological Factors.—Digestion and absorption of food are not more efficient in obese than in thin persons. Lipophilia (an extraordinary ability of the body to retain fat) has not been demonstrated to be present in the usual types of obesity. Local tissue avidity for fat, however, may be of importance in conditions in which the adiposity has a characteristic distribution, as, for example, in lipomatosis or lipodystrophy or in the condition called Cushing's syndrome. Obese persons do not conserve calories by accomplishing work with less effort and storing the difference. On the contrary, the total metabolism of obese persons is higher than normal, not lower.

It once was thought that the majority of obese persons might have endocrine defects, but this has not proved to be true. In only a minority of cases (perhaps about 5% of all obese persons

disorders of glands of internal secretion are demonstrable, among them hypothyroidism, hypogonadism, hyperadrenocorticism and hyperinsulinism. Underfunctioning of the thyroid gland is rarely the cause of obesity. The thyroid gland function and the basal metabolic rate are normal in the great majority of obese persons. When the sex glands (ovaries or testes) are absent or deficient in function, the subject may become more placid and less active physically and there is a predisposition to obesity, with fat deposits in certain areas: breasts, buttocks, hips and thighs. Formerly hypopituitarism was considered a cause of obesity, but pituitary disorders are not associated with adiposity unless the area at the base of the brain called the hypothalamus (*q.v.*) is impaired. In the hypothalamus are groups of nerve cells concerned with the regulation of appetite. When certain of these centres are damaged in experimental animals appetite is increased and obesity is a consequence unless increased muscular activity is enforced. Fröhlich's syndrome and other types of adiposogenital dystrophy characterized by adiposity and hypogonadism are due to hypothalamic disturbance plus pituitary disturbance, the gonadal deficiency being secondary to pituitary malfunction. Cushing's syndrome and disorders associated with excess secretion of the steroid hormones of the adrenal cortex are characterized by development of a striking "central" type of obesity in which the extremities tend to be spared. Similar adiposity may result from therapy with steroid hormones. Excess secretion of insulin by the pancreas may cause periods of low blood sugar and hunger and thus lead to obesity. (*See* also METABOLISM, DISEASES OF.)

Limitation of energy output from any cause may predispose to obesity. Laziness due to psychogenic factors is a common influence, but obesity also may develop if eating habits persist during periods of enforced inactivity.

Psychological Factors.—Improper childhood training, frustrations, nervous tensions and dissatisfactions may be expressed in increased food intake or decreased physical activity, and frequently both. Pleasure in eating may become a dominant personality trait, serving as a substitute for other satisfactions (social, business, sexual, etc.) that are unfulfilled. Problem children often become obese and use the condition to demand special attention. In the great majority of cases psychological factors are important, but in many instances both psychological and physiological influences favouring a positive energy balance may be discovered. In certain families may be seen hereditary factors that favour the development of obesity. Multiple causative factors are the rule, not the exception.

Symptoms.—Physical symptoms of obesity are fatigue and shortness of breath, and there may be aching in back, knees and feet. Later symptoms may be those of high blood pressure, heart failure, diabetes or other conditions to which obesity predisposes. Psychological results of obesity range from shyness and withdrawal to overly bold self-assertion. Often there are accompanying neuroses or even more severe psychological disorders.

Treatment.—It is better to prevent obesity than to attack the condition after it has reached considerable proportions. Proper eating habits should be established and, unless contraindicated, moderate regular exercise should be encouraged. When obesity is mild and uncomplicated, treatment with a low caloric diet and exercise should be sufficient. When obesity is more severe and causes are complex, treatment may include diet, physical therapy, drug and hormone treatment and psychotherapy.

Treatment has two aims: removal of causative factors and removal of excess stored fat. Removal of causative factors is relatively easy in rare cases only; for example, when a pancreatic islet tumour can be discovered to be responsible and can be removed surgically. Since, however, in the common types of obesity a disorder of appetite control is present, or there is a neurosis of which obesity is only a symptom, attempts to correct causative influences may prove difficult.

Whatever the cause of obesity, restriction of caloric intake in the diet is necessary to induce weight loss. Use of certain drugs under careful medical supervision may help to reduce appetite and ensure better observance of prescribed diets. The diet should allow about 10 calories per kilogram of ideal body weight if the subject is relatively inactive, or 15 to 20 calories per kilogram per day for moderate muscular exercise. Such a diet would allow 700, 1,000 or 1,400 calories per day for persons with ideal weight of 70 kg. (150 lb.). In reduction diets protein allowance usually should be liberal and fat minimal. The carbohydrate allowance should be supplied chiefly in the low carbohydrate bulky fruits and vegetables. Salt restriction may be advisable if fluid retention is present. Supplements of vitamin A and the B complex are advisable if dieting is to be prolonged, since foods containing these vitamins are restricted.

Regular exercise, preferably daily and preferably out-of-doors (such as walking, golf, swimming, etc.), is very helpful in increasing caloric output, but is even more valuable to improve muscular development, general health and morale. *See* also DIET AND DIETETICS; ENDOCRINOLOGY; HEART, DISEASES AND DEFECTS OF; MALNUTRITION: *Overnutrition*; NUTRITION.

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(C. M. MACB.)

OBITER DICTUM, that which is said by the way; an incidental statement. Specifically, in law, it refers to a passage in a judicial opinion which is not necessary for the decision of the case before the court. Such statements lack the force of precedent, but may nevertheless be significant. "In order that an opinion may have the weight of a precedent . . . it must be an opinion the formation of which is necessary for the decision of a particular case; in other words, it must not be *obiter dictum*." Dicta frequently take the form of statements which are unnecessarily broad. Thus when a young man willfully murdered his grandfather to prevent his revoking a will, the court held that the beneficiary was not entitled to the legacy which the will provided for him, saying that the law will not permit one "to take advantage of his own wrong, or to found any claim upon his own iniquity, or to acquire property by his own crime." In a subsequent case, involving a legatee who had negligently caused the testator's death in an automobile accident, the same result would not necessarily follow; the court would be free to distinguish the cases on their facts and limit the broad dictum of the earlier case.

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(B. CE.)

OBLATE (Lat. *oblatus*, "offered"), an ecclesiastical term for lay persons not professed monks, friars or nuns who have devoted themselves to follow the ideals of a religious rule of life. Formerly oblates also included children who were dedicated by their parents to a religious life.

"Oblate" is also familiar in the Roman Catholic Church as the name of a religious congregation of priests, the Oblate Fathers of St. Charles. This congregation was founded in 1578, under the name of Oblates of the Blessed Virgin and St. Ambrose, by St. Charles Borromeo (*q.v.*). A similar congregation of missionary priests, the Oblates of Mary Immaculate, have carried on extensive missionary activities in Canada. (*See* MARY IMMACULATE, OBLATES OF). Other congregations include the Oblates of the Virgin Mary (founded 1815), the Oblates of St. Francis de Sales (1871) and the Oblates of St. Joseph (1878). Of the congregations of women oblates, the best known is the Oblates of St. Frances of Rome (*see* FRANCES, SAINT). *See* also ORDERS AND CONGREGATIONS, RELIGIOUS. (C. J. BY.)

OBODRITES (BODRYCI, from *bodry*, "brave"), a people of the Polab group, the northwesternmost of the Slavs in medieval Europe. They inhabited the country between the lower Elbe river and the Baltic sea; *i.e.*, the country later divided between eastern Holstein (Wagria, so named from the Obodrite tribe of the Wagrowie, between the gulfs of Kiel and of Lübeck) and Mecklenburg. The Obodrites were allies of the Franks against the Saxons

in Charlemagne's time; but in 928 the Obodrite principality was conquered by the German king Henry I. The principality recovered its independence in 983 but was conquered again in the middle of the 12th century by Henry the Lion, duke of Saxony, after long resistance by the last pagan prince of the Obodrites, Niklot (d. 1160). Niklot's son Przybyslaw (Pribislav; d. 1178) accepted Christianity, acknowledged German suzerainty and was recognized in 1170 as a prince of the Holy Roman empire—to become the ancestor of the dukes of Mecklenburg (*q.v.*). First the dynasty and later the people became germanized.

See W. Bogusławski, *Dzieje Słowiańszczyzny północno-zachodniej,* 4 vol. (1887–1900). (K. Sm.)

OBOE, a treble woodwind instrument with a conical bore and double reed. It is used chiefly as a component of the orchestra but also has a considerable repertory of solo work.

History.—Even in its simplest form the conical pipe must be made by the skilful use of boring tools. No form of the instrument can be traced further back than about A.D. 300, nor is it indigenous among any primitive peoples in modern times.

Hautbois, or oboe, was one of the names applied to the shawm, the violently powerful instrument of outdoor ceremonial. But the oboe properly speaking (*i.e.,* the orchestral instrument) was the mid-17th-century invention of two French court musicians, Jean Hotteterre and Michel Philidor, and was designed to play indoors with the large bands of strings that were becoming common. This instrument, almost certainly softer and less brilliant in quality than the modern oboe, was probably first used in public in Lully's *Ballet de l'amour malade* (1657). Before the end of the 17th century it had become the principal wind instrument of the orchestra and military band and, next to the violin, the most important solo instrument of the time.

The early instrument, which had only two keys, could produce a fairly even chromatic scale by the use of "cross fingering" somewhat similar to that used by recorder players. The compass, at first two octaves upward from middle C, was soon extended, and solo works of the period of Mozart include the F above the treble staff. The instrument remained essentially the same well into the middle period of Beethoven.

(LEFT) ANTHONY BAINES, BY COURTESY OF THE CONSERVATOIRE ROYAL DE MUSIQUE DE BRUXELLES; (RIGHT) PHOTOGRAPH BY L. G. AUBIN FOR ENCYCLOPÆDIA BRITANNICA, INC.

(LEFT) 16TH-CENTURY SHAWM; (RIGHT) OBOE, ABOUT 1775, IN THE MACGILLIVRAY COLLECTION, LONDON

In the early years of the 19th century, however, the increasing complexity of music coincided with a number of improvements in the manufacture of keywork, particularly the introduction of metal pillars in place of the wooden ridges on which the keys had been mounted. This greatly reduced the threat to the airtightness of the instrument formerly associated with the introduction of additional keys, and in France, by 1839, the number of keys had been gradually increased to ten.

Meanwhile, before 1800, French players had adopted the narrow modern type of reed, and Guillaume Triébert (d. 1848) had begun his experiments, which, continued by his son Frédéric (d. 1878), were to result by the 1860s in an instrument almost identical with the modern oboe, both in bore and complexity of mechanism. This was essentially the expressive, flexible and specifically French instrument of the 20th century. The instrument in which the fingerholes are covered by perforated metal plates, now widely used in the U.S. and in France, was produced by François Lorée and Georges Gillet in 1906.

(LEFT) BY COURTESY OF T. W. HOWARTH & CO LTD.; (RIGHT) BY COURTESY OF MICHAEL WATTS, PHOTOGRAPH BY L. G. AUBIN FOR ENCYCLOPÆDIA BRITANNICA, INC

(LEFT) "GILLET MODEL" OR "SYSTÈME À PLÂTEAUX" OBOE, USED IN FRANCE AND THE U.S.; (RIGHT) MODERN AUSTRIAN OBOE

The centralized institutions of France probably helped to preserve the musical standards that made this evolution economically possible. (The working lives of the Triéberts roughly correspond to the greatest period of French grand opera; the new sensitive, lyrical oboe writing of Berlioz coincides with the early development of the new instrument; the gaiety, variety and agility in the scores of Delibes mark its completion.)

In other countries the decay of patronage and the public enthusiasm for military band music resulted in radically different traditions in oboe playing and manufacture. In Germany and Austria the rise of the many keyed instrument occurred earlier than in France and was accompanied by a development of the bore and reed that produced an increased loudness clearly of military inspiration. This resulted, after Beethoven, in a long period of neglect for the oboe. It is strange to consider that the dramatic solo in *Fidelio,* the high point of 19th-century German writing for the oboe, was almost certainly played on the baroque type of instrument with two keys. With the exception of the obbligato in Weber's *Der Freischütz* (1821), there is little after this in German scores that calls either for much sensitiveness or much technique until the end of the 19th century, when Richard Strauss campaigned successfully against the prevailing standards of playing. After a period of experiment with an extremely small reed, which was ill suited to the large German bore, the French oboe was fairly generally adopted by about 1925.

Comparable conditions in Italy produced a somewhat similar history. In modern times the German instrument (with a very small reed) survives in the U.S.S.R., where it is often played with a certain refinement, though it lacks the piquancy and sparkle of the modern French oboe. In Vienna an oboe similar to the German instrument, but with a rather more antique and less military character, is used exclusively by the Philharmonic orchestra and the Akademie. Its rather reticent and blending quality, which sounds well in the older classics, is caused, perhaps, more by the highly specialized type of reed used than by the inherent qualities of the instrument.

Elsewhere, orchestras use the French oboe exclusively, though often with slight local variations in the mechanism. An adaptation of the Boehm fingering to an otherwise normal French oboe is exported by Parisian makers to Spain and Latin America.

The Larger Oboes.—The cor anglais (*q.v.*), also known as the English horn, is pitched in F a fifth below the oboe and is a normal component of the modern orchestra, to which it was restored largely by the example of Berlioz and Wagner. It had been used intermittently, however, as a special effect ever since its earlier vogue in J. S. Bach's time, when the straight alto or tenor oboe of the 17th century made way for a curved instrument covered with leather and fitted with a globular bell. The origin of the name is unknown but it was to this form that the term cor anglais was specifically applied, and Bach's *oboe de caccia* was almost cer-

(LEFT AND CENTRE LEFT) BY COURTESY OF T. W. HOWARTH & CO., LTD.; (CENTRE RIGHT) PHOTOGRAPH BY L. G. AUBIN FOR ENCYCLOPÆDIA BRITANNICA, INC.; (RIGHT) BY COURTESY OF F. D. POGSON, PHOTOGRAPH BY L. G. AUBIN FOR ENCYCLOPÆDIA BRITANNICA, INC

(LEFT TO RIGHT) OBOE D'AMORE, "GILLET MODEL," WITH AUTOMATIC KEYS; COR ANGLAIS WITH THUMB PLATE; GERMAN HECKELPHONE; MODERN FRENCH BARYTON

tainly the same instrument. The curved form survived late in Germany and was used in Italy until about 1900.

The *oboe d'amore* in A, a minor third below the oboe, is made with a globular bell like that of the cor anglais. Introduced in Germany about 1720, it was much employed by J. S. Bach. It was revived by Charles Mahillon in 1878 for Bach performances. It is also used in a few 20th-century works.

The instruments pitched an octave below the oboe are more rare. The baryton, both in its tonal quality and in its proportions, resembles a larger and therefore lower-voiced cor anglais. Despite several early examples, notably those by H. Brod and Triébert, its effective history dates from F. Lorée's model of 1889. The heckelphone (*q.v.*), with a much larger bore and reed than the baryton, has a more distinctive tone but is rather heavy in the low register. It was first used by Richard Strauss in *Elektra* and *Salome*.

The Reed.—The chief factor in playing the oboe is the making of the reed and its control by the lips and breath. Most serious players make their own reeds, though in modern times there is a considerable trade in the ready-made article. The raw material of the oboe reed is the plant *Arundo donax*, which resembles bamboo in appearance. It grows in warm temperate or subtropical regions, but only the crops of the *départements* of Var and Vaucluse in the south of France are satisfactory for reedmaking.

The dimensions of reeds, thickness of gouging, and length and shape of the scraped vibrating surface vary in different countries according to ideals of tone and the physical aptitudes of players.

The Repertory.—The revival of the oboe as a solo instrument that began, to some extent, in the 1930s accelerated very rapidly after the end of World War II and by the early 1960s there were probably more concerto players than at any time since the 18th century. Though a number of modern concertos were written for the instrument, the rich repertory of the early 18th century still remains the stock in trade of the oboe soloist.

See also WIND INSTRUMENTS: *Reed Instruments*.

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OBRECHT (HOBRECHT), **JAKOB** (1452–1505), Netherlands composer, known chiefly for his sacred music, was born at Bergen op Zoom on Nov. 22, 1452. He was the son of Willem Obrecht, a trumpeter in the service of the duke of Cleves. Willem Obrecht had journeyed to Sicily and Mantua, and his musical contacts in Italy were ultimately to prove useful for his son. It has been suggested that the young Obrecht was trained at Ferrara, a city which he later visited when at the height of his fame. But his first certain appointment dates from 1484, when he served as instructor of the choirboys at Cambrai cathedral. In the following year he became succentor of the cathedral of St. Donatien at Bruges, but he soon applied for leave of absence to visit Italy. This was granted, and late in November 1487 he met Ercole I, duke of Ferrara, at the town of Goito in Lombardy. The duke had heard much of Obrecht's music and was one of his keenest admirers; once he had installed the composer in Ferrara he sought to prolong his stay by writing to Pope Innocent VIII and requesting that the next vacant benefice in Ferrara be given to Obrecht. The pope, however, did not grant this request; Obrecht returned north and by June 12, 1488, was in Bergen op Zoom. He resumed his duties in Bruges and was also nominated chaplain of the altar of St. Jodocus at Antwerp cathedral in 1498. He journeyed to Ferrara again in 1504 and in 1505 he died of the plague that ravaged the city and killed thousands of its residents.

Although Obrecht is best known for his liturgical music, he also wrote secular songs which include settings of Dutch, Italian and French texts. Twenty-five of these survive along with a number of motets, most of which are in honour of the Virgin Mary ("Salve regina," "Alma redemptoris mater," "Ave regina coelorum"). Twenty-seven settings of the Mass are extant, most of them for four voices. Obrecht's complete works were edited by Johannes Wolf (1912–21); other works were discovered later, and in the mid-1960s a new edition was being prepared by the Vereniging voor Nederlandse Muziekgeschiedenis. (D. W. St.)

OBREGÓN, ALVARO (1880–1928), Mexican soldier and president, was born near Alamos, Sonora, on Feb. 19, 1880. He had little formal education, and while a young man worked as a farmer and occasionally as a labourer in a small factory; in these two activities he developed a keen sense of reform. He did not take part in the revolution which overthrew the dictator Porfirio Díaz (1910–11), but in 1912 he led a group of volunteers in support of Pres. Francisco Madero against the rebels of Pascual Orozco. When Madero was overthrown and assassinated by the forces of Victoriano Huerta in Feb. 1913, Obregón joined with Venustiano Carranza against Huerta and consistently defeated the enemy armies. Huerta fled from Mexico in July 1914, and on Aug. 15 Obregón occupied Mexico City.

By Dec. 1914 differences among the victors brought new fighting. Obregón remained allied with Carranza against Pancho Villa and Emiliano Zapata; Obregón's military genius destroyed both opponents as serious threats within six months, although both remained as rebels for some years afterward. During the campaign against Villa, Obregón by decree instituted anticlerical policies and established maximum hours and minimum wages in the areas he conquered. At the convention which drafted the constitution of 1917, Obregón consistently gave strong support to the

more radical group, and to this extent was responsible for the revolutionary emphasis of that document. For a period in 1917 he served in Carranza's cabinet, but differences in ideology induced him to resign and for about two years he was politically inactive. He was a candidate for president in the election of 1920; in that year Carranza's attempt to retain power by having his own candidate elected brought about a rebellion in which Obregón played a leading role. Carranza was soon overthrown and on Dec. 1, 1920, Obregón was elected president.

As president, Obregón effectuated several of the constitutional provisions that Carranza had not enforced, and generally instituted widespread social and economic reforms. (*See* MEXICO: *Independent Mexico: Obregón and Calles.*) Because of his insistence on some of these reforms, the United States refused to recognize his government until 1923. Late that same year a rebellion began, led by Adolfo de la Huerta and supported by three-fifths of the army, but Obregón took the field and utterly defeated the rebels within four months; at no time in his career did he show more clearly his political and military brilliance. At the conclusion of his term he was succeeded as president by Plutarco Elías Calles.

Again a candidate for the presidency in 1928, Obregón was elected fraudulently after a bitter campaign in which his supporters assassinated a number of opponents. Shortly after his reelection, he returned from Sonora to Mexico City, where, on July 17, 1928, he attended a small victory celebration. While dining with his friends, he was shot and killed by José de León Toral, a fanatical Roman Catholic who held Obregón responsible for religious persecutions. (C. C. CU.)

OBRENOVICH (OBRENOVIC), the name of a dynasty which gave five rulers to Serbia in the 19th century. Whereas other European princes are generally numbered according to their Christian names, the Obrenovich princes are numbered according to their place in the dynastic succession. Milosh (*q.v.*) Obrenovich I was prince of Serbia from 1815 to 1839 and again from 1858 to 1860; his elder son Milan Obrenovich II (1819–39) was prince for 25 days in 1839; Milan's younger brother Michael (*q.v.*) Obrenovich III was prince from 1839 to 1842 and again from 1860 to 1868; Milan (*q.v.*) Obrenovich IV succeeded the childless Michael (his first cousin once removed) as prince in 1868 and was king of Serbia from 1882 until his abdication in 1889; and Alexander (*q.v.*) Obrenovich V was king in succession to his father Milan Obrenovich IV from 1889 until his assassination in 1903, when the dynasty became extinct.

O'BRIEN, one of the most common surnames in Ireland in the 20th century, is derived from Brian, the Christian name of the greatest medieval king of independent Ireland. He is usually known as Brian Boru (*Boroimhe*, "of the tribute"), who was killed at the moment of his great victory over the Northmen at Clontarf in 1014. He had been king of Thomond (northern Munster, comprising what is now County Clare with some adjacent territory) and his subsequent reign of 13 years as *Ard-ri* (high king of Ireland) was made illustrious by his military prowess, administrative developments and monastic foundations. It is incorrect to claim that the system of hereditary surnames was introduced by Brian Boru, but it is from his time that the general adoption of that form of nomenclature in Ireland dates. Since Ó (*Ua*) means grandson or descendant, he himself could not, of course, be styled O'Brien.

Before his time the Dalcassian clan known as *Uí Toirdealbhaigh*, to which his family belonged, was of comparatively minor importance. In the two centuries following his death the great sept of O'Brien divided into several branches throughout Munster, of which several of Brian's descendants were kings. The most important of these branches were the O'Briens of Ara in northern Tipperary, whose chief was known as Mac Uí Bhriain Ara; another branch settled by the Galtee mountains in the Aherlow district; a third moved farther east and acquired the fertile lands between the Comeragh mountains and Dungarvan in what is now County Waterford. These, and especially their original homeland, County Clare, are the counties in which the name is still most prevalent.

In the mid-18th century a branch of the family settled in France. A century earlier a branch had been established in the Netherlands, following the marriage of Daniel O'Brien with Susanna Jans, a Dutch lady, and became known as O'Breen. The O'Breens of Holland have thus no connection with the Irish sept of O'Breen (O'Braoin) of Brawney. The destruction of the old Gaelic order in the early 17th century and the transfer of legal work to English officials unacquainted with the Irish language resulted in some of them becoming almost unrecognizable in their new anglicized forms. Furthermore two surnames unconnected with O'Brien did to some extent assume that form. One of these was O'Breen (now seldom met with the prefix "O"), a natural mistake since O'Brien in Irish is pronounced as O'Breean. The infamous Jemmy O'Brien of 1798, for example, was an O'Breen, not an O'Brien. Similarly in some rare cases the Norman family of Bryan of County Kilkenny, when the period of Gaelic and Catholic submergence came to an end, assumed an "O" and became O'Brien. Conversely some O'Briens who had dropped the prefix wrote their name Bryan. Such cases, however, were never numerous. It may be added that the celebrated eight-feet-tall giant Patrick O'Brien, whose skeleton was acquired by the museum of the Royal College of Surgeons in London, only assumed the surname of O'Brien.

Sir Donough O'Brien, 16th Baron Inchiquin, chief of the name in 1962, is directly descended in the male line from Brian Boru. Until Tudor times Brian's successors remained virtually independent, though occasionally making minor concessions to the English as, for example, the cession by Brian Rua O'Brien of part of his territory between Limerick and Quin to Thomas de Clare who built the imposing castle of Bunratty, near the present Shannon airport. In that castle in 1272 De Clare murdered Brian Rua O'Brien in circumstances of great treachery and ferocity. Since the Anglo-Norman invasion the English kings had assumed the title of lord of Ireland, but in the 16th century, like the heads of the other great septs, the O'Brien of the time submitted to Henry VIII as king of Ireland. Murrough O'Brien (d. 1551), 57th prince of Thomond, had, like most of the other leading chiefs, been created a peer of the realm in compensation for the surrender of his Gaelic dignities: the titles conferred on him in 1543 were earl of Thomond and Baron Inchiquin. He also accepted the Reformation as part of the bargain and with certain exceptions his descendants remained loyal to the English king and the Protestant religion.

A notable feature of the original creation is that the succession to the earldom of Thomond was to pass to Murrough's nephew Donough, his son Dermod inheriting only the barony of Inchiquin. Other subsequent peerages given to the O'Briens became extinct and only the lesser of the original titles survives. This accounts for the present holder being Baron Inchiquin, not earl or marquess of Thomond or earl of Inchiquin. Conor O'Brien (*c.* 1535–81), 3rd earl of Thomond, was at war with the English for a while, but after his defeat and flight to France in 1570 he was pardoned. His son Donough (d. 1624), 4th earl, was active on behalf of Elizabeth I and under James I became president of Munster. The earldom became extinct after the death of Henry (1688–1741), 8th earl, who was created Viscount Tadcaster.

The Inchiquin line was also identified with the English interest, particularly in the 17th century, when the ruthless activities of Murrough O'Brien (*c.* 1614–74), 6th baron and 1st earl of Inchiquin, on behalf of Oliver Cromwell during the war of 1641–52 earned him the nickname of Murrough of the Burnings. He later espoused the royalist cause and did much to assist in bringing about the Restoration. His son William (*c.* 1640–92), 2nd earl, served under his father in France and Spain and spent some years as governor of Tangier. At the revolution in 1688 he took the side of William III, who made him governor of Jamaica, where he died in 1692. Murrough (1726–1808), 5th earl, was created marquess of Thomond in 1800, but on the death of his second son in 1855 the marquessate became extinct.

A very different picture is presented by the line descended from Daniel O'Brien (1577–1666), younger brother of Connor, 3rd earl of Thomond. Daniel was created Viscount Clare by Charles II, whom he joined before the Restoration; he had been prominent in the Irish parliament and subsequently a member of the supreme council of the Catholic confederation of Kilkenny. His grandson

Daniel (d. 1691), 3rd viscount, who had been lord lieutenant of County Clare under James II, was outlawed in 1691 and raised the regiment of James's Irish army, later to become famous as Clare's dragoons in the Irish brigade on the continent under the command of his son Charles O'Brien, nominally 5th viscount, who was mortally wounded at the battle of Ramillies (1706). His son Charles O'Brien (1699–1761), titular 6th viscount, commanded the Irish brigade at the battle of Fontenoy and was made a marshal of France in 1741. His claim to the earldom of Thomond, disallowed by the English authorities because of the attainder, was recognized by the French court. With the death of his son Charles in 1774 these titles became extinct.

In addition to the 6 O'Briens who served as officers in Clare's dragoons, there were over 20 O'Briens commissioned in other regiments of James II's Irish army; and 24 appear in the list of outlawries which followed the defeat of the Jacobite cause. Later they were equally prominent in the Irish brigade on the continent.

Others of the name have also distinguished themselves in various spheres of activity. In politics, besides Sir Lucius O'Brien (d. 1795), member of parliament and advocate of Irish independence, and William Smith O'Brien (1803–64), member of parliament and Young Irelander, there were William O'Brien (1852–1928), Parnellite and later independent member of parliament, and another William O'Brien (1881–), labour leader and comrade of James Connolly. Some politicians might better be included in the category of adventure and war, for example James Francis Xavier O'Brien (1828–1905), member of parliament, who took part in the Fenian rising of 1867 and the American Civil War, and Fitzjames O'Brien (1828–62), who was killed in that war. In the American Revolutionary War, Jeremiah O'Brien (1740–1818) and his two brothers John and William were renowned for their naval exploits on the American side; Adm. Donat Henchy O'Brien (1785–1857), on the other hand, served the British empire with distinction. A victim of war, though not an active participant, was Terence Albert O'Brien (1600–51), Dominican bishop of Emly, who was hanged by Gen. Henry Ireton after the siege of Limerick. Well-known names in literature and science are Matthew O'Brien (1814–55), mathematician and astronomer; Paul O'Brien (1763–1820) of Maynooth, and John O'Brien (d. 1767), bishop of Cloyne and Ross, who were Gaelic scholars; Richard Barry O'Brien (1809–85), historian, and Charlotte Grace O'Brien (1845–1909), poetess, novelist and philanthropist. The extent to which less known people of the name have contributed to the corpus of Irish literature is indicated by the fact that there are about 100 O'Briens in the Royal Irish Academy catalogue of Gaelic manuscripts. There are approximately 300 O'Briens mentioned in the *Annals of the Four Masters* from the date of the adoption of the name in the 11th century down to 1616, when that chronicle ends. Similarly in the *Annals of Innisfallen*, which deals principally with the southern half of Ireland, the name O'Brien appears more frequently than any other.

Another aspect is the connexion of place-names with families; thus in the case of O'Brien, there are Pubblebrien, one of the baronies of County Limerick, and O'Brien's Bridge, the village on the river Shannon where the ancient bridge joins the counties of Clare and Limerick.

See E. MacLysaght, *Irish Families* (1957), and *More Irish Families* (1960), which include bibliographies. (E. A. MacL.)

O'BRIEN, JAMES BRONTERRE (1805–1864), British radical, sometimes known as the "Chartist schoolmaster," was one of the few Chartists with a well-articulated theory of society and government and a realistic sense of tactics. Born at Granard, County Longford, in 1805, he was educated at Trinity college, Dublin, and moved to London in 1829, intending to practise at the English bar. He was quickly drawn into radical activities and later into working-class journalism. In 1831 he was acting editor of the *Poor Man's Guardian*, the unstamped organ of extreme radical views. After a short time in Birmingham at the height of the Reform bill crisis, he returned to London and his old newspaper. When the *Guardian* expired in 1835, he took up other journalistic assignments. He was a keen and searching writer who took pains to acquaint himself with the history and organization of revolutionary movements in Europe as well as with working-class politics at home. Bitterly opposed to his compatriot Daniel O'Connell, he naturally threw in his lot with Feargus O'Connor in the early days of the Chartist movement and from 1838 to 1840 he worked on O'Connor's *Northern Star*. He was one of the most important and influential Chartists at the convention in 1839, where he advocated "ulterior measures" to secure the Charter should constitutional means fail. However, he was sentenced to 18 months' imprisonment in 1840, and while in jail he had the first of a number of quarrels with O'Connor which transformed his political prospects. The two men were bitter enemies by 1844. O'Connor's land plan had no more scathing critic, and at the Chartist convention of 1848 O'Brien took up a moderate position, ridiculing the possibility of being able to use force effectively. In 1850 he was a joint founder of the National Reform league, which advocated socialist objectives. In his last years, spent in considerable hardship, he wrote political poetry. He died on Dec. 23, 1864. (A. Bri.)

O'BRIEN, WILLIAM (1852–1928), Irish patriot, a founder of the United Irish league, was born at Mallow, County Cork, on Oct. 2, 1852, the son of James O'Brien, a solicitor's clerk. He was educated at the Cloyne diocesan college and at Queen's college, Cork, and took up journalism in 1869. In 1881 he became editor of *United Ireland*, which he conducted with such vigour from August to October that it was suppressed for the time being, and O'Brien was put in Kilmainham jail with Charles Parnell and others. There he drew up the famous "No Rent manifesto," which led to the Land league's being outlawed.

Released in 1882, O'Brien resumed his campaign in *United Ireland* and was elected to parliament for Mallow in 1883. In 1886, O'Brien started the slogan of "no reduction, no rent." Parnell was out of Ireland at the time and eventually disavowed the plan, but O'Brien had stirred up a fierce agitation. To meet the situation the British government passed the Coercion act of 1887, under which O'Brien was sent to Tullamore jail. On his release he appeared in the house of commons to renew his obstructive tactics there.

After the O'Shea divorce case, in which Parnell was involved, O'Brien tried to mediate between the Parnellites and the anti-Parnellites, siding with the majority who rejected Parnell's claim to retain leadership. In 1900, after years of bitter strife, both sections were reunited under the Parnellite John Redmond, largely as a result of O'Brien's formation of the United Irish league in 1888. Having given active support to the Land conference, which secured agreement between the landlords and tenants' representatives and resulted in the Wyndham Land Purchase act of 1903, O'Brien became convinced that nationalists and unionists could unite for common purposes. He founded the All-for-Ireland league, which obtained a large following in County Cork, in opposition to Redmond's control of the United Irish league. But O'Brien's personal following did not survive the rise of the Sinn Fein agitation, and after World War I (Irish participation in which he had supported) he withdrew from public life. He died in London on Feb. 25, 1928.

O'BRIEN, WILLIAM SMITH (1803–1864), Irish patriot, leader of the Young Ireland movement, was born at Dromoland, in County Clare, on Oct. 17, 1803, and educated at Harrow and at Trinity college, Cambridge. He began to use his second name of Smith on inheriting his maternal grandfather's estates in Limerick. He entered parliament in 1828 as member for Ennis and from 1835 to 1848 represented the county of Limerick. Although he actively supported Catholic emancipation he opposed Daniel O'Connell's election for County Clare in 1828 and continued to oppose repeal of the legislative union until O'Connell's imprisonment at the end of 1843. O'Brien then joined the Repeal association and was at once appointed deputy leader while O'Connell was in prison. He became closely associated with Thomas Davis and Gavan Duffy and the brilliant group who later became the Young Ireland party; and in 1846 he led them in withdrawing from the Repeal association, when O'Connell demanded repudiation of any conceivable resort to arms. Early in 1847 they formed the Irish confederation to press for a more active policy during the years of famine. In May 1848, after a mission to Paris to congratulate the new French

republic, O'Brien was tried for sedition, but was acquitted. He exercised a restraining influence until the government issued warrants to arrest all the most active leaders. O'Brien then assembled them to make a last stand and appealed for a general rising. It collapsed in a short collision with the police and military forces at Ballingarry. O'Brien was arrested at Thurles, tried for high treason and condemned to death. The sentence was, however, commuted to exile to Tasmania for life. O'Brien obtained a full pardon in May 1856 and returned to Ireland. He died at Bangor, north Wales, on June 18, 1864.

O'BRYAN, WILLIAM (1778–1868), was the founder of the Bible Christian Church, an offshoot of Wesleyan Methodism which was confined almost entirely to southwestern England. He was born at Gunwen, Cornwall, on Feb. 6, 1778. He was for a time a successful Wesleyan local preacher, but his independent behaviour led to his expulsion in 1815. In 1815 he formed the first Bible Christian society at Shebbear in north Devon. By 1824 there were 6,200 members. After increasing friction between him and his followers, O'Bryan in 1829 withdrew altogether from the Bible Christians; only a small party seceded with him and they returned in 1835. He left England in 1831 and worked extensively as an itinerant revivalist in the United States and Canada. Though he revisited England frequently, he did not become reconciled to the Bible Christians there. He died in New York on Jan. 8, 1868.

The Bible Christians held doctrines common to the rest of Methodism, their organization being controlled by an annual conference after 1819. In 1907 they joined the United Methodist Church. *See* METHODISM.

See S. L. Thorne, *William O'Bryan, the Man and His Work* (1888); F. W. Bourne, *The Bible Christians, Their Origin and History* (1905).
(J. H. S. K.)

OBSCENITY, in general, refers to conduct offensive to the public sense of decency. From the point of view of the law, it is essentially concerned with the publication of indecent matter. In England until the 18th century it was regarded as a matter for the ecclesiastical courts, but in 1727 there was a successful prosecution for this offense in a temporal court, and thereafter it became recognized as an indictable misdemeanour at common law. In 1857 it was dealt with for the first time by statute in the Obscene Publications act of that year, now repealed (for England but not Northern Ireland) by the Obscene Publications act, 1959. (Neither statute has effect in Scotland.) In the United States, all of the states have laws regulating the dissemination of obscene materials, and more than 50 nations are parties to an international agreement for its control. The basic legal control has been through the criminal law, but the United States and most other countries also provide for administrative regulation by the customs, by the postal service and by state or local boards for the licensing of movie or stage performances. Possession of obscene materials without intent to sell is not a crime.

The principal target of the law has been commercialized pornography. However, control of obscenity necessarily entails control of discussions and portrayals of sex, lust and love, and it is, therefore, no surprise that the law has frequently provided celebrated controversies over government censorship of art and letters.

In 1957 the United States supreme court in *United States* v. *Roth* put to rest lingering doubts about any inconsistency between the law of obscenity and U.S. constitutional doctrines regarding freedom of speech and expression. The court also restated the basic U.S. definition of obscenity: "Whether to the average person, applying community standards, the dominant theme of the material taken as a whole appeals to prurient interests." This restatement, which seemed likely to become the formula for future U.S. cases, summarizes an important change in the law. The first great English precedent in *Regina* v. *Hicklin* in 1868 has been understood to mean that the test was the effect of isolated passages on the particularly susceptible. Not only does the *Roth* case make it unquestionable that the relevant audience is the average reasonable adult (unlike the test formulated by the English Obscene Publications act of 1959) and that the work must be considered as a whole (as in English law) but it strongly intimates that any more restrictive test would violate the U.S. constitution.

Two other points of importance have been clarified in decisions of the supreme court. First, obscenity no longer covers "thematic" obscenity in which immoral or unconventional ideas of sexual behaviour are sponsored. In 1959 the court held that New York city could not ban a movie simply because it "approvingly displays an adulterous relationship." Second, the court has indicated it will be difficult to create new crimes on analogy to obscenity; in 1947 it struck down as unconstitutional the attempt of New York to make it a crime to publish "massed" stories of crime and bloodshed.

Among troublesome issues that still remain are the constitutionality of motion-picture and postal regulations of obscenity, which have been challenged as prior censorship schemes; the status of the bookseller, who is frequently prosecuted although he may have little knowledge of or interest in the particular item; and the special problems of portrayals of "obscene violence" aimed at the young in the form of comic books.

Around the early 1920s the U.S. jurist Learned Hand spoke of obscenity as "the critical point" between candour and shame reached at any moment in a society. That remains an apt assessment both of the need for and the perplexity of the contemporary law of obscenity. *See* also CENSORSHIP: *Obscene Literature.*

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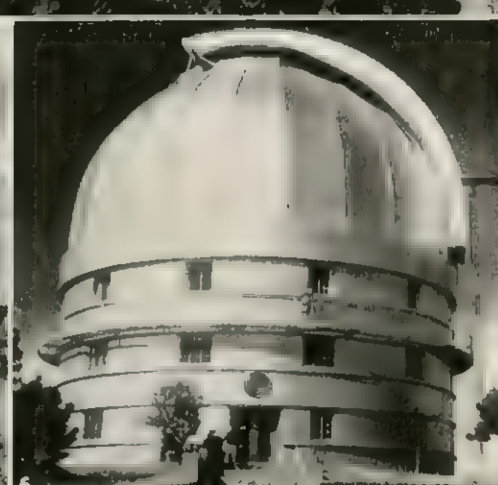
(H. Kn.)

OBSERVATORY (ASTRONOMICAL). This article covers the important observatories of the world. For a general discussion of the purpose and work of astronomical observatories and for the history and technical aspects of the telescope, *see* ASTRONOMY and TELESCOPE.

The erection of special buildings for astronomical research is a practice of long standing. It is said by Diodorus that the great temple of Belus at Babylon was built for astronomical purposes, and, since there is indication in the Chinese records that the gnomon was used for measuring the height of the sun in the reign of the emperor Yao (2300 B.C.), it may be said that the beginning of practical astronomy was contemporaneous in eastern and western Asia.

There is no evidence of the existence of an observatory of Greek or Alexandrine origin until the time of Ptolemy Soter, who, about 300 B.C., built one at Alexandria. The earliest records from an observatory known to be extant are those of Hipparchus (c. 140 B.C.), who has left a catalogue of stars from observations made at the island of Rhodes, repeating those made earlier at Alexandria. Three hundred years later, Ptolemy (A.D. 150) compiled a star catalogue, but it is doubtful whether this was from his own observation and, therefore, whether he had an observatory other than that at Alexandria.

The art of astronomical observation was revived several hundred years later in western Asia when observatories were established at Damascus and Baghdad and one at Mokatta by Caliph Hakim about A.D. 1000. A splendid observatory was built at Maragheh in northwest Persia by Hulagu Khan about A.D. 1260, but the most productive was that of the Persian prince Ulugh Beg, grandson of the great Timur, who, at Samarkand with his assistants, made a catalogue of stars from observations with a large quadrant in the first half of the 15th century. Later in that century, about 1471, Johann Müller of Königsberg, better known as Regiomontanus, set up an observatory at Nürnberg, with the help of Bernhard Walther of that city, furnished with instruments of his own design, and after his death in 1476, clocks, then a recent invention, were added to the equipment. The first observatory, however, that may be considered a prototype of modern national observatories was that of Tycho Brahe on the island of Hven (Ven), off the southwest coast of Sweden. To the building commenced on Aug. 8, 1576, he gave the appropriate name Uraniborg ("castle of the heavens").

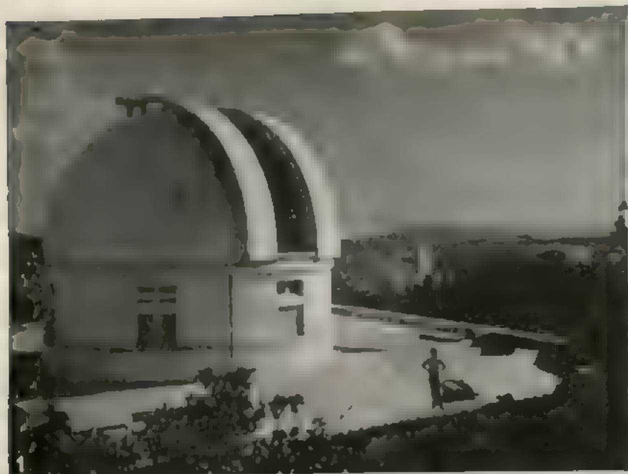


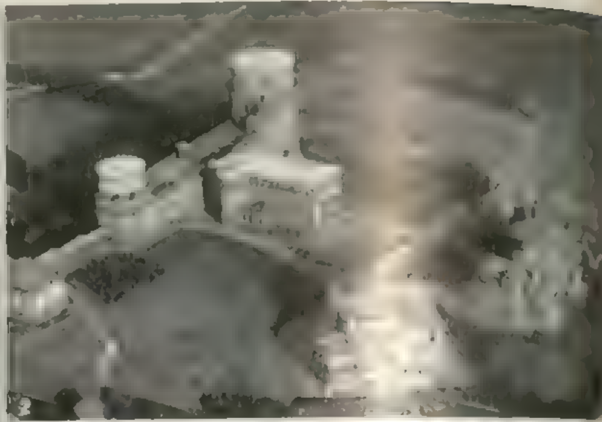
BY COURTESY OF (1) LICK OBSERVATORY, (2) EDISON R. HOGE, (3) THE DIRECTOR, MC MATH-HULBERT OBSERVATORY, (4) FAIRCHILD AERIAL SURVEYS, (5) YERKES OBSERVATORY, (6) ELWOOD M. PAYNE

AMERICAN OBSERVATORIES

1. The Lick observatory on Mt. Hamilton, Calif., completed in 1887–88. The domes on main buildings covering the 36-in. and 12-in. refractors are shown
2. The dome of the 200-in. Hale reflecting telescope, at Mt. Palomar, California
3. The McMath-Hulbert observatory of the University of Michigan, located near Pontiac, Mich., and devoted to solar work. The smallest dome houses a 24-in. reflecting telescope. The middle tower contains a coelostat and the tower-type solar telescope with a 30-ft. spectrograph. The highest tower also houses a coelostat and tower-type solar telescope with vacuum spectrograph
4. Mt. Wilson observatory, near Pasadena, Calif., established in 1904–05. Its largest reflecting telescope, completed in 1917, has a mirror 100 in. in diameter
5. Yerkes observatory of the University of Chicago, at Williams Bay, Wis., completed in 1897. View from the southwest
6. The W. J. McDonald observatory. Dome of the 82-in. reflecting telescope of Mt. Locke, Texas. Founded in 1939 jointly by the University of Texas and The University of Chicago

OBSERVATORY (ASTRONOMICAL)





[illegible] (4) YERKES OBSERVATORY, (2) THE ASTRONOMER ROYAL FOR SCOTLAND, (5) THE DIRECTOR, LA PLATA OBSERVATORY

OBSERVATORIES OVER THE WORLD

1. Dome of the 48-in. reflecting telescope of the Astrophysical observatory near St. Michel, 60 mi. northeast of Marseille, France
2. Royal observatory, Edinburgh, Scotland. On Blackford hill. Established in 1896 in place of an observatory on Calton hill, Edinburgh
3. Office building of the Astrophysical observatory near St. Michel, France
4. General view of the historic building of the Pulkowa observatory [illegible] the U.S.S.R., destroyed during the siege of Leningrad in World War II. The Russian government reconstructed the building on the original plans with instruments of modern type
5. General view of the La Plata observatory at La Plata, Argentina

Tycho Brahe's Observatory.—This building was of some magnitude and large enough to house Tycho and several young men who lived with him as students or observers. It was furnished with a large quadrant attached to a wall in the plane of the meridian, for to this astronomer is due the credit of appreciating the advantage of size in instruments of this type, and of the principle which is embodied in the mural circle. There Tycho Brahe with his assistants, one of whom was Longomontanus, a name well known in the science, observed the heavens and produced a catalogue of the positions of more than 1,000 stars. On the death of his patron, Frederick II, in 1588, Tycho was deprived of royal favour and income. In 1597 Tycho left Denmark, the observatory at Hven having been already dismantled.

The invention of the telescope in 1608 opened a new chapter in the history of observatories, and the building at Padua in which Galileo discovered and made the first observations of Jupiter's satellites on Jan. 7, 1610, may be regarded as the first of a new class. Others were created as additions to universities or similar institutions during the 17th century. In 1637, King Christian IV of Denmark established a permanent observatory at Copenhagen, which was completed 20 years later.

Johannes Hevelius, a member of a noble family of Danzig, built an observatory in 1641 in his own house and furnished it with an azimuthal quadrant of five-foot radius and a sextant of six feet, with which he measured the meridian altitudes of stars, sun, moon and planets, and their distances from one another in the manner of Tycho—that is, with plain sights, believing this to be superior to the newly adopted telescopic method.

Paris, Greenwich and Others.—Hevelius died early in 1687 and his work was not carried on, but by that date there had come into existence the two national observatories at Paris and Greenwich. The former was built in the years 1667–71, according to the designs of Claude Perrault, as an architectural monument. Under the Cassinis and others it has done much for astronomy. The Royal observatory, Greenwich, was founded in 1675 for the definite purpose of the improvement of navigation. Architectural pride again entered into the design, for Sir Christopher Wren wrote of it to Bishop Fell of Christ Church, Oxford, as built "a little for pomp," referring to the main building. The essential instruments were housed apart, and Wren's beautiful creation is merely a small item in its extensive domain.

Few establishments of the kind were erected during the next half century. Mainly because of the occurrence of the transit of Venus in 1769, George III built and furnished the King's observatory at Kew. The improvement in reflecting telescopes by James Short and the invention of the achromatic object glass in the later part of the 18th century marked the beginning of many observatories that have since become famous. The Radcliffe observatory at Oxford was erected 1771–74 from funds bequeathed by John Radcliffe, a court physician "for charitable purposes," the words being interpreted somewhat widely. Provost Andrews bequeathed a substantial sum for building and endowing an astronomical observatory for the University of Dublin which was built at Dunsink in 1785 but not furnished with instruments until many years later. An observatory was established and endowed at Armagh in Ulster in 1791 in charge of Primate Richard Robinson, while the most productive British observatory of the period was that of William Herschel at Bath, Datchet and Slough successively.

Early Continental Observatories.—Continental observatories established during this period were those of Mannheim (1772?), which was transferred to Karlsruhe in 1880, and again to Heidelberg in 1896; Lilienthal, founded by J. H. Schroter in [illegible] and furnished with a reflector made by Herschel; Leipzig, where a small observatory existed on the tower of the university in the years 1787–90; Breslau (1790); also one at Seeberg near Gotha founded by Duke Ernest II in 1788 that was made famous by F. X. von Zach and J. F. Encke. The observatory at Palermo, where G. Piazzi made his famous catalogue of stars, was founded in 1790, and at about the same time J. Lalande and his assistants were observing transits of stars from an observatory in the École Militaire, Paris.

19TH CENTURY

British Observatories.—A full list of observatories, public and private, founded in Great Britain during the next 100 years would be large. An observatory on Calton hill, founded by a private association, the Edinburgh Astronomical institution, in 1818, was taken over by the crown as a royal observatory in 1834 and transferred to its present site on Blackford hill in the years 1889–96. Cambridge university observatory was founded in 1820 and under its noted directors, George Biddell Airy, James Challis, John Couch Adams, Robert Stawell Ball and Arthur Stanley Eddington, has done valuable work; by the end of the century it was well equipped with instruments for solar and astrophysical observations. The Radcliffe observatory at Oxford was originally in the charge of the Savilian professor of astronomy, but this arrangement lapsed and the offices of professor and Radcliffe observer became distinct about 1839. In 1875 the University observatory came into existence, largely through the liberality of Warren de la Rue, for the use of the Savilian professor. The work of this observatory has been primarily photographic. An observatory was established at Liverpool mainly for the time service of the port in 1838, and at Glasgow a small observatory attached to the university, of which Alexander Wilson had been the first director about 1760, was enlarged and transferred to a new site in 1836.

Among private observatories the reflecting telescope, with a six-foot mirror made by Lord Rosse and set up at his seat, Parsonstown, Ire., in 1845, is famous, and scarcely less so are the smaller instruments of the same type made by William Lassell, and used by him at Liverpool 1844–52.

Observatories established in England in the second half of the 19th century were those of De la Rue, a pioneer in astronomical photography, at Cranford in Middlesex; of George Knott at Cuckfield, Sussex; and of William Huggins, the famous spectroscopist, at Tulse hill; the private observatory of Norman Lockyer, who afterward developed spectroscopic research at a state-supported establishment at South Kensington. Those of Edward Crossley at Halifax, Yorkshire, and Thomas Espin at Towlaw, Durham, have reputations based on double-star observations.

Colonial Observatories.—A feature of the 19th century was the establishment of British colonial observatories. Acting on the proposal of the board of longitude in 1820, the lord commissioners of the admiralty resolved to establish an observatory at the Cape of Good Hope for the improvement of practical astronomy. It came into being in the year 1829, and fulfilled its purpose as a government observatory under the directorship of Thomas Maclear, Edward James Stone, David Gill, George Washington Hough, Harold Spencer Jones, John Jackson and R. H. Stoy (from 1950). This observatory has a reversible transit of modern type and an equatorial twin telescope with a 24-in. photographic lens and 18-in. visual lens, known as the Victoria telescope for photographic and spectroscopic work. In 1834 Sir John Herschel established at the Cape a temporary observatory which is historically important. During four years he completed a survey of the southern heavens, extending the work his father had done many years earlier on the northern sky.

The first observatory on Australian soil was one on Dawes point, on the headland of which stands the present Sydney observatory, established in 1786. In 1853 Robert L. Ellery was appointed to superintend an astronomical observatory at Williamstown which was moved to Melbourne in 1861–63. With the observatories of Sydney and Perth, Melbourne has taken a share in the international work of charting the heavens by photography, and in addition meridian observing, magnetism, seismology, meteorology and time service form its activities. The Adelaide observatory was not completed until 1861. The observatory of Western Australia at Perth was established 30 years later. The aim of a small observatory established at Wellington, N.Z., under Sir James Hector, in 1869 for time service was later enlarged and the institution named the Dominion observatory.

Continental Observatories.—During this period many observatories were established on the continent of Europe, two of which were made famous by the labours of Wilhelm Struve. The

University at Dorpat, Livonia, Russia, possessed in 1820 an observatory of small dimensions, scantily equipped, of which Struve, a member of the faculty of the university, was given charge in 1813. His successful work attracted the attention of the Russian government, and soon the observatory was furnished with such instruments and pecuniary means as to raise it to the rank of a first class establishment, where Struve, almost single-handed, produced results of a very high standard. Attracted by Struve's work, the emperor Nicholas in 1834 resolved to erect a central observatory for the empire of Russia, and largely to Struve's design an observatory was completed in 1839 at Pulkovo near St. Petersburg, which was considered to be the finest and best equipped of the time. Another observatory of the first half of the 19th century, though not on the magnificent scale of Pulkovo, but associated with the name of a distinguished astronomer, was that of Königsberg, established by the king of Prussia in 1813 and put in the charge of F. W. Bessel, who had already made a reputation at the observatory at Lilienthal. The observatory at Altona near Hamburg, completed in 1823, was made famous because of its association with Heinrich Christian Schumacher, to whom is ascribed the encouragement given to astronomy by the Danish government. In 1874 this observatory was transferred to Kiel, which had then become the chief German naval station, and formed the international central bureau for distribution of astronomical information until World War I, when this useful work was transferred to Copenhagen.

The Royal observatory at Berlin had its origin in the year 1705. It was with the nine-inch refractor of this observatory that the planet Neptune was first seen. The establishment of an observatory at the University of Bonn was decided on by the king of Prussia in 1836, and Friedrich Wilhelm Argelander, who had been director of the Abo observatory, Finland, transferred to Helsingfors in 1832, was chosen as director. Although the instruments of this observatory were not large, stupendous work in star cataloguing, its principal branch of activity, was carried out by Argelander and his successors. The University of Strasbourg has an observatory attached to it, completed by the German government in 1881, consisting of three magnificent buildings placed in a large open garden. Its largest telescope, the great equatorial, a refractor with object glass of 20-in. aperture, is said to have been the largest in Germany at the time of its erection. The University observatory, Vienna, built on a new site in the years 1874–80 to replace one that dated from the middle of the 18th century, is a large structure standing in grounds of 14 ac. in extent, with an imposing façade and surmounted by four domes designed on the model of the Berlin observatory. Basel (1874), Bordeaux (1880), Breslau (1790), Budapest (1806), Cracow (1791), Kazan and Leipzig (1790, remodeled in 1861) are other universities of Europe that have observatories attached to them. At Heidelberg (Königstuhl), a private observatory founded by Max Wolf in 1877 was merged with Grand Ducal institute established in 1898, which combined two sections—one an astrometric observatory that had existed previously at Schwetzingen, Mannheim and Karlsruhe since 1764, and an astrophysical observatory under the direction of Wolf.

Among the notable observatories in northern Europe established before 1800 but greatly expanded in later years is the Stockholm observatory, founded in 1748. It is equipped with a large double equatorial telescope, a 40-in. reflecting telescope and many modern auxiliary instruments. Also notable are the observatory of the University of Uppsala, founded in 1730, the Royal observatory of Lund, first established in 1750, and the University observatory of Copenhagen, originally built about 1640 on the summit of the famous "round tower."

Before World War I there were ten French national observatories under the control of a consultative committee that reported annually to the government. The Paris observatory of the 17th century has been mentioned. Some that were resuscitated or created in the ten years after the war of 1870–71 have interesting histories. An observatory at Marseilles, founded by the order of Jesuits in 1702, was taken over in 1763, after the expulsion of the order, as the Royal Naval observatory and was made famous by Jean Louis Pons, Joseph Bernard, Adolphe Gambart [illegible] and Jean Chacornac. A new observatory was [illegible] which the older one was incorporated, and the names Stephen Jerome Coggia and Alphonse Louis N[illegible] recall many discoveries of minor planets and comets [illegible] instruments. The observatory at Toulouse had a [illegible] early as 1718, but the existing establishment dates from [illegible] when it was erected and supplied with excellent instruments at public expense, but with an inadequate staff, so that it was [illegible] for many years solely to meteors and meteorology.

The observatory at Bordeaux, together with those at Toulouse and Algiers, has taken a share in the international work of charting the heavens by photography. The Algiers [illegible] is an imposing group of buildings set up on a [illegible] near Algiers. The observatory at Nice was bequeathed by its founder to the University of Paris in 18[illegible], and later became a national institution. Other observatories were located at [illegible]souris, Besançon and Lyons. The last of ten is [illegible] observatory at Meudon near Versailles. For many [illegible] been pre-eminent in solar physics. It also has the largest [illegible]ing telescope in Europe, of 33-in. aperture, which was [illegible]sively for study of the planet Mars.

U.S. Observatories.—The first U.S. observatory is [illegible] been erected at the University of North Carolina [illegible] in 1831–32. It was destroyed by fire in 18[illegible]. [illegible] servatories were started at Williams college, Williamstown, [illegible] in 1836, at Hudson, O., 1836–37, and [illegible] the Nat[illegible] at Washington, D.C., which was actually established [illegible] J. M. Gilliss of the U.S. navy in 1843–44. The [illegible] encouraged and in many cases observatories were [illegible] lective financial help. By the efforts of O. M. Mitchel [illegible] raised for shares in a public company to build [illegible] Cincinnati, O. The first meeting of stockholders [illegible] May 23, 1842, and an object glass 11 in. in diameter [illegible] quite large for that epoch, was procured [illegible] Litchfield observatory of Hamilton college, Clinton, N.[illegible] founded by public subscription in 18[illegible]. An observatory [illegible] to the University of Missouri, Columbia, in 185[illegible] improved by a gift from S. S. Laws. In 1856 the Dudley [illegible]tory, Union college, Albany, N.Y., was established [illegible] local citizens and was named for the largest donor, Mrs. [illegible] Dudley. The Allegheny observatory of the University [illegible]burgh, Pa., founded in 1860, was completed [illegible] the liberality of W. Shand. The Dearborn observatory [illegible] University of Chicago was built in 1863, but was [illegible] western university, Evanston, Ill., in 1887. The [illegible]servatory attached to Princeton university [illegible] in 1866. The Leander McCormick observatory of the [illegible] of Virginia, Charlottesville (1885), the Washburn [illegible] the University of Wisconsin, Madison (1878), the [illegible] Michigan observatory, Ann Arbor (1854), and [illegible] observatories are used both for purposes of education [illegible] astronomical research.

The U.S. Naval observatory at Washington, D.C., is [illegible] akin to Greenwich, since it is a [illegible] for the purposes of the navy. Chronometers are [illegible] tested, and the staple astronomical work has been [illegible] star catalogues and astronomical calculations.

One of the most famous of the observatories [illegible] was that of Harvard college, the origin [illegible] Cranch Bond, a member of a Cornish family [illegible] 1786 and settled in Portland, Me., where he was [illegible] Bond had great aptitude for scientific research [illegible]omy, and when, in 1837, it was decided to [illegible] for Harvard, he, though engaged in a profitable [illegible] business, accepted the invitation to take charge [illegible] attached to the office until 1846. The original Harvard [illegible]tory (Dana house, 1839), and the new observatory [illegible] established by public subscription. Under the dir[illegible] Pickering, the work of this observatory was [illegible] and spectroscopic. Harvard had no telescope [illegible] new observatory was furnished with a 15-in. equatorial

of the two largest made up to then. Later a photographic [illegible] of 24-in. aperture was added, the gift of Miss Catherine [illegible]. Harvard had a branch observatory in Arequipa, Peru, at [illegible] tion in the Andes, built and largely supported by a sum [illegible] for the purpose by Uriah Boyden, but this was in 1928 transferred to South Africa.

Yale university has an observatory, founded in 1882, which is [illegible] for its work on the determination of stellar parallaxes and [illegible] astronomy. The private observatory of Percival Lowell of Flagstaff, Ariz., has attracted attention because of the [illegible] ons of the surfaces of the planets made there, for which it was founded in 1894. The outermost planet, Pluto, was discovered there in 1930.

In South America, there had been an observatory at Buenos Aires, Arg., in 1822, whose period of activity was short, so that the National observatory at Santiago, Chile, may be regarded as the first permanently founded (1856) on the continent. The National observatory of the Argentine republic, established at Córdoba, [illegible] did good service in cataloguing the stars of the [illegible] hemisphere. It acquired a 60-in. reflecting telescope. The other major South American observatory, also in Argentina, was founded at La Plata in 1882.

The last quarter of the 19th century may be said to have seen the beginning of the era of the large telescope, though the large [illegible] of Parsonstown (6 ft.) and Melbourne (4 ft.) were earlier. [illegible] refractor at Washington, D.C., dates from [illegible], but [illegible] years later a telescope was made on a considerably larger [illegible] through the beneficence of James Lick. The telescope, with [illegible] 36 in. in diameter, is set up in an observatory on [illegible] Hamilton, Calif. In 1895 a reflector with a silver-on-glass [illegible] diameter that had been used by A. A. Common [illegible] by Edward Crossley of Halifax, Eng., and with these instruments and others, the Lick observatory, attached to the [illegible] of California, Berkeley, has done much photographic [illegible] observation. The size of the larger instrument [illegible] years later when, in Oct. [illegible], through the [illegible] George Ellery Hale, C. T. Yerkes presented a refracting [illegible] object glass of 40-in. aperture, together with a large [illegible] building containing it on the shore of Lake Geneva [illegible] The University of Chicago. From that date the Yerkes [illegible] has been pre-eminent in spectroscopy and astro[illegible] and has contributed much to our knowledge of double [illegible] satellites and comets.

20TH CENTURY

Modern Observatories.—The names and locations of active [illegible] observatories are printed yearly in the *American [illegible] and Nautical Almanac*. The progress of astronomy [illegible] changes in the aim of celestial research, have brought [illegible] in the characteristics of observatories. At the beginning [illegible] century the equipment of an observatory may be said [illegible] consisted of a meridian instrument with an equatorial as [illegible]; in the latter half of the 20th century the latter was the more important instrument, usually supplemented by [illegible] equipment, spectrographs and other instruments. [illegible] determination of the positions of [illegible], the [illegible], however, continues as standard work at Greenwich, Washington, D.C., and other national observatories, since [illegible] are necessary for the maintenance of fundamental [illegible]

[illegible] trends of the 20th century have been the making of [illegible], in some cases of [illegible] for special re[illegible] and the establishment of branches [illegible] [illegible] considered more suitable [illegible] than [illegible]. One important example is the observatory [illegible] 1904–05 on Mt. Wilson, 5,700 ft. above sea level, near [illegible] Calif. This observatory was established by George [illegible] as a department of the Carnegie institution of Washington. The telescopes are on Mt. Wilson where the observations are made. The library, laboratory, [illegible] offices [illegible] are in the valley below. For solar observations [illegible] telescopes—one 150 ft. high and one 60 ft. high—are used. A revolving mirror, known as a coelostat, and a fixed mirror on the top of the tower reflect the sun's light through an object glass downward. In each of the towers the spectrograph is mounted in a well under the tower, the depth of the well being one-half the height of the tower. With these instruments a continuous photographic record of the sun's surface is maintained day after day. This observatory has two large reflecting telescopes, one having a mirror 60 in. in diameter and one with a mirror 100 in. in diameter. The 100-in. telescope has been used with an interferometer for measuring the diameters of stars and has served for a great variety of researches. Optical arrangements for both telescopes provide for the use of different focal lengths in the Newtonian, Cassegrain or coudé form, and include powerful spectrographs. Additional instruments are a horizontal solar telescope, a 50-ft. interferometer, and 10-in. and 5-in. photographic refractors.

Another large U.S. observatory is the McDonald observatory of the University of Texas, Austin. Established in 1939 on Mt. Locke, 6,828 ft. above sea level, in the Davis mountains of Texas, it was organized under a co-operative agreement between two universities, the University of Texas building the observatory and the University of Chicago providing the scientific staff. The mirror is 82 in. in diameter and is mounted in a telescope of the cross-axis type, with the tube situated on the side of the polar axis. There is a prime-focus camera used for direct photography at the focus of the 82-in. mirror, without other reflections such as are common in a Newtonian telescope. A second camera provides for direct photography at the Cassegrain focus. Spectrographic equipment includes a slitless spectrograph for low-dispersion spectra, a spectrograph for use at the Cassegrain focus and a coudé focus spectrograph for high-dispersion spectra. The program at McDonald has been mainly spectrographic. The Perkins observatory was founded at Ohio Wesleyan university, Delaware, O., in 1924. It was equipped with a 69-in. reflecting telescope and was operated jointly with Ohio State university. In 1960 the instrument was moved to Flagstaff, Ariz.

Palomar Observatory.—This observatory was built by the California Institute of Technology to which the General Education board of the Rockefeller foundation made a grant in 1928 for the construction of a 200-in. reflecting telescope. Its operation is under a joint co-operative plan between the California institute and the Mt. Wilson observatory of the Carnegie institution. It is located at an elevation of [illegible] ft. on Palomar mountain, which is [illegible] from Mt. Wilson. The combined institutions are [illegible] termed Mt. Wilson and Palomar observatories. The dome and building for the great telescope were erected in [illegible]. The dome, which is 137 ft. high and of about the same diameter, is insulated throughout to protect the telescope from change of temperature when not in operation. The building which supports the dome has three floor levels on which are offices, photographic rooms, air-conditioning units, electrical switchboards and [illegible] and a large vacuum chamber for aluminizing the 200-in. mirror.

In the centre of the building, rising to the height of the third or operating floor, is the heavy structural steel framework which supports the two pedestals carrying the telescope. The frame or yoke in which the tube rests is rectangular in shape with tubular side members 10 ft. in diameter. A unique feature is the horseshoelike form of the north member of the yoke which permits the telescope to be turned northward as far as the north pole. The lower surface of this member is accurately [illegible] and serves as the north-bearing surface of the telescope mounting. The tube and frame, weighing a total of about 500 tons, are carried on a system of bearings employing high pressure oil pads which nearly eliminate friction and [illegible] ease of motion.

The tube, 22 ft. in diameter, is designed to avoid angular deflections at its ends and thus to reduce [illegible] effects of flexure. Uniform driving of the telescope is accomplished by a synchronous motor fed by current generated by a vibrating string standard and [illegible]

The disk for the 200-in. mirror is a single block of Pyrex glass cast by the Corning Glass works. It consists of a surface plate about [illegible] in. thick supported by a network of deep ribs. An opening 40 in. in diameter is cast in the centre of the disk. The fin-

ished mirror weighs about 16 tons. In the first grinding to spherical form in 1938, more than five tons of glass were removed. The slow and difficult work of parabolizing the surface was interrupted by World War II. The mirror was completed and installed in 1948. This instrument, named the Hale telescope, is used in two forms: primary focus with focal length of 55 ft.; and coudé combination, equivalent focal length 500 ft. In addition to the Hale telescope, the Palomar observatory put in operation a 48-in. telescope of the Schmidt type, working at ratio F/2.5 and utilizing a 72-in. concave spherical mirror. Smaller instruments include an 18-in. Schmidt telescope and a 20-in. reflector.

Other Observatories.—Canada has a 72-in. reflector at the Dominion Astrophysical observatory established in 1916 at Victoria, B.C., as a branch of the Dominion observatory at Ottawa, which itself had grown from a modest establishment used by the survey department. The telescope has been devoted chiefly to astrophysical work. In 1935 this size was surpassed by the 74-in. Pyrex mirror at the David Dunlap observatory of the University of Toronto. In spite of a rigorous climate this reflector has performed admirably.

In the eastern hemisphere an observatory specially adapted for solar investigation was established in Canberra, Austr., by the federal government of Australia as a link in the chain of such institutions around the world, of which the Solar Physics observatory at Cambridge, Eng. (moved from South Kensington in 1911), and that at Kodaikanal, southern India (which was established as a government institution about 1900 and replaced, in part, the observatory of the government of Madras founded in 1792), are others. The D. O. Mills expedition from Lick observatory established a 37-in. reflecting telescope at Santiago, Chile, in 1903 for spectroscopic study of southern stars. This station was discontinued in 1929. The former Harvard southern station, located near Bloemfontein, S.Af., is known as the Boyden observatory and is operated jointly by six northern institutions: Armagh, Dunsink, Hamburg, Harvard, Stockholm and Uccle. It has a 32-in. reflecting telescope of the Baker-Schmidt type and a 60-in. reflector, one of two in the southern hemisphere. The other is at the National observatory, Córdoba, Arg. Yale university set up a southern branch in 1925 at Johannesburg, S.Af., where a 26-in. photographic refractor was used for measuring stellar parallaxes. It was transferred in 1955 to Mt. Stromlo, Austr., to be used jointly with Columbia university. The University of Michigan established a branch at Bloemfontein in 1927, primarily for the study of double stars. The principal instrument is a 27-in. refractor. From 1954 to 1958 it was used by the Lowell observatory for the study of Mars. The observatory of the Republic of South Africa at Johannesburg has a 26-in. refractor. The largest instrument in the southern hemisphere is the 74-in. reflector of the Radcliffe observatory at Pretoria, S.Af., in operation from 1948. A telescope of equal dimensions was placed in operation in 1955 at the Mt. Stromlo observatory, near Canberra, Austr. In 1942 the National Astrophysical observatory in Tonantzintla, Mex., was dedicated. Its principal instrument is a 22-in. reflecting telescope of the Schmidt type.

Some notable additions were made to the observatories of Europe in the first quarter of the 20th century. Since the climate of Pulkovo, U.S.S.R., was considered to be unfavourable for observation, three branch establishments were founded through the influence of Oscar Backlund, its director: at Odessa (1898) and Nikolayev (1912), for astronomy of position, and at Simeis in the Crimea for astrophysical work. Backlund died in 1916, but in his last years the Russian government sanctioned the expenditure of large sums of money for equipment for the new observatories, and during 1926 a reflecting telescope with a mirror 1 m. in diameter and a photographic refractor with an objective of 41-in. aperture were supplied to the Simeis observatory by a British firm. The observatory of Geneva, Switz., which is of very early foundation (1772), possesses a reflector with mirror 1 m. in diameter, the gift of a member of the staff. The Astrophysical observatory at Potsdam, Ger., which dates from 1878, was enriched by the addition of a 32-in. photographic refractor in 1899, and in 1921 a tower telescope was erected on its grounds as a tribute to Albert Einstein.

A tower telescope was set up at the Royal Astrophysical observatory at Arcetri (Florence) designed for solar observation. A new object glass was supplied to this institution in 1925 by the German government, by way of war reparation. The Italian Royal observatory at Milan, with which the name of Giovanni Virginio Schiaparelli is associated, was removed and improved by the help of resources similarly supplied. The observatory at Bergedorf, Ger., 5 mi. S. of Hamburg, developed out of a local school of navigation in the city of Hamburg. Contributions by the citizens for instruments enabled the school to grow into the Hamburg municipal observatory. In 1906 it was transferred to Bergedorf and the new establishment was completed in 1909. In addition to instruments used for time service, there is a reflector, 1 m. in aperture, and a large twin telescope for photography. This observatory has been especially successful in the discovery of comets.

In Great Britain, transfer of the Royal Greenwich observatory to Herstmonceux castle in Sussex began after World War II and was completed in 1958. The original site at Greenwich, now surrounded by the city of London, is a park, but the main building designed by Wren has been preserved. The Norman Lockyer observatory, originally the Hill observatory, is on the top of Salcombe hill near Sidmouth, Devon. It contains instruments from the observatory of Frank McClean at Rusthall, near Tunbridge Wells, and others used at the government establishment formerly at South Kensington. The spectroscopic classification of stars and the determination of their parallaxes from examination of their spectra were covered in its program.

In 1914 at the Allegheny observatory, Pittsburgh, a 30-in. long-focus photographic refractor was completed. This instrument, at mid-20th century still the largest of its kind, has been used almost wholly for measurement of stellar parallaxes. A 37-in. reflecting telescope was installed at the University of Michigan in 1911. At the Lick observatory, a 120-in. reflecting telescope was completed in 1959. Schmidt-type telescopes of 24-in. aperture were placed in operation at Warner and Swasey observatory, Case Institute of Technology, Cleveland, O. (1941), and at the University of Michigan (1950). The McMath-Hulbert observatory, also a part of the latter institution, has been devoted primarily to the study of the sun. It has two tower telescopes (40-ft. and 70-ft.), the larger equipped with a vacuum spectrograph.

With funds granted by the National Science foundation, the Association of Universities for Research in Astronomy (A.U.R.A. established the Kitt Peak National observatory in Arizona. The principal instruments are an 84-in. reflector and a giant solar telescope, in which the sun's light is reflected down an inclined 300-ft tube and tunnel. In 1964 A.U.R.A. began construction on the Cerro Tololo Inter-American observatory in Chile.

The Haute Provence observatory at St. Michel in southern France has a 77-in. reflector, completed in 1958. An observatory of an unusual type was established in France in 1930 by Bernard Ferdinand Lyot of Meudon, who set up his apparatus on the Pic du Midi in the Pyrenees mountains at an elevation of 9,300 ft. There, with a special refracting telescope and optical system of his own design, he obtained remarkable results in the photography of the solar corona, prominences and spectrum of the corona in full sunlight. Using a cinematograph, he was able to record the movements of the prominences by means of motion pictures. A station of the Harvard observatory using equipment of a type similar to that of Lyot was established at Climax, Colo., in 1940. This became the high-altitude station of the University of Colorado. A still more elaborate solar observatory of similar type was established by the U.S. air force in 1951 at Sacramento Peak, N.M.

At the Karl Schwarzschild observatory near Jena, East Germany, a 79-in. reflector was completed in 1960.

In 1964 plans for two new major observatories were announced. The European Southern observatory is a co-operative undertaking by astronomers of Belgium, France, the Netherlands, Sweden and West Germany. A site was selected in Chile, and plans called for several large instruments, including a 140-in. reflector. The other observatory was to be established in Canada by the Canadian government, and a 150-in. reflector was planned.

Several special observing stations for tracking artificial satel-

lites were established at widely separated locations by the Smithsonian Astrophysical observatory, with headquarters at Cambridge, Mass. Operation of these stations began during the International Geophysical Year (*q.v.*), 1957–58.

In World War II many observatories in continental Europe and some in England were damaged. Two great Russian observatories, Pulkovo and Simeis, were almost totally destroyed. Restoration of the Pulkovo observatory was completed in 1954. New and modern equipment has been added to the larger observatories in the U.S.S.R. since World War II. The Crimean Astrophysical observatory has a 50-in. reflecting telescope at Simeis, and a 104-in. reflector was completed in 1960 at Nauchny in the Crimea. The Sternberg Astronomical institute at Moscow and the Byurakan observatory in Armenia are the other major institutions. Noteworthy solar installations are operated at the universities of Leningrad, Lvov and Kharkov.

Radio Observatories.—Radio waves from space were first recorded in 1931 by Karl Jansky of Bell Telephone laboratories, using a directional antenna. Additional pioneering work was done a few years later by Grote Reber, who employed a 30-ft. parabolic reflector of his own construction, at Wheaton, Ill. These installations, though only temporary, deserve recognition as the first radio observatories. Immediately after World War II, great activity in astronomical radio observations began simultaneously in Australia and in England. Most of this early work was done with instruments adapted from the equipment of installations for radar experimentation. After the first successes, design and construction of new "radio telescopes" specifically for astronomical research were begun. This development has proceeded with extraordinary rapidity and recalls the burgeoning of astronomical spectroscopy in the later years of the 19th century.

A radio observatory departs considerably from the traditional plan of an astronomical institution. Instead of a main large building surmounted by domes housing the instruments, the radio observatory consists primarily of the bulky instruments themselves, sometimes spread over many acres, in addition to a comparatively small building to house the recording equipment and a workshop. The offices of the observatory may be located a number of miles from the observing station. Because a radio observatory is not hampered by cloudy weather, continuous automatic recording is possible. However, electrical disturbances can be a serious handicap, and the site for a radio observatory must be chosen at a sufficient distance from industrial establishments.

The largest radio observatories were developed independently of already existing astronomical institutions. One of the foremost is the Radiophysics laboratory at Sydney, Austr., whose two "Mills cross" antenna arrays have dimensions of 1,500 and 3,500 ft. A steerable paraboloid 210 ft. in diameter was completed at Parkes, Austr., in 1963. At the Jodrell Bank experiment station of the University of Manchester, the largest fully steerable paraboloidal radio telescope, with a diameter of 250 ft., began operation in 1957. The Cavendish laboratory, Cambridge, Eng., operates an interferometer-type system of four large paraboloids. On the European continent, the most extensive installation is that of the Leiden university observatory, whose large paraboloids have been used to map the distribution of hydrogen in the structure of the Milky Way. Other large instruments are an 83-ft. paraboloid at Bonn university, West Germany, and one of 72-ft. diameter at Moscow, U.S.S.R.

In the United States, the Naval Research laboratory, Washington, D.C., completed a 50-ft. precision paraboloid in 1952, and an 84-ft. one in 1958. The Harvard observatory has one of 60-ft. diameter. In 1959 an 85-ft. paraboloid was completed at the University of Michigan. In the Owens valley, the California Institute of Technology has two 90-ft. paraboloids that can operate as an interferometer. The National Radio observatory at Greenbank, W. Va., has fully steerable paraboloids 85 ft. and 140 ft. in diameter and a tiltable 300-ft. paraboloid that operates in the meridian. Fixed paraboloids have attained still larger dimensions. Ohio State university completed one measuring 360 ft. by 70 ft. in 1962, and one 400 ft. by 600 ft. began operation at the University of Illinois in 1963. In 1964 Cornell university completed a fixed spherical reflector with movable receiver at the Arecibo Ionospheric observatory in Puerto Rico. *See* also TELESCOPE, RADIO.

Observations from Balloons, Rockets and Space Probes.—Observations with instruments carried in rockets above the atmosphere became commonplace during the decade following World War II. Beginning in 1957, the Princeton university observatory made observations from unmanned balloons at 80,000 ft. and above, commanded by radio from the ground.

The successful launchings of the first artificial satellites by the Soviet Union and the United States were quickly followed by astronomical observations from space vehicles. Among the most noteworthy were the photography of the moon's far side by the U.S.S.R.'s Lunik 3 (Oct. 1959), observation of Venus by the U.S. probe Mariner 2 (Dec. 1962), and close-in photography of the moon by the U.S. Ranger 7 (1964) and Rangers 8 and 9 (1965). In July 1965 the U.S. Mariner 4 photographed Mars from about 10,000 mi. out. *See* also SPACE EXPLORATION.

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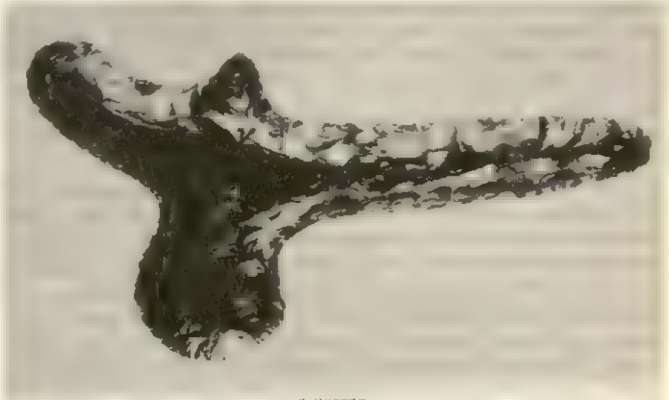
(H. P. H.; W. S. As.; D. B. MN.)

OBSERVER CORPS, an organization of civilian volunteers who man observation posts and report, usually by telephone, to military authorities on the movement of aircraft that they observe. The Royal Observer corps played a major role in the defense of Britain during World War II. During the 1950s the corps took on the additional duty of measuring and reporting radioactivity in the event of a nuclear attack. The U.S. Ground Observer corps, organized during World War II, was discontinued in Jan. 1959 because of the rapid development of electronic means of detection. *See* AIR POWER.

OBSIDIAN, a natural glass of volcanic origin, usually black and of a chemical composition equivalent to granite. Obsidian, which has a vitreous lustre, was used by American Indians and many other primitive peoples for weapons, implements, tools and ornaments. Due to its fracture, like glass, conchoidal, with smooth curved surfaces and sharp edges, the sharpest stone artifacts were fashioned from obsidian. Centuries ago the Mayas used obsidian for mirrors. Obsidian in attractive and variegated colours is used as a semiprecious stone. It forms by rapid cooling of viscous lava, has a vitreous lustre and is slightly harder than window glass, or about 5.5 on the Mohs' scale (*q.v.*). The typically jet black colour is due to abundant closely spaced crystallites (microscopic embryonic crystal growths). So numerous are these tiny inclusions that the glass is opaque except on thin edges. Red and brown obsidian receives its colour from included iron oxide dust; whereas light gray shades may be due to abundant tiny gas bubbles or finely crystallized patches. Variegated types with banding or mottling in black and red or black and gray are common.

Most obsidian is associated with volcanic rocks and forms the upper portion of rhyolitic lava flows. Less abundantly it occurs



BY COURTESY OF CHICAGO NATURAL HISTORY MUSEUM

MONOLITHIC AX CHIPPED FROM OBSIDIAN FOUND IN BRITISH HONDURAS. MAYAN, LATE CLASSIC (A.D. 600–900)

as thin selvages of dikes and sills. Well known are the obsidians of Mt. Hekla in Iceland; the Lipari Islands, off Italy; and Obsidian cliff in Yellowstone National park, Wyo.

Composition and Characters.—Most obsidians are extremely rich in silica and are roughly compositional equivalents of granite and rhyolite (*qq.v.*). Others correspond to trachyte, dacite, andesite and latite. Glassy rocks equivalent to basalt are rare and go by the name tachylyte instead of obsidian. The composition of natural glass may be approximated from its index of refraction (*see* also MINERALOGY).

Average index values for volcanic glass are: rhyolitic—1.495; trachytic—1.505; dacitic and andesitic—1.515; and basaltic—1.57. Glassy rocks are roughly 6% lighter than their crystallized equivalents, and their densities increase with index of refraction. Average density values for volcanic glass are: rhyolitic—2.37; trachytic—2.45; dacitic and andesitic—2.50; and basaltic—2.77.

In addition to the crystallites, which are too small to show polarizing effects under the microscope, obsidian may carry abundant microlites (tiny polarizing crystals) many of which are large enough to be identified as feldspar. Both crystallites and microlites, however, are more magnificently and abundantly displayed in pitchstone (*q.v.*).

Some obsidians carry numerous large, well-formed crystals (phenocrysts) of quartz, alkali feldspar and plagioclase, many of which contain abundant inclusions of glass. Less common are phenocrysts of biotite, hornblende or augite. With increase in number of phenocrysts these porphyritic glasses pass into a glassy rock called vitrophyre.

Many obsidians contain spherical aggregates (spherulites) up to several inches across but generally a small fraction of an inch in diameter and composed of radially arranged needlelike crystals (*see* SPHERULITE). Some of these spherulites consist of concentric shells separated by annular (ring-shaped) interspaces. Such structures are known as stone bubbles or lithophysae.

Characteristic of many natural glasses is a streaked or swirly structure consisting of bands or trains of phenocrysts, microlites, crystallites or spherulites and believed to have formed by flowage of viscous lava. Some flow structures consist of alternating bands of different coloured obsidian. In others layers of bubble-free glass alternate with highly visicular glass (pumice, *q.v.*).

Obsidian is relatively poor in water, generally containing less than 1% by weight. This water represents only part of that contained in the original melt, most having escaped as steam when the lava poured out on the surface. A small chip of obsidian heated under a blowpipe will fuse readily and lose its water by volatilization. A second heating, however, will show the material to be highly infusible. This experiment demonstrates the fluxing action of water in rock melts. Under high pressure at depth rhyolitic lavas may contain up to 10% water which helps to keep them fluid even at a low temperature. Eruption to the surface, where pressure is low, permits rapid escape of this volatile water and increases the viscosity of the melt. Increased viscosity impedes crystallization and the lava solidifies as a glass.

Chemical composition controls in large part the formation of glassy rocks. Natural glasses have compositions close to quartz-alkali feldspar (*see* QUARTZ; FELDSPAR; SILICON: *The Silicates*). They may reach very low temperatures without crystallizing, but at these low temperatures their viscosity may be high. Forced solidification at this stage by sudden cooling and loss of volatiles will favour the formation of glass, because high viscosity inhibits crystallization.

Volcanic glass is unstable and tends to change spontaneously. This change (devitrification) involves the transformation from the glassy to the crystalline state and the material loses its vitreous character and takes on a stony appearance. Geologically ancient glasses are very rare and most glassy rocks are of Tertiary (early Cenozoic) age or younger. There is good reason to believe that glassy rocks were abundant in ancient geological time, but nearly all of these have since become devitrified. Devitrification commonly begins along cracks in the glass or around phenocrysts. It may spread outward until eventually the entire mass has been converted to a finely crystalline aggregate composed mostly of quartz, tridymite and alkali feldspar. If no glass remains, it may be difficult to demonstrate that a particular rock was ever glassy. The presence of spherulites, lithophysae and perlitic cracks (*see* PERLITE) is generally considered good evidence for the former existence of glass.

Closely related to obsidian are perlite, pitchstone and pumice. It is believed that under favourable conditions obsidian may be converted to perlite by adding water. Often in such cases the only remnants of the original obsidian are found in the cores of the glassy perlite beads. For chemical analyses of obsidian and related glassy rocks *see* PITCHSTONE. (C. A. CN.)

OBSTETRICS is the branch of medicine that deals with human reproduction. In its broadest sense it encompasses the entire life cycle, for the creation of a new individual begins long before conception and life is a timeless process that continues in an unbroken line from parent to child.

Ideally speaking, the obstetrician's interest in the future mother should begin prior to puberty, continue through adolescence and maturity and culminate in pregnancy, delivery and the postpartum, or recovery, period. Modern medical practice, with its increasing emphasis on the prevention of illness, should include periodic examinations of the mother throughout her reproductive period and the postmenopausal years. The trend today, particularly among specialists, is to combine obstetrics with gynecology, which concerns itself with the prevention and treatment of diseases of the reproductive organs.

Maternity care is the major clinical activity of the obstetrician. The phenomenal reduction in the hazards of birth for mothers and babies has focused increasing attention on the emotional aspects of childbearing. Thus, education for parenthood prior to and during pregnancy has assumed great importance. The usual prenatal medical supervision designed to keep the mother in good health, to prevent pregnancy complications and to safeguard the normal growth and development of the baby is now supplemented by discussions, lectures and exercise programs. Knowledge concerning the birth process will dispel fear; relaxation and emotional support during labour and delivery and favourable body postures will decrease tension and discomfort, thereby reducing the need for anesthetics and the likelihood of complications. Thus, the normalcy of human reproduction is emphasized.

The modern education of every young physician includes instruction in the biological sciences and human reproduction as well as clinical experience in the management of normal pregnancy and delivery. He must learn to recognize incipient complications and be able to institute corrective measures.

In the U.S., the physician who wishes to prepare himself for the specialty of obstetrics must undertake formal postgraduate training in an approved institution for at least three years. The completion of this program is followed by oral and written examinations and if he passes them he is certified by the Board of Obstetrics and Gynecology as a specialist.

See also CHILDBIRTH; MATERNAL AND CHILD HEALTH; MIDWIFERY; and references under "Obstetrics" in the Index. (M. E. DS.)

OBWALDEN, a demicanton which, with Nidwalden, forms the canton of Unterwalden (*q.v.*) in central Switzerland. The population (1960) 23,135, is mostly German-speaking and Catholic. The capital is Sarnen (6,554). Unterwalden was one of the three cantons that founded the Swiss confederation in 1291. Obwalden includes the small lakes of Sarnen and Lungern and the ski resorts of Melchsee-Frutt and Engelberg. At Engelberg are the famous Benedictine monastery and church, founded about 1120.

OCARINA, a wind instrument, originated in Italy toward the end of the 19th century as a musical development from the traditional Italian carnival whistles of earthenware, often in the form of a bird and sounding only one or two notes. The ocarina (meaning "little goose") is made of earthenware or metal and is sounded on the flageolet principle.

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ITALIAN OCARINA

It has eight finger holes and two thumb holes and sometimes a tuning plunger at one end. The instrument won professional popularity in the 1930s, when ocarinas or "sweet potatoes" of different sizes were played in harmony in U.S. popular music. It is still manufactured as a toy instrument. *See* also WIND INSTRUMENTS: *Flutes.* (A. C. BA.)

O'CAROLAN (CAROLAN), **TURLOGH** (TERENCE) (1670–1738), one of the last of the Irish harper-composers and the only one whose songs survive in both words and music in any significant number, was born near Nobber, Co. Meath. About 1684 the family moved to Ballyfarnon, Co. Roscommon, where O'Carolan's father was probably employed in the iron foundry of Henry MacDermott Roe. MacDermott Roe's wife was responsible for O'Carolan's early education. When, at the age of 18, he became blind from smallpox she apprenticed him to a harper and maintained him for three years. After he completed his apprenticeship, she provided him with money, a guide and a horse. As an itinerant harper he traveled widely in Ireland. He died at Alderford, Co. Roscommon, on March 25, 1738. O'Carolan enjoyed a considerable reputation as a song writer and composer of extemporary verse, though as a performer he was never regarded as a master. One of his melodies was used by Thomas Moore for his song "Oh! the sight entrancing." A selection of O'Carolan's verse in the original Irish was published in Tomás Ó Máille's *Amhráin Chearbhalláin. The Poems of Carolan* (1916).

See D. O'Sullivan, *Carolan*, 2 vol. (1958).

O'CASEY, SEAN (1880–1964), Irish playwright, whose dramas of the Dublin slums contributed to the later stages of the Irish literary renaissance, was born in Dublin on March 30, 1880. His early years were spent in great poverty and he worked as a casual labourer when not unemployed. The Dublin general strike of 1913 influenced his development. In 1923 *The Shadow of a Gunman* was produced at the Abbey theatre (*q.v.*), followed in 1924 by *Juno and the Paycock* and in 1926 by *The Plough and the Stars*. These three are by common consent his finest plays. The last-named was bitterly attacked in Ireland and in the year it was staged he left the country for good. His exile (in England) was confirmed two years later by the Abbey's rejection of *The Silver Tassie*, produced in London in 1929.

Subsequent plays include *Within the Gates* (1933), *The Star Turns Red* (1940), *Red Roses for Me* (1942), *Oak Leaves and Lavender* (1946), all treating social themes in a more expressionist manner than his earlier work; the extravaganza *Cockadoodle Dandy* (1949); and two satirical comedies about clericalism in Ireland, *The Bishop's Bonfire* (1955) and *The Drums of Father Ned* (1958). He also wrote six tumultuous volumes of autobiography: *I Knock at the Door* (1939), *Pictures in the Hallway* (1942), *Drums Under the Windows* (1945), *Inishfallen Fare Thee Well* (1949), *Rose and Crown* (1952) and *Sunset and Evening Star* (1954). He died on Sept. 18, 1964, at Torquay, Eng.

O'Casey's later plays are in general too partisan, too didactic and too overtly "poetic" to be entirely successful, though many contain scenes of great beauty and comic power. It is on his early plays, with their tragic-comic picture of Dublin tenement life during the "troubles," their wonderful range of comic characters and their impartial celebration of all the contradictory elements of the human spirit, that his reputation principally rests.

See D. Krause, *Sean O'Casey: the Man and His Work* (1960); S. Cowasjee, *Sean O'Casey* (1963). (A. CR.)

OCCASIONALISM, in the philosophy of the Cartesians (*q.v.*), is the argument that God is the sole efficient cause, created things being merely "occasional" causes. Beginning as an answer to the problem of the union between soul and body (*see* BODY AND MIND; DUALISM), it expands this answer to cover the relationship between all finite substances. In the early polemics on occasionalism reference was made to passages in the works of Philo Judaeus, Pierre d'Ailly and Gabriel Biel which Francisco Suárez had criticized and to passages in certain Arabic writings which St. Thomas Aquinas had criticized; but these occur in contexts very different from that of the Cartesian problem.

René Descartes (*q.v.*) not only takes a radically dualistic view of soul and body but also holds the mechanistic concept of matter as an essentially inert extensity or extension, in which movement is kept in being by God, its original and general cause (*Principia*, ii, 37–38; letter to the marquess of Newcastle, Oct. 1645). Yet Descartes maintains the notion of the "concourse" of secondary causes; and if he describes bodily stimuli as "giving occasion" to the soul to experience certain feelings (*L'Homme*), he still affirms that there is a "substantial union" with reciprocal action between soul and body. Only a few Cartesians, however, namely those with a tendency to empiricism, Pierre Sylvain Regis and Robert Desgabets, claim that we have experience of this union, the body's instrumental causality not precluding a real dependence of the body on the soul. The other followers of Descartes go back to the principle of all activity in order to explain the nexus between the two heterogeneous terms.

For Johann Clauberg (*q.v.*) the mutual and reciprocal conjunction between one component's activity and the other's passivity takes effect from God's will, which makes them succeed one another. Arnold Geulincx (*q.v.*) insists particularly on the argument *Quod nescis quomodo fiat, non facis* ("You cannot be said to do anything unless you know how it comes to be done") and criticizes the alleged consciousness of effort: my body, the "occasion" for me to perceive other bodies, is an instrument intermediary between the sole efficient Cause and my thought. Louis de La Forge (*Traité de l'esprit de l'homme*, 1666) is the first to use the term "occasional cause" for the impression of the body in the production of ideas by the soul, which is the principal and effective cause: he thus keeps the traditional notion of the soul's "power" after having extended the notion of inertia to the mind, but goes back to God to explain the transition from one idea to another (in his conversations of 1658 as recorded in Jacques Gousset's posthumous *Causarum primae et secundarum realis operatio*, 1716). In 1666, making the point that the will to move the body does not act "directly or by itself," La Forge speaks of "reciprocal dependence" between soul and body. Géraud de Cordemoy carries occasionalism even further: God is the universal cause, and when one body seems to move another we can only register a succession of movements, the meeting of the bodies being an occasion for the Mind which is moving the first body to move the second. Thus "God does all that is real in our actions, without depriving us of freedom." Thenceforward occasionalism becomes the distinguishing mark of the Cartesians. One of their antagonists, the Jesuit Antoine Rochon (*Lettre d'un philosophe à un Cartésien*, 1672), protests that their argument about bodily motion could logically be applied to make God the author of all the motions of our minds.

It was Nicolas Malebranche (*q.v.*) who, by systematizing its various elements, established occasionalism as a "Christian philosophy" in opposition to the pagan view of nature and secondary causes as so many minor divinities. Developing his precursors' themes (the absence of any intelligible relationship between soul and body; criticism of the illusory consciousness of direct action on bodies; and the reduction of the impact of two bodies to their successive positions), he points out that we have no clear idea of the soul and no common measure for will and ideas, but that we have clear knowledge of an extensity void of all internal dynamism. Furthermore, God's action on created things must obviously be both necessary (continuous creation) and sufficient, so that any other efficient cause is superfluous. Occasional causes, meanwhile, can be shown to determine the application of "general laws," those of nature and those of grace alike. Under those of nature he includes not only the communication of movement, but also the rational union of the soul to God or the vision of ideas in God, with its occasional cause in the act of attention (our attention also determines the general movement whereby God inclines us toward the good, so that our freewill is preserved). For general laws of grace, examples are the occasional causality of angels in the miracles of the Old Testament and the particular manifestations of the will of Jesus Christ, occasional cause of the distribution of graces, in the New.

Johann Christoph Sturm (1635–1703), professor of mathematics at Altdorf, upheld occasionalism in his works *De naturae agentis idolo* (1692) and *De natura sibi incassum vindicata* (1698) against criticism by the physician Günther Christoph Schelham-

mer. G. W. Leibniz (*q.v.*) broadened this field of criticism by propounding a dynamism of his own: notwithstanding some external resemblances (for instance the denial of reciprocal influence between created substances), his "pre-established harmony" is quite different from occasionalism, which, despite Malebranche's specification of general laws, he accuses of postulating a "perpetual miracle." Likewise there is no way of reconciling occasionalism with the parallelism of the "attributes" according to Spinoza (*q.v.*), who, instead of making action in the body correspond to passion in the soul, or *vice versa*, holds that the same transition from passion to action comes about in thought and in extension singly, thanks to the internal dynamism of the *conatus* and to the immanent unity of Substance as a whole, which takes the place of a transcendent First Cause.

Detached from their theological context, the Cartesians' arguments for reducing the causality of created things to a succession of "occasions" paved the way for the empiricist approach of David Hume. *See* CAUSALITY.

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OCCUPATIONAL THERAPY has evolved from the recognition that work helps to restore the mentally and physically ill. It was observed that many patients at mental hospitals benefited from working in the establishments' utility services. In the latter part of the 19th and early years of the 20th centuries the first experiments were made in the use of crafts as a means of occupying the inmates of mental hospitals. This gave rise to the idea of workshops and in 1908 the first occupational therapy workshop was opened in Chicago.

General or diversional therapy is the prescribed use of activities, especially in the treatment of patients where boredom and depression are concomitant with a prolonged period in bed or confinement in hospital or at home. Often it can aid patients to realize and to discover latent abilities. Light crafts such as painting, needlework and weaving are the usual skills employed and the development of a high craft standard contributes to the satisfaction and well-being of the patient.

Specific therapy is that prescribed by the physician or surgeon for a specific remedial purpose, the scope being wide and varied. Physically the prescription is usually aimed at the increase of joint motion, strength of muscle or development of co-ordinative motor skills and work tolerance. These may also be required for the psychiatric patient, with the addition of reorientation and alleviation of stress, anxiety states and hysterical physical symptoms. Heavier crafts are used to obtain specific movements.

History.—World War I brought opportunity for development and introduced the need for work in the field of physical illness. Initially the prime consideration was to relieve the monotony of wounded men confined to bed for long periods, but it was soon observed that certain activities not only created a better morale but also increased the mobility of injured limbs, and it became the custom to order craft activities as part of the treatment.

Until this time, supervision and instruction were given by craftsmen and craft teachers without any medical knowledge; but it was clear that in order to expand the work and meet the new need personnel would have to be specially trained. The first schools of occupational therapy were started in Philadelphia and Boston, although in the Netherlands and the United Kingdom staff members were being trained in hospitals and curative workshops.

Elizabeth Casson set up a workshop in Bristol, Eng., sent one of her staff members to the U.S. to train and then began training students at Dorset House in Bristol. In London the Occupational Therapy Centre and Training school was inaugurated and these two centres continued until World War II, when Dorset House was evacuated to Bromsgrove eventually moving to Oxford, where it remained. The London Occupational Therapy centre had to suspend its activities, because of bombing, for a period, after which time it resumed in new premises.

Between the wars the scientific application of craft activities for the treatment of both mental and physical conditions developed simultaneously, but with the advent of war and the resultant casualties, among both sevicemen and civilians, the demand in the U.K. for therapists trained in the physical field outran the training capacities of the two schools. An emergency training scheme was inaugurated that continued until the end of the war. The Association of Occupational Therapists in England and the Scottish Occupational Therapy association were formed as examining bodies and, with the advent of the National Health service, became officially recognized for the U.K. After 1952 no occupational therapist could work in the National Health service unless qualified with either of these associations or with certain overseas bodies, and after 1963 state registration was obligatory in the U.K.

In the U.S. the American Association of Occupational Therapists sets an examination for registered therapists, but in some states a therapist before practising must pass a state registration examination as well. Similar developments occurred throughout the world, especially in the Scandinavian countries, the Netherlands, Belgium, Australia, New Zealand and Canada.

In 1952 the decision was made to form a World Federation of Occupational Therapists and in 1954 the first international congress of occupational therapists was held in Edinburgh. The second world congress was held in Copenhagen in 1958, when more than 30 countries were represented. The third world congress was held in Philadelphia in 1963, when 37 countries were represented.

The World Federation of Occupational Therapists is an associate member of the Conference on World Organizations Interested in the Handicapped, a conference of nongovernmental organizations pertaining to the rehabilitation program of the United Nations and the World Health organization. It publishes documents as a guide to the setting up of new schools in countries where occupational therapy is being developed and lays down minimum standards for training.

Modern Activities.—The occupational therapist, in order to carry out the treatment prescribed by the physician, must have adequate knowledge of anatomy, physiology, medicine, surgery, psychiatry and psychology, as well as knowledge of the skills used as treatment measures. A period of supervised clinical experience is required in order to learn to apply in practice the subjects learned in theory. The qualified occupational therapist is trained to treat either physical disabilities or mental illness; these two large divisions provide many specialized fields requiring further study and experience. In both areas, however, the work is divided into the following two main classifications: (1) vocational evaluation and (2) rehabilitation for daily living.

Vocational Evaluation.—To rehabilitate and resettle the disabled, either for return to work or for home employment, it is essential to assess their ability to work. Methods vary from simple activity tests to full-scale work tests and psychiatric assessment. In the U.S. particularly, objective methods of work sampling were evolved in several centres. These samples used tests related to industrial processes and to known working norms and provided a scientific basis on which the rehabilitation officer and employment agencies could evaluate the patient's work potential.

After assessment some prevocational training or practice may be necessary and many occupational therapy departments have units where the patient may be taught, or gain experience in, the use of tools for trades (*e.g.*, woodwork), light industrial work (*e.g.* light assembly work) and clerical duties (typing, etc.). After initial training many are transferred to further training centres or direct to industry, others to employment in sheltered workshops maintained by government or voluntary agencies, and some to work at home. These last require training to a standard sufficient to enable them to command fair wages as outworkers. The type of work selected depends on local employment conditions.

Occupational therapy is vital for reorienting patients hospitalized or unemployed for long periods. Such patients must learn afresh to mix and work with other people, to work to time schedules, and to cope with the problems of traveling to work. The occupational therapist advises on how difficulties may be overcome and provides escort and encouragement until the patient regains confidence.

Rehabilitation for Daily Living.—An equipped kitchen unit is a standard part of most modern occupational therapy departments, and many centres have a "flat" so that practice in home care can be provided for the housewife before she resumes her duties after a serious accident or long illness. Here the cardiac patient, for example, can be taught how to avoid undue exertion by the placement of working equipment at heights that avoid the need for lifting or reaching. Working heights can be checked to minimize back strain for those with spinal injuries. The arthritic and hemiplegic can try out variations of padded handles and be shown methods of moving pans and heavy articles, so that painful joints and weak muscles may be relieved of strain.

The difficulty of caring for an elderly chronically sick relative in the home is increased when there is insufficient help in the home, especially when the women of the family are employed outside the home. When the patient is able to care for himself the difficulty is minimized. Occupational therapy provides not only the sphere for training in daily living activities but also help in provision of aids that make eating, dressing and toilet less fatiguing for the elderly or chronically sick. One of the unique features of occupational therapy in the U.K. is the widely developed service of domiciliary occupational therapy, which provides many homebound patients with assistance in their problems of daily living, a social contact and in many cases a source of income through the provision of work.

Possible Future Development.—The fields most likely to be developed are those that make people more active and employable: the provision of help and guidance for the elderly and chronically sick and their employment in such agencies as the Golden Age centres and workshops provided by voluntary organizations in the U.S. and the occupation centres and sheltered workshops of the U.K. The wider use of domiciliary occupational therapy is also to be expected. Younger patients are helped by rehabilitation centres that give a quick and vigorous program of re-education after hospital treatment, and by centres for work evaluation.

See also PHYSICAL THERAPY; REHABILITATION, MEDICAL AND VOCATIONAL.

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(E. M. BH.)

OCEAN AND OCEANOGRAPHY. The ocean (also called the world ocean or the oceans) is the interconnecting body of salt water which occupies 70.8% of the surface of the earth. An ocean is one of the major subdivisions of this sheet of water, lying between the continents. Smaller partially enclosed subdivisions of the oceans are called seas.

This article is divided into the following main sections:

I. INTRODUCTION

1. Oceanography and Its Scope.—Oceanography is the scientific study of the ocean in all its aspects. Although it may be regarded as a separate science, it actually is a common meeting ground of four sciences. It includes the physical study of the water and wave movements, the geological study of the form of the ocean basins and the characteristics of the sediments laid down in them, the chemical study of the water and dissolved substances and the biological study of the plant and animal life in the sea. Some writers have preferred the term oceanology to embrace all these fields, and thalassography has also been employed, but the weight of usage is behind the term oceanography. The similar study of lakes and other freshwater bodies is limnology.

Together with lakes, rivers, underground water and atmospheric water vapour, the ocean makes up the major division of the earth's surface known as the hydrosphere. The other divisions are: the atmosphere, or gaseous portion; lithosphere, or solid portion; and biosphere, or living portion. Although the physical aspects of oceanography are commonly included as one of the subdivisions of geophysics, the chemical aspects more properly belong to geochemistry, the geological aspects to geology and the biological aspects to the life sciences.

The word ocean came into English from the French *océan*, which in turn was derived from the Latin *oceanus* and Greek *okeanós*. The term was originally applied to the great river or outer sea that encompassed the ancient world of Eurasia and Africa, as distinguished from the Mediterranean and other inland seas. It was personified in classical mythology as the god Oceanus, son of Uranus (sky) and Gaia (earth) and husband of Tethys, a titaness. In 13th-century English the terms "sea of ocean" and "sea ocean" were often used, and later, down to 1650, the form "ocean sea" was common.

The word oceanography was first used in English by W. Dittmar in 1883; the German *Ozeanographie* (now often replaced by *Meereskunde*) is a few years older.

2. Significance of the Ocean.—The ocean serves and affects mankind in many ways. So vast is it that often these ways are contradictory. The ocean stores heat and water that have a profound influence on weather and climate; yet castaways at sea may die from cold or thirst. The sea is a barrier to invasion, so that island races have developed parliaments (Iceland in 930; Britain in 1275) and other democratic institutions when their continental kindred were still in feudalism. Likewise, the breadth of the Atlantic facilitated the winning of independence by the United States and the Spanish possessions in America, and the subsequent operation of the Monroe Doctrine. On the other hand, to those who master its technology, the sea is a means of communication. The frontiers of the United States and Canada were pushed east from the Pacific as well as west from the Atlantic because it was easier

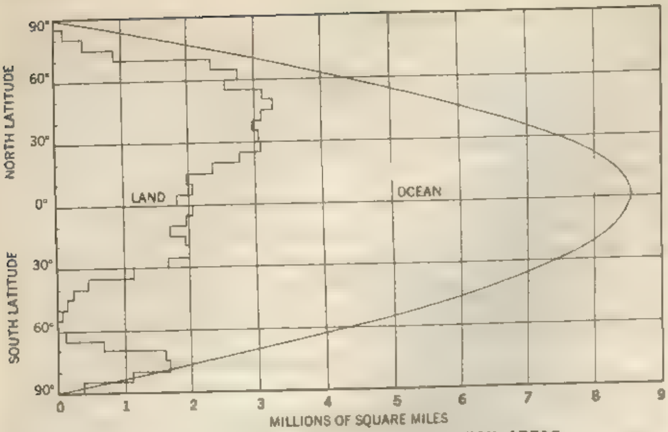


FIG. 1.—DISTRIBUTION OF LAND AND OCEAN AREAS

The smooth curve represents the total area of the earth's surface in each five-degree band of latitude

to sail around Cape Horn than to cross the continent overland.

The sea is an important source of food, particularly of animal proteins and fats; yet into it are dumped the sewage of seaside communities and even radioactive wastes. The sea serves for recreation and for the disposal of garbage. From its animals and plants are obtained not only precious jewels but also the raw materials for such prosaic items as paint, fertilizer and glue. Land and the fertility of the soil are lost to the sea and won back from the sea. Salt and chemicals are recovered from sea water, building materials from the nearby continental shelves, and coal, petroleum, gas and sulfur from shafts and wells drilled miles offshore in shallow water.

3. Causes of the Ocean.—In possessing an ocean, bordered by continents, the earth is probably unique among the planets and satellites of our solar system. To understand why this has come about, we need to ask three questions:

1. Why are there ocean basins? The answer to this question is that the rocks making up the outer portion of the earth's crust are not uniform in their properties or chemical constitution. Over large areas of the earth's surface, the rocks are characteristically light in colour and relatively light in weight. They are classed as granitic, since granite is the major rock type. Over larger areas, the rocks on the average are darker in colour and heavier in weight. These are the basaltic rocks, since among them basalt is the chief type. It is known from studies of the propagation of earthquake waves that the core of the earth at a depth of a few hundred miles below the surface has the properties of a fluid. The crustal rocks, about 50 mi. thick, in effect are floating on this liquid core. The areas of granitic rock, since they are lighter, stand higher than the surrounding areas of basaltic rock, just as a cork floats higher than a piece of wood the same size. The granitic areas thus form the continents, and the basaltic areas are the ocean basins. Were the crustal rocks of the earth uniform in composition, the earth's surface would consist of one vast ocean, more than a mile deep. Under such conditions, although an occasional volcanic island might form above the ocean surface, it probably would soon sink and disappear below the surface again, as the locally overloaded earth's crust adjusted to the strain by the process of isostasy (*q.v.*).

2. Why is there water in the ocean? Even if we have explained ocean basins, we have not yet completely accounted for the ocean. The moon, for example, though it is known to have suitable basins, has a bone-dry surface. The reason why there is water in the oceans is threefold. In the first place, molten rock, such as lava, holds much more water when liquid than when it hardens and cools. Thus, as the earth's crust has solidified during geologic time, water vapour has been given off to the atmosphere. Analyses of gases from volcanoes and fumaroles show that this process is still going on today. Something like this must have happened on the moon, yet the moon has no ocean. The explanation is that gravity is much weaker on the moon than on the earth. Gas molecules in the earth's atmosphere behave just as does any other moving body with respect to the earth's gravitational field: if the escape velocity of 7 mi. per second is exceeded, the body can escape to outer space. At the boiling point of water (212° F.) the mean speed of water molecules is only 0.4 mi. per second, and the probability that any molecule may have $17\frac{1}{2}$ times this speed at this temperature is infinitesimally small. Therefore, even if fairly high temperatures exist in the upper atmosphere, the earth does not lose water molecules. For the moon, where a temperature of 212° F. is regularly exceeded on the face presented to the sun the escape velocity is only 1.4 mi. per second. At 212° F., one water molecule has this speed for every 60,000 having the mean speed. Thus the moon fails to hold water vapour or the other light gases that make up our atmosphere and hydrosphere and hence it lacks an ocean. The second reason that there is water in the ocean, therefore, is that the earth's gravity keeps the water from escaping into space, just as it also retains the air we breathe. As the third reason, the pressure-temperature relationships on the earth's surface are such that the water is mainly in liquid form. Conceivably the atmosphere could be so hot that all the water existed in vapour form. A temperature of at least 705° F. (the critical temperature of water vapour) would be necessary, and the corresponding atmospheric pressure would then be of the order of 5,500 lb. per square inch. On the other hand, if the earth's temperature at sea level never exceeded 32° F., the ocean basins would be filled with solid ice. Since there still would be water vapour in the atmosphere, and snow still could fall, a vast continental glaciation might take the place of the present river drainage system. Since neither of these extreme temperature conditions exists, we have the ocean in its present form.

3. Why is the ocean salty? The salts in the ocean are one result of over 2,000,000,000 years of disintegration of the igneous rocks of the earth's crust. The soluble materials remain in the ocean; the insoluble precipitates have formed sedimentary rocks and the ocean sediments. The ocean contains all the elements originally present in the igneous rock to the extent that they are soluble, are not adsorbed on clay or are not removed by biological activity. Suspended material and dissolved salts, extracted from the rocks of the continents, are still delivered to the sea by rivers. Much of this eroded material is from sedimentary rocks that have previously passed through the same cycle. Equivalent amounts of new sediments are being laid down at the same rate. The result is that the sea is in a steady state with regard to the composition of its salt, and it has probably maintained a close approximation to this present composition for millions of years.

When changes in drainage pattern and climate cut off lakes from their outlets to the sea, they soon become salt lakes. Great Salt lake in Utah is an example. Standing over 4,200 ft. above sea level, it never was part of the ocean. Evaporation keeps it from overflowing, the salts leached out of the surrounding mountains remain behind, and, in the approximately 100,000 years since its parent Lake Bonneville became isolated, the Great Salt lake has become eight or ten times as salty as the ocean. Most of the world's other salt lakes, such as the Dead sea, Caspian sea and Aral sea, have acquired their salt in this fashion, independently of

TABLE I.—*Percentages of Water for Each Latitude Band*

Latitude band	Total area (000,000 sq.mi.)	Percentage covered by sea	
		Northern hemisphere	Southern hemisphere
0° to 5°	8.542	78.6	70.4
5° to 10°	8.479	75.7	75.4
10° to 15°	8.352	76.5	76.4
15° to 20°	8.164	70.8	79.6
20° to 25°	7.915	65.2	70.9
25° to 30°	7.606	59.6	75.9
30° to 35°	7.239	57.7	84.2
35° to 40°	6.817	56.8	93.4
40° to 45°	6.342	51.2	96.4
45° to 50°	5.818	43.8	97.5
50° to 55°	5.249	40.7	98.5
55° to 60°	4.638	45.0	99.9
60° to 65°	3.990	31.2	99.7
65° to 70°	3.310	28.7	70.5
70° to 75°	2.602	65.5	38.0
75° to 80°	1.874	77.1	10.7
80° to 85°	1.131	85.2	0.0
85° to 90°	.378	100.0	0.0
Whole hemisphere	98.446	60.6	81.0

Aerial view shows erosive power of the sea along the Dutch coast. The sea curls inland cutting deep channels and sweeping away land: low tide reveals plains of mud and sand

An English beach at low tide. The rise and fall of the tides is related to the positions of the sun and moon

Belching smoke and steam, a new volcano emerges from the sea on the Myojin reef 170 mi. S. of Tokyo, Japan

Sand from nearby beaches, carried by currents, cascades down the walls of the Cape San Lucas submarine canyon off Lower California

Photograph taken by deep-sea camera shows a sandy portion of the western Indian ocean bottom at 1,756 fathoms. Ripples in the sand are caused by bottom currents

THE SEA

BY COURTESY OF (CENTRE LEFT, BOTTOM RIGHT) U.S. NAVY, (BOTTOM LEFT) SCRIPPS INSTITUTION OF OCEANOGRAPHY, THE UNIVERSITY OF CALIFORNIA; PHOTOGRAPHS, (TOP LEFT) KLM AEROCARTO, (TOP RIGHT) CAMERA PRESS LTD.—PIX FROM PUBLIX (BOTTOM LEFT) CONRAD LIMBAUGH

OCEAN AND OCEANOGRAPHY

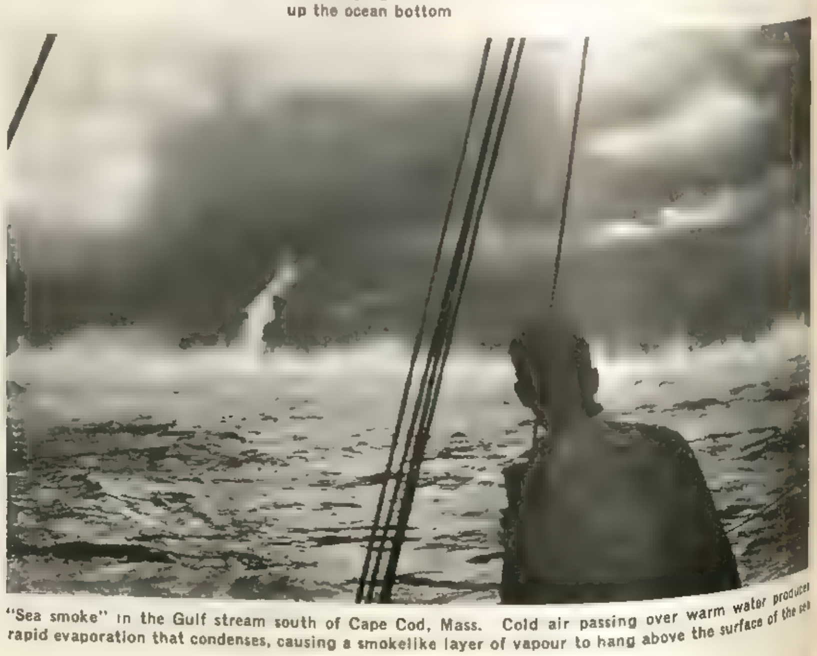
The floating instrument platform ("Flip"), operated by the Scripps Institution of Oceanography, La Jolla, Calif. Bow (visible here) extends 50 ft. above the water; stern can be submerged and contains delicate instruments for measuring underwater sounds

Soviet scientists lower an instrument that measures the speed and direction of currents in the polar sea

U.S. scientist probes under the tongue of a 60-ft. fin whale to study feeding habits

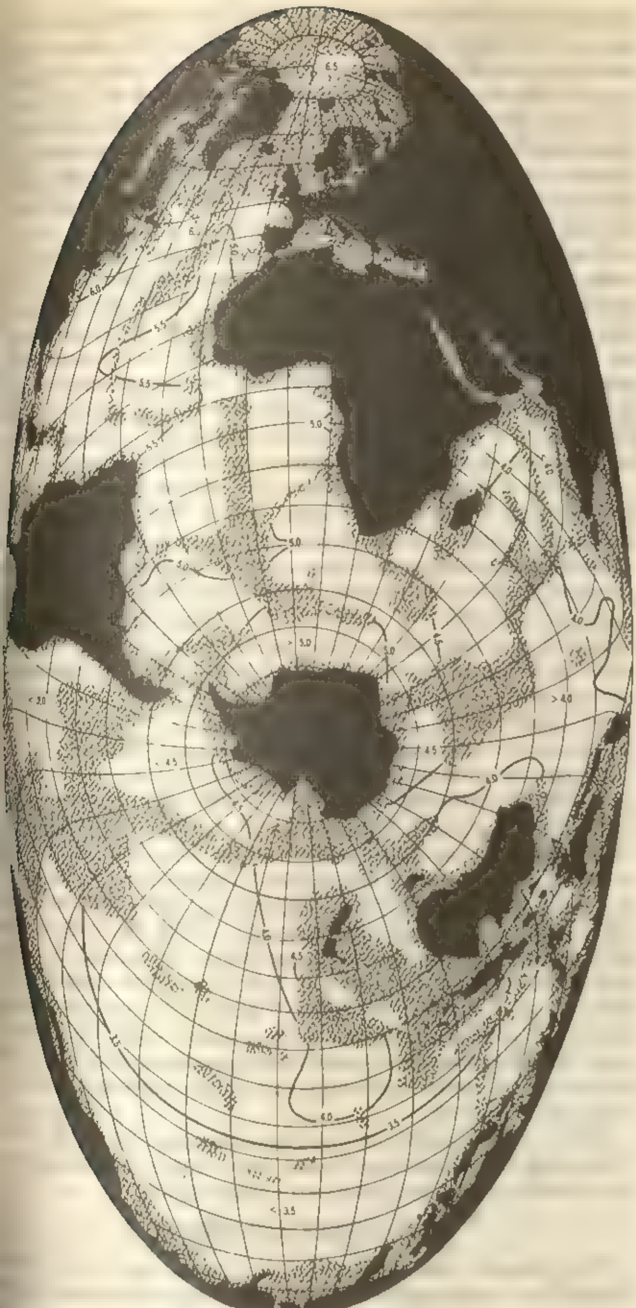
Soviet oceanographers measure a core of bottom sediment. By drilling and studying the cores, scientists analyze the layers of debris that make up the ocean bottom

Oceanographers with a voluminous water sample; radio isotopic analysis of such samples reveals information about horizontal and vertical motion of water masses



"Sea smoke" in the Gulf stream south of Cape Cod, Mass. Cold air passing over warm water produces rapid evaporation that condenses, causing a smokelike layer of vapour to hang above the surface of the sea

SCIENTIFIC STUDY OF THE SEA



BY COURTESY OF E. D. STROOP AND H. STOMMEL

FIG. 2.—THE WORLD OCEAN, SHOWING THE INTERCOMMUNICATING NATURE OF THE OCEAN BASINS

The white zones are deeper than 13,000 ft., the approximate average depth of the ocean. Contours of dissolved oxygen, in volumes per 1,000 vol. of sea water (ml./l.), are also shown

the ocean. They represent oceans in miniature.

II. THE OCEAN BASINS

1. Distribution of Land and Sea.—The relative distribution of land and sea in relation to latitude is of fundamental importance in understanding how the ocean behaves as a whole. Thus, the north polar region is an ocean basin which communicates chiefly with the North Atlantic and is connected to the Pacific only by the shallow Bering strait. The south pole, on the other hand, is on land, but is surrounded entirely by water, which communicates with all the other oceans. Fig. 1 illustrates the relative proportion of land and water areas of the earth, while fig. 2 shows how all the ocean connects in the Antarctic. The percentages of water for each latitude band are given in Table I (after Erwin Kossinna).

2. The Seven Oceans.—The term "seven seas" is often encountered in the works of medieval Arabic geographers. The Turkish hydrographer Piri Reis in the 16th century listed them as the South China sea, Bay of Bengal, Arabian sea, Persian gulf, Red sea, Mediterranean sea and Atlantic ocean. These were the waters of the Mohammedan world prior to the fall of Constantinople (1453). The phrase appeared in E. FitzGerald's translation of Omar Khayyam in 1859 and was popularized by Rudyard Kipling as the title of a book of verses in 1896.

It happens that, although there is considerable disagreement among various authorities as to the number and designations of the major subdivisions of the ocean, a very convenient arrangement is into seven oceans, as shown in Table II.

TABLE II.—*Major Subdivisions of the Ocean*

Ocean	Area in sq.mi.	Mean depth in feet
Arctic	5,427,000	5,010
North Atlantic	17,646,000	10,780
South Atlantic	14,098,000	13,420
North Pacific	31,639,000	14,050
South Pacific	32,361,000	12,660
Indian	28,400,000	13,002
Southern (Antarctic)	12,451,000	12,240

In this scheme, the equator is taken as the boundary between the North and South Atlantic and North and South Pacific; the Southern (Antarctic) is arbitrarily bounded by the parallel of 55° S.; and the meridians of Southeast cape, Tasmania, and Cape Agulhas, S.Af., determine the limits of the Indian ocean, South Pacific and South Atlantic. The further breakdown of the ocean into seas, gulfs and straits has been the subject of careful study by the International Hydrographic bureau, whose *Publication No. 23* should be consulted for details. The total area of the ocean is 142,022,000 sq.mi., total volume 328,750,000 cu.mi. and mean depth 12,450 ft.

3. Ocean Depths.—Relative to the size of our planet, the ocean forms hardly more than a wet film over the part of the earth that it covers. To visualize the true scale of the Pacific between Panamá and Manila or Yokohama and Callao, let the thickness of an ordinary pencil mark ($\frac{1}{16}$ in.) represent the average depth of the ocean. Then to represent the distance of over 8,000 mi. on this same scale, we must continue the pencil line for 5 ft. Or, on the blackboard, if we are to represent the average depth of the Atlantic by a chalk line $\frac{1}{8}$ in. wide, to cover the distance from Jacksonville, Fla., to Southampton, Eng., we will need to make the line 56 ft. long.

We must not infer from this picture of the ocean that its bottom consists only of vast level plains. Although it is true that river drainage systems, the chief factors in shaping the land, do not exist under the sea, there are still mountain ranges and canyons, basins and ridges, and peaks and valleys as well defined as any on land. We cannot see these features with our own eyes, as we can the land features, and only the painstaking tabulation and plotting of ocean soundings make them apparent.

Fig. 3 shows that the deepest ocean is much farther below sea level than the highest mountain is above. This figure is the hypsographic curve of the earth's surface. It shows the area of the earth's solid surface above or below any given elevation or depth. The mean height of the dry land is 2,760 ft.; the mean height of the physical earth's surface is 29% of this or 800 ft.; the mean level of the crust of the solid earth is 8,000 ft. below sea level.

4. Sea Level.—Sea level, or more properly mean sea level, is the average height of the sea surface after all wave motion has been smoothed out. Since some of the highest waves are those of the tide, it is necessary to average observed tide levels for 19 years in order to eliminate all the astronomical influences on them (*see* TIDE).

Longer series of observations often show substantial changes in mean sea level with time. Thus along the east coast of the United States, sea level between 1930 and 1950 rose about one-fourth inch per year, or at the rate of two feet per century. This effect is generally attributed to the melting of polar icecaps, which are thereby adding more water to the ocean. In Scandinavia, on the other hand, tide gauges show that the land is rising relative to the water, and there the effect is explained as isostatic

nificant quantities of the oxides of cobalt, copper and nickel, forms crusts on any exposed projection above the bottom. These manganese nodules often contain as a core a shark's tooth or the ear bone of a whale, two types of skeletal remains that prove highly resistant to decay and redissolving on the ocean floor.

The oozes, defined as pelagic sediments with over 30% skeletal remains, are subdivided first into calcareous and siliceous oozes and then again according to the predominant skeleton type. Thus the calcareous oozes include globigerina ooze, containing the tests of planktonic foraminifera, and pteropod ooze, made up chiefly of the shells of pelagic snails. The siliceous oozes include radiolarian ooze, which is essentially red clay with more than 30% of the skeletons of warm-water protozoa, and diatom ooze, containing the frustules (tiny shells) of diatoms. The siliceous oozes exist only where the rate of supply of diatoms or radiolarians is greater than the rate of solution of silica in the deep waters; thus the diatom oozes are confined to productive belts in the North Pacific and Antarctic, and the radiolarian oozes are found only under the eastern part of the Equatorial current in the North Pacific. Except near the equator, the rest of the North Pacific is covered almost entirely with red clay. The other oceans have both red clay and globigerina oozes. Pteropod ooze is found only in mid-Atlantic. Seismic measurements indicate that there is a thickness of about 1,000 to 1,200 ft. of unaltered pelagic sediments in the deep oceans.

4. Rates of Sedimentation and Past Climates.—Various calculations have shown that the average rate of deposition of red clay is about one inch every 2,500 years, and rates for the other pelagic types of deposit are not much greater. It is technically quite feasible to lower sharpened pipes to the bottom and drive them in to depths of 70 ft. or more, and thus samples can be obtained that go back in time for 2,000,000 years. Since the layers are preserved in the pipe in the order in which they were laid down, it is possible to examine the deposits with various techniques that tell of past climates and events. For example, a layer of glacial till would indicate an era of lower temperatures in the past, while pumice or ash would reveal volcanic activity. The tests of foraminifera can often be identified as predominantly cold-water or warm-water forms. Oxygen isotope analysis can be applied to the O^{18}/O^{16} ratio, which is a delicate "fossil thermometer." Providing information of this nature is but one of the many ways in which oceanography comes to the assistance of other sciences.

IV. PHYSICAL PROPERTIES OF SEA WATER

1. Salinity and Chlorinity.—All the principal salts in sea water are found everywhere in the same proportions, and only the total quantity of salt in a given amount of sea water varies significantly. It is therefore possible to express this relationship as the salinity. Salinity is defined as the weight of dissolved salt in 1,000 parts of sea water, *i.e.*, grams per kilogram, when all the carbonates and organic matter have been converted to oxides, and all bromides and iodides to chlorides. The value found in accordance with this definition is about one-half of 1% lower than the actual weight of dissolved solids. Because of the accuracy required in physical oceanography, it is necessary to report salinity to four significant figures, and, as the Scandinavian countries (where physical oceanography developed) use decimal currency, it has become customary to report salinity not as per cent (%) but per mille ($^0/_{00}$). By this convention, the four-digit numbers look like amounts of money, and printing and proofreading of long columns of figures are made easier. Thus salt content of the open ocean, which ranges from 3.2% to 3.6% salt, is expressed as salinity $32^0/_{00}$ to $36^0/_{00}$.

Seas receiving extensive river drainage may have lower values. The northern Bay of Bengal, Yellow sea and Okhotsk sea all have surface salinities as low as $30^0/_{00}$; the surface water of the Black sea is about $16^0/_{00}$; and the Baltic in the spring drops as low as $1^0/_{00}$. Where evaporation is high and river drainage and rainfall low, salinities as high as $40^0/_{00}$ are encountered in the Persian gulf and $41^0/_{00}$ in the Red sea.

It is not easy to make determinations of salinity directly, so that it is usually derived from measurements of some other property, such as electrical conductivity, specific gravity, index of refraction or chlorinity. The chlorinity of sea water is the value derived from direct titration of the halides with silver nitrate. Chlorinity was originally defined as the proportion (per mille) of halides in sea water if all the bromides and iodides were replaced by chlorides. The relationship between chlorinity and salinity was found in 1902 by Martin Knudsen and collaborators to be $S=0.03+1.805\times Cl$. Many years later, it was discovered that, mainly because of changes in values for atomic weights, chlorinity as defined by this expression (which formed the basis of Knudsen's tables) was 45 parts in 100,000 lower than the value given by the original definition, and J. P. Jacobsen and Knudsen in 1940 therefore redefined chlorinity as 0.3285233 of the silver equivalent of sea water.

The constant term 0.03 in the relationship between salinity and chlorinity is of interest, because it means that water having zero chlorinity still has a salinity of $0.03^0/_{00}$. This apparent paradox results from the fact that low salinities in the ocean generally result from mixing with river water rather than rain water. River waters usually contain significant quantities of dissolved salts, invariably with much more sulfate and bicarbonate than chloride, and hence their chloride values are zero while their total salt values are still significant.

2. Temperature, Freezing Point and Heat Capacity.—The freezing point of ordinary sea water (salinity $34.75^0/_{00}$) is 28.7° F. Temperatures in the ocean range upward from this value to maxima of a little above 85° F. in the open tropical seas and as high as 90° in the Persian gulf in summer.

The distribution of surface temperatures in the ocean is approximately as shown in Table III.

Below the surface, the ocean almost invariably shows a decrease of temperature with depth, reflecting the fact that colder water is denser and hence sinks below warmer water. Fig. 4 shows a typical distribution of temperature with depth in the ocean. Near the surface there is generally a layer of constant temperature resulting from mixing by the action of wind and waves. This mixed layer, or isothermal layer, has a thickness ranging from 10 ft. or less in calm regions to as much as 600 ft. in trade-wind latitudes. Below it is a zone of rapid temperature decrease, the thermocline, which merges smoothly with the temperature of the deep oceans. The ocean is everywhere colder than 60° F at a depth greater than 1,200 ft., and even at the equator the temperature in deep water is as low as 35°, since the water of the deep oceans has sunk from the surface in polar regions. The average temperature of the ocean was determined in 1957 by R. B. Montgomery and associates to be 39° F.

TABLE III.—*Approximate Distribution of Surface Temperatures*

Average surface temperature, ° F.	Percentage of area of ocean
35 or below	12 5
35 40	4 9
40 45	3.6
45 50	4.8
50 55	5.2
55 60	5 5
60 65	5 9
65 70	7.5
70 75	10 2
75 80	17.0
80 85	22.8
85-90	0.1

There is an important difference between temperatures in the sea and those encountered in deep wells or mine shafts on land. In sedimentary rock, there is a temperature increase of 1° F. for every 60 to 110 ft. of depth. In the sea, this geothermal gradient is almost entirely suppressed, and when it is encountered, in deep water basins separated by ridges from the general flow of bottom water (as in the Mediterranean sea), it amounts to only 1° F. in 10,000 ft. of depth.

The specific heat of sea water is reduced only slightly below that of distilled water by the dissolved salts and amounts to about 0.93 B.T.U. per pound. The significance of this figure is the comparison with the specific heat of air, 0.24 B.T.U. per pound, and of rock and soil, 0.19 to 0.22. Thus the total heat capacity of the

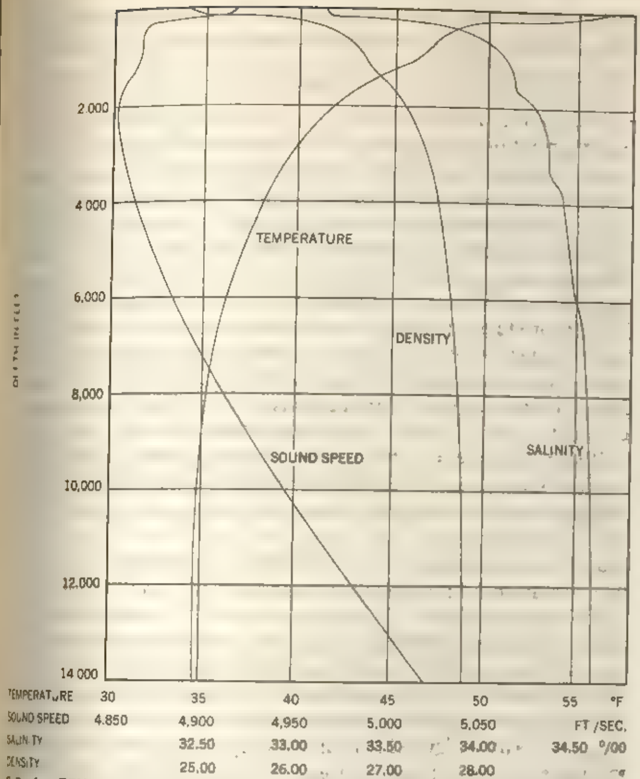


FIG. 4—TEMPERATURE, SALINITY (IN PARTS PER 1,000 BY WEIGHT), DENSITY (IN σ UNITS, EQUAL TO 1,000 × [SPECIFIC GRAVITY—1]) AND SOUND SPEED, SHOWING TYPICAL VARIATION WITH DEPTH IN THE PACIFIC OCEAN OFF SOUTHERN CALIFORNIA

lower 10,000 ft. of the atmosphere is matched by the top 2.7 ft. of the ocean, and the heat capacity of the top 100 ft. of the dry land, which is as deep as any annual heating or cooling effect is felt, is the same as the top 40 ft. of the sea. The annual variation of surface temperature in the sea has a maximum range of 15° F. at about latitude 40° N. in the Atlantic and 18° F. in the North Pacific. It amounts to only 3° or 4° F. in the tropics and 9° or 10° F. in the south temperate zones. Annual variations are felt to a maximum depth of about 600 ft., unless the water at the surface is cooled sufficiently to cause it to sink to the bottom. This condition takes place in the winter in the Arctic and Antarctic oceans and in the eastern Mediterranean sea. In the polar regions, formation of denser water at the surface is accelerated by ice formation, which by removing part of the water makes the remaining water saltier.

Fresh water has a maximum specific gravity at 39.2° F., which means that water cooled below this temperature cannot sink to the bottom of a lake until the entire lake has reached this temperature. The addition of salt to water, however, lowers the temperature of maximum specific gravity very rapidly, and at a salinity of 24.70$^0/_{00}$ this temperature is the same as the freezing point. At higher salinities, *i.e.*, everywhere in the open oceans, sea water always has a higher specific gravity the lower its temperature.

The main source of heat in the ocean is radiation from the sun, most of which is absorbed in the top five feet of water. Except under unusual conditions, however, such as in sheltered bays, mixing by waves and wind distributes this heat through a much greater depth. When the air is colder than the sea surface, this heat is given off again to the atmosphere. The ocean thus exerts an ameliorating effect on climate. Since the global circulation of air is from west to east in temperate and polar latitudes, this effect is felt much more on the western edges of continents. Ireland, in the same latitude as Labrador, has a much milder climate, and the Gulf stream, though it passes close to the coasts of North Carolina and Virginia, is virtually without influence on their climate or that of the rest of the United States.

3. Density and Pressure.—Sea water weighs almost exactly 64 lb. per cubic foot, so that 35 cu.ft. weigh a long or shipper's ton (2,240 lb.), a relationship widely used in naval architecture. Since the density of distilled water is 62.43 lb. per cubic foot, the specific gravity of sea water, in round figures, is 1.025. For the same reason as stated under salinity, it is customary to report the density of sea water in a unit equivalent to "grams per litre excess over one kilogram," designated by the symbol σ. In this notation, the specific gravity of 1.025 is expressed as σ of 25. Density increases with increasing salinity but decreases with increasing temperature. It also increases with increasing pressure, because of the slight but appreciable compressibility (about 4 parts in 100,000 per atmosphere pressure). Fig. 4 includes a typical curve of density as a function of depth. The pressure increases in the sea as depth increases, at the rate very nearly of one atmosphere for each 33 ft. Table IV gives the average pressure in the ocean as a function of depth.

TABLE IV.—*Average Pressure as a Function of Depth*

Depth in feet	Pressure in pounds per square inch
1,000	445
2,000	892
4,000	1,788
6,000	2,685
8,000	3,586
10,000	4,488
20,000	9,034
30,000	13,640
35,958	16,415

The values shown represent the pressure due to sea water alone, and for strict accuracy an additional 15 lb. per square inch should be added to include the atmospheric pressure in the total pressure at depth.

As an example of how pressure affects specific gravity, we can take the calculation of the mean density of sea water. The mean temperature of 39° F. and mean salinity of 34.75$^0/_{00}$ yield a specific gravity of 1.02762 or σ of 27.62 from Knudsen's tables. This value of σ is designated $\sigma_{t,0}$ to indicate that it is corrected for temperature but not for pressure. The mean depth of the ocean is 12,450 ft., and the pressure at this depth is 5,600 lb. per square inch. Application of compressibility, as given in LaFond's tables, yields $\sigma_{t,p}$ of 44.90 or specific gravity of 1.04490 for this pressure.

Multiplying 62.43 by 1.04490 gives 65.23 lb. per cubic foot as the average density of sea water in the ocean. Since the volume of the ocean is 3.288×10^8 cu.mi. and there are $5{,}280^3$ or 147,197,-952,000 cu.ft. in a cubic mile, the total weight of sea water in the ocean is $65.23 \times 3.288 \times 10^8 \times 1.472 \times 10^{11}$ or 3.16×10^{21} lb.

4. Electrical Conductivity.—Since sea water is a fairly strong salt solution, its electrical conductivity is much greater than that of pure water. The values of electrical resistance given in Table V are for sea water of salinity 34.75$^0/_{00}$.

TABLE V.—*Values of Electrical Resistance*

Item	At 39° F.	At 77° F.
Ohms per foot cube	1.01	0.69
Ohms per inch cube	12.1	8.3

5. Colour and Transparency.—The blue colour of sea water, like the blue of the sky, is the result of molecular scattering of light. Dissolved yellow pigments produced from the decay of plants give the green colour to coastal waters. Abundant phytoplankton and suspended sediments add a brownish tinge to estuarine waters.

In certain oceanic areas, such as the Sargasso sea, where phytoplankton is scarce, sea water is nearly as transparent as distilled water. Where phytoplankton is more abundant, the transparency is much less. The area near the surface to which sufficient light penetrates to enable phytoplankton to carry on photosynthesis is called the euphotic zone. Its thickness ranges from a maximum of over 300 ft. in the open sea to 3 ft. or less in estuaries.

6. Sound in the Sea.—The speed and other characteristics of sound in the ocean are of considerable practical importance. The reception of a reflected sound signal can be used to determine the depth to the bottom and to layers in the sub-bottom, and also to locate schools of fish or other submerged objects. Echo-location

systems, known in naval parlance as asdic or sonar, have been highly developed for detecting submerged submarines. (*See* SOUNDING; ECHO SOUNDER.)

In the operation of sonar, the refraction, scattering and absorption of sound are limiting factors. Refraction results from the variation in speed of sound, which causes bending of the sound rays. The speed of sound at one atmosphere pressure, salinity 34.75‰ and temperature 39° F. is 4,800 ft. per second, or about 4.5 times its speed in air. The speed increases with increasing pressure, temperature or salinity. In the thermocline, temperature decreases rapidly, but in the deeper layers it changes more slowly whereas pressure steadily increases; hence, sound speed commonly shows a minimum value at an intermediate depth, as in fig. 4. Horizontally directed sound waves tend to be refracted toward the zone of low sound speed, and thus they are trapped in the zone of minimum speed and may be transmitted for long distances with little loss in intensity.

This layer or channel is the basis of the system of sofar (*so*und *f*ixing *a*nd *r*anging), which has been proposed as a means of long-distance communication, particularly for the location of survivors at sea. An explosive charge set to detonate at the depth of the sound channel could be detected by hydrophones placed at the proper depth thousands of miles away, and the differences in time of the arriving signals could be used to construct hyperbolas that would intersect at the detonation point.

Much of the scattering of sound in the ocean results from echoes produced by living organisms, many of which migrate upward to the surface at night from a depth of about 1,000 ft. Absorption is due mainly to the content in sea water of dissolved magnesium sulfate, which has a specific ability to absorb sound, particularly at high frequencies.

V. MOVEMENT OF SEA WATER

1. Currents.—Motion of water particles in the sea is of various kinds. The molecular motion involved in the propagation of sound has been covered above. The periodic rise and fall of the surface is described in the articles TIDE; WAVES OF THE SEA. There remain to be considered the horizontal and vertical circulation of water masses in the sea. The horizontal movement of water is called a current. In the ocean there exist both tidal currents, or tidal streams, which are associated with the tidal rise and fall of sea level and result from the same causes, and nontidal currents. The nontidal currents show considerable regularity in their general flow, although they may be modified by a persistent wind that blows for several days in the same direction. However, in temperate and boreal latitudes changes in weather tend to occur too quickly for the ocean to respond to them, so that the nontidal currents in a given season of the year are relatively stable.

2. Coriolis Force.—In describing the motion of any particle on the rotating earth, it is necessary to consider the rotation of the earth. To an observer in space, the motion would not appear the same as to an observer also on the rotating earth. Since a body once set in motion continues that motion relative to space, it has an apparent deflection relative to the observer on the rotating earth. The horizontal component of this deflection is proportional to the sine of the latitude, and thus it is a maximum at the poles and zero at the equator, and the direction in which this apparent deflection is exerted is opposite on opposite sides of the equator.

This deflecting force is called Coriolis force, after the French engineer who first derived it mathematically in 1835. Coriolis force actually affects all motion on the earth's surface, but usually it is slight in comparison with the other forces of friction and propulsion. In the cases where a motion once initiated is proceeding against almost negligible friction, however, it must be considered. These cases include a projectile or missile in flight, a swinging pendulum (Foucault's pendulum), a moving air mass (*see also* BUYS BALLOT'S LAW) and an ocean current.

The direction of Coriolis force is to the right (clockwise) in the northern hemisphere and to the left (counterclockwise) in the southern. Since this is the apparent direction in which the sun moves, it is convenient to describe it as *cum sole* ("with the sun"). If no other force acts on a body moving with speed v, it will be directed *cum sole* in a circle (the inertia circle), the radius r of which is given by the centrifugal force $\frac{V^2}{r}$. This will equal the Coriolis force, $2\omega v \sin\phi$, where ω is the angular velocity of the earth's rotation ($.729 + 10^{-4}$ radians/second) and ϕ is the latitude. In latitude 40°, this relationship yields a radius of 3 mi for a speed of 1 m.p.h. Obviously, therefore, ocean currents that flow in the same direction for thousands of miles at speeds of this order of magnitude cannot persist unless a force is provided to oppose Coriolis force. Just as in the atmosphere, this opposing force is supplied by the pressure gradient. In the sea, pressure is given by the product of gravity × depth × density. Gravity is of course constant at any point, so for a given depth the pressure can be varied only by varying the density. Thus if a permanent steady ocean current is found to exist, there will be found a density gradient across it, with the lightest water *cum sole*.

Water movement in the inertia circle has been observed in the tideless Baltic sea, under conditions where there were no density gradients in the water, but, in general, motion of this kind is unusual in the sea.

3. Tidal Streams and Estuaries.—In restricted channels, a tidal stream exhibits a regular pattern of ebb (seaward flow) and flood (landward flow). The duration of each corresponds generally to the time interval between high water and low water, but in the case of river mouths, the ebb is usually longer or faster than the flood, in order to accommodate the river flow. In such a river mouth, there is generally an upstream undercurrent of sea water, forming a salt wedge, which thins out upstream with a fairly sharp interface between the salt water and the fresh water above. Mixing takes place all along this interface, and the salt water returns to the sea mixed with the river water in the upper layers.

The water discharged to the sea by a river is fresher and therefore lower in density than the sea water, hence it tends to turn *cum sole* along the coast. Thus, along the Atlantic coast of the United States, which has numerous rivers producing an appreciable lowering of the coastal salinity, the general inshore current sets to the south as far as Cape Hatteras. On the coast of California, where rainfall and runoff of the coastal rivers is confined chiefly to the winter months, the California current sets south in the summer, but in winter a well-defined north-setting inshore current, the Davidson current, makes its appearance.

The Amazon river is unique among the great rivers of the world in that its mouth is exactly on the equator, where Coriolis force is zero. Since there the fresh water has no tendency to be deflected either right or left, instead of hugging the coast it spreads out in a thin layer to seaward, so that the fresh waters of the Amazon can be detected for scores of miles off its mouth.

Tidal currents exist in the open sea as well as in restricted channels, since they represent the motion of the water particles in the progressive or standing waves that comprise the tide. In deep water their effect is small and almost immeasurable, but on the continental shelves they are usually the predominant current. When not confined by coastal barriers, tidal currents generally change direction continually *cum sole*, and where the tide is mainly semidiurnal in character a drifting object completes a roughly circular path every 12 hours. A typical diameter for such a circle is 4 or 5 mi., but appropriate hydrographic publications, *e.g.*, the U.S. coast and geodetic survey *Current Tables* for United States waters, should be consulted for specific details at a given locality.

4. Wind-Driven Currents.—Whenever the wind blows over a stretch of water for an appreciable time, the frictional drag between wind and water and between the layers of water will set the water in motion. V. W. Ekman showed in 1902, as the result of observations of the drift of pack ice made by Fridtjof Nansen in the "Fram," that in water of sufficient depth, assuming that the water is homogeneous and that eddy viscosity does not vary with depth, the surface wind current is directed 45° *cum sole* from the wind direction. Each layer below the surface is deflected further *cum sole* by the layer above, but with a lower speed so that the water on the average is carried 90° *cum sole*. There even exists a depth (equal to $7.6W\sqrt{csc\ \phi}$ where W is wind speed in

feet per second) at which the current initiated by the wind flows in the direction opposite to the wind, although its speed is only $\frac{1}{23}$ that of the surface current. The speed of the wind-driven current at the surface is $.013W\sqrt{\csc\phi}$. It is obvious that these relationships cannot be valid near the equator.

5. **Permanent Currents.**—Fig. 5 presents the system of permanent surface currents in the ocean. Comparison with a chart of average prevailing winds shows in general good agreement with the principle that the water moves about 45° *cum sole* from the wind, but there are two notable individualities that result from other causes. The well-developed countercurrents that flow eastward just north of the equator in the Pacific and Atlantic and just south of it in the Indian ocean do not appear to agree with what would be expected from prevailing winds. However, H. U. Sverdrup in 1947 showed that the equatorial countercurrents develop in the region of minimum wind stress and can be derived from a knowledge of wind stress alone.

The intense currents that develop on the western sides of the oceans, such as the Kuroshio in the North Pacific, the Gulf stream in the North Atlantic and the Agulhas current in the Indian ocean, likewise are not related to the local winds. Henry Stommel between 1948 and 1951 showed that this westward intensification of surface currents results from the variation of Coriolis force with latitude, and that, although the winds add energy to the current system of each ocean over the whole ocean, this energy is dissipated mainly in the strong western current. W. S. von Arx confirmed this finding by model experiments in 1952. G. Neumann in 1955 accounted for the lack of such a pronounced western current in the South Atlantic by showing that there the change in Coriolis force with latitude is nearly offset by a corresponding change in the depth of the current system.

Fig. 5 clearly justifies the division of the ocean into seven main oceans. Each ocean has its own virtually closed surface circulation, that of the Antarctic being to the eastward around Antarctica and that of the Arctic (not shown) entering from the Atlantic in the Barents sea, proceeding northeastward, circling the pole and leaving down the east coast of Greenland. In comparison, the exchange with the Pacific through Bering strait is much less important, though Martin Johnson has shown from study of the zooplankton that appreciable quantities of water reach the Arctic coast of Alaska from the Bering sea. It is particularly noteworthy that in the surface circulation of the ocean very little water crosses the equator, except where the South Equatorial current impinges on the bulge of South America. This flow makes up for the water that sinks below the surface in the northern North Atlantic in winter and crosses the equator near the bottom.

6. **Measurement of Currents.**—Numerous means, direct and indirect, have been developed for measuring ocean currents. If the navigator of a ship keeps careful records of his course and speed, the difference between the position so given (the dead reckoning) and the position actually fixed by astronomical or electronic means can be attributed to the effect of current. Hundreds of ships report daily observations of this sort to the world's hydrographic offices, and although the results of necessity average the current over fairly large distances, sufficient observations are available to permit averaging out of all random errors. These results form the basis of generalized current maps of large areas, such as fig. 5. A somewhat similar method involves the dropping of bottles or cards (bottle post or drift cards) at known positions and noting the position of recovery. This method is excellent when practical applications are desired, such as the fate of sewage or oil disposed of at sea or the drift of fish eggs, but it tells very little about the actual path of the currents between the points of release and recovery.

An elaboration of the drift bottle is a drogue, or other object, which will be acted on by the current at a predetermined depth and will tow a light or radar reflector floating on the surface. Such a drogue can be followed from a boat for days or weeks and its successive positions determined. A further refinement, developed by J. C. Swallow in 1955, is to provide the float with a simple sound-generating apparatus, leaving it independent of any connection with the surface, and to follow its course by listening with directional hydrophones. This method has provided information on currents as deep as 5,000 ft.

Surface currents are readily determined from anchored ships by the same methods as those used to find a ship's speed through the water. Numerous observations of tidal currents have been made in this way from lightships. The Ekman meter, used for subsurface currents from an anchored ship, is essentially a propeller steered into the current by a vane. Mechanisms are fitted for stopping and starting at predetermined times, and counting dials read the number of turns of the propeller in the elapsed time.

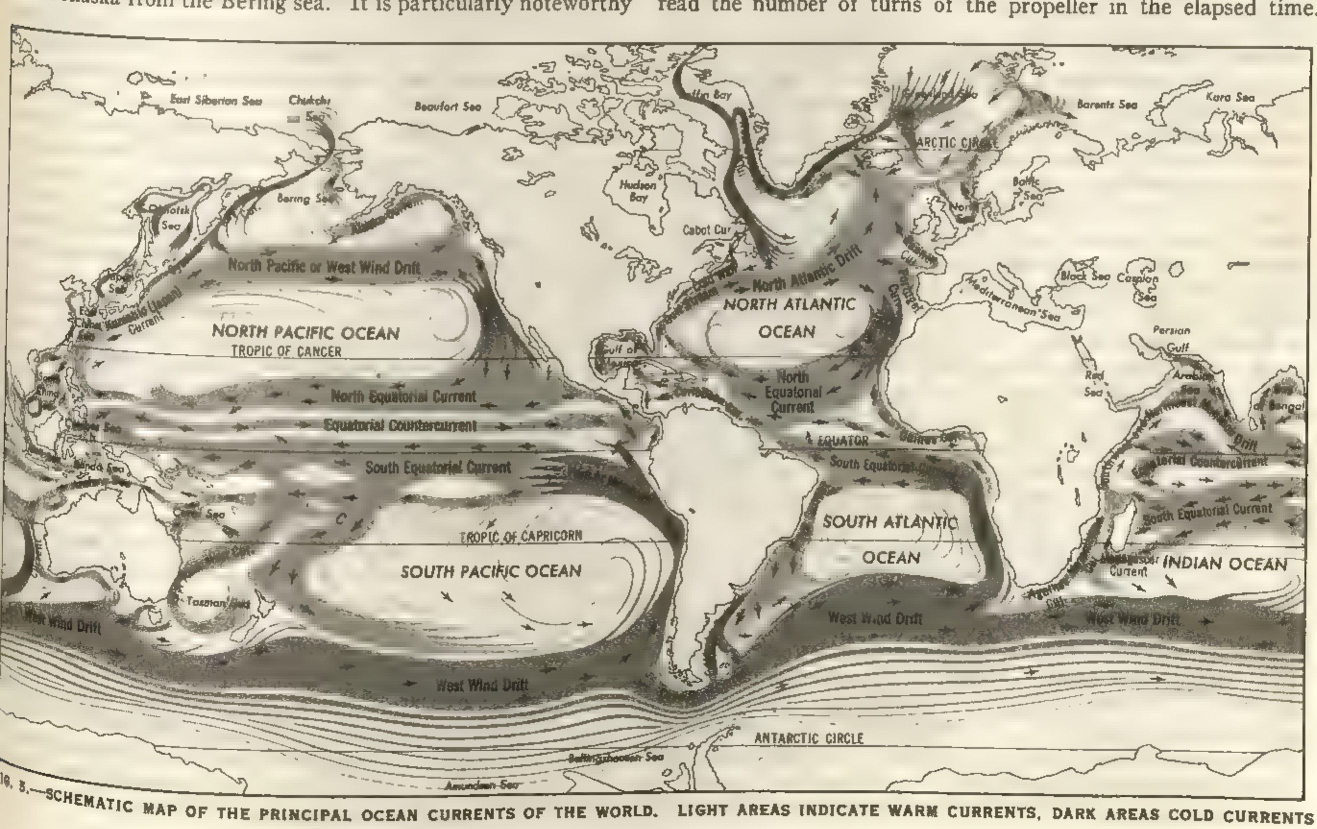


FIG. 5.—SCHEMATIC MAP OF THE PRINCIPAL OCEAN CURRENTS OF THE WORLD. LIGHT AREAS INDICATE WARM CURRENTS, DARK AREAS COLD CURRENTS

Lead or bronze pellets drop at intervals into a compartmented compass box to show the current direction. The Roberts meter is somewhat similar in principle, but transmits its readings electrically or by radio from a buoy at the surface. There have been many other developments along similar lines, but the principal drawback with such devices is the difficulty of anchoring a ship in deep water.

A method developed in 1948 by Von Arx is to make use of the electrical properties of sea water itself. Since sea water is an electrical conductor, any motion it makes in the earth's magnetic field will set up an electrical current. A pair of electrodes in tandem, towed behind a ship, will record an electrical signal proportional to the component of the ocean current normal to the ship's course. A 90° change in course, therefore, will provide both components of the ocean current. The geomagnetic electrokinetograph, or GEK, thus has no problems of anchoring in deep water; in shallow water the electrical conductivity of the bottom needs to be considered. Joseph L. Reid, Jr., in 1952 showed that the observed drift of a drogue at 30 or 60 ft. among the islands off southern California agreed excellently with the integrated currents obtained simultaneously with the GEK.

A variation on the same principle is to use fluctuations in electrical current recorded in a submarine cable. This method has been employed in the English channel and in the Straits of Florida to measure the total current transport through the strait, and excellent agreement with flow deduced from tide, sea level and winds has been obtained in the Straits of Dover with this method by K. F. Bowden.

The geomagnetic methods, drogues and meters all give the total resultant water movement at any point, inertial, tidal and wind driven as well as permanent. By determining accurately the density of the water at a number of points, it is possible to compute the permanent currents, since, as shown above, the density gradient is matched by Coriolis force. In practice this is done by stopping a ship at intervals of about 60 mi. and lowering sampling bottles equipped with recording thermometers to a number of depths. Commonly 15 or more samples are taken to depths of down to 4,000 ft. or more, the samples being only 30 ft. apart near the surface but at greater intervals as the depth increases. The temperature is read at each depth to .03° or .04° F.; the salinity of the water sample is determined to $.02^{0}/_{00}$, and from these the density or specific gravity is calculated to .01 in σ_t. Each vertical series of samples constitutes an oceanographic station, and at each station the average density is computed for the vertical water column by an ingenious series of approximations. Since pressure is the product of density × gravity × depth, the height of the water column above levels of identical pressure at two adjacent stations will vary inversely with the mean densities, and the difference in height is equivalent to a difference in sea level between the two stations. On a nonrotating earth, the water would flow like a river, downhill from the higher level to the lower; but since on the rotating earth the density gradient is assumed to be balanced by Coriolis force, the motion must be directed not down the slope but 90° *cum sole*. The downslope acceleration, slope × gravity, thus equals $2\omega v \sin\phi$, or $v = \text{slope} \times \text{gravity}/2\omega \sin\phi$. At latitude 45°, for two stations 100 mi. apart, if the difference in sea level (or dynamic height) is one foot, the slope is 1/528,000 or 1.89×10^{-6}; gravity is 21.94 mi. per hour per second; and $2\omega \sin\phi$ is $2 \times .729 \times 10^{-4} \times .707$ or 1.03×10^{-4} radians per second. Hence the current speed is

$$\frac{21.94 \times 1.89 \times 10^{-6}}{1.03 \times 10^{-4}} = .40 \text{ m.p.h.}$$

In regions like the Gulf stream, where speeds of 4 m.p.h. are often observed, the sea level therefore changes about one foot in ten miles. In practice, a map of the sea surface is prepared, much like a weather map, on which contours of equal dynamic height are drawn. The current direction is along the contours, and its speed is inversely proportional to the spacing of the contours.

This geostrophic, *i.e.*, earth's rotation, method, of course, is not valid near the equator, where Coriolis force vanishes in respect to horizontal movement. Its main drawback elsewhere is its dependence on locating a level of no motion above which the densities are averaged. But the validity of the assumption that friction can be neglected and hence the details of computed current flow will agree with those observed by other methods has been repeatedly demonstrated: in the Gulf stream by Georg Wüst in 1924 comparing direct current measurements from an anchored ship; on the Grand Banks by the International Ice patrol, comparing observed drifts of icebergs; and in many other cases. The geostrophic method is also of less use in very deep water, since there the variations in density are not much greater than the uncertainties in their measurement.

7. Subsurface Currents.—In general, in the upper layers of the sea, the geostrophic method can be employed to determine currents below the surface as well as at the surface itself. It has shown that the California current extends to a depth of less than 1,500 ft., the Kuroshio and Gulf stream to 3,000 or even 5,000 ft., and the West Wind Drift in the Antarctic to 10,000 ft. In certain areas the currents at depth are opposite to those at the surface. Thus, Wüst in 1955 computed that at a depth of 10,000 ft. along the Atlantic coast of South America there are currents setting southerly with speeds up to 0.28 m.p.h., while near the bottom, in depths of 11,500 ft. or more, there are currents setting in the opposite direction with speeds as high as 0.35 m.p.h. Stommel in 1956 showed that similar currents should exist beneath the Gulf stream, and such southerly setting currents at depths of 8,200 to 9,200 ft., with speeds up to 0.2 or 0.3 m.p.h. were observed there using Swallow floats from the R.R.S. "Discovery II" in 1957. Photographs of the ocean bottom confirm the existence of strong currents at great depths, as they frequently show the presence of ripple marks.

A subsurface current of a much different character was demonstrated by Townsend Cromwell in 1952 on the equator in the central Pacific. The surface current, the Equatorial current, set west at about 1 m.p.h., while drogues placed at a depth of only 200 ft. revealed the existence of a narrow current (which has been named the Cromwell current) setting at an even greater speed in the opposite direction. R. Montgomery subsequently called attention to records of a similar undercurrent in the Atlantic, and J. Knauss observed an equatorial undercurrent in the Indian ocean in 1963.

8. Density Currents.—Certain permanent currents in the ocean are unrelated to the general wind-driven circulation that has just been considered. For example, in the Straits of Gibraltar there is a strong surface current (up to 4 m.p.h.) entering the straits above an equally strong subsurface current flowing in the opposite direction. This circulation results from evaporation in the Mediterranean, which produces water of high salinity that sinks below the surface in the winter months. Although the net evaporation from the Mediterranean amounts to only 1.5 cu.mi. per day it sets up an exchange of about 25 times as much water, so that the inflow through the straits is 36.3 cu.mi. per day and the subsurface outflow 34.8. This influx of water is equivalent to the total volume of the Mediterranean every 75 years.

9. Turbidity Currents.—Another type of transport in the sea completely unrelated to the kinds of current previously described is the turbidity current. This type of flow is thought to take place chiefly down the continental slopes, where loose mixtures of sediments and water collect. From time to time, it is believed, these collections of material dislodge, often under the impetus of earthquakes, and the turbulent mixture of sediments and water, with an average density much greater than water but with many of the properties of a fluid, cascades down the slope like an avalanche. For many years the existence of such currents was accepted only by geologists, on the basis of small-scale laboratory experiments and of the observed characteristics of marine sediments, sedimentary rock and submarine canyons, which are otherwise very difficult to explain. Bruce C. Heezen and Maurice Ewing in 1952, however, presented information from the timing of breaks of transatlantic telegraph cables after an earthquake near the Grand Banks in 1929 which showed that a disturbance had proceeded down the continental slope at a rate up to 60 m.p.h., and they subsequently demonstrated that the basin at the foot of the slope was covered with freshly deposited sediment of shallow-water origin. Al-

though this report was by no means universally accepted at the time as proof of the existence of such turbidity currents, an earthquake at Orléansville, Alg., in 1954 broke cables in a similar fashion, yielding a downslope speed up to 45 m.p.h.

10. Vertical Water Movements.—When a persistent wind blows along a coast that lies to the left of the wind direction (in the northern hemisphere) the net transport of water in the wind-induced current is offshore. Since the coast acts as a barrier, water to replace that blown offshore can only come from the deeper layers. This phenomenon is known as upwelling, and it exists along the coast of northern California in summer and off Morocco, Peru and South-West Africa. The replacement water comes from a depth of 600 to 1,000 ft., that is, from well down the thermocline and below the euphotic zone, so that the water is both appreciably colder and richer in plant nutrients than the water it replaces. Zones of upwelling, therefore, considerably modify the climate of the coasts where they occur (the coastal fogs of California result from this cause, for example). They are also productive fishing areas.

TABLE VI.—*Abundance of Elements in Sea Salt*
(in parts per 1,000,000 parts of sea water by weight)

Element	Average concentration	Remarks	Element	Average concentration	Remarks
Hydrogen	2.7	(also in water) major constituent	Silver	.0003	...
Helium	.000005	(only as a gas)	Cadmium	.0001	.
Lithium	.17	conservative	Indium	.02§	..
Beryllium	.0000006	...	Tin	.003	..
Boron	4.8	major constituent	Antimony	.0005§	.
Carbon	28	major constituent	Tellurium	.	.
Nitrogen	.5*	nonconservative	Iodine	.05	nonconservative
Oxygen	1,920†	major constituent	Xenon	.0001	(only as a gas)
Fluorine	1.3	major constituent	Caesium	.0005	.
Neon	.0001	(only as a gas)	Barium	.050	conservative
Sodium	10,680	major constituent	Lanthanum	.000003	.
Magnesium	1,290	major constituent	Cerium	.000001	.
Aluminum	.01	conservative	Prasodymium	.	.
Silicon	3	nonconservative	Neodymium	.00002	.
Phosphorus	.07	nonconservative	Promethium	‡	...
Sulfur	895	major constituent	Samarium	.000004	.
Chlorine	19,215	major constituent	Europium	.000001	
Argon	0.6	(only as a gas)	Gadolinium	.000006	.
Potassium	385	major constituent	Terbium	.	.
Calcium	410	major constituent	Dysprosium	.000007	.
Scandium	.00004	.	Holmium	...	.
Titanium	.001	...	Erbium	.000006	.
Vanadium	.002	nonconservative	Thulium	..	.
Chromium	.00005	...	Ytterbium	.000005	.
Manganese	.002	nonconservative	Lutecium	.000001	.
Iron	.008	nonconservative	Hafnium	.	.
Cobalt	.0005	nonconservative	Tantalum	.	.
Nickel	.002	nonconservative	Wolfram	.0001	.
Copper	.003§	nonconservative	Rhenium	.	.
Zinc	.01§	nonconservative	Osmium	.	.
Gallium	.00003	conservative	Iridium	.	.
Germanium	.00007	conservative	Platinum	.	.
Arsenic	.003	nonconservative	Gold	.000004	...
Selenium	.004		Mercury	.00003	.
Bromine	65	major constituent	Thallium	.00001§	.
Krypton	.0003	(only as a gas)	Lead	.0003	
Rubidium	.12	conservative	Bismuth	.00008	.
Strontium	8	major constituent	Polonium	.	.
Yttrium	.0003	nonconservative	Astatine	...	...
Zirconium	...	...	Radon	6×10^{-16}	(only as a gas)
Niobium	.00001	...	Francium	...	..
Molybdenum	.01	nonconservative	Radium	1×10^{-10}	.
Technetium	‡	...	Actinium	.	..
Ruthenium	...	...	Thorium	.00005	.
Rhodium	...	...	Protactinium	2×10^{-9}	..
Palladium	...	...	Uranium	.003	conservative

*Also as gas. †Also as gas and in water. ‡Probably does not occur in nature. §Or less.
Source: Based on compilations by E. D. Goldberg and T. Chow.

In the open sea, areas of similar upward water movement are found in regions of divergence—lines along which the currents tend to flow away on both sides. Again the continuity is maintained by water that rises to the surface. Generally the vertical movement is less than 1,000 ft., as along the Pacific equator and the northern boundary of the Equatorial countercurrent, but in the Antarctic, particularly south of the Atlantic, deep water rises to the surface.

Convergences are lines toward which currents flow from both sides and where water, therefore, must be sinking. The water sinks only to the depth where water of corresponding density is found, which in most regions is not far below the surface, and there it spreads out sideways. The bottom water of the Mediterranean, however, is renewed by surface water that sinks in winter along its northern coasts; the Arctic ocean is filled with water that has been cooled in the Norwegian sea; the deep water of the North Atlantic is renewed from the surface just to the south of Greenland; and the rest of the ocean derives its bottom water mainly from the Antarctic, where the densest water is formed in winter along the continental shelf, particularly in the Weddell sea. Lines of convergence exist all around Antarctica (the Antarctic convergence), as well as in the subtropics, the tropics, the Equatorial current system and the North Pacific.

VI. CHEMISTRY OF SEA WATER

1. Elements in the Sea Salts.—About 60 of the first 92 elements in the periodic table have been detected in sea water. They exist mainly as dissolved salts, although some are dissolved gases, some are mainly in particulate form, and hydrogen and oxygen of course make up the water itself. In each 1,000 parts by weight of sea water, on the average, there are 965.1 parts of water and 34.9 of salt. The water is composed of 108 parts of hydrogen and 857.1 parts of oxygen, in addition to which 1.9 parts of oxygen and a trace of hydrogen are in chemical combination in the salts, mainly with the sulfur, carbon and boron. There is also a significant quantity of oxygen present as dissolved gas (*see* Table VI).

Although no sharp line can be drawn, it is possible to distinguish between the major constituents and the minor constituents in the salt. The major constituents consist of the cations of sodium, potassium, magnesium, calcium and strontium and the anions of sulfate, chloride, bromide, fluoride, carbonic acid and boric acid. They are found everywhere in the ocean in virtually the same proportions and make up 99.997% of the total dissolved salts. The minor constituents are all the rest of the elements. They in turn can be separated into conservative and nonconservative elements. The conservative elements, like the major constituents, are found everywhere in constant proportion to the total salts. The nonconservative elements show a variation in their relative concentration, principally through being selectively removed from the water by plants and animals. Table VI lists the elements in order of atomic number and gives their average concentration in sea water as far as they have been determined.

2. The Plant Nutrients in the Sea.—In agriculture, the main plant nutrients with which the farmer concerns himself are nitrogen, phosphorus, potassium and, to a lesser extent, calcium and magnesium. In the sea, as Table VI shows, potassium, magnesium and calcium are so abundant relative to the other necessary elements that they can be ignored as limiting factors in growth of plants. However, a new element, silicon, makes its appearance in the sea as a plant nutrient, since it is required by diatoms in the formation of the tiny shells (frustules) of silica with which they surround themselves. Although silicon is one of the most abundant elements in the earth's crust, the extremely low solubility of its compounds limits its availability in sea water. The main plant nutrients in the sea therefore are phosphorus, nitrogen and silicon.

All three of these elements are characteristically in short supply in the surface layers of the ocean, in the depths where sunlight is adequate for photosynthesis. Below this depth, they undergo rapid increases in concentration resulting from the redissolving of their compounds from the organic detritus sinking from above,

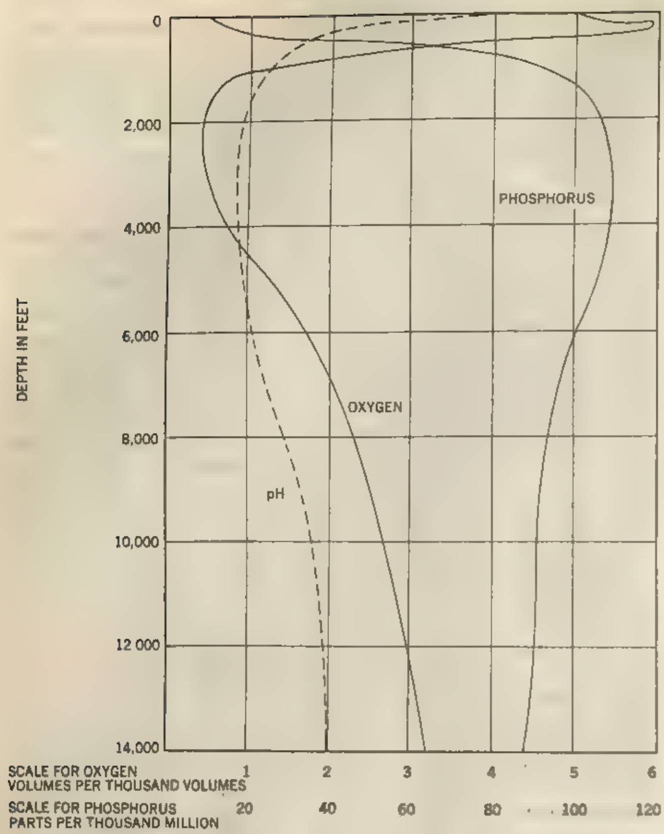


FIG. 6.—DISSOLVED OXYGEN, pH, AND DISSOLVED INORGANIC PHOSPHORUS, SHOWING TYPICAL VARIATION WITH DEPTH IN THE PACIFIC OCEAN OFF SOUTHERN CALIFORNIA

Multiplying the phosphorus values by 6.5 would furnish a good approximation to the curve for nitrogen (in nitrate)

or from the metabolism of the bacteria and animals living in the deeper water. Phosphorus occurs in the sea chiefly as dissolved phosphate, although there are also significant quantities of organic phosphate compounds dissolved in the waters near the surface. Fig. 6 shows the typical distribution of phosphate with depth in the North Pacific. The association of a maximum in the phosphate curve with a minimum in the oxygen curve is characteristic of all the oceans.

There is less phosphate in the waters of the Atlantic, a typical curve for that ocean increasing from zero at the surface to 60 parts of phosphorus per 1,000,000,000 parts of sea water (by weight) at 3,000 ft. depth and decreasing again to about 45 at 6,000 ft. Occurrence in the Indian ocean is intermediate between the Atlantic and Pacific.

Like phosphorus, nitrogen occurs to some extent in dissolved organic compounds in the sea, but their distribution is not well known. Most of the dissolved nitrogen in the sea is in the form of nitrate. The distribution of nitrate with depth is very similar to that of phosphate, and all the statements in the preceding paragraph and in fig. 6 about phosphate will be equally true for nitrogen, if the values for phosphorus are multiplied by 6.5. Ammonia also occurs to some extent in the sea, as the first step in the decomposition of organic matter, either by bacteria or metabolically. In the illuminated layers it is utilized by plants as readily as nitrate, and in the deeper layers it is oxidized by bacteria, first to nitrite and then to nitrate.

Silicon occurs both in solution, as silicate, and in particulate matter, as clay or undissolved fragments of diatoms. The same kind of increase of silicate with depth is observed as with nitrate and phosphate, typical values ranging from 300 parts of silicon per 1,000,000,000 at the surface to 5,000 at a depth of 6,000 ft. in the Pacific and from 50 at the surface to 1,000 at 6,000 ft. in the Atlantic. Since silicon is not needed by bacteria in their metabolism, its regeneration in the water must be entirely from physical solution of the silica in diatoms, and hence maxima do not occur in association with oxygen minima.

In comparison with the total amount in the sea, very little phosphate or nitrate enters the sea from rivers. Silica, however, is delivered to the ocean in abundance from the weathering of rocks. Thus there is usually enough silicate in the upper layers of the sea to support diatom growth after the nitrate and phosphate are used up, and silicate therefore is less often a limiting factor in plant growth than phosphate or nitrate.

3. Trace Elements.—Although most of the elements present in sea water are in quantities that the chemist would designate as traces, this term refers specifically to certain elements that are needed to support plant and animal life, but in quantities much smaller than those of the carbon, oxygen, hydrogen, nitrogen, calcium, phosphorus, silicon, sulfur, sodium, potassium and chlorine that make up 99.9% of the weight of living organisms. They are not needed for general tissue building or skeletal formation, but enter into specific compounds that serve such purposes as catalysts in respiration. Examples are magnesium in the chlorophyll molecule, iron in hemoglobin, copper in the hemocyanin of crustaceans, iodine in thyroxin or di-iodo-tyrosine in seaweeds and fluorine in teeth enamel. Other elements that are known to be required in the nutrition of plants are boron, zinc, molybdenum, cobalt and manganese.

Vanadium is accumulated by certain holothurians and tunicates (niobium may replace vanadium in one species of tunicate); bromine is incorporated into organic compounds in some corals and marine snails; and other marine organisms concentrate arsenic and nickel. Of these elements, cobalt and nickel are the least abundant in sea water, but there is no evidence to show that this low concentration limits plant growth. Iron and manganese, however, which are only slightly more abundant, very likely do limit growth in the sea, since their compounds are present in sea water mainly in particulate form and must be supplied largely by erosion or drainage from the continents. The other trace elements are for the most part sufficiently abundant in the ocean to take care of the requirements of most marine organisms. The vanadium-rich holothurians and tunicates are an exception. Their blood contains up to 10% vanadium, which is 50,000,000 times as much as there is in sea water. The requirement for collection and concentration of these trace elements is probably the main factor controlling the growth and abundance of these animals, although the role played by vanadium (or niobium) in their metabolism is not yet understood.

4. Dissolved Gases.—Besides the dissolved salts, sea water contains appreciable concentrations of dissolved gases. The exact amounts depend on the previous history of the water. The values given in Table VII represent saturation of the gases in equilibrium

TABLE VII.—*Saturation of Gases*
(solubility in volume of gas per 000 volume of sea water [ml./l.])

Gas	At 39° F.	At 77° F
Helium	.00004	.00004
Nitrogen	13.0	8.9
Oxygen	7.2	4.8
Carbon dioxide	.38	.20
Neon	.00018	.00014
Argon	.36	.23
Krypton	.00007	.00005
Xenon	.00002	.00001

with the atmosphere at the standard pressure of one atmosphere and the stated temperatures. In addition radon, which is radioactive with a half life of about four days, has been detected in sea water to the extent of about 3×10^{-12} millilitres per litre (ml./l.). Because of its short half life, it is not in equilibrium with the atmosphere.

Dissolved nitrogen is the most abundant gas in the ocean, as it is in the air. Although both nitrate-fixing bacteria and denitrifying bacteria have been identified in bottom mud, it appears that they lack sufficient nitrate and other food sources to operate to any significant extent in the sea. The dissolved nitrogen in sea water therefore shows little fluctuation and always corresponds closely to equilibrium with the atmosphere at the temperature and salinity of the water sample.

Dissolved oxygen, on the other hand, shows great variations in the ocean. Where photosynthesis takes place in the upper, illuminated layers of the ocean, oxygen values may exceed 120% of saturation. On the other hand, where biological oxidation is taking place in the absence of photosynthesis or renewal from the surface, the oxygen will be depleted. The distribution of dissolved oxygen with depth thus characteristically shows a marked decrease below the illuminated layers, with the curve going through a minimum and then increasing again with depth as in fig. 6. In the Atlantic, the values at great depth are often higher than at the surface, but in the North Pacific the increase is not so great. This difference in the oxygen content at depth reflects the different sources of supply of the deep water, which in the Atlantic is renewed by sinking from the surface both in the Arctic and the Antarctic, whereas the Pacific is cut off from the Arctic basin by Bering strait and can be renewed only from the south. Fig. 2, a plot of oxygen values at 13,000-ft. depth, well illustrates this difference. The oxygen values for the North Pacific (at the bottom of the figure) are below 3.5 ml./l., whereas at the same latitude and depth in the North Atlantic, the values are 5.0 to 6.0.

Under special conditions, oxygen depletion in the sea can be carried to the point where all the dissolved oxygen is used up. This effect occurs when the supply of decaying organic material sinking from above exceeds the supply of oxygen. Under such conditions, sulfate-reducing bacteria multiply, obtaining their oxygen requirement from the abundant sulfate ions in sea water and producing hydrogen sulfide. This gas is poisonous to practically all other forms of life in the sea. In the presence of oxygen it is quickly oxidized to sulfate and water.

The figures in Table VII for the solubility of carbon dioxide refer only to the amount in true physical solution. It will be observed that carbon dioxide is relatively much more soluble in water than the other gases, as it makes up nearly 2% of the gases in equilibrium with the atmosphere, in which it amounts to only .03%. Besides this great physical solubility, carbon dioxide is also in chemical combination in the dissolved salts, principally in the form of bicarbonate ion. In general, for each molecule of oxygen that is used up in respiration or oxidation, one molecule of carbon dioxide is produced, so that the curve for carbon dioxide as a function of depth should be a mirror image of the curve for oxygen. At great depths, however, the total carbon dioxide continues to increase, as the result of the redissolving of calcium carbonate particles which slowly sink through the depths from the photosynthetic zone where they were formed as mollusk shells, foraminifera tests and the like.

The high solubility of carbon dioxide in the sea is of great importance in understanding long-range changes of climate. Carbon dioxide in the atmosphere acts much like the glass in a greenhouse, passing the shorter radiation received from the sun but trapping the longer infrared radiation that originates on the earth's surface. Doubling the carbon dioxide content of the atmosphere would increase the surface temperature of the earth by 6½° F. Until the 20th century, the atmosphere and the ocean were in a steady state with regard to carbon dioxide, with precipitation of calcium carbonate in marine sediments proceeding about as fast as production of carbon dioxide by volcanoes. However, the great expansion in combustion of coal, oil and natural gas since about 1900 is supplying carbon dioxide from these "fossil fuels" at a rate estimated to provide a 30% increase in atmospheric carbon dioxide in a century. There is about 60 times as much carbon dioxide in the sea as in the atmosphere, but the rate at which the sea comes to equilibrium with the atmosphere is unknown. One of the principal problems investigated during the International Geophysical Year in 1957–58, therefore, was the distribution of carbon dioxide between the surface layers of the sea and the atmosphere, in order to determine how rapidly the sea will absorb the extra atmospheric carbon dioxide.

Helium, neon, argon, krypton and xenon belong to the family of "noble gases," which are chemically inert and are thus without significance in the sea. The atmosphere also contains traces of hydrogen gas, but there is no information as to whether the sea is in equilibrium with the atmosphere with regard to dissolved hydrogen. Methane and perhaps other hydrocarbon gases are known to be produced during the decomposition of organic matter, but their distribution in the sea has never been investigated.

5. Direct Production of Chemicals From Sea Water.—By appropriate chemical treatment, certain elements can be extracted directly from sea water without preliminary concentration. Thus, sea water is first acidified and then chlorinated to liberate bromine, which is extracted by blowing it out of the water with a current of air. The recovered bromine in turn is used to make ethylene dibromide, a constituent of ethyl gasoline.

Similarly, magnesium hydroxide is precipitated from sea water when the water is made alkaline. The alkali commonly used is calcium hydroxide, made by calcining oyster shells. The precipitate of magnesium hydroxide is filtered from the sea water. It is used directly as milk of magnesia, calcined to magnesia (MgO), converted to magnesium carbonate or treated with hydrochloric acid to produce magnesium chloride, which in turn, through electrolysis of the molten salt, is the basis for production of metallic magnesium. For the recovery of salts from sea water by evaporation, *see* SALT.

6. Gold From Sea Water.—Much popular interest has been aroused by the reported analyses of sea water for gold, silver and uranium. The hypothetical value of these substances in a cubic mile of the ocean is impressive. However, to obtain one troy ounce of gold from the sea (assuming 100% recovery) would require the processing of 8,000,000 tons of sea water and involve the separation of the gold from 280,000 tons of salts. Although 80 oz. of silver and 50 lb. of uranium would theoretically also be obtainable, it appears entirely impractical to obtain precious metals on a commercial basis. *See* also GEOCHEMISTRY.

VII. BIOLOGICAL OCEANOGRAPHY

It is virtually impossible to draw a firm line of division between marine biology (*q.v.*) and biological oceanography. However, we can include under biological oceanography the interrelationship between the plants and animals of the sea and its waters, currents and sediments, and consider marine biology as being concerned primarily with the form, functions and life histories of the organisms themselves. Many of the interactions between organisms and the chemistry of sea water and between organisms and the bottom sediments have already been covered.

1. Organisms and the Physical Properties of Sea Water.—Excepting the plants and animals of the intertidal zones, those that live in the sea are surrounded by an abundance of water at all times, and hence they do not develop the special tissues and organs for conserving water that are found in land forms. Likewise, the giant seaweeds have no need for the complicated vascular structure of trees, and their "roots" are simply devices for anchoring (holdfasts), not for collecting water. The buoyant support offered by water permits the development of such creatures as jellyfish, which entirely lack any skeletal structure and in fact are 96% sea water and 4% protoplasm (which itself is five-sixths water). Likewise, the organic matter in diatoms consists of about 6% chlorophyll, whereas the green leaves of land plants are only about 0.8% chlorophyll, since the large majority of the plant cells have to serve other functions than photosynthesis. Whales grow to a length of 100 ft. and a weight of over 100 tons; yet in the water they are swift and agile. A land-dwelling quadruped of like dimensions would have hopelessly overloaded limbs.

From the standpoint of temperature, the sea is a much more comfortable environment than the land. The total annual range of temperature, which may amount to 100° F. or even 125° F. on land, does not exceed 15° F. in the ocean, and the elaborate leaf-shedding that most land plants undergo in the temperate zones in order to minimize storm and ice damage in the winter is unknown in the marine environment. As long as light is available, marine plants thrive, whatever the temperature, and ice floes often are stained on their undersides by proliferating layers of diatoms. The open sea, however, lacks the firm support that terrestrial creatures derive from land, and therefore the drifting organisms of the sea (plankton) generally are equipped with some mechanism that keeps them from sinking to the depths. Thus, most diatoms,

which are single-celled algae with a siliceous covering that has a greater density than sea water, are shaped to provide the maximum drag, so that they will sink as slowly as possible. Dinoflagellates, chlorophyll-containing protozoa which are second only to the diatoms as primary producers of organic matter in the sea, have similar adaptive structures and are also equipped with a pair of oarlike flagellums with which they are to a limited extent self-propulsive.

The acoustic properties of water are utilized by only a few marine organisms. Numerous kinds of fish are known to make drumming or grunting noises, for purposes not entirely clear; porpoises and other cetaceans also emit sounds; and certain shrimp found over rocky bottom in subtropical waters produce sharp crackling sounds by snapping the joint of a lobsterlike claw. As individuals none of these amounts to much as a noise producer, but collectively, when croakers gather on their spawning grounds in breeding season, porpoises collect in schools of hundreds of individuals or the shrimp live as they normally do, in swarms of millions, the production of noise can be tremendous and it can effectively interfere with the use of sonar and similar underwater acoustic gear. In the case of porpoises, W. N. Kellogg in 1958 demonstrated that the production of sound is for echo-ranging purposes, since porpoises easily find fish and avoid obstructions that they cannot see.

Hydrostatic pressure in the sea is of little concern to most forms of life, just as the ordinary atmospheric pressure is of slight influence on terrestrial forms. At sea level, for example, an average man, with a skin area of about 19 sq.ft., is supporting a total atmospheric load of about 40,000 lb.; yet, since this pressure is exerted equally in all directions, it is self-equalizing and insensible. Likewise the tremendous pressures at great depths in the sea are self-equalizing.

Pressure changes are significant to two groups of organisms. One is the fishes equipped with swim bladders. They are unable to make rapid adjustments to changes of depth, and it is not uncommon for fish caught even in moderate depths of water (as cod on continental shelves) to reach the surface with swim bladders abnormally distended. The other group is the air-breathing animals, which for the most part are unable to operate very far below the sea surface. In free dives, men have penetrated to a depth of about 200 ft. without special equipment, 300 ft. with compressed air and 350 ft. with special atmospheres. Helmeted divers have reached 600 ft., breathing a mixture of oxygen and helium. These achievements are far overshadowed by those of the sperm whale. Bruce Heezen in 1957 reported 13 cases of whales tangled in submarine cables, which showed that sperm whales regularly swim along the ocean bottom at depths as great as 3,700 ft. The physiological mechanism that permits them to accomplish this was not explained.

One great difference in physical characteristics between the land and the aqueous environment is in the availability of solid surfaces. These are so common on land as to be taken for granted, but this is not the case in the ocean. It has been shown that in order to carry out their metabolic functions efficiently, bacteria must have a nearby solid surface. Thus the limiting factor in the growth of marine bacteria is usually the lack of surfaces, not of nutrients. A fresh surface introduced into the sea is quickly covered with a slimy film of multiplying bacteria. Organisms such as diatoms, gorgonian corals and probably others secrete antibiotics to inhibit growth of bacteria, but inorganic particles are soon coated with them. Marine sediments are rich in bacteria, which were carried to the bottom on settling particles and were able to multiply vigorously with a plentiful supply of food and of solid surfaces.

2. Phosphorescence.—The production of light by organisms is primarily a phenomenon of the sea (*see* BIOLUMINESCENCE). Phosphorescence, as it is generally called by the mariner, is found in many of the animals of the deep ocean, where it may serve as lure for prey, as protection to frighten away attackers or as an aid in mating, but its most spectacular manifestations are among the plankton of the surface layers, especially in warmer waters. Here a disturbance such as breaking waves or the wake of a ship may stimulate millions of tiny organisms into glowing. Individually each is but a speck, but collectively the light can be bright enough for reading the proverbial newspaper. A special form of this surface luminous activity has been observed in the Arabian sea, where it has long been known to seamen as the "wim-wams." It consists of revolving bands of light, several miles long, rotating slowly about a centre like spokes of a wheel. In 1955 a reliable report was made of several cases where luminous patches in the sea responded to stimulation by the ship's radar, but no explanation of the connection was available.

3. Mass Mortalities in the Sea.—The preceding discussion of life in the ocean has emphasized the factors that encourage organisms to grow and multiply. There also exist, however, physical and chemical relationships in the sea that result in catastrophic destruction of living forms. These relationships can have causes as simple as lowered temperature from an unusually cold winter or lowered salinity from exceptional river discharge. Changes in current can also be responsible, such as the famous El Niño of Peru, which brings unusually warm water south along the coast, with destructive effects first on the fish and then on the guano birds that feed on them. Vertical mixing can carry to the surface water low in oxygen (as in Walvis bay, South West Africa) or high in hydrogen sulfide (as in the Black sea), with fatal results to the surface fauna.

Another more complicated cause is uncommonly heavy growth of dinoflagellates in the surface layers. In many parts of the world these organisms from time to time multiply in such numbers as to colour the ocean surface red. They also produce toxic substances, which if concentrated by mussels or other shellfish render them highly poisonous, and which may also kill fish and invertebrates. The "red tide" of the west coast of Florida is the result of concentrated growth of the dinoflagellate *Gymnodinium brevis*. Both chemical and physical factors are involved in its extraordinary growth. Growth-stimulating factors derived from the coastal bayous are carried out to sea at times of increased river discharge; but only when currents and water temperatures happen to be suitable so that the growth-promoting substances are not widely dispersed can an outburst of the "red tide" develop.

VIII. ORGANIZATIONS FOR STUDY OF THE OCEAN

1. International.—The intercommunicating nature of the ocean has fostered the creation of a number of international organizations devoted to furthering its study. Among these are the International Council for the Exploration of the Sea, with headquarters at Copenhagen, which was established in 1902; the International Commission for the Scientific Exploration of the Mediterranean Sea, established in 1908; and the International Commission for the Northwest Atlantic Fisheries, established in 1949. These three groups are primarily concerned with collecting the oceanographic information required for proper management of the international fisheries in their respective areas. The International Hydrographic bureau, founded at Monaco in 1921, serves as a clearinghouse for information related to hydrography and charting. An Intergovernmental Oceanographic commission, with headquarters in the UNESCO Office of Oceanography, was established in 1961.

2. Europe.—Among the important institutions conducting research on the ocean are the Institute of Oceanology of the Academy of Sciences and the State Oceanographic institute, Moscow; the Havsforskningsinstitut in Helsinki, Fin.; the Oceanographic institute of Göteborg, Swed.; the Geophysical institute of the University of Bergen and the ministry of fisheries laboratory, both at Bergen, Nor.; the German Hydrographic institute, Hamburg, and the Institute für Meereskunde of the Universities of Kiel and Hamburg; the Rijkswaterstaat at The Hague and the Royal Netherlands Meteorological institute at de Bilt; the Institut Océanographique at Paris; and the Thalassolographic institute of Trieste, Italy. In Great Britain, the National Institute of Oceanography at Wormley, Surrey, was established by royal charter in 1949 to centralize work previously conducted in several government departments. Oceanographic work in connection with fisheries is conducted by the ministry of agriculture and fisheries laboratory at Lowestoft and by the fishery board for Scotland laboratory at Aberdeen. Private biological associations maintain laboratories

at Plymouth and at Millport, and training in physical oceanography is offered by Liverpool university. Tide studies are centred at the Liverpool Tidal institute, Birkenhead.

3. **North America.**—In Canada, oceanography is co-ordinated by the Joint Committee on Oceanography, established in 1947. The Fisheries Research board maintains a laboratory at Nanaimo, B.C., and jointly with the Department of Mines and Technical Surveys operates the Bedford Institute of Oceanography near Halifax. The institutes of oceanography at the University of British Columbia, Vancouver, and at Dalhousie university, Halifax, provide graduate instruction in oceanography. The Defence Research board maintains the Naval Research establishment at Dartmouth, N.S., and the Pacific Naval laboratory at Esquimalt, B.C., which work on specialized problems such as sound transmission in the sea.

In the United States, the Chesapeake Bay institute of the Johns Hopkins university, Baltimore, Md., the Institute of Marine Science of the University of Miami, Fla., the departments of oceanography of Texas Agricultural and Mechanical university, the University of Rhode Island, Oregon State university, New York university and the Universities of Hawaii and Alaska, the Scripps Institution of Oceanography of the University of California, La Jolla, the Allan Hancock foundation of the University of Southern California, Los Angeles, and the oceanographic laboratories of the University of Washington, Seattle, are among the colleges and universities that offer graduate instruction and conduct research in oceanography. Woods Hole Oceanographic institution, at Woods Hole, Mass., is a private institution established in 1930 to prosecute the study of oceanography in all its branches.

Among United States governmental organizations, the coast and geodetic survey of the department of commerce, the fish and wildlife service of the interior department, the Coastal Engineering Research centre of the U.S. army corps of engineers, and the U.S. coast guard all have programs of investigation in oceanography. In the naval establishment, the Navy Electronics laboratory at San Diego, Calif., the Mine Defense laboratory at Panama City, Fla., the Naval Ordnance laboratory at Whiteoak, Md., the Naval Research laboratory at Anacostia, D.C., and the naval oceanographic office at Suitland, Md., conduct studies of the ocean. The National Oceanographic Data centre, administered by the navy but financed jointly by several agencies, was established in Washington in 1960.

4. **Other Countries.**—In keeping with its extensive fisheries, Japan has numerous laboratories engaged in oceanographic investigations. The Ocean Research Institute of the University of Tokyo was established in 1962 as a centre for basic research. In Australia, the division of fisheries and oceanography of the Commonwealth Scientific and Industrial Research organization maintains a laboratory at Cronulla, New South Wales. The department of scientific and industrial research operates an oceanographic observatory at Wellington, N.Z. In India, Andhra university at Waltair is active in oceanography. The division of fisheries of the department of commerce and industries maintains a laboratory at Cape Town, S.Af.

See also references under "Ocean and Oceanography" in the Index.

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OCEANIA commonly refers to land areas scattered throughout the south-central Pacific ocean. The word has, however, been used with many meanings; the most inclusive, though least useful, embraces all insular regions between Asia and the Americas. A more practical definition excludes such nontropical areas as the Ryukyu and Aleutian islands and the Japan archipelago. The most popular usage delimits Oceania further by eliminating Indonesia, the Philippines and Formosa, since those islands and their peoples seem more closely related to the Asian mainland. This leaves an island area bordered by and including New Guinea, Palau and the Mariana Islands on the west, Hawaii and Easter Island on the north and east respectively, and extending southward to Australia and New Zealand. Europeans, when they charted these islands, divided Oceania into four parts: (1) Australia; (2) Melanesia (New Guinea eastward to Fiji); (3) Micronesia (Mariana, Caroline, Marshall and Gilbert islands); and (4) Polynesia (a triangle of many islands, including Hawaii, New Zealand and Easter Island). Ethnological studies cut across the traditional divisions of Oceania. This article reviews events in the settlement of the area, changes involved in the process and gives a survey of the archaeology of Oceania. For later history, administration, trade and further geographical description *see* Pacific Islands; Melanesia; Micronesia; Polynesia; also such articles as Australia, Commonwealth of; Hawaii; Fiji.

ETHNOLOGY

Oceania includes more than 10,000 islands and nearly 500,000 sq.mi. of land. Thirty thousand years ago no human beings lived there. When men entered the area they brought with them plants and animals new to Oceania together with social, political, economic and religious customs from their Asian homeland. Each island became a laboratory in which small communities of people experimented with local resources. Innovation also resulted from contact among island populations, each of which gradually evolved a unique pattern of life. By mid-20th century approximately 2,500,000 islanders were living in Oceania; their earlier cultures were being revolutionized by increased contact with the rest of the world.

Migrations.—Scientists still debate the details of Oceanic migrations, but there is overwhelming agreement on the east-Asian origin of Oceanic peoples. It is well established that during the Pleistocene epoch (Ice Age), which ended possibly 11,000 years

PATTERN OF PACIFIC MIGRATIONS BASED UPON THE THEORY OF THE EAST-ASIAN ORIGIN OF OCEANIC PEOPLES

The original occupation of Australia and New Guinea from the mainland is believed to have begun during the last period of the Pleistocene, about 20,000 years ago

ago, early forms of men were living in Asia and the westernmost islands of the Indies. These islands were then part of a single land mass (Sunda-land) joined to the mainland of Asia. Later, as glacial expanses in the northern hemisphere melted, the waters of the Pacific rose as much as 300 ft. and drowned the land bridges. New Guinea and Australia were also united (as parts of Sahul-land, separated from Sunda-land by a geologically unstable zone of islands including, *e.g.*, the Moluccas, Lesser Sundas and Celebes). Named Wallacea, the intervening region was characterized by ocean depths up to 16,000 ft., with islands never more than 60 mi. apart.

Throughout the last major Pleistocene period small bands of people, employing rafts or crude canoes, crossed Wallacea and made their way by slow stages to New Guinea and Australia. These first arrivals in southwest Oceania have been regarded as representing three principal racial stocks. The Oceanic Negrito stock, dominant among inhabitants of the tropical jungle of Queensland and in the interior of New Guinea, is revealed by short stature, dark skin and frizzly hair. The Murrayian or Ainoid element, present also in the aboriginal Ainu of Japan, characterized by lighter skin, wavy hair and short, quite hairy bodies, survives in mixed form in southeast Australia and in the high plateaus of New Guinea. The Carpentarian stock (sometimes called Veddoid because of similarities with the linear build, dark skin and wavy hair of men of south India) is detected in the appearance of central and north Australians and among the tribes of north and south coastal New Guinea.

The earliest immigrants from the Indies lived by hunting, fishing and collecting wild plant food. They lacked many of the cultural accomplishments of later arrivals from the Asian mainland. Wherever they settled, each group adapted to local conditions and many unique cultures and languages evolved. This heterogeneity became much more pronounced later, and the physical appearance of each population came to reflect differences resulting from mutation, natural selection, admixture, selective mating and small population

These conditions continued in the southwest Pacific for perhaps the first three-quarters of man's residence in Oceania. All of Australia and most of Melanesia were eventually discovered and settled by small colonies of these primitive food-collectors. Before the end of that period, however, a major cultural revolution had begun in Asia, best described as a shift to economies based on plant cultivation and livestock domestication. Such changes favoured a more stable existence, the development of more specialized skills and the concentration of larger populations in more permanent settlements. By 3000–2000 B.C. the first effects of these changes reached Oceania, apparently introduced from east Asia via the Indies and the Philippines by immigrants who are often referred to as Indonesians (or proto-Malays). These brown-skinned peoples, with straight to wavy black hair, medium stature and prominent cheekbones, are believed to have combined an Ainoid ancestry with genetic elements from Mongoloid peoples who were then moving south on the Asian mainland.

The more or less continual movement of Indonesians into New Guinea and other Melanesian islands to the east (although not into Australia in any force) contributed further to the genetic mixture of island populations. The newcomers spoke languages of the Austronesian (or Malayo-Polynesian) family, in time adopted by most of the coastal New Guineans and other Melanesian residents. (Other languages that have survived and are not known to be related to Austronesian, most of them in the New Guinea interior, are simply lumped together and called Papuan.

In like manner most of the food-collecting islanders learned to cultivate taro, yams, bananas and breadfruit introduced by the Indonesians from Asia. In spite of Indonesian influence, the inhabitants of Melanesia continued to display their Negritoid ancestry, and to retain many social and religious customs that resemble those of some Australian aborigines.

The far-flung islands of Micronesia and Polynesia to the north and farther east presented formidable obstacles to would-be migrants from either Melanesia or the Indonesian region. These small islands, in contrast with those settled in the southwest Pacific, did not provide adequate food for long-term support of people skilled only in hunting and other food-collecting techniques. Especially was this true in coral atolls of the Carolines, Marshalls and Gilberts. Furthermore the great distances separating the islands of Micronesia-Polynesia demanded seaworthy craft. These barriers were surmounted probably not later than [illegible] B.C. when Micronesia was entered by voyagers of predominantly Indonesian type not unlike those who had infiltrated Melanesia.

BURT GLINN—MAGNUM

CHIMBU WARRIOR OF NEW GUINEA

Short and dark-skinned, the Chimbu are linguistically and culturally Papuan (non-Melanesian) and probably represent a mixture of Negritoid and the other original genetic stocks from Asia

Limited evidence of prevailing winds, ocean currents and flyways of migratory shore birds suggests that pioneer voyages into Micronesia may have started from the Moluccas in the Indies or from the Bismarcks northeast of New Guinea. Archaeological evidence alternatively suggests a connection with the Philippines. Food producers with improved stone tools in those island regions could have built seaworthy canoes with sails and stabilizing outriggers. In the west Carolines, Palau is only 450 mi. from the Moluccas with four coral isles as convenient stopovers, and is no farther from the Philippines. Truk in the central Carolines is farther from the Moluccas and closer to the Bismarcks but is separated from the latter by nearly 500 mi. of water and only two intervening atolls. Drift voyages by fishermen or local travelers carried off course in storm or calm were probably more significant in the discovery of Micronesian islands than adventurous or colonial expeditions.

By whatever routes they came the discoverers of Micronesia made the small islands livable by supplementing the rich marine resources with such efforts as the cultivation of root and tree crops and the breeding of pigs and chickens. The contrasting environment of high volcanic islands (the Marianas and Palau, Yap, Truk, Ponape and Kusaie in the Carolines) and low coral atolls influenced these adaptations. Unique local development was fostered by geographic isolation, but to the extent that interisland trade existed in some areas (notably the Carolines) local differences perhaps were minimized. In support of these trading expeditions skills improved in canoe construction and handling, and navigation by the stars. Growing communities, associated with larger and more dependable food reserves, sought additional land for expansion. As the flow of immigrants continued—many of them probably forced out by population pressure from east Asia—many Micronesians were vanquished, absorbed or pushed out. Perhaps some even returned to the Melanesian islands of their ancestors or sought refuge in marginal places in that sector of the Pacific, and thereby added confusion to the history of Oceanic settlement by an intrusion of Melanesian-derived but Micronesian-adapted traits.

Micronesians must have taken 60 or 70 generations before some ventured in their sailing canoes to settle larger and more provident islands beyond the bounds of Micronesia. To the northeast lay only empty horizons and to the east only small improvident atolls in the Marshall, Gilbert and Ellice archipelagoes. To the southeast were lush volcanic islands at the eastern extremity of Melanesia which already may have been settled by migratory groups from western Melanesia. Sir Peter Buck proposed that Oceanic "vikings" had sailed from the Carolines through the screen of atolls to the high islands of Samoa, bypassing all of Melanesia. An alternative view suggests that persons from the New Hebrides or adjacent islands in east Melanesia were impelled to sail on to Fiji, Tonga and Samoa, even northward into eastern Micronesia.

While opinions differ as to the precise sequence in the discovery and settlement of Polynesia, few authorities still regard it as a direct migration from the Indies (or even as far west as Asia) by people who spent only a minimum time in Melanesia or Micronesia before reaching Polynesia. Rather the immediate source of Polynesians is placed in central Micronesia or east Melanesia (or a combination of both), and the migration is conceived as a more or less continuous flow of small groups that lasted for centuries and involved many persons. Most of the many islands of Polynesia were probably settled in the period beginning about 1000 B.C. and continuing until A.D. 500, a span of at least 60 generations. In west Polynesia, early centres of dispersal were Tonga and Samoa. In the eastern Pacific the more widely scattered islands, including Hawaii, Easter Island and New Zealand on the outer rim, were settled later from Tahiti and other islands in east Polynesia.

Polynesians in pre-European times were fairly homogeneous in race, language and culture, especially when compared with the Micronesians and the extremely heterogeneous Melanesians. Local variants that existed within Polynesia are explained by a combination of factors. Polynesians, like other Oceanic peoples, have always lived in small communities of only a few hundred persons or even less. Local distinctions in cultural tradition and physical type in such small groups could easily have resulted from the 25 centuries of inbreeding and relative geographic isolation following the first Polynesian settlement. Also, if all Polynesians were not descended from a single group that entered the area in 1000 B.C., but stemmed from a more enduring migration over many generations, then it is reasonable that changes in race, language and culture had meanwhile occurred in the region in which the migration had been initiated. All subsequent migrants into Polynesia from that outside source would reflect these changes.

E. AUBERT DE LA RÜE

IRRIGATED TARO GARDEN ON HUAHINE, SOCIETY ISLANDS

A basic foodstuff of the region, taro came from Melanesia to Micronesia and Polynesia with early settlers. Livestock and such crops as taro helped make many of the small, distant islands habitable

Whatever mixture of racial types exists in the Polynesian people is believed to have occurred mainly prior to dispersal within the Polynesian area. Generally speaking, Polynesians are taller and more robust than Micronesians but this may simply be the product of better living conditions in Polynesia. Although Micronesians display more physical diversity than Polynesians, they are predominantly of the brown-skinned Indonesian type. The Carolinians (apart from Palauans who, like the Marshallese at the other end of Micronesia, exhibit some Negritoid features) closely resemble the Polynesians, with the Gilbertese of east Micronesia intermediate both geographically and genetically. Most Polynesians are regarded as primarily of Indonesian type with a Negritoid strain suggested. This is consistent with the idea of a people that originated in central Micronesia and was exposed to Negritoid elements in east Melanesia before entering Polynesia.

Linguistically, Polynesians reveal a close affiliation with Fijians (most other Melanesian languages are quite divergent, an indication of greater antiquity), and are not greatly different from most Micronesians. Only Palauan and Chamorro (spoken in the Marianas) are excepted since these are more nearly akin to languages of the Philippines and the Indies. About the time that Polynesia was

being settled, Mongoloid Malayans from east Asia (also called deutero-Malay to distinguish them from the earlier, less Mongoloid proto-Malay) overran the Indies and the Philippines, forcing many earlier residents into less desirable inland regions. This tide of Asian humanity touched Micronesia only in its western extension and Melanesia only in places along the north coast of New Guinea. The Polynesians meanwhile, continuing their wanderings well into the Christian era, reversed the direction of their earlier expeditions and left their imprint on such western Pacific communities as Kapingamarangi and Nukuoro in Micronesia, and in Fiji, New Hebrides, Loyalty Islands and various Polynesian outliers along the fringe of Melanesia as far west as the Bismarcks. (*See* also AUSTROASIATIC LANGUAGES; MALAYO-POLYNESIAN LANGUAGES.)

Cultural Change.—When men from England, France, Germany, Holland and Spain explored the Pacific from the 16th to the 18th centuries, their journals reported a seemingly unlimited variety of ways in which Oceanic peoples had met and solved problems of living in a tropical ocean-bound environment. In the New Guinea interior Europeans observed Negrito hunters living in small bands with a minimum of technological and political attainments. They described similarly impoverished aborigines in the Australian wasteland who nonetheless performed elaborate ceremonials and had a seemingly complex kinship organization that defied the visitors' understanding. In some parts of Melanesia they met dark-skinned islanders in small autonomous communities who practised agriculture and accumulated wealth in pigs and shell money but conducted tribal initiations resembling those of Australian hunters. In other Melanesian islands they found other dark-skinned people who showed little interest in the spiritual, but who revealed a consuming passion for genealogies, aristocratic hierarchies and organized warfare, as did many Polynesians and some Micronesians. But in Micronesia Europeans also discovered brown-skinned natives who in many social institutions more closely resembled the mystically inclined gardeners of Melanesia.

Oceania has been described as a vast laboratory in which human experiments in living were tried by about 1,000 groups with as many unique results. The relationship between experimental group and environment was reciprocal. Pottery could not be made in islands without clay deposits, outrigger canoes could serve no purpose in the highland interior of New Guinea, breadfruit trees could not be grown on coral atolls in dry zones. But the islanders did exercise controls over the environment. They bred chickens and pigs on islands that before had supported none; they invented sleeping bags as protection against disease-bearing insects; they transported soil to coral isles where taro plants could not otherwise have been cultivated. The immigrant Indonesians with their superior technology survived in Micronesia where the hunting peoples of Australia would probably have failed.

In social organization, political authority and religious belief the relationship of Oceanic customs to the physical setting was less significant. Thus it was possible for technologically simple tribes in Australia and New Guinea to be as different from each other as they were in kinship and ceremonial practices. Similarly, though Polynesians shared an economy based on fish, coconuts and taro, some groups combined the functions of chief and priest in one man (usually the informal head of an extended family), while Hawaiians developed a semifeudal system of land tenure and political control reinforced by a corps of religious specialists.

Attempts to reduce the cultural systems of Oceania to an orderly scheme have depended much on the divisional concepts of Micronesia, Polynesia, Melanesia and Australia. However, scientific understanding of Oceanic prehistory has been hindered by the perpetuation of these divisions. Melanesia and Australia may be differentiated by certain features of the landscape, but while economic activities of the respective inhabitants were often notably different, social and religious practices suggested a commoner background. The divisional notions of Polynesia and Micronesia fail to distinguish between high and low island habitats that occur in both areas and, as with Australia-Melanesia, the separation of Polynesia from Micronesia is clouded by the occurrence of certain sociocultural institutions in both regions. The distribution of specific traits frequently overrides traditional borders, for example, loom weaving in the Carolines, a few Melanesian islands and none of Polynesia; a simplistic form of wood carving art in Micronesia, Fiji, Tonga and Samoa; hereditary ruling aristocracies in Hawaii, Tahiti and Tonga, some of Micronesia and only Fiji in Melanesia. The traditional divisions of Oceania are useful for geographic description but they fail to coincide with cultural patterns.

Reconstruction of Oceanic history requires information about the physical setting, the techniques, institutions and values brought by island migrants to new settlements and the nature of contacts with other groups, whether based on trade, warfare or ceremonial exchange. But even this knowledge is not enough, since vital clues to any community's history lie concealed in the individual's contribution to group life. Unfortunately Oceanic peoples were not historians in the European sense; they kept no written records but transmitted their knowledge orally. The individual in those traditions remained largely anonymous or assumed some legendary character that may or may not have been related to historic fact.

In the few centuries since Europeans discovered Oceania a revolution has occurred comparable to the changes initiated more than 4,000 years earlier by food-producing Indonesians. The impact of enormously increased contact in World War II was still having its effects in the 1960s. A new culture in the Pacific was emerging, but the same processes of change could be counted upon to produce island communities adapted to the changing scene. (L. E. MN.)

CHILDREN OF MOOREA, SOCIETY ISLANDS, FRENCH POLYNESIA

Like its neighbour Tahiti, Moorea is largely a high island of basaltic lavas. The low island in the background, however, is coral reef

WERNER STOY FROM FPG

ARCHAEOLOGY

The first cultural base that can be traced from Oceanic data is that called Mesolithic (Middle Stone Age). Finds in Melanesia, primarily in New Guinea, suggest that there may have been a still earlier, probably Late Paleolithic, penetration of those lands. That this reached Australia is very dubious and that it moved out into the islands of Polynesia is highly improbable. The Mesolithic people, with a simple hunting, fishing and shellfish gathering culture, spread widely from Asia and southeast Asia through Indonesia and Melanesia into Australia-Tasmania. The Mesolithic way of life must have ended as an important cultural component by 3000–2500 B.C. in Indonesia; remnants of it still endure among a few Australian aborigines on reservations.

Neolithic (New Stone) changes were represented by the addition to the old Mesolithic base of pottery, agriculture, domesticated animals, techniques of abrading, grinding and polishing stone, water craft (canoes) adequate for travel on the high seas and the use of massive stone in building and sculpture. The Neolithic also

until recently, the cultural base of the peoples of Melanesia and Micronesia-Polynesia. Australia-Tasmania, to judge from the Mesolithic cultural level, was settled relatively early, probably during the last glaciation. Tasmanian archaeology is not well understood, but the links that exist point toward Australian relationships. Genetically the Tasmanians show Negritoid relationships, indicating that they must have moved out of Melanesia—for it is there that the nearest true Negritoids live—as very early migrants.

In Australia there were no early or mid-Pleistocene cultures. The Cohuna and Talgai skulls do not vary greatly from Australian norms. Australian prehistory falls into inland and coastal aspects. Since the inland depends upon surface collections, their chronologic relationships are not well understood. A few coastal middens have long period sequences and offer the best hopes of arriving at time sequences for both the coast and, comparatively, the interior. The types of stone tools indicate a relationship with widespread Indonesian and Melanesian Mesolithic cultures.

Specifically, the Hoabinhian I of Indonesia and its pebble choppers, cores and hammerstones are similar to those tools of southeast Australia. Most intriguing of the old Australian stone industries is the Microlithic (small stone). Tiny chipped blades are abundant on inland sites in the southern parts of the continent. These small tools are a world-wide aspect of the Mesolithic. Thus the problems of Australian prehistory are not isolated but are an integral part of those of southern Oceania-Indonesia and southeastern Asia. The chronology of Australian-Tasmanian cultural sequences depends primarily on radiocarbon dating, climatological and geological complexes. South-central Australia undoubtedly supported a culture using microliths and small projectile points as early as 4000 B.C., while a sequence in the Sydney area shows well-developed local cultures about 2,000–3,000 years earlier. These dates are probably minimal (*see* GEOCHRONOLOGY).

Melanesia, the land of Oceanic Negroids, was settled before Australia-Tasmania, first by a Negritoid and then by an Australoid population, both apparently with Mesolithic cultures, and later by Neolithic Negroids. The three subracial groups have mixed extensively and this has beclouded knowledge of their genetic past. Early archaeological remains, presumably often located along the strands, have been covered by waters rising from the glacial ebb about 200 ft. or more below the present stand. Archaeological work in Melanesia as a whole is scant and early sites are rare. An aspect of Oceanic Neolithic culture of southeastern Asian origin is megalithic construction. These large stone remains include platforms, walled areas, heroic human and animal figures, large mortars and pestles, etc. A concentration of Melanesian megaliths exists in eastern New Guinea, the highlands and adjacent islands. Mesolithic sites with older Australian and Indonesian affiliations have been studied. Investigations in the tumuli of the interior of the Ile des Pins, New Caledonia, show large coral-ironstone "concrete" cylinders 6–10 ft. in diameter in their centres, covered with earth. Their builders and functions remain a mystery.

Three levels of cultural change appear in Fiji Neolithic sites: an early level with pig and chicken bones and potsherds showing relief decoration; a middle level in which dog bones were first found and plain pottery prevailed; and the late level characterized by shell concentrations, previously lacking, and incised pottery. Radiocarbon dates place the early period around the time of Christ, the mid-period through the 7th to 10th centuries A.D. and the late period to the 14th century. Pottery relates to the west, into Indonesia. New Caledonian radiocarbon dates run from about 3,000 years ago to within the last few centuries. Therefore Neolithic agricultural pottery makers had penetrated into eastern Melanesia about 1000 B.C.

Major migratory movements of the ancestral Polynesians were almost certainly out of Indonesia. Once thought to have been first into western Micronesia and thence on to the east, they now appear to have skirted along northern Melanesia and finally centred strongly into western Polynesia (Samoa-Tonga) and thence moved on to the Tahiti (Society Islands) and Cook islands whence populations fanned out over the entire Polynesian triangle. Linguistic and archaeological evidences combine to suggest that Samoa was reached by at least 1000 B.C. and Tahiti only a few centuries later. In the 1960s radiocarbon dates secured were A.D. 79 for Samoa, 130 B.C. for the Marquesas Islands, A.D. 386 for Easter Island, A.D. 124 for Hawaii and A.D. 1015 for New Zealand. It appears that the vast area of Polynesia was explored and settled by Neolithic sailors in about a millennium and a half, with New Zealand the latest to be discovered and exploited. It is not possible to consider the later chronology in Polynesia without using the information derived from the carefully kept genealogies which record migrations out from the Society Islands in the 9th, 11th and 14th centuries. These memorized genealogies do not help with the more ancient periods, however, for two reasons: they do not and cannot be expected to carry back that far, and there is a strong possibility that social development had not then evolved a place or need for such records. Sites on the Hawaiian islands of Nihoa and Necker have an archaic type of Polynesian culture, apparently less strongly agricultural and with a less rigidly set social structure. These sites were probably inhabited in the 10th and 11th centuries; local cultural change and probably migrants from the Society Islands in the 12th to 14th centuries brought about the highly developed way of life encountered by the first Europeans.

In the older periods in central Polynesia the assembly courts and long narrow terraced platforms (*ahu*) were separate. In later periods these were combined into the *marae*, a large paved area with a high, often almost pyramidlike terraced platform at one end. Upright monoliths, or slabs in series, were employed as constructional or architectural items. This fusion of different features into the *marae* must have occurred in the Society Islands after the migrations to Easter Island, or the architectural lines of development in the two groups were otherwise separated, because the terraced *ahu* alone is used on Easter Island. The giant stone heads of Easter Island find their closest stylistic relatives in eastern Polynesia from New Zealand to the Marquesas. The technical and mechanical details of carving and handling the statues were within the capabilities of the high Neolithic Polynesians. The Easter Island "script," which is not true writing, is apparently an almost calligraphic sequence of decorative motifs and perhaps of mnemonic aids. Easter Island lacked large forest trees for canoes, hence few woodworking tools are found there. (*See* also EASTER ISLAND.)

Polynesian culture could mold itself to differing environments and mold these to its uses with equal ease. The migrants to New Zealand (Maori) moved from the small tropical Society Islands to a large temperate country. The great forests contained logs for canoes and buildings; fine stones (basalts and jades) existed for tools and ornaments. The New Zealanders developed a stone tool inventory beyond that of the usual Polynesian. Again, the full-fledged *marae*, with *ahu*, does not appear in New Zealand. A large Maori population resulted in the development of extensive middens. Excavations of the earlier sites have indicated that the first colonizers hunted the later extinct giant forms of the flightless bird which they called the moa. These archaic moa hunters must have known agriculture when they arrived in New Zealand, but no evidence of it is found in their middens. Perhaps they became less dependent upon cultivation as they learned to hunt the large and easily conquered game. They lasted, culturally, beyond the period when they could depend on the moa for food—into the 13th century. Whether or not they developed culturally into the classic Maori is not known. The latter may have been new migrants from Tahiti, as some of their artifacts suggest and as the genealogies state. New Zealand, then, was apparently discovered and settled in the 9th, 10th and 14th centuries by several different movements of peoples, called Fleet Maori, from the Society Islands.

Among the items that the Fleet Maori are said to have brought with them was the sweet potato, the *kumara*. This is a South American plant and must have been brought from Peru by an 8,000-mi. round-trip voyage from the Tuamotus or Marquesas, or have made the trip to inner Polynesia from Easter Island after it had been transferred there from South America. At any rate it could not have arrived in Tahiti later than the 13th century and its presence there attests that these islanders were making the longest high seas voyages that man had made up to that time.

The Tonga group of western and central Polynesia was influ-

enced by contact with Fiji; Tongans transferred Melanesian traits from there to other parts of Polynesia and returned the favour with Polynesian traits brought to Fiji. Most interesting archaeologically is the fact that pottery, most like some from New Caledonia, was once made on Tonga and then, not proving to be a necessary adjunct of the culture, became a lost art. Pottery has also been found on Samoa, associated with an occupation dated by radiocarbon in the 1st century A.D. Pottery appears in the Marquesas in the earliest excavation dated there, also by radiocarbon, about a century later. Thus the early, and probably the earliest, settlers in these islands made and used pottery. Probably they were absorbed or extirpated by later arrivals who did not. The *langi* of Tonga, stone-faced burial mounds, cannot be older than the 11th century. The great Tongan trilithon is a three-piece gateway 17 ft. high and 19 ft. wide. The visible portion of the monument must weigh approximately 100 tons. There are traditional data concerning the methods employed and the reasons for its erection. Tongan stonework appears to have had a quick efflorescence in the 13th to 16th centuries. Widespread rough stonework, rarer stonecutting, failure to break joints, occasional use of L-shaped stones as corner ties and cut slabs often weighing many tons are characteristic of Polynesian architectural stonework.

Highly conventionalized stone carvings, developed upon a tradition of wood carving, employed a heavy squat body, flexed legs with short thighs, heavy calves, forearms over the abdomen and exaggerated head and facial characteristics. These variations are discernible from Hawaii to New Zealand in stone, wood and as petroglyphs. This art style appears to have its origins early in Indonesia. Burial practices of Micronesia and Polynesia are varied. Commoners were often buried or exposed on the strand while nobles were buried in vaults, mummified or coffined.

Most of the islands of Micronesia are atolls, as are the equatorial islands of Polynesia. These low islands offered little to the Neolithic migrant in the way of arable land, forests or stone; *Tridacna* shell became a substitute for stone for tools—adzes, pestles, etc. It is only on the largest atolls and on the few volcanic islands in the Carolines and Marianas that archaeological evidence can be expected, not only of recent cultural change but of traces of the earliest migrants.

Megalithic constructions occur throughout Micronesia on the high (volcanic) islands, as they do in Polynesia. Excavations on the Marianas have uncovered extended burials, shallow middens and an enormous number of potsherds of a red utilitarian ware. Later material is dated by radiocarbon at A.D. 845; the earliest date, 1527 B.C., is associated with a hard red pottery. Even older material is found and Neolithic settlers were in Saipan at least as early as 2000 B.C., if the radiocarbon dates may be trusted.

The Palau Islands and Yap also supported peoples who made pottery and who are related linguistically and culturally to the Philippine Islands and Malaysia to the southwest. Stone platforms and the stone cartwheel money of Yap are the megalithic traits of that island. Palau, although partly volcanic, lacked good stone for cutting tools, and most of the adzes, etc., were made of *Tridacna* shell. Archaeological remains include megalithic constructions and carvings, large terraced hills and money of glass armrings sawed into sections, and glass beads presumably traded from the Philippines. Pottery from the later period is a coarse red ware. Deep in the terraced sites this is replaced by a thin dark ware. Both archaeology and tradition vouch for periods of population growth and cultural evolution, with megalithic and earthwork construction, followed by cultural decay and abandonment of the great sites on the volcanic islands, and then a resettlement only a few centuries before European contact. On Yap a radiocarbon date of A.D. 176, the earliest secured, indicates that agricultural people, making a fine red pottery, were living at this period on the Yap archipelago.

See also references under "Oceania" in the Index. (D. O.)

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OCEANSIDE, a resort city of southern California on the Pacific coast, is 40 mi. N.W. of San Diego at the mouth of the San Luis Rey river. One of the famous California missions San Luis Rey, founded in 1798, is located there and Camp Pendleton, a major U.S. marine corps base, is immediately to the north.

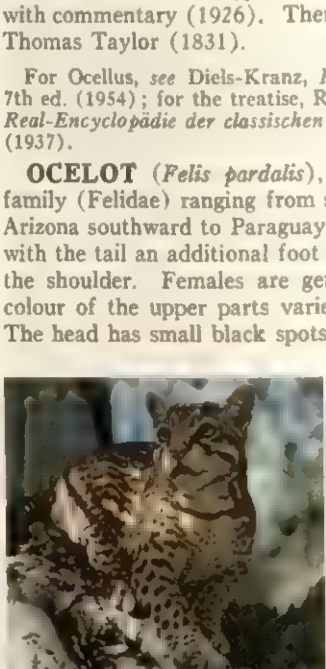
Incorporated in 1888, Oceanside grew slowly before World War II. From 1940 to 1950, however, the population nearly tripled. A mild, dry climate combined with an ocean beach, fishing facilities, municipal swimming pools, a community centre and several golf courses provide recreation for residents and vacationers. The economic life depends largely on the tourist trade, services to Camp Pendleton and light industry. Oceanside established the council-manager form of government in 1947. For comparative population figures *see* table in CALIFORNIA: *Population.* (A. F. Mn.)

OCEANUS, in Greek mythology, the river that encircles the earth (conceived as flat). Beyond it, to the west, are the land of the Cimmerii where the sun never shines, the country of dreams and the entrance of the underworld. In Hesiod's *Theogony* Oceanus is the son of Uranus and Gaea, the husband of Tethys father of 3,000 streams and 4,000 ocean nymphs. In Homer he is the origin of the gods. As a common noun the word gets practically the modern sense of ocean.

OCELLUS LUCANUS (OCELLUS OF LUCANIA; Greek spellings of the name vary between OKELLOS, OKKELOS, EKELLOS etc. (6th?–5th century B.C.), Greek philosopher of the Pythagorean school, was perhaps a pupil of Pythagoras himself. His name was attached to a later treatise *On the Nature of the Universe* (current in the 1st century B.C.), which reflects many of the views ascribed to Philolaus (*q.v.*). The best edition is by R. Harder with commentary (1926). There is also an English translation by Thomas Taylor (1831).

For Ocellus, *see* Diels-Kranz, *Fragmente der Vorsokratiker*, vol. i, 7th ed. (1954); for the treatise, R. Beutler, "Okellos," Pauly-Wissowa *Real-Encyclopädie der classischen Altertumswissenschaft*, Halbband 34 (1937).

OCELOT (*Felis pardalis*), an American species of the cat family (Felidae) ranging from southwestern Arkansas, Texas and Arizona southward to Paraguay. Adults are from 3 to 4 ft. long with the tail an additional foot or more and stand about 1½ ft. at the shoulder. Females are generally smaller than males. The colour of the upper parts varies from pale gray to deep brown. The head has small black spots, and there are two black bars on the cheeks. Four or five parallel black stripes are present on the neck, and black-edged elongate spots of dark colour are arranged in chainlike bands on the body. The underparts are whitish, and the tail is marked above with dark bars or blotches.



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OCELOT (FELIS PARDALIS)

Ocelots are excellent climbers and inhabit forested or brushy regions. They hunt chiefly at night and feed upon small to medium-sized reptiles, birds and mammals. Breeding may occur at any season, and a litter usually contains two young, which resemble the adults in colour pattern but are of a darker shade. Ocelots are easily maintained in captivity and some are readily tamed. The smaller margay (*q.v.*) resembles the ocelot in gen-

eral appearance and in range, but differs in certain features of the pelage and skull. *See* also CAT; CARNIVORE. (J. N. L.)

OCHINO, BERNARDINO (1487–1564), Italian Protestant reformer, important for the influence of his mystical and rational tendencies on the thought of left-wing Protestantism. A native of Siena, he was the vicar-general of the newly founded order of the Capuchins in Italy and was so renowned as a preacher that the pope had to regulate his engagements. Commissioned to read and refute Protestant works, he was himself converted, but did not at first declare himself openly because of the hope that Italy as a whole might embrace the reform. When the Roman Inquisition was established in 1542 he was summoned to Rome but instead fled over the Alps to Geneva. There he demonstrated his Protestantism by marrying a refugee from Lucca. After an interval he was made in 1545 the pastor in Augsburg of a congregation of young German clerks of the banking house of Fugger who had served their apprenticeship in the branch at Venice. When in the Schmalkaldic War the emperor captured Augsburg, Ochino fled to England and there played a prominent part in the Reformation under Edward VI. His *Tragoedie or Dialoge of the Unjuste Usurped Primacie of the Bishop of Rome* (1549) lauded the reforms instituted by Henry VIII and Edward VI. Then came the Catholic Mary I and Ochino fled to the continent. He was made the pastor of a congregation of Italian refugees at Zürich but soon alienated the magistrates and ministers of the city by a series of indiscretions. His tract against the Roman view of purgatory was deemed untimely when Zürich was in imminent danger of attack by the Catholic cantons. His assertion that the differences over the Lord's Supper between the Zwinglians and the Lutherans were only a bagatelle offended both parties. And his description of predestination as an inextricable labyrinth in a tract dedicated to Elizabeth I outraged the Calvinists. To avoid the local censor Ochino brought out at Basel his *Dialogi XXX* (1563), in one of which his defense of monogamy was felt to be inferior to his apology for polygamy. He was banished and, with four children (his wife being dead), he set out in Dec. 1563 for Poland. There his *Tragoedie* was issued in Polish with adaptations to the local situation. However the Catholics persuaded the monarch to banish all foreign dissidents and in 1564 Ochino again took to the road. He died in Moravia toward the end of 1564. There is no evidence in his writings that he was, as claimed by adversaries, an Anti-Trinitarian, but he did interpret the atoning death of Christ as having effected a change only in the attitude of man toward God rather than in that of God toward man. This theology affected the Socinians.

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OCHOA, SEVERO (1905–), Spanish-U.S. physician and biochemist, co-winner with Arthur Kornberg of the 1959 Nobel prize for medicine, was born in Luarca, Spain, on Sept. 24, 1905. He received an A.B. degree from Málaga college in 1921 and an M.D. degree from the University of Madrid in 1929. In 1929–31 he was a student and research associate at the Kaiser Wilhelm institute in Berlin, and in 1932–33 he was at the National Institute of Medical Research in London. He returned to Spain in 1934 to teach in the physiology department of the University of Madrid, but left again in 1936 because of the Spanish Civil War. He pursued his researches at Heidelberg in 1936–38 and at Oxford in 1938–40. In 1940 he went to the United States, working first as an instructor and research assistant in pharmacology at Washington university in St. Louis. In 1941 he joined the faculty of the college of medicine of New York university as a research assistant in pharmacology; he was chairman of the school's department of pharmacology from 1946 until 1954, when he became chairman of the department of biochemistry.

Ochoa's major contributions were in the intermediary metabolism of the cell. He was one of the first to provide evidence that the energy from metabolism is stored and utilized by means of the so-called "high energy" phosphate compounds. He and his co-workers did much to clarify the details of the metabolic transformation of such key compounds as acetic and pyruvic acids to carbon dioxide, fat, etc. In 1955 he described the finding of an enzyme system that led to the synthesis of compounds resembling naturally occurring ribonucleic acid (RNA); for this work he was awarded a share of the 1959 Nobel prize. The increasingly positive evidence that RNA is the chief template or specific pattern for protein synthesis by the cell marked this finding as uniquely important. (R. LE.)

OCHOA Y RONNA, EUGENIO DE (1815–1872), Spanish scholar and writer, was born in Lezo (Guipúzcoa). Of minor importance for original works, his militantly literary review *El Artista* (1835–36) contributed significantly to the success of romanticism and he was the first critic to acclaim the realist novel of Fernán Caballero *La gaviota* in 1849. As editor for Ribadeneyra, Madrid, and more particularly of Spanish classics (ballads, novels, prose, plays of L. de Moratín, Lope de Vega, Calderón de la Barca and Tirso de Molina) for Baudry, Paris, he reintroduced Europe to Spanish literature. His *Apuntes para una biblioteca de escritores españoles contemporáneos* (1840) is still useful. He compiled a catalogue of Spanish manuscripts in the libraries of Paris (1844). He died in Madrid. (R. F. B.)

OCHRE, a native earth coloured with hydrated iron oxide. It varies in colour from pale yellow to deep red, brown and violet. There are two kinds—one having a clayey basis, while the other is a chalky earth; the former variety is in general the richer and purer in colour of the two. Both kinds are widely distributed in beds or pockets, mainly in stratified rocks and rubble and rarely as extensive deposits. Some ochres require only grinding, whereas other varieties require calcination whereby the original colour is modified. In the calcination process the associated earth exercises a marked influence, clayey ochres developing red and violet tints, while chalky varieties take brownish-red and dark brown hues. The well-known ochre, terra di Siena, which in its native state is a dull-coloured earth, assumes when burned a fine warm mahogany-brown hue highly valued by artists. Ochres containing much organic matter are sometimes calcined to improve their drying properties in varnish or oil.

Ochres are also artificially prepared in large quantities—Mars yellow is either a pure hydrated ferric oxide or an intimate mixture of that substance with an argillaceous or calcareous base, and by careful calcination they can be transformed into Mars orange, violet or red, all reliable pigments.

OCHS, ADOLPH SIMON (1858–1935), U.S. newspaper publisher who made the *New York Times* one of the world's greatest newspapers, was born in Cincinnati, O., on March 12, 1858, of Jewish parents who had emigrated in their youth from Bavaria. In 1865 the family settled in Knoxville, Tenn. While still a schoolboy Adolph delivered newspapers; at the age of 11 he was an office boy and at the age of 14, a printer's devil on the *Knoxville Chronicle*. In 1875–76 he was a compositor for the *Louisville* (Ky.) *Courier-Journal;* in 1877 he helped establish the *Chattanooga Dispatch;* and in 1878, at the age of 20, he gained control of the decrepit *Chattanooga Times* for $250. He soon placed the *Times* on a firm basis, and made it one of the leading newspapers in the south.

In 1896 Ochs acquired controlling ownership of the financially faltering *New York Times*, and formed the New York Times company. He steadily strengthened the paper's journalistic and financial position, raising its circulation from 9,000 in 1896 to 466,000 daily and 730,000 Sunday copies in 1934. In 1901 Ochs purchased the *Philadelphia Times*, which he merged with the *Public Ledger* and sold to Cyrus Curtis in 1912. He was a founder of the Southern Associated Press, and from 1900 to his death in 1935 was a director of the Associated Press.

The influence of Ochs upon newspaper publishing in the United States was marked and highly beneficial. Entering New York publishing when "yellow journalism" was at its height, in competition with the richest and most powerful newspapers in America, he boldly adopted the slogan, "All the News That's Fit to Print," and devoted his paper, not to sensations, but to giving intelligent readers a daily news report that was trustworthy and complete. In a few years he made the *New York Times* an outstanding example of enterprise in news gathering, and ultimately

the most widely respected and quoted newspaper in the United States. Ochs introduced such innovations as a book-review supplement and rotogravure printing of pictures and pressed for higher standards in the presentation of advertising.

Interested in making accurate source material available to the public, in 1913 he began publishing the *New York Times Index*, the only complete U.S. newspaper index, and, in 1925, advanced $50,000 annually for ten years toward the cost of the editorial preparation of the *Dictionary of American Biography*, repayment to be made from royalties. In 1918 the *Times* was awarded the first Pulitzer gold medal in journalism for meritorious public service. Ochs died on April 8, 1935, in Chattanooga.

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OCKHAM, WILLIAM (WILLIAM OF OCCAM) (*c.* 1280–1349), English schoolman, known as Venerabilis Inceptor. Born probably at Ockham, Surrey, he joined the Franciscans around 1300. At Oxford he studied the arts prior to 1310, and theology, 1310–15, lectured on the Bible, 1315–17, and the *Sentences*, 1317–19, and prepared himself for his doctorate, 1319–23. Accused of heresy by the chancellor of Oxford in 1323, he was summoned to Avignon to account for some of his doctrines. He was confined to his convent from 1324 to 1328.

Pope John XXII ordered various theses from his works to be examined by the masters of theology in 1325–27, but his works were never actually condemned. In 1328 his championship of the Spirituals, a branch of the Franciscans, brought him into further conflict with the pope, and as a result he and Michael of Cesena, general of the Franciscan order, joined the emperor Louis of Bavaria who was at that time in contest with the papal curia. Expelled from the order in 1331, Ockham came into sharper conflict with the pope, this time on theological grounds. Yet, when Michael of Cesena died in 1342, Ockham received from him the official seal of the order, and was recognized as general by his party. He died at Munich in 1349, having tried to be reconciled to the church after the death of the emperor (1347).

Ockham was one of the most interesting figures in the great contest between pope and emperor, which laid the foundation of modern theories of government. In the *Opus nonaginta dierum* (written in 1330), and its successors, the *Tractatus de dogmatibus Iohannis XXII papae* (1335–38) and in the *Defensorium contra errores Iohannis XXII papae* (1335–39), Ockham only incidentally expounds his views as a publicist, the *Compendium* being of special interest because it selects four papal constitutions that involved a declaration against evangelical poverty, and insists that they are full of heresy. The *Octo quaestiones de potestate papae* (1339–42) attacks the temporal supremacy of the pope, insists on the independence of kingly authority, which he maintains is as much an ordinance of God as is spiritual rule and discusses what is meant by "state." His views on the independence of civil rule were even more decidedly expressed in the *Consultatio de causa matrimoniali*, in which he contends that it belongs to the civil power to decide cases of affinity. By 1343 his great work, the *Dialogus*, was in circulation. His last political work, *De electione Caroli IV*, restates his opinions upon temporal authority.

In philosophy, Ockham's most significant doctrines fall within the field of psychology, metaphysics, logic and theodicy. In the first, he contends that since singulars alone exist, the universal has an objective value only inasmuch as it is thought; that the *intellectus agens* ("active intellect") and its end product and the *species intelligibiles* are superfluous because abstraction follows naturally upon perception or intuition, the fundamental forms of human knowledge; that will and not intellect is the primary faculty of the soul, and that both faculties, like memory, are identical with the substance of the soul; and that a *forma corporeitatis* ("substance of the body") must be admitted if the independence of the soul is to be preserved. In metaphysics, Ockham teaches that matter has its own essence apart from form; that accidents are only aspects of substance; that the problem of individuation is meaningless because each thing is singular in itself; and that between essence and existence there is no real distinction. The famous dictum—*pluralites non est ponenda sine necessitate* ("multiplicity ought not to be posited without necessity")—has become known as "Ockham's razor," though it had already been stressed by other Scholastics. In logic, next to Albert of Saxony, Ockham is the most powerful systematist of the middle ages. In theodicy, he asserts that the existence of God and his attributes, including his unity and infinity, are not provable by a strict syllogism.

In theology, Ockham has been considered as a forerunner of Martin Luther and the originator of theological skepticism. Both affirmations are inexact: Ockham did not make much of the philosophical arguments of earlier theologians, and applied to theology his famous "razor"; however, he was respectful of tradition and traditional understanding of the Bible. *See* also NOMINALISM.

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(E. M. Br.)

OCKLEY, SIMON (1678–1720), English orientalist, whose chief work is *The Conquest of Syria, Persia, and Ægypt, by the Saracens*, generally known as *The History of the Saracens*. Born at Exeter in 1678, he was educated at Queen's college, Cambridge, later becoming a fellow of Jesus college and vicar at the nearby village of Swavesey. In 1711 he was appointed professor of Arabic at Cambridge. Being the father of a large family and insufficiently paid he fell into debt in his later days and was for a time imprisoned in Cambridge castle. His troubles are related in Isaac D'Israeli's *Calamities of Authors*. He died at Swavesey on Aug. 9, 1720.

Ockley's first book was the *Introductio ad linguas orientales* (1706) in the preface of which he urged the importance of a knowledge of oriental literature for the study of theology. For his *History of the Saracens* he took as his authority a manuscript of the pseudo-Waqidi's *Futuh al-Sham* ("Conquest of Syria"), which is historical romance rather than history, but his book was widely read and long remained the standard English work on the early history of Islam. He also published a number of translations including *The Sentences of Ali* (1717), a translation of the sayings of the Prophet's son-in-law.

O'CLERY, MICHAEL (1575–1643), Irish chronicler, who directed the compilation of the *Annála Ríoghachta Éireann* (*The Annals of the Four Masters: see* IRISH LITERATURE: *Gaelic Literature: Late Period*), a work of incalculable importance to Irish scholarship, was born at Kilbarron, Donegal, in 1575, the grandson of a chief of his sept. He was baptized Tadhg but took the name Michael when he became a Franciscan. He had already gained a reputation as an antiquary when he entered the Irish college at Louvain; and, in 1620, Hugh Macanward, the warden of the college, sent him back to Ireland to collect manuscripts. Assisted by other Irish scholars he began to collect and to transcribe everything of importance he could find. The results were the *Reim Rioghroidhe* (1630), a list of kings, their successions and their pedigrees, with lives and genealogies of saints, the *Leabhar Gabhala* (1631), an account of the successive settlements of Ireland; and the famous *Annals* (1636), a chronicle of Irish history from antiquity to 1616. At first a mere record of names, dates, battles, etc., with occasional quotations from ancient sources, the *Annals* begin to take on the character of a modern literary history as they approach the author's own time. O'Clery also produced a *Martyrologium* of Irish saints, an Irish

glossary and other works. He worked in very humble circumstances and died at Louvain in 1643. (A. CR.)

O'CONNELL, DANIEL (1775–1847), Irish political leader, known as the Liberator and first of the great 19th-century Irish parliamentary leaders, was born on Aug. 6, 1775, near Cahirciveen in County Kerry. He was adopted as a child by an uncle, known as Hunting Cap, who had organized a flourishing contraband trade with France. Daniel was sent to France to attend the Roman Catholic colleges at St. Omer and Douai and when the Austrian Netherlands were occupied by the French Revolutionary armies, O'Connell escaped to England. These early experiences coloured his later career and though he was inspired by the new doctrines of popular sovereignty he was opposed to revolutionary excess. After studying law in London he was called to the Irish bar in 1798 and achieved prominence by his denunciations of the Act of Union whereby the Irish parliament was extinguished. He believed that any assembly claiming to represent the Irish people must insist on the abolition of the anti-Catholic laws. O'Connell proceeded to revive the agitation for equal rights on broader lines than previous attempts and undertook the cause with boldness and energy. He had outstanding gifts as a lawyer and his work both in Dublin and on circuit brought him a national reputation; and as a demagogue he could excite or pacify the illiterate masses, who regarded him as their champion.

O'Connell circumvented the government's suppression of representative committees by organizing a nationwide series of "aggregate meetings" of Catholics to petition for strictly legal demands. His appeal was sufficiently wide to gain the support of Protestants. His defense of John Magee, a Protestant journalist, who was prosecuted in 1814 for criticizing the viceroy, aroused vast enthusiasm since he used the occasion to denounce the entire system of government in Ireland. Nevertheless Magee was fined heavily and O'Connell's wealthier supporters were deterred for some years. By the time of Lord Wellesley's appointment as viceroy in 1821, O'Connell's fighting spirit had revived. He began to organize a huge popular movement, financed by monthly subscriptions of 1*d.* from all members of the Catholic association. It spread rapidly and its very size precluded suppression; liberal support in England was gained and several bills were introduced for Catholic relief, only to be rejected by the house of lords. A new generation of prosperous and educated Catholics gained confidence from his efforts and example. In 1828 O'Connell contested a by-election at Clare although as a Catholic he would be unable to take his seat. His overwhelming victory convinced the prime minister, the duke of Wellington, of the necessity for concessions to avert civil war and led to the Emancipation act (1829).

O'Connell then took his seat in the house of commons where his ability and personality commanded attention and invited support. He became the leader of the Irish members who came to be known as "O'Connell's tail." He then turned his attention to the repeal of the union of 1800. The Whigs, who had supported O'Connell in 1828–29, when in office after 1830 proved less sympathetic and the rift was only sealed by the bargain, known as the Lichfield House compact (1835) whereby O'Connell promised a period of "perfect calm" while the government passed urgent measures of reform. O'Connell's position in parliament became more decisive after 1834. He helped to defeat Sir Robert Peel's Conservative government in April 1835 and a weakened Whig ministry returned to office. They continued in office until 1841 despite mounting difficulties, largely because of Irish support, given in return for moderate reforming measures in Ireland and because the Conservatives had given no indication that they intended to do anything for Ireland. He had refused the office of Master of the Rolls from Lord Grey and later rejected an offer of the attorney generalship. His friends organized the annual O'Connell tribute to make up for his loss of income from the law and to help the party funds.

By 1840 cooperation with the Whigs had achieved nothing, funds were sinking and O'Connell was urged to revive the agitation for repeal of the union. He founded the new Repeal association and after a difficult start a series of monster meetings was held in all parts of Ireland. They assumed vast proportions without any open collision with the law and during 1843 O'Connell virtually abstained from attending parliament. The climax of this program, a meeting at Clontarf, near Dublin, was intended to assemble 1,000,000 supporters but was prohibited in Oct. 1843 and military precautions were taken. O'Connell and his colleagues were imprisoned and fined but the sentence was quashed on appeal to the house of lords, and the men were released in 1844.

By then his health was failing and an open conflict developed with the younger men who became known as Young Irelanders and who were clamouring for more active leadership. By 1845 O'Connell's strength was almost gone but he made an effort to obtain government relief during the potato famine. Traveling to the south in search of sunshine he died at Genoa while on his way to Rome, on May 15, 1847. His death revived his popularity and he was widely acclaimed as the liberator of a downtrodden people. *See* IRELAND: *History*.

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O'CONNOR, FEARGUS EDWARD (*c.* 1796–1855), the most prominent Chartist leader, was born at Connorville in County Cork, Ireland, probably on July 18, 1796, the son of the Irish Nationalist politician Roger O'Connor. He claimed royal descent from the ancient kings of Ireland. He studied law and was admitted to the Irish bar in 1830. He turned from law to politics, however, and entered parliament as member for County Cork in 1832 and was a follower of Daniel O'Connell. He quarreled bitterly with O'Connell on grounds of policy as well as through a clash of temperament and ambition, and was unseated in 1835. Thereafter he turned to radical agitation in England although he continued to press Irish grievances and to seek Irish support. He gathered enthusiastic crowds, particularly in the discontented north of England, and on the publication of the Charter in 1838 became the best-known Chartist leader. Owing to his rough humour, his energy and his invective he became their most popular speaker and his journal, the *Northern Star* (1837), gained a large circulation. He outbid local Chartist leaders in their own strongholds and succeeded in making Chartism (*q.v.*) a mass movement of protest. Both his methods and his views led him into a series of quarrels with other Chartist leaders, particularly William Lovett, and at the convention of 1839 these differences were exposed. Although not concerned in the "insurrection" of 1839 he was imprisoned for a year for seditious libel. After 1841 he acquired a position of almost undisputed leadership in Chartism, but he was unable to lead the movement to victory.

He vacillated in his attitude toward the middle classes and even toward the Charter itself, concentrating in the mid-1840s on his land plan, a scheme for settling urban workers on small holdings. The plan failed, and although O'Connor was elected to parliament for Nottingham in 1847, his power was waning. So too were his abilities; there were many signs that his egocentricity bordered on madness and the failure of the Charter in 1848 marked the beginning of the end. O'Connor was declared insane in 1852 and died in London on Aug. 30, 1855. (A. BRI.)

OCOTEPEQUE, a small department in western Honduras that borders El Salvador and Guatemala.

Population (1961) 52,989. The departmental capital and largest town, Nueva Ocotepeque, had only 4,118 people in 1961. The population, consisting mostly of highland Indians, is exceedingly isolated and has to depend entirely on pack and cart transportation. The department has no all-weather roads and all settlements are in small highland valleys. Although only 15% of the land in farms is cultivated, Ocotepeque ranks first in the nation in the production of wheat, third in tobacco and seventh in potatoes. Several handicraft industries are significant locally. (C. F. J.)

OCOTILLO (*Fouquieria splendens*), a North American shrub of the candlewood family (Fouquieriaceae), called also coachwhip, Jacob's staff and vine cactus. It is a characteristic shrub of rocky deserts from western Texas to southern California and southward in Mexico. Near the base the stem divides into several slender, erect, furrowed, intensely spiny branches, usually from 8 to 20 ft. high. It bears small rounded leaves, the midribs of

which harden into the spines, and showy bright-scarlet flowers in branched terminal clusters, 6 to 10 in. long. The ocotillo is sometimes grown as a hedge plant in its native range.

OCTAVIA, in Roman history, the name of three women of the Julio-Claudian house.

Octavia Maior, half sister of Octavian (later the emperor Augustus), the daughter of Gaius Octavius by his first wife, Ancharia. She married Sextus Appuleius and their son of the same name was consul in 29 B.C.

Octavia Minor (before 63–11 B.C.), full sister of Octavian, the daughter of Gaius Octavius and his second wife, Atia. She was probably born in 69. She married in 54 Gaius Marcellus by whom she had two daughters, Claudia Marcella *maior* and *minor*, and a son, M. Claudius Marcellus (*see* Marcellus). On the death of Gaius Marcellus in 41 she was married to Mark Antony with the aim of reconciling him with her brother. This succeeded at first and later, in the friction of 37, a reconciliation, again the result of her efforts, took place at Tarentum. In 36 however Antony left for the Parthian War and continued his liaison with Cleopatra (*see* Antonius); although Octavia took out troops and money to him (35) he refused to see her and formally divorced her in 32. She lived an exemplary life, bringing up Antony's children by Cleopatra as well as her own.

Octavia (d. 62), daughter of the emperor Claudius and Messallina, was married in 53 to Nero (*q.v.*), who divorced, banished and eventually murdered her. The extant Latin tragedy *Octavia* deals with her misfortunes.

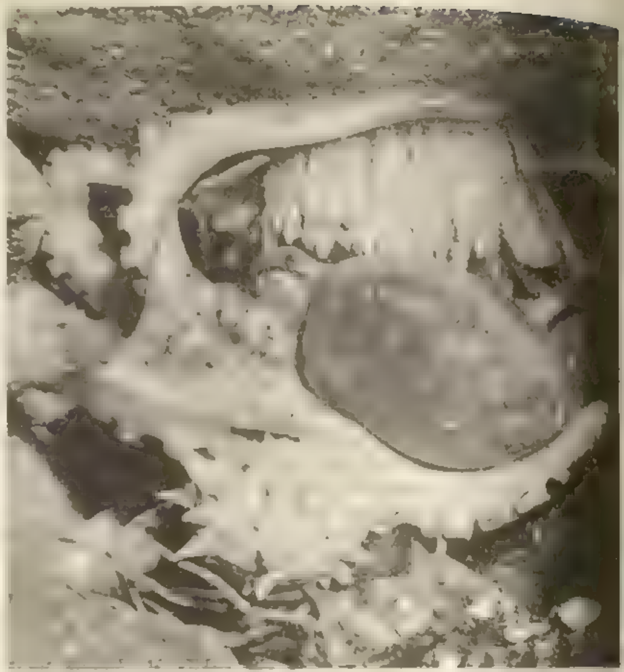
OCTOBER, the tenth month of the modern calendar, with 31 days. Its name (from Lat. *octo*) records the fact that in the early Roman calendar, which began with March, it was the eighth month. Following the precedent of July and August, several attempts were made to rename it in honour of Roman emperors or members of their families, *e.g.*, Domitianus, Herculeus (for Commodus) and Faustinus (for Faustina the Elder), but without lasting success. The witches, hobgoblins and ghosts of Halloween (October 31), still familiar in children's masquerades, are apparently relics of a pre-Christian Celtic feast of the dead, held at this season. (F. R. Wn.)

OCTOPUS, in popular terms any member of the eight-armed cephalopods, order Octopoda; technically, a member of the genus *Octopus*, a large group of widely distributed, shallow-water mollusks. About 36 genera of octopods are known, being divisible by habitat into four broad groups: those living in the littoral or shallow seas (*Octopus, Eledone*), in deep water on the bottom (*Benthoctopus, Bathypolypus*), oceanic in the upper layers (*Tremoctopus, Argonauta, Ocythoe*) and free-swimming in deep water (*Cirroteuthis, Eledonella, Grimpoteuthis*).

Shallow-water octopods vary greatly in size, the smallest, *Octopus arborescens*, about 1½ in. long, occurs in the Indian ocean. The largest may be the giant *Octopus dofleini*, from Alaskan waters, of which one specimen had an arm spread of about 32 ft.; the body proper, however, was only about 18 in. long.

Large octopods have long enjoyed a reputation for ferocity, no doubt because of their sinister appearance, and exaggerated stories of their attacks are numerous. By nature they are retiring animals, but attacks on man are well authenticated though seldom fatal. A few cases are on record of fatalities caused by their bites when handled carelessly, a venom being secreted by the posterior salivary glands in certain species.

The common octopus (*Octopus vulgaris*) is widely distributed in tropical and temperate seas throughout the world. It ranges from Connecticut to Brazil in the western Atlantic and from Britain to Africa in the eastern Atlantic. It lives in holes or crevices along the rocky bottom and is secretive by nature, feeding mainly on crabs and other crustaceans. It has been credited with considerable intelligence, based largely on the extensive studies on learning and memory carried out by J. Z. Young and others at the zoological station at Naples, Italy. *O. vulgaris* has a saccular body; the head is only slightly separated and bears large, complex eyes and eight contractile arms surrounding the mouth. The arms are beset with two rows of fleshy, deeply set suckers capable of great holding power. The mouth is equipped



BY COURTESY OF MARINELAND OF FLORIDA

OCTOPUS (OCTOPUS VULGARIS) IN ITS LAIR WITH HANGING EGG CLUSTERS

with a pair of sharp, horny beaks for biting and a filelike organ, the radula, for drilling shells and rasping away flesh.

In American waters the common octopus mates in the winter, the male passing the spermatophores (sperm bundles) directly into the mantle cavity of the female by means of a specialized hectocotylized arm. The eggs, about ⅛ in. long, are laid in winter and early spring in festoons under rocks and in holes, the total number of eggs amounting to 50,000–180,000. The female guards the eggs during the four to eight weeks required for the larvae to hatch. During this time the female broods over the eggs, cleaning them with her suckers and agitating them with water from her funnel. Upon hatching, the tiny octopods, which closely resemble their parents, are unable to take up a bottom life immediately and spend several weeks in the drifting plankton. In other species, such as *Octopus briareus* of the southeastern United States and Caribbean, the eggs are comparatively large, about ½ in. long, and are laid in a single layer under rocks; the young upon hatching are more developed, lack a planktonic stage and immediately take refuge on the bottom.

Little is known of the life history of the bottom-dwelling deep-water octopods such as *Bathypolypus arcticus*, which is distributed from Florida to Scandinavia and Siberia. Many of the deepwater forms show modifications such as reduction of the gills and loss of the radula.

Oceanic octopods dwelling in the upper layers are largely plankton feeders (*Tremoctopus, Ocythoe*). *Tremoctopus* attains considerable size and is widely distributed, occasionally being cast up on our southern beaches; it has a deep web between the upper three pairs of arms, perhaps of use in collecting plankton. *Argonauta* is discussed in the article Nautilus.

The free-swimming deepwater octopods show considerable modification. The gelatinous *Eledonella* and *Vitreledonella* are poor swimmers found from about 600 to 7,500 ft. They are widely distributed in the seas; a specimen of the former has been taken from a depth of 17,400 ft. A peculiar deep-sea form is *Cirrothauma murrayi*, which is blind. Like several other deep-sea genera, it is unusual among the octopods in the possession of elongate, paddlelike fins. The flapjack devilfish (*Opisthoteuthis*) is flattened and disclike, gelatinous, with the arms deeply involved in its web. It lives in the bottom ooze in many seas.

The shallow-water octopods (*Octopus, Eledone*) move by crawling about the bottom, or when alarmed, by shooting swiftly backward through the water by a jet of water from the funnel. These forms eject copious quantities of ink when they are en-

dangered, the ink being used as a screen behind which the animal slips away. In some species the ink paralyzes the sensory organs of the attacker. The common octopus has highly developed pigment-bearing cells and can change its colours to an astonishing degree and with great rapidity.

Octopods, which feed mainly upon crabs and lobsters, at times during years of exceptional abundance in England have been responsible for nearly destroying the lobster fishery. In turn they are fed upon by a number of marine fishes such as the cod.

Octopods have long been considered a great delicacy by peoples of the Mediterranean area who prepare them in many ways. They are fished for throughout the Mediterranean and the Caribbean, and are taken off California, Japan and in Oceania and the far east. When properly prepared the flesh is sweet, tender and demands a high price. *See* CEPHALOPODA; MOLLUSK.

See F. Lane, *Kingdom of the Octopus* (1957). (G. L. V.)

OCTROI, a tax levied by a local political unit, normally the commune or municipal authority, on certain categories of goods on their entry into its area. The institution of such tax in Italy goes back to Roman times, when it bore the title of *vectigal* or *portorium*, and in France to the 13th century. Suppressed in the latter country under the Revolution in 1791, the tax was reestablished five years later; and until the close of the first quarter of the 20th century it was operative very generally throughout the land. It was abolished in Belgium in 1870 and in Egypt in 1903; after World War II it still persisted in France, Italy, Spain, Portugal and Austria, but there was a marked tendency toward radical reduction in its total area of operation, or even its general suppression. The last octrois which had survived in France were suppressed from Jan. 1, 1949, by a decree of Dec. 9, 1948. Public opinion in France had been critical for generations of a tax system that was highly irksome, inconvenient in its mode of collection and unduly costly in relation to its yield (the levy process sometimes absorbed 50%). It was turned decisively against the system by the phenomenal increase of motor traffic.

O'CURRY, EUGENE (1796–1862), Irish scholar, an industrious copyist and translator of Irish manuscripts, was born at Dunaha, County Clare, in 1796. He examined and arranged many of the Irish manuscripts in the Royal Irish Academy and Trinity College library and compiled the catalogue of those in the British museum. In 1854 he was appointed professor of Irish history and archaeology in the new Catholic University of Ireland. His lectures, which give a full account of the medieval chronicles, historical romances, tales and poems, were published in 1861. Subsequent volumes entitled *On the Manners and Customs of the Ancient Irish* appeared in 1873. He died in Dublin on July 30, 1862. (A. CR.)

ODAENATHUS (or ODENATUS, latinized forms of Aramaic ODAINATH) (d. A.D. 267 or 268), the name of a famous prince of Palmyra who succeeded in recovering the Roman east from the Persians and restoring it to the empire. He belonged to the leading family of Palmyra, which bore, in token of Roman citizenship, the name of Septimius; earlier members of the family (probably of Arab descent) include two Roman senators, Septimius Odainath and Septimius Hairan, the latter (Odaenathus' brother or father) being referred to as "chief of the Palmyrenes" in A.D. 251. The year when Odaenathus became chief of Palmyra is not known, but already in an inscription dated 258 he is styled by Palmyrenes *vir consularis* (*i.e.*, of consular rank) and "master."

The defeat and capture of the emperor Valerian (A.D. 260) left the eastern provinces largely at the mercy of the Persians. Odaenathus, apparently after a rebuff from the Persian king Shapur I, launched an offensive. He fell upon the victorious Persians who were returning home after the sack of Antioch, and before they could cross the Euphrates inflicted upon them a considerable defeat.

Then, when two usurping emperors were proclaimed in the east (261), Odaenathus took the side of Gallienus, the son and successor of Valerian, attacked the usurper Quietus at Emesa (Homs, in western Syria), and after Quietus' death was rewarded for his loyalty by the grant of an exceptional position (262).

Odaenathus may have assumed the title of king before; but he now became *corrector totius Orientis:* not emperor, but the emperor's extraordinary deputy in the east. In a series of rapid and successful campaigns, he crossed the Euphrates and relieved Edessa, recovered Nisibis and Carrhae (Harran) and even took the offensive against the power of Persia and invested Ctesiphon, the capital, itself; he probably also brought back Armenia into the empire. These brilliant successes restored the Roman rule in the east. There can be little doubt that Odaenathus aimed at independent empire; but during his lifetime no breach with Rome occurred. He was about to start for Cappadocia against the Goths who had invaded it when he was assassinated, together with his eldest son, Herodes, by his nephew Maeonius (or Odaenathus; ancient accounts vary).

After his death (267 or 268) his widow Zenobia (*q.v.*) succeeded to his position, and practically governed Palmyra on behalf of her young son Vaballathus or Athenodorus. *See* PALMYRA. (G. A. C.; X.)

ODA NOBUNAGA (1534–1582), Japanese general and statesman who was the principal agent in unifying Japan after the long period of feudal wars that had continued since the 14th century. He was the administrator of a fief near the present city of Nagoya, and conquered a consolidated bloc of territory across the waist of the central island of Honshu. He skilfully used the wealth of the rising merchant class to finance his conquests and to swell the coffers of the imperial house, for he expected imperial approval of a future unification of the country. In 1573 he deposed the shogun, thus ending the Ashikaga shogunate. In 1576 he built a magnificent castle at Azuchi as a monument to and administrative centre for his power. He gave protection and economic aid to the Jesuit missionaries who began to arrive in Japan in some numbers at this time. He may have done so partly because he admired them, but it is more likely that Nobunaga saw in Christianity a potential counterweight to the influence of the Buddhist temples. These temples were serious impediments to unification of the country, and Nobunaga is said to have destroyed several thousand of them in central Japan.

See also JAPAN: *History*. (T. C. SH.)

ODE, a ceremonious poem on an occasion of public or private dignity, in which personal emotion and general meditation are united. The Greek word *ōdē*, which has been accepted into most modern European languages, meant a choric song, usually accompanied by a dance. Alcman (7th century B.C.) originated the strophic arrangement of the ode, and Stesichorus (640–555 B.C.) invented the triadic structure of strophe (*q.v.*), antistrophe and epode which characterizes the odes of Pindar and Bacchylides. Choral odes were also an integral part of the Greek drama, separating the action and commenting on the events of the plot (*see* DRAMA: *Greek Drama*). In Latin the word was not used until very late, and no Latin poet attempted to emulate Pindar, a task which Horace likened to Icarus' presumptuous flight. Horace's *carmina*, written in stanzas of two or four lines, are now universally called odes, and in literature after the Renaissance the word ought always to be qualified by the epithet Pindaric or Horatian. The aristocratic Greek, immediately celebrating athletic victories of noble youths with a public performance of choric songs of elaborate complexity and passionate brilliance, and the bourgeois Roman, patient enough to spend seven years to perfect the phrasing of a short poem which would be read in private by a sophisticated friend, have nothing in common; and it is unreasonable to expect much in common between the Pindaric and Horatian odes of modern literatures.

Pindar's challenge rather than Horace's caution proved acceptable to the Renaissance poets. Within 20 years of Aldus Manutius' first edition of Pindar's poems (1513), Luigi Alamanni (1495–1556) published his Italian imitations, but it was not until 1550, when Pierre de Ronsard published four books of *Odes* in French, that the form became established in the vernacular literatures. In Italy Gabriello Chiabrera wrote Pindaric odes on Ronsard's model, and in England the first signs of the fashion are to be discovered in the poetaster John Southern's *Pandora* (1584). In the 17th century Jonson, Milton, Thomas Randolph, Abraham Cowley, Dryden and Charles Cotton all wrote odes which, whether or not

they were entitled Pindaric, were more indebted to Pindar than to Horace. Of these Dr. Johnson considered Dryden's "To the Pious Memory of Mrs. Anne Killigrew" "undoubtedly the noblest ode that our language ever has produced." Modern taste would probably accept Dryden's own preference for "Alexander's Feast."

To the Augustan spirit of the next century Horace was more congenial, though many poets still attempted to soar with the Theban eagle, only to fall winged, as Horace had said they must. Thomas Gray alone achieved the Pindaric sublime in two famous odes, "The Progress of Poesy" and "The Bard." He was "consequently a little obscure," said Horace Walpole; but he showed the way to the romantics, for whom the liberty of the ode was most opportune. Wordsworth, Coleridge, Shelley, Tennyson, Patmore, Swinburne, Robert Bridges and others continued the tradition with impartial deference to Pindar or Cowley whose *Pindarique Odes* (1656), although irregular, had been among the first to establish the form in England. In France Victor Hugo, in Germany Goethe, Schiller and Hölderlin, and in Portugal Antonio Dinis da Cruz e Silva all testified to the vigour of the Pindaric type. Keats's odes ("To a Nightingale," "On A Grecian Urn," etc.) which are neither Pindaric nor Horatian, and which we call odes only because Keats is great enough to persuade us, have also been imitated.

Dominant as Pindar's influence has been, even from the 16th century poets have intermittently conceded the truth of Horace's judgment. Ronsard gave up attempting to rival Pindar, content to be, in his own opinion, Horace's better. Chiabrera followed his example, and also Bernardo Tasso's. But the Spaniards, Garcilaso de la Vega, Fernando de Herrera and Luis de León, were more consistent in their admiration of Horace and less inclined to venture on Pindaric flights. In England Michael Drayton was the first to produce a collection of odes in *Poems Lyric and Pastoral* (1606), in the preface to which he describes the kind and admits his principal debt to Horace. Jonson followed, and even when imitating the Pindaric triad his tone is Horatian. "The tribe of Ben" were as Horatian as their progenitor, but it remained for Andrew Marvell to write the finest Horatian ode in the language, "An Horatian Ode Upon Cromwell's Return From Ireland" (1650), in a four-line stanza which suggests, without reproducing, Horace's Alcaic stanza. In the Augustan age many imitated Horace, and with less risk than the imitators of Pindar: they neither rise so high nor fall so resoundingly. Matthew Prior was the most expert Horatian of the early 18th century, William Collins of the next generation, before romantic enthusiasm, disdainful of *aurea mediocritas*, was transported by the Pindaric. At the end of the 19th century Robert Bridges recovered something of Horace's polish; but the Epicurean urbanity of the Horatian ode is still further than the ardent nobility of the Pindaric beyond the grasp of the 20th century.

See also PINDARICS.

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ODENDAALSRUS, a town of Orange Free State province, Republic of South Africa, lies 38 mi. S.W. of Kroonstad at 4,411 ft. above sea level. Pop. (1960) 15,047, comprising 6,070 Europeans, 8,861 Bantu, and 116 Coloureds. Although it obtained municipal status in 1912, Odendaalsrus remained little more than a village until 1946 when one of the world's richest goldfields was discovered near its boundaries. It grew rapidly in size and now contains modern buildings, including a town hall, schools, a hospital, a park and sports facilities. It is linked with the main railway line between Johannesburg and Cape Town. (HE. ST.)

ODENSE, the third largest town of Denmark, port and chief town of Odense *amtsraadskreds* (county council district), lies on the Odense river in a central position on Fyn (Fünen) Island about 175 km. (109 mi.) by road and ferry west of Copenhagen. Pop. (1960) 111,145. Near the town hall (rebuilt 1955) stands the Gothic St. Canute's (St. Knud's) cathedral (*c.* 1300), originally founded by him in the 11th century; his shrine and traditional tomb are in the crypt. There is a richly carved and gilded altarpiece (*c.* 1520). The castle (now the county administrative offices) was built by King Frederick IV in 1721 partly on the foundations of St. Hans' monastery which was built by the Order of St. John of Jerusalem together with St. Hans' church. The Greyfriars hospital in Jernbanegade, originally a Franciscan monastery, was founded in 1279. The home of Hans Christian Andersen, who was born at Odense in 1805, is now a museum; there are also an open air museum (the Fünen village) and museums of art, archaeology and history. The construction of a ship canal (1796–1804) linked the town with Odense fjord and increased its importance as a port. Odense is on the main railway from Copenhagen to Esbjerg and Germany and there is an airport at Beldringe. The town has electrical and machine industries, textile mills, breweries and shipbuilding. Agricultural products are exported.

Odense dates back to heathen times. The name is derived from *Odin's vi* ("Woden's Sanctuary"), but is first mentioned in history about A.D. 1000. King Canute was killed in front of the high altar in St. Alban's church in 1086. He was later canonized and his shrine became the resort of pilgrimages throughout the middle ages, the town thus becoming a religious and commercial centre.

ODENSE AMTSRAADSKREDS consists of the northern part of the island of Fyn. Pop. (1960) 207,273. Area 701 sq.mi. It consists chiefly of fertile arable land. The production of butter, cheese and bacon is important; there is also fruit-growing and sugar-beet cultivation. The towns have manufacturing industries, especially Odense. Lindo, on the firth of Odense, has a shipbuilding yard for ships up to 100,000 tons. (SV. L.)

ODENWALD, a wooded upland in Germany, 80 km. (50 mi.) long by 40 km. (25 mi.) broad, situated mainly in the *Land* (state) of Hesse, with small portions in Bavaria and Baden-Württemberg. A popular tourist area, it stretches between the Neckar to the south and the Main to the north and overlooks the Rhine valley to the west. Uplands of crystalline rocks, which are closely settled, lie in the western part, but most of it is an upland of horizontal sandstones covered with coniferous woods. It is bounded against the Rhine by fault scarps comprising a rich and densely settled strip called the Bergstrasse ("mountain street"). The highest points are the Katzenbuckel (2,054 ft.), Neunkircher Höhe (1,985 ft.) and the Krähenberg (1,821 ft.). The wooded heights overlooking the Bergstrasse are studded with castles and medieval ruins.

The Odenwald, the hunting ground of the Nibelungs, was the background for the epic poem *Nibelungenlied* (*q.v.*), according to which Hagen slew Kriemhild's husband at the well (a popular point of interest to tourists). The *Nibelungenstrasse* cuts across the Odenwald from west to east between Worms and Würzburg and though marked for tourists, is certainly not accurately placed. Another legendary figure is the "Wild Huntsman of Rodenstein" (popularized by Joseph Victor von Scheffel) who supposedly galloped with fearful din to Schnellerts castle. (R. E. D.)

ODER (Czech. and Polish ODRA; ancient VIADUA), a river of Europe, 567 mi. long, which rises in the Carboniferous rocks of the Oder mountains, Czech. After flowing southeast, it bends northeastward and then northwestward to enter the Silesian plain. There, the river widens into a broad valley with low banks and cuts through Recent deposits. In its lower course it has a branched channel with its main course flowing past Szczecin (Stettin) into the Oder Haff (Zalew Szczecinski or Stettin lagoon), which is connected with the Baltic sea by three arms, the Peene, Swina and Dziwna (Dievenow), joining the islands of Usedom (Uznam) and Wolin (Wollin). The Swina is the main channel for navigation.

The Oder enters Poland north of Ostrava and skirts the western side of the Upper Silesian coalfield. It receives a number of left bank tributaries from the gneisses and granites of the Bohemian massif, the chief being the Kłodzka, Kaczawa (Katzbach), Bóbr (Bobrawa), and the Lusatian Neisse (Nysa Luzycka); but the major part of the drainage basin lies to the east and the biggest affluents are those on the right bank, the Warta with its tributaries the Notec and Obra, the Mala Panew and Barycz. Between the confluence with the Neisse and a point near Gryfino south of Szczecin, the Oder forms the frontier between Poland and the

German Democratic Republic. The drainage basin of the river lies almost entirely in Poland and covers more than one-third of the country.

The principal towns on the Oder's banks are Raciborz, Opole, Brzeg, Wroclaw (Breslau), Glogow (badly damaged in World War II), Frankfurt an der Oder, Kostrzyn, Szczecin and Swinoujscie. The river forms an important highway into the German Democratic Republic, Poland and Czechoslovakia, and communist plans envisage it as a major artery for heavy industrial traffic, linking the Moravian and Upper Silesian economic regions with Szczecin and the east-west canal systems of the Spree, Mittelland and Notec-Vistula. The inter-war partition of the Upper Silesian coalfield handicapped mineral traffic via the Oder, which is linked to the western part of the coalfield by the Gliwice canal (25 mi.). The establishment of unified Polish control over the coalfield and the Oder river in 1945 stimulated investment in improvements and extensions to the navigable system; a canal, linking the upper Oder and Vistula rivers, and the building of many factories along its banks were projected. In 1958 a long-term project for linking the Oder with the Danube via the Moravian gate was agreed between Poland, Czechoslovakia and the German Democratic Republic, under which the Oder was to be made navigable throughout for 1,000-ton barges by 1970, with traffic on the river estimated to reach 5,000,000 tons by that year. Hitherto the river had been navigable for barges only as far as Raciborz, where it is about 100 ft. wide.

Growing industrial demand for water has contributed to rapid industrialization alongside the Oder. Among major industries are fertilizers at Kedzierzyn, cement around Opole, a chemical combine at Brzeg producing phenol and chlorine, copper south of Glogow based on large and recently proved deposits, and extensive brown coal working in Zielona Gora *wojewodztwo* (province). At Szczecin important shipyards were reconstructed and built between 1945 and 1960. The port of Szczecin developed rapidly, by 1958 handling two-thirds of total Polish transit turnover, principally with Czechoslovakia, the German Democratic Republic and Hungary. By the early 1960s, with a total turnover of more than 8,000,000 tons of cargo, it handled the greatest volume of any Polish port. (Ed. Br.)

ODESSA, an *oblast* of the Ukrainian Soviet Socialist Republic, U.S.S.R., formed in 1932, lies between the Black sea (south) and the Moldavian S.S.R. (west), and between the Rumanian frontier on the Danube delta and the Tiligul lagoon (Tiligulski Liman). Area 12,780 sq.mi. Pop. (1959) 2,027,807. The *oblast* is divided by the Dniester estuary which lies across its narrow "waist." The southwest is coastal plain, sloping gently to the Black sea. This part up to 1954 formed the separate Izmail *oblast*. The northeastern part extends farther inland, occupying the western half of the Dniester–Southern Bug interfluve, and reaching the southern hills of the Volyno-Podolsk upland. The whole *oblast* lies within the steppe and is marked by a dry climate. Rainfall ranges from 12 in. a year on the coast to 18 in. on the upland. The continental climate is much modified by the proximity of the sea, with January average temperatures −2° C. (28° F.) on the coast to −5° C. (23° F.) inland, and July averages from 23° C. (74° F.) on the coast to 22° C. (71° F.) in the north. There is little surface water and all but the largest rivers are liable to dry up in the summer. Soils are mostly fertile chernozems and little of the natural grass steppe remains unplowed. The whole coast is low, with long offshore bars enclosing lagoons in the drowned lower river valleys, most of which are rapidly silting up.

Of the 1959 population, 48% (964,159) were urban, living in 11 towns and 17 urban districts. More than two-thirds live in Odessa, the remaining urban areas being small. The most important are Izmail (48,103), Kotovsk (27,383) and Belgorod-Dnestrovski (21,832). Industry is chiefly concentrated in Odessa, but food processing is widespread in the smaller towns, based on an intensive agriculture. Grains dominate the arable with nearly 70% of the sown area. Winter wheat, maize (corn) and barley are the chief crops. Sunflowers are the main industrial crop, with sugar beet important in the uplands and some flax, hemp and mustard. Vegetables, especially melons, are widely grown, and are intensively cultivated in the market gardening area around Odessa. In the southwest there are vineyards and orchards, with Bolgrad as the chief wine centre. Livestock husbandry is well developed, with dairy and beef cattle in first place but also large numbers of sheep including karakul. (R. A. F.)

ODESSA, a seaport and *oblast* administrative centre of the Ukrainian Soviet Socialist Republic, U.S.S.R., stands on a shallow indentation of the Black sea coast, about 19 mi. N. of the Dniester estuary (Dnestrovski Liman); 275 mi. S. of Kiev. Pop. (1959) 667,182. Although there had been settlement on this site since ancient times (*see* Tripolye), the present town owes its origin to the establishment of a Tatar fortress (Khadzhibei) in the 14th century. After a period of Lithuanian-Polish supremacy, the fortress passed to Turkey (1764). In the Russo-Turkish War of 1774 it was stormed by the Russians and in 1791 was ceded to Russia. In 1792–93 a new fortress was built and in 1794 a naval base and commercial quay were established. In 1795 the new port was named Odessa after the ancient Greek colony of Odessos, the site of which was believed to be in the vicinity. During the 19th century it developed rapidly and by 1863 it was the third town of Russia, with 119,000 inhabitants. In 1866 railways reached Odessa and it expanded to 403,000 people by 1897. It was second in importance as a port to St. Petersburg and Russia's major grain-exporting port. Odessa was one of the chief centres of the 1905 uprising and the scene of the mutiny of the warship "Potemkin." After the Revolution, Odessa underwent a number of conflicts and was several times occupied by foreign troops before Soviet power was finally established. During World War II much damage was suffered in the prolonged defense against German and Rumanian troops and in the subsequent occupation and liberation. (While occupied it was made the capital of Transnistria [Rumanian zone of administration].)

Although modern Odessa has lost some of its relative importance it is still a major industrial centre and port. Among its engineering products are machine tools, cranes, winches, tractor parts, plows, cinematic apparatus, gas generators, mining equipment, printing and refrigerating machinery and weighing machines. There are ship repair yards, and superphosphate fertilizers, clothing, jute bags, leather goods and foodstuffs are also made. The port, one of the largest in the U.S.S.R., is well equipped to handle a range of cargoes. After 1957 a new port was constructed at Ilyichevsk, 15 mi. S. There is a fishing fleet and it is the base of the Soviet Antarctic whaling fleet. Odessa has good rail communications to Cherkassy and central Russia, to Khmelnitski and the western Ukraine, to Kishinev and Rumania and to Izmail.

Odessa is a cultural centre, with the I. I. Mechnikov State university (1865), the Filatov Institute of Eye Diseases, other higher educational establishments and many technical and specialist schools. There is a theatre of opera and ballet and several other theatres and museums. (R. A. F.)

ODESSA, a city of western Texas, U.S., is on the southern high plains 45 mi. S.E. of the southeastern corner of New Mexico and is the seat of Ector county.

One of the largest known meteor craters in the United States is located a short distance south of Odessa. It is more than 600 ft. in diameter and more than 150 ft. deep.

In 1881 the site was named for Odessa, Russia, by railroad construction workers who noted the similarity of the region to their Russian homeland. The town was established in 1886 by German wheat farmers from the north, but the county was devoted entirely to ranching when it was organized in 1891. Incorporated in 1927, the city adopted a council-manager form of government in 1946.

Oil was discovered in the late 1920s, and, with the establishment of the petroleum and related industries, the town's population, which was less than 3,000 in 1930, increased more than twentyfold in 30 years. Pop. (1960) 80,338; standard metropolitan statistical area (Ector county) 90,995. (For comparative population figures *see* table in Texas: *Population*.) Located in the geographic centre of the Permian basin, one of the largest known oil reserves, Odessa is a major distribution and servicing point for the petroleum industry. Manufactures include oil-field equipment, petroleum

products, synthetic rubber, cottonseed oil, chemicals and tile. Large deposits of carbon black, potash, salt, limestone and potassium are also mined and processed in the vicinity. Stock and poultry raising are also carried on. Odessa junior college (1946), located within the city, is municipally controlled. For the geography of the region *see* LLANO ESTACADO. (E. WE.)

ODIN (ÓðINN), one of the principal gods in Scandinavian mythology. The picture of him, however, which results from the wealth of sources, both literary and archaeological, is so complex that it is difficult to determine his role and nature exactly. The Roman historian Tacitus states that the Teutons worshiped Mercurius; and, if only because of the identity of *dies mercurii* (Mercury's day) with Wednesday (Woden's day), there can be little doubt that the god Woden whose name was the earlier form of Odin is meant. He is worshiped preeminently. There is corroborative evidence of this cult, but not sufficient to show whether it was practised by all the Teutonic tribes or to enable conclusions to be drawn about the nature of the god. Literary sources, largely aristocratic in character, give the impression that much later, at the end of the heathen period, Odin was the principal god in Scandinavia; but it is not certain that this was always so. Thor (Þorr) is also very prominent, and it is Tyr (Tiw) whose name is etymologically related to Zeus-Jupiter. Some scholars have even denied that Odin is autochthonous, although it

ANTIKVARISK TOPOGRAF.SKA ARKIVET BY COURTESY OF THE STATENS HISTORISKA MUSEUM, STOCKHOLM

DETAIL OF A PICTURE-STONE FROM GOTLAND, ABOUT A.D. 800, SHOWING ODIN RIDING HIS EIGHT-LEGGED HORSE, SLEIPNIR

is difficult to explain his highly complex character by foreign influences. He also appears as one of a triad.

From the earliest times he was a war god, and he appears in heroic literature as the protector of heroes; fallen warriors go to him in Valhalla. The spear which he normally carries is probably as much a symbol of authority as a weapon; he rides an eight-legged horse, Sleipnir, and the wolf and the raven are dedicated to him. He was also the god of poets, and two versions exist of the story of how he stole the poets' mead; it has been suggested that this mead can be equated with the fluid represented in cosmological speculations as the source of life. Odin is the great magician among the gods and is associated with runes. In outward appearance he is a tall, old man, with flowing beard and only one eye. A wide-brimmed hat covers part of his face, and he wears a cloak. In all his functions, including the martial, qualities of mind are prominent.

See also GERMANIC MYTHOLOGY AND HEROIC LEGENDS: *The Gods*. (K. C. K.)

ODO OF BAYEUX (*c.* 1036–1097), earl of Kent, half brother of William the Conqueror, who gave him the bishopric of Bayeux in 1049, was the son of Herluin of Conteville by Arlette, who had previously been mistress of Robert I, duke of Normandy. Ambitious and energetic, scandalously immoral, Odo had a many-sided career. As bishop he typified the pre-reform age of the Norman church, when the great churchmen were essentially scions of the aristocracy placed in possession of the church's wealth. Yet he spent lavishly on the building of his cathedral, created its capitular organization, and gave financial help to young students. It is likely that the Bayeux tapestry was commissioned by him, probably for the dedication of his cathedral (1077). Odo was active in the invasion of England, fighting in the battle of Hastings (1066). In 1067 he was made earl of Kent with special responsibility for guarding the southeast. He shared with William Fitz-Osbern and Geoffrey, bishop of Coutances, the task of ruling England in the king's frequent absences. In 1082 he was tried and imprisoned on a charge of raising troops without royal permission, probably to form a private army to defend the pope against the emperor Henry IV, though he was said later to have aspired to the papacy himself. Released on the accession (1087) of William II, he soon rebelled (1088) in support of Robert Curthose, duke of Normandy, and though the revolt was crushed Odo was allowed to join Duke Robert whose right-hand man he became. He was foremost in the movement leading to the first crusade and was at Palermo on his way to the Holy land when he died in Feb. 1097.

See F. M. Stenton, *Anglo-Saxon England*, 2nd ed. (1947), and (ed.) *The Bayeux Tapestry* (1957). (G. W. S. B.)

ODOACER (*c.* 433–493), the first barbarian king of Italy, reigned from 476 to 493. The son of one Idico or Edeco, he is said to have belonged to the nation of the Sciri, though some say that he was a Rugian. In either case he was a German. A glorious future was foretold for him by St. Severinus in 470, when he was 37 years of age. He wandered in company with the Sciri to Italy about that date and eventually, along with the remnants of several other barbarian peoples who had been uprooted from their homes in the confusion which followed the fall of Attila's empire, he entered the service of the emperor Anthemius. But these barbarian troops supported Ricimer in overthrowing Anthemius, and they also supported Orestes in overthrowing the emperor Julius Nepos. As a reward for their support Orestes promised them a share in the senatorial estates of Italy, and when he did not carry out his promise, they revolted against him under Odoacer's leadership. Odoacer stormed Ticinum (Pavia), where Orestes had taken refuge, and finally captured and executed him in Placentia (Piacenza) on Aug. 28, 476. Odoacer then deposed Orestes' son Romulus Augustulus and allowed him to live in Campania. His army, which was composed of troops of several nations, had proclaimed Odoacer as king on Aug. 23. His aim now was to keep the actual administration of Italy in his own hands, while recognizing the country as being under the overlordship of the emperor at Constantinople. Accordingly, in 477 he sent a deputation of senators to Zeno at Constantinople asking for the rank of patrician and requesting that he be entrusted with the government of Italy. Zeno granted the first of these requests but asked Odoacer to acknowledge as emperor Julius Nepos, who was still living in Dalmatia. This Odoacer refused to do, but he did recognize the overlordship of Zeno himself; and in fact Nepos was killed on May 9, 480.

The senate at Rome supported Odoacer, and members of the leading aristocratic families received high honours and offices from him. Although he allowed the city prefect to hold his post only for one year so as to prevent any prefect from gaining too much prominence, Odoacer introduced few changes of importance into the administrative system in Italy. The distribution of estates to his Germanic followers—the matter which had led them to revolt against Orestes—was carried through apparently without serious opposition. There was unrest, however, among them in 477 and 478, and two counts named Bravila and Adaric are known to have lost their lives; but from the later period of the reign no such disturbances are known.

The church was little affected by Odoacer's rule. He himself was an Arian, and rarely intervened in the affairs of the Catholics. As for foreign politics, he had entered Dalmatia after Nepos' assassination there but did not succeed in crushing opposition until 482. In 484 the usurper Illus begged Odoacer's help in his struggle with Zeno. Odoacer refused, but nonetheless attacked the Il-

lyrican provinces in Illus' support; and Zeno incited the Rugi, who lived between Linz and Vienna, to attack Italy so as to distract him. Hence, in the winter of 487–488 Odoacer crossed the Danube and defeated the Rugi in their own territory, taking prisoner their king, Feletheus, and his wife, Giso, whom he executed in Ravenna. In a later campaign he defeated their son and thus put an end to Rugian power. Feeling himself insecure on the Danube, he ordered his brother Onoulf to evacuate the Roman provincials who lived there and bring them to Italy. The Visigothic king Euric, who had occupied much of Spain and Provence, including Arles and Marseilles, attempted an invasion of Italy but was repulsed by Odoacer's generals. But Euric retained some of the territory which he had overrun, and Odoacer's northwestern boundary was now formed by the Ligurian Alps. On the other hand, he recovered Sicily (apart from Lilybaeum) from the Vandals in return for an annual tribute.

For the circumstances of the invasion of Italy by Theodoric and the Ostrogoths and the campaigns of 489–493, in which Odoacer put up a stubborn and at times successful resistance to the invaders, *see* THEODORIC. When Ravenna, Odoacer's last stronghold, was finally surrendered to the Ostrogoths, Theodoric treacherously slew him there with his own hand on March 15, 493. His relatives and supporters were killed on the same day.

See J. B. Bury, *History of the Later Roman Empire*, vol. i, ch. 12 (1923); E. Stein, *Histoire du Bas-empire*, vol. i, ch. 11 (1959).

(E. A. T.)

ODONATA, an order of insects comprising the dragonflies and damselflies. *See* DRAGONFLY.

O'DONNELL, a name of great prominence in the history of Ireland, especially from the 13th to the 16th century. There are five distinct clans or septs of O'Donnell. Four of these are of comparatively minor importance, but that of Tir Conaill (Tyrconnell), is outstanding. *The Annals of the Four Masters* (a compilation of materials on Irish history) mention no fewer than 201 individual O'Donnells of the Tyrconnell clan; there are only four entries for the O'Donnell sept of Corcabascin in west Clare, three for the Idrone (Leinster) family, and one for that of Ui Maine (Hy Many). All these, however, are still found in considerable numbers in the localities in which they originated.

In the northwest O'Donnell was the name of a powerful group of families, lords of Tyrconnell (all County Donegal except the promontory of Inishowen) from the beginning of the 13th century when Eighneachan, the first O'Donnell chief of note, wrested that territory from the O'Cannanains, later extending their sway over Inishowen, Fermanagh, part of Cavan and the northern part of Connaught (Connacht). As a clan they were known as Clann Dalaigh, from Dalach (d. 868), an early ancestor. The surname was derived from his 10th-century descendant Domhnall (Donnell) but their descent, like that of O'Neill of Tyrone, is traced from Niall Naoighiallach, of the Nine Hostages, king of Ireland at the beginning of the 5th century.

During the period of almost continuous warfare in the middle ages, the second outstanding chief of the name was Gofraidh (Godfrey), son of Donnell Mor O'Donnell (d. 1241), who, inaugurated chief in 1248, consolidated the position won by Eighneachan and died in 1258 of wounds received at the battle of Credran (1257), which was a decisive victory over their great rivals the O'Neills. Also important was Aodh Ruadh (Hugh Roe) O'Donnell (1427–1505), who as far as possible avoided war with the earl of Tyrone and often worked in alliance with James IV of Scotland and is remembered as the founder of the monastery of Donegal, which was later the scene of the labours of the Four Masters.

He was succeeded by another Hugh (d. 1537), called both Hugh Dubh or Duv (*dubh*, "black") and Hugh Og (*óg*, "young" or "junior"), who also enjoyed a long reign. He went on a pilgrimage to Rome in 1510, returning two years later to resume his leadership unchallenged, itself a sign that his father's policy, which he continued, had borne fruit. Intermittent warfare with the O'Neills could not be avoided, though O'Donnell's decisive victory over Conn O'Neill at Knockavoe in 1522 secured his position for a considerable time. In the time of Hugh Dubh's son, Manus O'Donnell (d. 1563), the English conquest of Ireland really began to be undertaken seriously and the first steps were taken toward national resistance. Reluctance on the part of the O'Neills and their ancient enemies the O'Donnells to form a strong combination greatly weakened opposition to the English, who were skilful in taking advantage of this situation, while the O'Donnells, like the other great chiefs, sought to make use of the English in their own interests when it suited them. The summary execution in the Tower of London of Silken Thomas, 10th earl of Kildare, and his five uncles in 1537, consolidated the opposition to Henry VIII. The remaining heir to the earldom was Gerald, a boy of 12 who was secretly in the charge of his aunt, Lady Eleanor MacCarthy. She married Manus, who in that year was inaugurated the O'Donnell, *i.e.*, chief of the clan, thereby securing a powerful protector for the boy. Gerald was, moreover, related to Conn O'Neill and the formation of the Geraldine league followed, the ultimate aim of which was the complete overthrow of English rule in Ireland. Though several of the principal chiefs went to England to submit to Henry VIII, Manus did not accompany them, but in 1541 he made terms at Cavan with Sir Anthony St. Leger who, presumably without any bias in his favour, commented on his elegant bearing and attire. The Four Masters, whose connection with the O'Donnells must not be forgotten when considering their eulogies, call him "a learned man, skilled in many arts, gifted with a profound intellect." Though he did not himself write the *Life of St. Columcille*, he caused it to be written.

Calvagh O'Donnell (d. 1566), the next chief, held the position officially for only three years, though in practice he ruled from 1555, when he deposed his father with the aid of the MacDonnells. His half brother, Hugh MacManus, took his father's side and enlisted the help of his cousin Shane O'Neill. O'Neill's invading army was defeated in 1557 by Calvagh, whose overlordship of Tyrconnell was then recognized by the English government. Shane got his revenge in 1561; he captured Calvagh and his wife and held them prisoners under extremely brutal conditions for three years. When at length Sir Henry Sidney intervened in 1566 to restore Calvagh, this benefited his son Hugh rather than himself, as he died a few months later and Hugh was duly inaugurated as chief of the name. Calvagh's son Con, who might possibly have succeeded, though primogeniture was not mandatory in the Gaelic system, was at the time a prisoner in the hands of Shane O'Neill. Hugh was now in a position to resume the traditional struggle with the O'Neills, in which of course he had the tacit approval of Sidney. He routed Shane at Farsetmore near Letterkenny in 1567, which caused Shane to seek refuge with the MacDonnells of Antrim, who in revenge murdered him and thus terminated the career of one of the most outstanding though not the most admirable figures in Irish history.

Hugh abdicated in 1592 in favour of his eldest son Hugh Roe O'Donnell (1572–1602), known as Red Hugh, grandson of Manus by his marriage with Judith O'Neill. Hugh Roe has been described as the last of the old Gaelic kings. He was then only 20 years old and his previous experiences helped to make him an inveterate enemy of the English. When less than 16 years old he had been kidnaped by Sir John Perrot, the lord deputy, who, conscious of the O'Donnell family's connexions with the O'Neills, feared a dangerous combination against the English government. He was long imprisoned in Dublin castle, made an abortive attempt to escape in 1590 and was finally successful in Jan. 1592.

Red Hugh's first concern was to drive out the English sheriff and his company of undisciplined marauders who, despite promises, had come to Tyrconnell and occupied the monastery of Donegal, after expelling the friars. This he accomplished successfully. Two expeditions against Turlogh Luineach O'Neill followed. Red Hugh's exploits in 1594 have been exaggerated; but in 1595 and 1597 he certainly turned his attention again to the west, making good his control of Connaught from Sligo to Leitrim. These, however, were minor operations compared with the war which followed, famous for the great Irish victory of the Yellow ford in 1598, where O'Donnell played a major part, and for the disaster of Kinsale (Dec. 1601). O'Donnell's march to join Tyrone at Kinsale was remarkable; in 24 hours he and his men covered no

less than 40 mi. including the almost impassable Slieve Phelim mountains. Red Hugh's support of the Spanish commander, Juan del Aquila, who counseled an immediate attack against the advice of the more cautious O'Neill, may well have brought about the crushing defeat that may be regarded as the death blow of the old Gaelic Ireland. O'Donnell then went to Spain where he died, said to have been poisoned by an English agent, though this has never been fully proved.

Meanwhile his cousin and brother-in-law Niall Garve O'Donnell (1569–1625) had gone over to the English. Though Hugh had delegated his authority to his younger brother Rory when he left for Spain, Rory was never inaugurated in his place. After Hugh's death Niall Garve, who had meanwhile quarreled with the lord deputy, was chosen chief by his own partisans. He did not long enjoy his position as he was charged with complicity in Sir Cahir O'Dogherty's rising of 1608 and imprisoned in the Tower of London, where he died.

Rory O'Donnell (1575–1608) accompanied Hugh to Kinsale. In 1603, having already signified his allegiance to Lord Mountjoy, the lord deputy, he went to London with Tyrone, and James I created him earl of Tyrconnell. The government's terms for a settlement satisfied neither Niall Garve nor Tyrconnell; Niall Garve's career was soon terminated and Tyrconnell began negotiations with Spain, which led to his sudden departure with Tyrone from Ireland in Sept. 1607, an event known as "the flight of the earls." Tyrconnell went to Rome and died three months afterward. His daughter Mary Stuart O'Donnell (b. 1607) was the heroine of many romantic and dangerous adventures. Rory O'Donnell was posthumously attainted in 1614 thus bringing more than 100,000 ac. in Ulster to the crown; but his son Hugh Albert was recognized by the court of Spain, where he lived, as earl of Tyrconnell.

Hugh Albert is supposed to have appointed Hugh Baldearg O'Donnell as his heir, but this is improbable. Hugh Albert died in 1642 and Hugh Baldearg lived until 1704. The latter fought with distinction for James II at the Boyne and at Aughrim, but later quarreled with Richard Talbot, earl and titular duke of Tyrconnell, and went over to William III. He did not remain in that service but returned to Spain and, taking part in campaigns in Italy and Austria, rose to high military rank. He was great-grandson of Con Mac Calvagh and from his line are descended the Larkfield O'Donnells. The chief of the name in 1962 was John O'Donel of Monkstown, County Dublin, of the Larkfield branch, and the presumptive successor to the title the duque de Tetuán, the next senior branch of the name. The 1st duque de Tetuán was Leopoldo O'Donnell (1804–67) who became a field marshal and grandee of Spain and was several times a prominent member of the government. There were also branches of the clan in Austria, the best-known individuals being Gen. Graf Karl O'Donnell (1715–71) of the Larkfield line. Gen. Daniel O'Donnell (1666–1735), great-grandson of Hugh Dubh of Ramelton, was another notable soldier; he led a regiment of the Irish brigade against the duke of Marlborough at Oudenaarde and Malplaquet. Other notable bearers of the name were James Louis O'Donnell (1738–1811), a Franciscan, known as the apostle of Newfoundland; John Francis O'Donnell (1837–74), poet and Fenian propagandist; and Patrick Cardinal O'Donnell (1856–1927), archbishop of Armagh. *See* also IRELAND: *History*.

See E. MacLysaght, *Irish Families* (1957), and *More Irish Families* (1960), which include bibliographies. (E. A. MacL.)

O'DONNELL, LEOPOLDO, CONDE DE LUCENA and DUQUE DE TETUÁN (1809–1867), Spanish general and politician, a loyal supporter of Isabella II, was born at Santa Cruz de Tenerife on Jan. 12, 1809. He made his name by his successful campaigns against the Carlists in the 1830s. He went into exile in France with María Cristina I (*q.v.*) in 1840 and helped to overthrow the Spanish government headed by Gen. Baldomero Espartero (*q.v.*) in 1843. He served in Cuba from 1844 to 1848 and then returned to Spain to become minister for war. In this post he shared control of affairs during the so-called *bienio progresista* (1854–56) with Espartero, whom he displaced as premier in July 1856, having formed a supporting group of dissidents known as the Unión Liberal. He led the administration only until October, but returned to power from 1858 to 1863. During this ministry he took command of the victorious expedition to Morocco (1859–60) which captured Tetuán. O'Donnell was rewarded with the title duque de Tetuán. He resumed office briefly in 1865–66; but though he was severe in repressing the San Gil rising (June 1866) he was not so harsh as the queen wanted and had to hand over his authority to Gen. Ramón María Narváez. He then retired to Biarritz, where he died on Nov. 6, 1867. O'Donnell enjoyed great personal popularity as a result of his successful African campaign, but his administration was marred by his lack of political ability and the absence of any clear political program.

See M. Ibo Alfaro, *Apuntes para la historia de D. Leopoldo O'Donnell* (1868).

ODONTOGLOSSUM, a genus of more than 100 species of showy, tropical-American, tree-perching (epiphytic) orchids; over 30 are grown in greenhouses for their unusual flowers. *O. grande* (the so-called baby orchid) of Guatemala and *O. crispum* of Colombia have flowers three to six inches wide in handsome clusters. With their many hybrids these are among the showiest, best-known and most easily grown of all orchids. (N. Tr.)

ODORIC (*c.* 1286–1331), Franciscan friar, traveler and a *Beatus* of the Roman Catholic Church who spent three years in China, was born about 1286 at Villanova, a hamlet near Pordenone in Friuli. At an early age he took the vows of the Franciscan order and entered their house at Udine. Between 1316 and 1318 Friar Odoric was sent to Asia where he stayed until 1329. During these years there was a great extension of missionary activity.

His route to the east lay by Trabzon and Erzurum to Tabriz and Sultaniah, in all of which there were Franciscan houses, thence by Kashan, Yazd, Persepolis and the Shiraz and Baghdad regions to Hormuz on the Persian gulf; at the last, he embarked for India. He landed at Thana near Bombay about 1322. After visiting many parts of India, and possibly Ceylon, he sailed in a junk to Sumatra calling at several ports along the northern coast, to Java, to the coast of Borneo (possibly), to Champa (south Cochin China) and to Canton.

He traveled extensively in China and visited Hangchow (Cansay, Khanzai or Quinsai, *i.e., Kingsze* or royal residence), then renowned as the greatest city in the world (he included many details about its splendours in his narrative). Continuing northward, he crossed the Yangtze, embarked on the Grand canal and traveled to Peking (Cambaluc). He stayed for three years in Peking, and was possibly attached to one of the churches founded by the archbishop Giovanni di Monte Corvino.

Returning to Europe by way of central Asia, Odoric seems to have journeyed through Tibet, possibly visiting Lhasa. Thereafter, he appears to have traveled to northern Persia, to Millestorte, once famous as the land of the assassins in the Elburz mountains, and thence, probably by way of Tabriz, to Venice. The account of the last stages of his homeward journey is vague and fragmentary. During at least a part of his long journeys Odoric was accompanied by Friar James, an Irishman.

Shortly after his return Odoric entered the Minorite house attached to St. Anthony's at Padua; there in May 1330 he related the story of his travels; his itinerary was taken down in simple Latin by Friar William of Solagna. Several months later while on his way to the papal court at Avignon, Odoric fell ill at Pisa. He was taken to the Franciscan house at Udine where he died on Jan. 14, 1331.

The fame of Odoric's journeys seem to have made a greater impression on the laity of Udine than on his Franciscan brethren. The latter were about to bury him, when the chief magistrate (*gastald*) of the city interfered and ordered a public funeral. Odoric's body was buried in the presence of the patriarch of Aquileia and other dignitaries. Popular acclamation made him an object of devotion and the municipality erected a shrine for his body. Although his fame had spread far and wide before the middle of the 14th century, he was not formally beatified until 1755.

Numerous surviving copies of Odoric's narrative (of the original Latin text as well as of versions in French and Italian) show how quickly it became popular. The substance of Sir John

Mandeville's supposed travels in India and China were taken without acknowledgment from Odoric.

BIBLIOGRAPHY.—Of the many manuscripts of Odoric's narrative extant, the chief one is in Paris (Bibliothèque Nationale, Mss. Lat. 2584, fol. 118r.–127v., of *c.* 1350); it was first printed at Pesaro in 1513. The best editions are G. Venni, *Elogio storico alle gesta del Beato Odorico* (1761); H. Yule (ed.), *Cathay and the Way Thither*, vol. i, pp. 1–162 and vol. ii, appendix, pp. 1–42 (1866). (E. M. J. C.)

O'DUFFY, EOIN (OWEN) (1892–1944), Irish military leader, was born on Oct. 30, 1892, near Castleblayney, County Monaghan, Ire. He joined Michael Collins' Irish rebels in 1917, but was captured and imprisoned in Belfast as leader of a rebel division. After release, he rejoined Collins in 1921, became chief of staff (1921–22) and then general officer commanding the Irish Free State forces (1924–25). He was also chief commissioner of the Civic guard (1922–33) but was removed from that post by Eamon de Valera. O'Duffy then joined the opposition, which he helped weld into the United Ireland party with the avowed purpose of fighting communism; he became its president in 1933. During this period, he also headed the Blue Shirts, a fascist offshoot organization of the U.I. party with a one-time boasted membership of 120,000. O'Duffy, however, was a poor politician and the U.I. disintegrated under his leadership. He himself resigned in 1934. To revive his waning prestige, he recruited 1,400 volunteers who joined Francisco Franco's "holy crusade against bolshevism" in Spain in 1936. But the O'Duffy brigade lost heart after a taste of battle and returned home in disgrace after six months in Spain. With this fiasco, O'Duffy lost what was left of his prestige. He died in Dublin on Nov. 30, 1944.

ODUM, HOWARD WASHINGTON (1884–1954), U.S. sociologist best known for his studies of social problems of the south, was born on May 24, 1884, near Bethlehem, Ga. He was educated at Emory university, the University of Mississippi, Clark college (Ph.D., 1909) and Columbia university (Ph.D., 1910). After joining the University of North Carolina in 1920, he pioneered in the development of social science, founding and heading departments of public welfare and sociology, a research institute and the journal *Social Forces*. Odum did his first important work on the social life and folk culture of the Negro, using both sociological and literary materials. In *Rainbow Round My Shoulder* (1928) he achieved literary artistry. At Pres. Herbert Hoover's request, Odum and William F. Ogburn organized and edited the report *Recent Social Trends* (1933). In *Southern Regions of the United States* (1936) he developed regional analysis and theory as a contribution to the South's reintegration in national life. In public service he sought new standards in race relations, public welfare, higher education, regional planning and penal reform. His major avocation, the breeding of Jersey cattle, brought him a master breeder's award. Odum's last book was *American Sociology* (1953). His system of sociology is best presented in his text, *Understanding Society* (1947). He died on Nov. 8, 1954, in Chapel Hill, N.C. (R. B. V.)

ODYSSEUS, called ULIXES by the Romans and ULYSSES generally since, Homeric hero prominent in western literature and imagination. His characteristics are intelligence, experience and endurance, sometimes seen as low cunning and insensitivity. He was the son of Laertes and Anticleia (or of Sisyphus), the husband of Penelope, the father of Telemachus and a protégé of Athena.

In the *Iliad* Odysseus at the behest of Athena restores Agamemnon's authority and rallies the disaffected Greeks, who are already rushing to their ships (ii, 142–335; for synopses of *Iliad* and *Odyssey* see HOMER). When Agamemnon too has had enough, Odysseus points out that there is nothing for a hero to do but stay and fight (xiv, 85–87). The death of friends also must simply be endured (xix, 220–233). In the end Achilles too realizes that there is no alternative to battle and no recompense for death—his own or Patroclus'. Odysseus' realism is seen at its grimmest in the night raid on the Trojan camp (book x), where he acts as Diomedes' preceptor in stealthy butchery. In sum, Odysseus in the *Iliad* is the effective man of worldly wisdom.

In the *Odyssey* Odysseus is the taker of Troy and even more prominently the man of experience. Here is first mentioned his stratagem of the wooden horse (*see* TROY) and his being judged more worthy than Ajax (*q.v.*) of the arms of Achilles. Not that his unpleasant side is ignored; rather, a virtue is made of it. Odysseus' burglar-grandfather Autolycus gave him the significant name "Odysseus," meaning something like "giver of pain" (xix, 405–409), and Odysseus saved that name from oblivion by living up to it. His first deed on leaving Troy is to sack a city, whereupon he is roughly handled. Yet the alternative to city-sacking, as expressed in the affair of the Lotus-eaters, involves "forgetting one's home." Next, he advances from being "No-man" to announcing himself as "Odysseus"—"giver of pain"—by putting out the Cyclops' eye with a red-hot stake. One of the analogues suggested is that to be born is a Cyclopean adventure—to pass from anonymity to crying one's name in the teeth of a hostile universe. This seems to be a necessity, for when Aeolus suspends nature's contrariness, Odysseus becomes trustful for a moment, and homecoming is lost. The Laestrygones are the cannibal giants whom Odysseus does not defy, and who thereupon destroy his fleet. With Circe it is the show of force that turns her menace to balm. The adventure in the land of the dead suggests the pain that lies at the heart of things, and its value. The dead recognize Odysseus in terms of the pain he connotes, and the speech of Hercules, the most hostile-appearing shade of all, implies that pain, given and suffered, wins immortality itself. Odysseus next safely negotiates the Sirens and their temptation to hear about life rather than experience it. Scylla and Charybdis give the *Odyssey's* choice in its most schematic form: face certain trouble from the monster, or be swallowed by the maelstrom. (The same choice is present at the beginning of the poem: oblivion with Calypso "the Hider" or certain trouble on the sea.) The cattle and sheep of the Sun suggest days and nights—there are 350 of each. To court oblivion by eating them merely to avoid the pain of hunger is like consuming one's days in inactivity to avoid the pain of a life in which to act is to injure and be injured but not to act is not to know and be known. Odysseus, resisting the temptation to oblivion, acts. Good, mild king though he has been, only his willingness to kill his enemies and deceive his friends can put his kingdom to rights and keep his name alive.

The later tradition found this strong stuff. Pindar (*Nemeans*, 7 and 8) thinks Odysseus despicable and his defeat of Ajax a fraud. In Sophocles' *Ajax*, heroic intransigence confronts Odysseus' wisdom, as in the *Iliad;* in *Philoctetes* Odysseus and Neoptolemus remind one of Odysseus and Diomedes in book x of the *Iliad*. (Stories making this second pair partners in crime, like the murder of Palamedes [*q.v.*] or the theft of the Palladium [*q.v.*], suggest the same source.) In Euripides' *Hecuba, Troades* and *Iphigenia at Aulis* Odysseus is a ruthless politician; in his satyr play *Cyclops* Odysseus is a burlesqued sophist. Plato gives him credit for intelligence and at the same time condemns his Homeric career by making him at the end of the *Republic* choose an obscure life for his next existence. Odysseus is a villain in the *Aeneid*, as he is in Seneca's adaptations of Euripides. Dante puts Odysseus and Diomedes together in one flame in the *Inferno*. But not all versions of Odysseus were unfavourable. Archilochus, Theognis of Megara, the Stoics and Cynics, Cicero and Horace all admired him. So did Racine and Fénelon, followed by Giraudoux. Calderón de la Barca reformed, Tennyson romanticized and Hauptmann made a madman of him. In Shakespeare's *Troilus and Cressida* he is an enigmatic man of the world. In Joyce's *Ulysses*, as Leopold Bloom, the man of hostility becomes a man of peace, with a name fecund rather than predatory in its connotations. *See* also references under "Odysseus" in the Index.

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OEBEN, JEAN FRANÇOIS (*c.* 1715–1763), influential French cabinetmaker of German ancestry, was born probably between 1715 and 1720. In 1751 he began to work under Charles Joseph Boulle (son of André Charles Boulle) in the Louvre, Paris; and in 1754 he became "joiner and cabinetmaker to the king." He died in Paris on Jan. 21, 1763.

Oeben's style marks the transition from Louis XV to Louis XVI.

His work is characterized by wood marquetry in various colours and by solid, elegant bronze mounts. He also produced furniture with secret compartments and mechanical devices. His masterpiece, now in Versailles, is the *bureau du roi*, a magnificent desk which he began in 1760 and which was finished by J. H. Riesener in 1769.

See H. Vial, A. Marcel and A. Girodie, *Les Artistes décorateurs du bois*, vol. ii (1922); and F. de Salverte, *Les Ébénistes français du XVIIIᵉ siècle*, new ed. (1953). (S. Gr.)

OECOLAMPADIUS, JOHN (1482–1531), German humanist, patristic scholar and the reformer of Basel, was born at Weinsberg in Württemberg. His German name was Hüszgen. After schooling at Weinsberg and Heilbronn, he studied at Heidelberg. He left in 1506 to become tutor to the sons of the elector palatine, but in 1510 became preacher at Weinsberg. In 1513 he resumed studies at Tübingen, where he came into closer contact with southern German humanism and acquired remarkable versatility in Greek, Latin and Hebrew, teaching Greek from a grammar of his own devising. In 1515 he moved to Basel and assisted in the production of Erasmus' edition of the Greek New Testament, later preparing the index to the Erasmian edition of St. Jerome. In 1518 while penitentiary at Basel he translated some disciplinary treatises of certain Greek Fathers. These became a dominant interest and in the next years he produced translations of works by Gregory of Nazianzus, Basil, John of Damascus and two major works, a translation of *Psegmata* (*i.e.*, selected works) by Chrysostom and the commentary on the Gospels by Theophylact. In 1518 through the influence of the humanists Willibald Pirkheimer and the brothers Bernhard and Konrad Adelmann he became cathedral preacher at Augsburg. His mystic leanings, his patristic studies, his scholarly temperament, led him to enter the Brigittine monastery at Altomünster in April 1520 but disillusion and his Lutheran sympathies, manifested in his *Canonici indocti* (1519) and *Judicium de Luthero* (1521), caused him to leave in 1522 and he took refuge for a time as chaplain to the Adullamite company ranged round Franz von Sickingen in the Ebernburg.

Oecolampadius returned to Basel where he worked for a time in the printing house of Andreas Cratander and in 1523 became lecturer and professor in the university (where he had taken his D.D. in 1518). His lectures to great audiences in three languages and his sermons at St. Martin's church soon made him the dominant figure in the city. From 1522 onward he was the loyal friend and ally of Huldreich Zwingli. He acquitted himself manfully in 1526 when at the disputation of Baden he had almost alone to defend the cause of the Reformation against a formidable Roman Catholic team. In 1528 the disputation at Bern was packed with reformers, and Oecolampadius characteristically preached "On the love of Christ for his Church." In the next years he delivered an impressive series of lectures and sermons on biblical books, some of which were published. In the eucharistic controversy, Oecolampadius was on the side of Zwingli and it was his contribution to provide patristic support in a series of writings of which the *De genuina verborum domini* (1526) was the most notable. At the colloquy of Marburg (*q.v.*) in 1529 he was paired with Luther in fairly amiable but inconclusive debate. Affairs came to a head in Basel early in 1529 and Oecolampadius took a leading hand in shaping the reforming ordinances which went out at Easter and which established the Reformation in the city. At the spring synod of the Basel churches in 1530 he preached a notable oration "De reducenda excommunicatione" in which he tried to offset the dominance of the magistracy after the Zürich pattern by proposing a church discipline in which pastors and lay elders also shared.

The years 1530–31 were much occupied with writing and disputing with Anabaptists, who were suppressed in the city. Oecolampadius loyally supported Zwingli's foreign policy and under the shock of the disaster of Cappel in Oct. 1531 his health gave way. He died on Nov. 23, 1531. He had married in 1528. Oecolampadius' pendulous nose, sallow complexion and black eyes gave scope for caricature, but his character and learning were respected even by his enemies. From an introverted dilettantist he emerged after 1526 as a real leader, never simply a tool of Zürich, bringing to the Basel Reformation his own stress on inward religion and on true churchmanship. He symbolizes that important appeal among the reformers not only to Scripture but to the "old Fathers." For portrait *see* article Reformation.

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OEDIPUS, in Greek mythology, king of Thebes who unwittingly killed his father and married his mother. Homer tells how his mother hanged herself when the truth concerning their relationship became known, though Oedipus apparently continued to reign at Thebes until his death. In the post-Homeric tradition, most familiar from Sophocles' *Oedipus Rex* and *Oedipus Coloneus*, but doubtless shaped initially by the cyclic epics, there are notable differences in emphasis and detail.

The story is that Laius, king of Thebes, was warned by an oracle that his son would slay him. Accordingly when his wife, Iocaste (Jocasta; in Homer, Epicaste), bore a son, he exposed the baby on Mt. Cithaeron, first pinning his ankles together—hence the name Oedipus, "swell-foot"—to ensure that no one would save the child, if found, or perhaps to make it impossible for his ghost to walk. A shepherd took pity on the infant, who was adopted by Polybus, king of Corinth, and his wife and brought up as their son. In early manhood Oedipus was taunted by a drunkard concerning his parentage and visited Delphi to learn the truth. The oracle informed him that he was fated to kill his father and marry his mother, so he resolved never to return to Corinth.

Traveling toward Thebes he encountered Laius, who provoked a quarrel in which Oedipus killed him. Continuing on his way Oedipus found Thebes plagued by the sphinx, a fabulous winged monster, half-human half-leonine, who put a riddle to all passersby and destroyed those who could not answer (*see* Sphinx). Oedipus solved the riddle, and the sphinx killed herself. In reward, he received the throne of Thebes and the hand of the widowed queen, his mother, Iocaste. They had four children: Eteocles, Polyneices, Antigone and Ismene. Subsequently the whole truth came to light: Iocaste committed suicide, and Oedipus, after blinding himself, shunned the daylight in the palace, or (in Sophocles' version) went into exile, accompanied by Antigone and Ismene, leaving his brother-in-law, Creon, as regent. He met his end at Colonus near Athens, where he was swallowed into earth and became a guardian hero of the land. The curse which he laid on his undutiful sons culminated in the deaths of Eteocles and Polyneices (*see* Seven Against Thebes), and so was ultimately responsible for the death of Antigone. The dramatic highlights in Oedipus' story were portrayed in ancient art; his encounter with the sphinx has caught the imagination of some modern artists also (*e.g.*, J. A. D. Ingres).

There may be a hard core of historical truth in the legend of Oedipus, but it is impossible to isolate it from the elements of folk tale with which it has become fused. Oedipus appears in the folk traditions of Albania, Finland, Cyprus and Greece, where his story is still told in a version apparently uninfluenced by Christianity. In medieval times Judas rather oddly displaces Oedipus in the *Golden Legend* of Jacobus de Voragine and in the *Mystère de la passion* of Jean Michel and Arnoul Greban. In *Le Roman d'Oedipus*, an anonymous work of the 15th century, the sphinx becomes a cunning and ferocious giant. The ancient story has intense dramatic appeal; through Seneca the theme was transmitted to a long succession of playwrights including Corneille, Dryden and Voltaire. It has had a special attraction in the 20th century, motivating Igor Stravinsky's secular oratorio *Oedipus Rex*, André Gide's *Oedipe* and Jean Cocteau's *La Machine infernale*. There is, in fact, something archetypal in the Oedipus legend; but while it is easy to understand how Freud chose the term "Oedipus complex" to designate a son's feeling of love toward his mother and jealousy and hate toward his father (*see* Psychoanalysis), it must be observed that these are not emotions that motivate Oedipus' actions or determine his character in any ancient version of the story.

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OEHLENSCHLÄGER, ADAM GOTTLOB (1779–1850), the leading figure of the "golden age" of Danish literature, was born on Nov. 14, 1779, in Copenhagen. A year later the family moved to the royal palace of Frederiksborg, where his father was keeper. The renaissance architecture, paintings and sculpture which surrounded him during his boyhood there gave his taste its classical trend, and harmony became the keynote of his poetic genius.

After leaving school, he tried acting (1797–99), and then began to study law, but neglected it for aesthetics and old Scandinavian literature. A prize-winning paper on replacing Greek by Old Norse mythology in modern poetry foreshadowed his own poetic practice. He began to publish poems and in the summer of 1802 *Erik og Roller*, a pastiche of an old Norse saga, was actually in the press, but Oehlenschläger destroyed the proofs after meeting Henrik Steffens (*q.v.*), a scientist, Norwegian by birth, who had returned to Copenhagen from Germany a champion of the new romanticism. As a result of his influence, Oehlenschläger published *Digte* (Dec. 1802; dated 1803), which inaugurated a new period in Danish literature. "Guldhornene" (Eng. trans., *The Gold Horns*, 1913), the ballad which set the keynote for the volume, was written after an 18-hour discussion with Steffens. In symbolic pictures it expresses the romantic ideas of history and nature, but its setting and characters are Norse. Oehlenschläger showed his epic grasp by discarding lyrical vagueness for sculptured outline. *Digte* also included "Sanct-Hansaften-Spil" ("A Midsummer Night's Play"), a lyrical drama of contemporary Danish life, combining literary satire with elevated poetic discourse on love and nature.

The success of *Digte* was confirmed by *Poetiske Skrifter* (two volumes, 1805), containing the lyric cycle on the life of Jesus Christ annually realized through nature, Oehlenschläger's most daring pantheistic poem, which was condemned by the Danish church; "Vanlundurs Saga"; and the drama "Aladdin," in which he depicts his own life, the lamp symbolizing intuitive poetic genius. In the same year, in recognition of his position as Denmark's greatest living poet, he received a government grant, allowing him to travel for four years in Germany (where he met the leaders of the romantic movement and visited Goethe), France and Italy. While abroad, he published *Nordiske Digte* (1807) which marked a break with Steffens and the Schlegels. Rebelling against the subjectivity of the ultra-romantics, he turned to history and mythology as the basis of his poetry. This is illustrated by the works included in the new volume: "Uthors Reise," an epic in five cantos on Thor's journey to Jothunhein; "Baldur hin Gode," a mythological drama on Balder the Good, written in a classical Greek style; and "Hakon Jarl," his first tragedy on a national hero. In the preface he hailed Goethe, Schiller and Shakespeare as his masters.

Oehlenschläger returned to Denmark in the autumn of 1809, and, settling in Copenhagen, was appointed professor of aesthetics there in 1810. During the 1820s he was fiercely attacked by J. L. Heiberg (*q.v.*), the leading critic of the younger generation of poets, and lost his position of undisputed supremacy. Despite this, his popularity increased, and in 1829 he was crowned with laurel in Lund cathedral by Esaias Tegnér. On his 70th birthday he was hailed as the "Adam of our Parnassus" by all the contemporary Danish poets. He died at Copenhagen, on Jan. 20, 1850. His *Erindringer* were published in 1850–51.

Oehlenschläger set the fashion in many literary kinds. His long series of plays includes *Axel og Valborg* (1810; English translation 1851) and *Hagbarth og Signe* (1815), two tragedies of unhappy love; *Coreggio* (1811; Eng. trans. 1846) and "Yrsa," conceived as a Greek tragedy, and forming the last part of the trilogy *Helge* (1814); and the chronicle plays *Tordenskjold* (1833) and *Dronning Margareta* (1834). In *Dina* (1842) and *Kjartan og Gudrun* (1849) he tried to follow the fashion of the time by portraying more complex characters. He had a vivid sense of dramatic situation but his plays are deficient in logical structure. He also wrote stories, again based mainly on themes from Norse legends. It is as a writer of ballads and epics that he excels, however. The romantic ballads of his youth, the two epic cycles of *Helge*—ballads linked by a narrative, a poetic *genre* of his own creation—stand comparison with those of Goethe and Schiller, and in *Nordens Guder* (1819; Eng. trans. *The Gods of the North*, 1845), an epic made up of a number of cantos in different metres, he competes with Homer: "The Homeric nature awoke my own, the Greek inspired me to the Northern."

His poetry cannot be classified as merely romantic: it shares the hellenist inspiration of Goethe, Winckelmann and Herder. He combines classical strength with romantic ardour and inspiration.

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OENEUS, in Greek legend, king of Calydon, husband of Althaea and father of Meleager (*q.v.*); through them he is connected with the legend of the Calydonian boar. He is also independently connected with Hercules (*q.v.*), as the father of Hercules' bride Deianeira, whom he won from the river-god Achelous. Oeneus may have been originally a wine-god: his name is derived from the Greek word for wine. Moreover, according to one story, Dionysus was the real father of Deianeira.

(H. W. PA.)

OENGUS, SAINT (OENGUS MAC OENGOBANN, called THE CULDEE) (fl. 8th/9th century), an Irish monk associated with a movement that aimed at the reform of Irish monasticism and author of the *Félire*. The reformed monks called themselves "Fellows of God" (*Céli dé*, anglicized "Culdees"). What little is known about Oengus personally derives mainly from an Irish poem that is found in one manuscript of his *Félire*. He was a monk at Clonenagh in Leix, then became a pupil of Máel-Rúan of Tallaght near Dublin, who was prominent among the monastic reformers. Later Oengus founded his own church, Dísert-Oengusa in Leix. His feast day is March 11.

About the year 800 he composed in Irish his *Félire* (calendar) in 365 quatrains (one for each day of the year) with a prologue and epilogue. Under each day are listed the names of Irish and foreign saints, each with a conventional epithet or, occasionally, with some historical or legendary detail. The recitation of this and similar verse "calendars" both in Irish and in Latin was probably a form of devotion to all the saints, which seems to have held an important place in the liturgy of the early Irish church.

The Middle Irish *Saltair na Rann*, a versification of biblical history, was written by a later Oengus Céle Dé.

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OENOMAUS, in Greek legend, the father of Hippodameia. His death was caused by Pelops. *See* PELOPS.

OENOTHERA, the generic name of the evening primroses and sundrops, several species of which are favourite garden plants. The genus, comprising about 150 species, is native to the new world and belongs to the evening primrose family (Onagraceae; *q.v.*). The common evening primrose (*O. biennis*) is often a troublesome weed both in North America and in Europe, where it has become naturalized; the form known as var. *grandiflora* is a showy plant, sometimes cultivated for its flowers. Other species grown in gardens are *O. missouriensis* and *O. speciosa*, the latter with white flowers, grading to pink. The genus acquired importance in connection with Hugo de Vries' observations, especially on *O. lamarckiana*, which led to his theory of mutations (*see* EVOLUTION, ORGANIC: *Theories of Evolution*).

OERSTED (ØRSTED), **HANS CHRISTIAN** (1777–1851), Danish physicist and chemist, the discoverer of electromagnetism, was born Aug. 14, 1777, in Rudköbing. He was graduated as a pharmacist from the University of Copenhagen in 1797, received gold medals for essays in aesthetics and medicine, and obtained the Ph.D. degree in 1799 for a dissertation on Kant's philosophy. After extensive foreign travel and lecturing, he became professor at the University of Copenhagen in 1806. He suggested establishment of the Technical University of Denmark and became its first president in 1829.

Oersted's first physical researches dealt with electric currents

and acoustics. For nearly 30 years he gave time to the compressibilities of liquids and gases. His most important contributions to chemistry were the preparation of metallic aluminum (1825) and the discovery of piperidine (1820). Influenced by a philosophical belief in the unity of the forces of nature, he made many attempts to show that chemical and magnetic forces, and light have common electrical bases. During an evening lecture in April 1820 he discovered that a magnetic needle is deflected by an electric current (*see* INSTRUMENTS, ELECTRICAL MEASURING). The fundamental importance of this discovery was rapidly recognized, and he was honoured as one of the great physicists of the age.

Oersted was an inspiring teacher and lecturer and wrote numerous popular articles. In 1824 he founded a society devoted to the spreading of scientific knowledge among the general public. Since 1908 this society has awarded an Oersted medal for outstanding contributions by Danish physical scientists. In 1937 the American Association of Physics Teachers established an Oersted medal awarded to eminent physics teachers. In 1934 the name "oersted" was adopted for the unit of magnetic field strength. Oersted died in Copenhagen on March 9, 1851.

See essays by Kirstine Meyer in *H. C. Oersted: Scientific Papers* (1920); T. W. Chalmers, *Historic Researches* (1952). (J. R. Ns.)

OERTEL, HANNS (1868–1952), German linguist known especially for his contributions to Sanskrit syntax, was born in Geithain, Saxony, on April 20, 1868. Educated in the United States (Ph.D., Yale, 1891), he taught successively at Yale, Basel, Marburg and Munich. He wrote on Vedic literature, on general linguistic problems and particularly on Sanskrit syntax, and for many years was one of the editors of the *Zeitschrift für vergleichende Sprachforschung*.

In his *Syntax of Cases in the Narrative and Descriptive Prose of the Brahmanas* (1926) Oertel followed the lead of Berthold Delbrück (*q.v.*), but his plans for further work in that direction were brought to an end by the destruction during World War II of his house, library and carefully catalogued references. His *Lectures on the Study of Language* (1901), although interesting, is considered outmoded. Oertel died in Munich on Feb. 7, 1952. (MY. F.)

OETA (modern OITI), a triangular mountain block in central Greece, an outlier of the chief dividing range. It consists mainly of a dissected limestone plateau, about 6,200 ft. high, with a summit of 7,060 ft., and carries woods of beech and oak, with fir and pine on the higher slopes. The northern face of the massif is formed by a straight escarpment overhanging the Sperkhios valley, but its southern slopes, of less resistant rocks, are more gentle and are much eroded by the headstreams of the Mornos river. The eastern edge, cut by ravines, overlooks the Pournaraki pass, beyond which rise the Kallidhromon mountains. In mythology Oeta is the scene of the death of Hercules. (WM. C. B.)

OFFA (d. 796), Anglo-Saxon king of Mercia (*q.v.*) from 757 to 796, is the central figure in English history in the second half of the 8th century. A civil war gave him the Mercian kingdom in succession to his cousin Aethelbald (716–757) who in his later years had been overlord of all the English peoples south of the Humber. The first part of Offa's reign was spent in the re-establishment of the Mercian supremacy. He was strongly resisted in several of the smaller kingdoms, notably Kent, but he succeeded in creating what was in effect a single state covering the whole country between the Humber and the channel. He treated the lesser kings of this country as his subjects, exacting their formal submission, insisting that their grants of land to their own retainers or to churches needed his consent, confirming their charters and requiring them to attend his court. He married one of his daughters to Beorhtric, king of Wessex (789), and another to Aethelred, king of Northumbria (792), thereby extending his direct influence beyond the Humber. His reign marks by far the greatest advance hitherto made toward the political unification of England.

His position was recognized on the continent. His younger contemporary Charlemagne, king of the Franks, regarded him as the outstanding English ruler of his time. Their relations were often uneasy and a personal dispute led to a suspension of cross-channel traffic shortly before 790. Its renewal was followed by a commercial treaty (796) which shows Charlemagne and Offa dealing with each other on equal terms. The closeness of their previous association is illustrated by a rumour current at Rome to the effect that Offa had proposed to Charlemagne the deposition of Pope Adrian I and the election of a Frankish churchman in his place. The pope himself disbelieved the story, but its circulation proves at least the reality of Offa's fame.

Offa, in fact, was on terms with Pope Adrian which enabled him to carry through a remarkable, if temporary, change in the organization of the English church. The archbishop of Canterbury, whose authority covered the whole of southern England, had his seat in the kingdom where Offa's political domination was most strongly resented. To free the churches of his own country from the control of an archbishop belonging to an unfriendly province, Offa in 787 induced Pope Adrian to send the pallium, which was the symbol of metropolitan authority, to Hygebeorht, bishop of Lichfield. It was certainly with Offa's good will, and probably at his request, that in 786 the pope sent two legates to England, who secured the acceptance of a program of reform by the clergy and nobility of both the northern and southern provinces.

It is probable that Offa used this unprecedented mission as a means of acquainting the Roman court with his design of creating an archbishopric of Lichfield. He may well have taken the same opportunity of securing the papal approval for the consecration of Egfrith, his son, as king of the Mercians which took place in 787 and is the first recorded ceremony of the kind in English history.

There still survives a memorial of Offa's effective power in southern England in the remains of the great earthwork known as Offa's dike which he caused to be drawn between his own kingdom and the Welsh tribes beyond his border. It was the object of the dike to draw a boundary line between English and Welsh settlements from the estuary of the Dee in the north to that of the Wye in the south. The line is not now continuous, partly because it has been worn down in the course of 12 centuries, but also because in forest country such as the Herefordshire plain the forest itself was regarded as a sufficient barrier. But on open ground and in the high places of the mountain zone its remains are most impressive. Its line is always drawn so as to command the country to the west and the trackways leading from Welsh into English territory. Throughout its course it shows the activity of a directing mind.

The most permanent achievement of Offa's reign was the establishment of a new form of currency composed of silver pennies bearing the king's name and title and also the name of the moneyer responsible for their quality. They are remarkable for a delicacy of execution and a refinement of portraiture which set the best examples apart from all other coins in the Old English series. Amid infinite varieties of design, the principles governing Offa's coinage were maintained by later kings, and until recent times there has never been any break in the continuity of the English currency since his day. His own attitude toward the currency as an advertisement of the royal dignity is shown by the issue of coins closely resembling his own in type, but bearing the name and portrait of Cynethryth his queen.

No contemporary account of Offa has survived, and the history of his reign is a collection of fragmentary references. The laws which he is known to have issued have long disappeared. There are no adequate materials for a picture of his character. He was a patron of learning and a notable benefactor to many churches, but his rule was arbitrary and he was ruthless to all who opposed him. What can be said is that he left a deeper impression on English history than any other king before Alfred.

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OFFA OF ANGEL (fl. 4th century A.D.), a continental Anglian ruler, son of Wermund and ancestor of the Mercian royal house. The Old English poem *Widsith* refers obscurely to his victory in single combat by *Fifldor*, probably the Eider river. The Danish historians Saxo Grammaticus and Svend Aggesen elaborate

the story. In Wermund's old age, he was threatened by the Saxons, who suggested a decision by single combat of the kings' sons. Offa had up to then been speechless with shame because Keto and Wigo, sons of Wermund's governor of Schleswig, had broken the rules of single combat by together attacking the man who had slain their father; he now undertook to fight the son of the Saxon king and another champion at once. A much corrupted version of this story appears in the English *Vitae duorum Offarum*, which places the seat of Wermund not on the continent but at Warwick. It is probable that the Offa whose marriage to a lady of murderous disposition is mentioned in *Beowulf* is Offa of Angel: this story the *Vitae* transfer to his descendant, Offa of Mercia.

See R. W. Chambers, *Introduction to Beowulf*, 3rd ed. (1959); H. M. Chadwick, *Origin of the English Nation* (1907). (AL. C.)

OFFALY (UABH FAILGHE), a county of the Republic of Ireland in the province of Leinster, covers 771 sq.mi. On the west it shares with several other counties the distinction of a boundary in the Shannon, but it consists mainly of a large yet not unvaried section of the central lowland, though its southwestern boundary runs for many miles along the main crest of the Slieve Bloom mountains. It is mainly a mixture of peat bogs and cultivable land composed of glacial drifts over Carboniferous beds: a feature of particular interest is the fine series of eskers, or grand ridges, notably at Clonmacnoise, an ancient monastic site near the Shannon and one of the greatest religious foundations in Ireland (*see* CLONMACNOISE). In all, seven-tenths of the county is improved agricultural land; the bogs generally cover a few square miles, interspersed with farmland, and two of them, at Ferbane in the west of the county and near Portarlington in the east, are used to feed peat-fired electric-power stations.

The county formed part of the ancient kingdom of Offaly which included portions of Tipperary, Leix and Kildare. There are many raths, and a chain of moats commanding passes of the bogs extended throughout the county. On the borders with Tipperary is an ancient causeway that presumably once led to a crannog or lake dwelling. The area was inhabited by O'Connors and was annexed to the crown upon title claimed by descent from Roger Mortimer, a marcher lord from Herefordshire, who had held sway there in the 13th century and in the adjacent kingdom of Ossory or Leix. Offaly was shired as King's county in 1556, named to honour Mary I's consort, King Philip of Spain. An elaborate plan for colonizing Leix and Offaly was adopted by the government under Mary, the natives being required to vacate two-thirds of the area. They resisted resolutely for the rest of the century, being subdued only in the general subjugation of Gaelic Ireland at the beginning of James I's reign.

Offaly is united with Leix under the same county manager but has its own county council meeting at Tullamore. Birr and Tullamore (*q.v.*) are urban districts. Edenderry is administered by town commissioners. The county is united with Leix to send five members to the *dáil*.

The population of the county was 51,533 in 1961. More than two-fifths of the people live in towns and villages. Of these the largest is Tullamore (6,243) which in 1833 replaced Philipstown (now Daingean) as the assize and county town. Tullamore has a worsted mill, malting plant, distillery and a bacon and sausage factory. Of the other towns some have seen a measure of industrial growth. Birr and Edenderry have footwear factories, Clara a jute mill and at Edenderry, on a branch from the Grand canal, there is also a furniture factory. There are several other smaller places, such as Banagher at one of the few crossings of the Shannon, which serve as small market towns with monthly fairs for stock.

Of the county's improved farmland, two-thirds is permanent pasture, one-fifth under crops and the rest used as meadow. Wheat is prominent, with over 20,000 ac. devoted to it annually. It is sold to mills, and barley is sold to maltsters, notably at Tullamore. The sale of cattle at the fairs is a main economic activity. The general standard of farming is good.

Tullamore and Clara are on a branch railway line from Athlone to Portarlington; in 1947 the line from Clara to Banagher was closed for passenger traffic. Motor transport serves the county and the canal still carries some cargo.

See Philip Wilson, *The Beginning of Modern Ireland* (1912). (T. W. FR.; HU. S.)

OFFENBACH, JACQUES (originally JACOB) (1819–1880), French, originally German, composer who created a type of light burlesque French comic opera known as the *opérette*, which became one of the most characteristic artistic products of the second empire. Born at Cologne on June 20, 1819, he was the son of a cantor at the synagogue there, Isaac Juda Eberst, who had been born at Offenbach am Main. The father was known as "Der Offenbacher" (*i.e.*, the man from Offenbach) and the composer was known only by his assumed name, Offenbach. Attracted by the more tolerant attitude in Paris to the Jews, Offenbach's father took him there in his youth and in 1833 he was enrolled as a cello student at the Paris conservatoire. In 1844, having been converted to Catholicism, he married Herminie d'Alcain, the daughter of a Spanish Carlist. In 1849, after playing the cello in the orchestra of the Opéra-Comique, he became conductor at the Théâtre Français. In 1855 he opened a theatre of his own, the Bouffes-Parisiens, which he directed until 1866 and where he gave many of his celebrated operettas, among them *Orphée aux enfers* (1858). He then produced operettas, at Ems in Germany and an opera-ballet in Vienna (*Die Rheinnixen*, 1864), returning in 1864 to Paris, where at the Variétés he produced his successful operetta *La Belle Hélène* (1865). Other successes followed, including *La Vie Parisienne* (1866), *La Grande Duchesse de Gérolstein* (1867) and *La Périchole* (1868). From 1872 to 1876 he directed the Théâtre de la Gaîté, and in 1874 he produced there a revised version of *Orphée aux enfers*, described then as an "opéra-féerique." This venture was a financial failure and in 1876 he made a tour of the U.S. The remaining years of his life were devoted to composition. He died in Paris on Oct. 5, 1880.

His only grand opera, *Les Contes d'Hoffmann*, remained unfinished at his death. It was orchestrated and provided with recitatives by Ernest Guiraud, who also introduced the famous barcarolle taken from *Die Rheinnixen*. Described as an "opéra-fantastique," it was first produced at the Opéra-Comique on Feb. 10, 1881.

Writing in a fluent, elegant style and with a highly developed sense of both characterization and satire (particularly in his irreverent treatment of mythological subjects), Offenbach was appropriately named by Rossini "our little Mozart of the Champs Élysées." Indeed, he was almost as prolific as Mozart. He wrote over 100 stage works, many of which, transcending topical associations, were maintained in the repertory in the 20th century.

See S. Kracauer, *Offenbach and the Paris of His Time* (1937); S. Sitwell, *La Vie parisienne* (1937). (E. LR.)

OFFENBACH, a town of Germany in the *Land* (state) of Hesse which after partition of the nation following World War II became part of the Federal Republic of Germany. Pop. (1961) 116,195. Situated on the left bank of the Main near the Rhine–Main airport, with a river port (coal, oil), Offenbach lies 5 km. (3 mi.) upstream of Frankfurt. It adjoins the Cologne–Frankfurt–Nürnberg motorway and the Frankfurt–Beera–Berlin railway. In the town the alkaline Kaiser–Friedrich–Spring feeds a well 787 ft. deep.

The earliest mention of Offenbach was in a document of 977. It was part of the imperial forest of Dreieich and in 1407 a mint was established there. In 1486 it was acquired by Count (later Prince) von Isenburg-Birstein; the Isenburg castle has an impressive Renaissance façade. The town's prosperity began with an influx of Huguenot craftsmen in 1698–1703; it was annexed to Hesse in 1816. Offenbach was badly damaged in World War II and has since been rebuilt. New buildings include the town hall and offices of the federal board for distilled liquors, the directorate of the German meteorological service, the federal customs board and the chamber of trade and industry. The Klingspor museum has exhibits of modern calligraphy and book-printing.

The largest industrial town of old Hesse, Offenbach has a noted tanning and leather goods industry, with a unique leather museum and biannual leather trade exhibitions. Other industries include steelwork construction, machinery and electrical products, chemicals (dyes, soap, perfumes), soft drinks and textiles.

OFFENBURG, a town of Germany, in the *Land* (state) of Baden-Württemberg, which after partition of the nation following World War II became part of the Federal Republic of Germany. Pop. (1961) 27,569. It lies in the valley of the Kinzig river 63 km. (39 mi.) N. of Freiburg im Breisgau by road. Gothic and baroque buildings, picturesque lanes, fountains and half-timbered houses characterize the town, which is a rail junction and intersection point of important roads. Offenburg, the principal town of the Ortenau wine and fruit-growing district, is also an economic and cultural centre of middle Baden. Industries include printing, the production of structural steel, machinery, electrical equipment, chemicals, textiles and peppermint. The tourist trade is important. The town was founded by the Zähringer margraves in 1263 on the site of a Roman settlement; from 1289 to 1802 it was a free imperial city, and in 1846–49 a centre of the freedom movement in Baden. (RR. H.)

OFFICE MACHINES AND APPLIANCES. For a variety of reasons the work load of business offices has increased in striking fashion during the 20th century and, because much of the work is repetitive and routine, many different types of office machines and appliances have been developed to handle it. The manufacture of office machines and appliances has become a major industry, with new products constantly under development.

The decision to shift from manual to machine operation is usually determined by consideration of the following factors:

1. Saving of labour. This is basically a matter of determining estimated savings in direct labour charges during the life of the machine and comparing these savings with estimated machine costs.
2. Saving of time. Time saved in office routine may greatly improve operations elsewhere in the enterprise.
3. Effects upon personnel. Mechanization involves important changes in the nature of the work and may require retraining of workers. It may also cause morale problems. Such difficulties may nullify anticipated savings in labour.
4. Need for accuracy. Because errors in the office operations may result in annoyance to customers and possible loss of revenue, some firms find it desirable to purchase equipment that assures greater accuracy.

WRITING AND REPRODUCING MACHINES

Typewriters.—The typewriter, the most common of office machines, has been in use for approximately a century and has virtually eliminated handwritten letters and reports. Many improvements have, of course, been made in the typewriter since its invention, including the introduction of electric typewriters and automatic typewriters. (For a discussion of the history and development of the typewriter *see* the separate entry TYPEWRITER.)

Dictating and Transcribing Machines.—Dictating and transcribing machines provide for storage and later reproduction of spoken messages. Dictating machines are of two main types—mechanical or magnetic—and record the voice on plastic disks or belts, wire or coated tape. These materials can be removed from the machine after dictation and forwarded to the point of transcription. The transcribing machine, in a manner similar to the dictating machine, reproduces the dictated message so that the stenographer may type it. By use of these machines, stenographic transcription tasks can be carried out while the executive is dictating additional material. In this way, typing efficiency is much increased. A recent development has been the use of centralized dictating systems whereby individual microphones are connected to a central bank of dictating machines. The benefits of this method are the use of fewer machines and better flow of work.

Duplicating Machines.—Many different kinds of duplicating machines have been developed. Regardless of variation in process, all of these machines entail the preparation of a master copy from which duplicate copies are made by the machine. Note should be made of the fact that the use of carbon paper inserts makes the typewriter into a duplicating machine. This process is used extensively when a small number of copies is desired; it has a practical limit of about 8 copies on the manual and about 18 copies on the electric typewriter.

The stencil method of duplicating employs a coated fibre sheet (the stencil). Using a typewriter without a ribbon, the operator types the copy on the stencil, thus cutting the coating and exposing the fibre base to permit ink to pass through. Signatures or drawings may be placed on the stencil with a hand stylus. The stencil is then fastened to the outer surface of a hollow rotating cylinder that has a padded exterior surface saturated with ink. The ink flows through the cuts in the stencil as the cylinder rotates. Simultaneously, sheets of paper are passed under the cylinder and applied to the stencil under light pressure. Up to 5,000 copies can be made in this fashion from a single stencil, and stencils can be stored for considerable periods of time and then reused.

There are available two types of hectograph duplicators: gelatin and spirit. The gelatin process, now rarely used, requires the preparation of a special master paper upon which the copy to be duplicated is typed, written or drawn by use of a special ink or ribbon. This sheet is then pressed, face down, against a prepared moist gelatin surface and the image is transferred to the gelatin in reverse form. Sheets of paper pressed against this impregnated gelatin receive an image impression. Either a flatbed or rotary machine, similar to that used in the stencil method, may be used for making the duplicate copies. The master copy can be prepared in a variety of colours by using ink and carbon sheets of different shades. Multicoloured copies may thus be produced in one operation. The practical limit on copies produced by the gelatin process is from 50 to 100.

The spirit method is also referred to as the "direct" or "fluid" process. The master copy is prepared in the same way as for the gelatin process. The master sheet is then fastened to a rotating drum. As copy sheets, slightly moistened by a special liquid, are brought into direct contact with the master sheet, a minute amount of the carbon is transferred to them, resulting in the finished copies. Multicolour duplication in one operation is possible, as in the case of the gelatin process. The master sheets may be saved and reused. A further advantage of this process is that information can be added to or deleted from the master. Up to 300 copies can be made from one master sheet.

Offset duplicating processes require chemical fixing of copy on a metal sheet or, in more recent developments, preparation of a paperlike master copy by typewriter or by xerography. This master impression is inked and brought against an intermediate composition agent, usually rubber, to which the image is transferred. The image is immediately transferred to a copy sheet. This operation is performed by a power-driven machine. Many thousands of copies can be produced and masters can be stored for indefinite periods, and reused.

Raised-image duplicating processes use a variety of techniques for producing a master form on which the text stands in relief. The master forms are made by typesetting machines that closely resemble those used in printing.

Photocopying Machines.—Several different photographic processes have been devised for producing copies of drawings or written material. The most commonly used processes in this category are diffusion transfer and dye line. In the first process the master copy is made by typing, drawing or printing on a translucent paper or cloth sheet and is then placed upon sensitized negative paper and exposed to light. The negative is then placed in contact with a sheet of positive transfer paper and fed into a developer. When these two sheets are peeled apart the image is transferred to the positive paper. Dye line requires a translucent original and uses only one sheet of sensitized paper but the principle is similar. It is the cheapest of all photocopying processes. The dry dye line process uses ammonia fumes rather than liquid to develop the image and thus obviates problems of paper shrinkage. In both diffusion transfer and dye line, machines have been developed that perform all operations automatically.

Commercial application of heat or infrared copying methods, sometimes called thermography, are relatively new. Special copy paper and the original copy are placed in contact with each other and run through a machine where they are exposed to infrared or heat rays. The original copy absorbs the rays in areas darkened by print, line drawings or illustrations, thereby making the same

impressions on the heat-sensitive surface of the copy paper. The original with new copy paper attached may be put through the machine repeatedly to produce the number of copies desired.

Xerography as a means of copying is based on the principle of magnetism and thus differs from other methods that use chemicals or heat rays. It is generally regarded as a very flexible method, for it will copy anything that is written, printed, typed or drawn. It will also reproduce halftones and will enlarge, reduce or produce copy of the same size. This method of copying requires the preparation of a xerographic metal plate covered with powder and charged with electricity. Negatively charged powder adheres to the positively charged image to be copied. A sheet of ordinary paper is placed over the plate and charged positively. The copy paper attracts powder from the plate, forming a direct positive image. This paper is then heated for a few seconds to form a permanent print. The reproducing units in the process include a fuser, a copier and a special camera. These separate units have been combined in one machine and the whole process has been made fully automatic.

In contrast with the contact processes are the photographic processes wherein cameras are used to take pictures of the material to be reproduced. Most processes produce a negative from which positive copies in various sizes may be made.

Another modern development is the microfilm camera that produces negative images on film. This process is invaluable in saving space when storing documents of all sorts, for hundreds of pages of correspondence can be recorded on a small roll of microfilm. The film may be studied through a viewer, which shows it in its original size, or may be used to make reproductions of the original copy.

A host of specialized reproducing machines exists. The most widely used are check-writing machines that print amounts on checks so that they cannot be altered, and check-signing machines. Numbering, dating and receipting machines are small manually operated devices, the names of which are largely self-descriptive.

Imprinting Machines.—The most common of the machines in this category is the addressing machine, which addresses postcards, envelopes, shipping labels or tags. They are also used widely for imprinting checks, production orders, schedules, requisitions, time tickets, routing slips, tax bills and a host of other similar forms. There are three basic methods of reproduction on these machines: (1) spirit hectograph master cards, (2) stencil cards and (3) metal plates.

Hectograph master cards are made with the aid of hectograph carbon. The imprint on the card is transferred by means of a chemical solution to envelopes or other forms. Up to 250 imprints may be made from a single master card.

Stencil cards consists of small pieces of stencil tissue mounted in a cardboard frame. The copy to be imprinted is typed or written on the stencil tissue. When a drawer of cards is attached to the addressing machine, the machine automatically brings the cards and envelopes or other forms together, performs the imprinting, places the stencil cards in a tray and stacks the imprinted forms.

Metal plates of various sizes may be embossed with the desired copy on a special machine. The imprint is made on envelopes or other forms through an inked ribbon as the plates are fed through a machine. The machines operate automatically at high speed, and the plates are practically indestructible.

Many attachments for these machines are available to provide special services. For example, a selector permits certain plates to pass through the machine without imprinting, thus permitting mailings to go only to selected groups. A cut-off device permits the printing of selected data only. A repeating device prints the data several times before the plate is ejected, thus permitting names and addresses to be entered on envelopes and invoices, for example, in one operation. A dating device that enters the date on forms along with the other data embossed on the plates is used frequently in entering names and addresses on letters and statements. It is also possible to use these machines for distribution and addition of figure information. Holes punched in plates at predetermined points activate a sensing mechanism that translates desired information and lists it on forms being prepared. The preparation of billing records and payrolls are examples of ways in which this device may be used.

COMPUTING AND ACCOUNTING MACHINES

Calculating Machines.—Since the earliest days, man has aspired to free himself from the drudgery of calculation. Probably the earliest, and yet the most long-lasting, machine of this sort is the abacus (*q.v.*). Various versions of this instrument were extensively used in pre-Christian Rome and Greece as well as in Egypt and China, and continue to be widely used in much of the orient today. It was not, however, until the great rise of interest in natural philosophy in western Europe in the 17th century that serious interest arose in the development of calculating instruments. With the predictive abilities of the new physical theories of Galileo, Kepler, Descartes, Newton and others, there came a real desire to use these theories; and this desire called for substantial calculating.

John Napier invented the logarithm, which made the task of multiplying very much easier. The mechanizing of his logarithms led to the development of a whole class of calculating machines called analog or measurement devices.

In 1642 Blaise Pascal invented an adding machine that in some sense represents the first digital calculator. It is called digital since it performs its operations by a counting of integers. In 1671 Gottfried Wilhelm Leibniz invented a machine that performed the multiplication process by repeatedly adding. His "stepped-wheel," which still appears in a few 20th-century devices, was his most important contribution to the development of calculating machines.

During the last quarter of the 19th century, F. S. Baldwin, W. T. Odhner and A. Burkhardt developed machines that were more compact and made possible the modern desk calculators. They could perform the processes of addition, subtraction, multiplication and division, as well as the operations of multiplying or dividing by powers of 10 by shifting numbers left or right. They could store the result of an operation on counter wheels visible to the operator and data could be introduced by means of keys on a board. In all these machines, however, it is necessary for the operator to intervene at each step of a calculation, and the time required for the calculation thus depends upon the speed of the user.

Modern computing machines fall into three basic types: adding-listing, key-driven and rotary. Adding-listing machines are used for addition and subtraction; they list the numbers entered into the machine and the answer on a paper tape. Key-driven machines operate the mechanisms directly upon pressing the keys. Rotary machines need the additional operation of a lever or motor bar to record the number in the register. Some varieties of computing machines list the numbers entered into the machine and the answer on a paper tape; others show the numbers in the register of the machine where they are read from dials rather than from a printed tape. Computing machines are equipped with either full or ten-key keyboards (twelve for sterling countries). Full keyboard machines provide a column of ten keys for each digit position. Ten-key machines have only ten keys and the digit position is shifted to the left successively with each depression of the key.

In carrying out a mathematical calculation, man performs three distinct functions that must be incorporated into any calculating machine: (1) he must first of all perform certain basic arithmetic operations; (2) he must read from instruction sheets what he is to do next; *e.g.*, take the number in column 1 of his work sheet, multiply it by the quantity he has just produced and store the result in column 2; and (3) he must store his initial, intermediate and final results as well as his instructions on sheets of paper or other media.

Many attempts were made by Charles Babbage, Lord Kelvin and others to make the entire process automatic but technical difficulties stopped them short of reaching their goal. Vannevar Bush and his associates at the Massachusetts Institute of Technology developed and placed in operation the first differential analyzer in 1930. It was the first fully automatic calculating in-

strument that could be programmed to do different types of problems. It has a fourth organ, not required by the human operator, an input-output. This was a device that permitted communication between the mechanism and the human user. Since 1930 the developments in this field have been little short of fantastic. Electronic-mechanical calculators have been developed that are capable of performing extremely complex computations at high speeds. (*See* COMPUTER.)

Cash Registers.—Cash registers are recording and adding machines used to help a merchant control his business and to assist salespeople in serving customers. They make records of each transaction, both for the customer and the merchant, and protect against mistakes and dishonesty. They are made in many different types, some extremely simple and others highly complex. Most cash registers have certain fundamental features and functions. The typical machine indicates the amount of a transaction at the top of the register so that it can be seen by both customer and salesman. It keeps separate totals of sales by various classifications. It prints and issues a receipt on cash sales or overprints a record of the transaction on a sales docket on charge sales. It keeps within the register an audit strip, which is a complete printed record of every transaction that has been made. It also has special counters to show the number of customers handled and the number of each kind of transaction.

Accounting Machines.—Accounting machines, or bookkeeping machines, are complex devices combining features of the computing machines already described with some provision for writing. They have taken over much of the labour of bookkeeping. Billing machines, for example, are designed to typewrite names, addresses and descriptions, to multiply and extend, to figure discounts, and to add net total. A simple accounting machine generally has only one or two registers and no typewriter facility. Abbreviated description keys are used to denote the type of transaction and the carriage is designed to hold a number of forms at once. This enables the operator to post associated documents, such as ledger card and day book, simultaneously. The more elaborate accounting machines have many registers, often have a typewriter built in and carry out a number of operations automatically. Accounting machines post to one account at a time and frequently accumulate in the manner of cash registers to permit summarizing and distributing accounts. The window-posting accounting machine is in common use in banks, hotels and retail stores. Customers' statements or passbooks are inserted into the machine, which prints the transaction on these forms as well as on an audit sheet and automatically calculates new balances.

Classifying and Tabulating Machines.—These machines use cards upon which coded data are recorded; their function is to facilitate sorting and tabulation of diverse data. The simplest card systems function by notching the perforated perimeter of the card according to some code. These systems are limited to performance of sorting tasks. They are operated by a simple machine or device, frequently merely a metal rod, which is inserted in a specific perimeter location of a stack of cards. It will thus penetrate both notched and unnotched holes. When the rod is lifted, those cards with notched holes will fall out.

The first modern device of this class was designed for the automatic tallying or tabulation of statistics; but with extensive development modern tabulating machines are capable of automatically figuring and printing a report based on the information given to it in the form of perforations in cards or tape. Between 1834–54, Charles Babbage in England designed and partly built an "analytic engine" in which both the amount to be operated upon and the nature of the operation were entered by perforated cards. His machine was never completed, largely because modern precision techniques of fabricating metal parts to close tolerances were then unknown. Development of the modern tabulating machine was accomplished by H. Hollerith.

Hollerith's first contribution was a means of tallying census returns through electrical reading of the data punched on cards and accumulating the totals in separate registers. The system was successfully used in the U.S. census of 1890 and the British census of 1911. During the next decade notable improvements were made, including automatic feeding of the cards under brushes for reading and a machine for sorting the cards rapidly into desired groupings. The U.S. census in 1900 furnished particularly outstanding evidence of the possibilities of the system. The population volume was ready one year and seven months from the start of enumeration; it was estimated that hand tabulation of the three factors alone of sex, nativity and occupation would have required the services of 100 clerks for seven years and 11 months. Since 1901, its commercial utility has been greatly increased. Hollerith's ideas were taken up and improved by the International Business Machines corporation; those of his assistant, James Powers, were developed by the Remington Rand company. The tabulating method is now to be found in general use throughout the world.

Whenever a transaction involves a number of amounts that are later to be used as units two or more times in compiling various totals, it has been found to be generally economical to "translate" it on a perforated card. If, for instance, the data connected with the cost of production of a certain part are recorded on a card, this card can then be used in computing totals of individual wages, departmental costs, machine costs and productive hours.

The card upon which the data are recorded in the form of perforations has a column for each number or symbol to be entered. The digits 0 to 9 are denoted by holes punched proportionate distances from the bottom edge of the card starting with the 9 position. Above the 0 position is space for two additional perforations used principally for actuating certain control operations of the machine. These additional positions may also be used for special classification numbers, or, in combination with perforations in the regular digit position, to denote alphabetical characters. The card is divided vertically into fields each of which denotes a particular fact of the total information recorded. Some of the information is descriptive and some of it is quantitative. The former class controls sorting and indicating while the latter represents amounts to be totaled. Sorting and totaling are accomplished by different machines. Three separate mechanical devices are necessary to the system: a perforating machine or punch, a sorter and a tabulator. The ordinary form of perforating machine has a set of 12 punches under which the card is advanced a column at a time. By means of a skip bar or stops, certain fields can be skipped where no punching is to be done. There are also more complete types of perforating machines arranged to permit automatic duplication of information already on one card on to others, to "gang" punch any predetermined number of cards with identical data, to number cards consecutively as they are punched. The speed with which trained operators can perforate the cards depends on the nature of the information being recorded as well as its extent. An output of 350 punched cards per hour might be considered an average performance.

Sorting the cards into the desired groups for tabulation is done at the rate of from 400 to 2,000 cards per minute for each digit of the class number. One well-known form of sorting machine has 13 pockets, one for each possible columnar perforation and one for rejects. The tabulator, or accounting machine, which totals and prints the amounts perforated in given fields, is capable of several different applications. The simplest form of this device consists of a set of counters actuated through a reading mechanism. Two methods of reading the cards are in use: electrical and mechanical. In the former, brushes make electrical contact through the perforations, thereby actuating magnets to trip the counters. The mechanical method employs a full set of pins which are brought down upon the card momentarily at rest and which penetrate the perforations to actuate the counters mechanically. Printing tabulators are arranged either to total the cards at high speed—about 150 per minute—and then print the total, or to list each card individually followed by a total for the group. By means of special control features, the machines automatically take totals of several fields after each sorted group and also store the amounts for grand totals. A great deal of flexibility is attainable in the way the items and totals may be made to appear on the printed sheet. With alphabetical printing, addition or subtraction automatically sensed by the machine and devices

added to the printing section for handling report and bill forms, tabulating machines have become automatic accounting and billing machines.

MISCELLANEOUS OFFICE MACHINES

In offices where large quantities of coins must be handled, machines are used to sort, count, wrap or dispense coins. Sorting is accomplished by the simple process of sifting the coins of various sizes. Trip counters count the coins and wrapping machines wrap a standard number of coins in a paper wrapper. The coin-dispensing machine releases a specific sum in coin upon depression of the appropriate key on a keyboard similar to that of an adding machine.

Mail-handling machines are designed to expedite handling of large quantities of incoming and outgoing mail. As the bulk of the work is required to handle outgoing mail, most machines are designed to aid in this task. The main types are folding machines, inserting machines and envelope sealers. Stamp-affixing machines mechanically separate stamps from a roll, moisten them and apply them to envelopes. Postage meters print stamp charges directly on envelopes or on adhesive strips. The machines are set by postal employees to print postage equal to the amount of deposit paid. An automatic postage meter and mail scale machine feeds, stamps, seals and stacks letters at a high rate of speed. It also automatically weighs and computes the postage on parcel post packages.

The modern office is frequently of such size that efficient communication becomes a factor in maintaining the flow of work. Two-way voice systems operate on the telephone principle to permit communication between specific areas. In a commonly used version the individual may call any one or any combination of a limited number of stations by depressing appropriate keys on the receiver-transmitter box. When he speaks into the box his voice, amplified electrically, is broadcast from similar boxes at the various stations. Others may then reply in similar fashion from their stations.

Telewriting and teletype systems provide written or typed communications between two or more points. Messages are received and recorded even though no person is in attendance at the receiving machine. These systems are especially valuable for rapid intercommunication among a number of widely separated offices. Teletype systems, for example, frequently span an entire country.

Closed-circuit television installations permit viewers to see documents and hear explanations transmitted from distant locations. Rapid transmission of recorded information is thus possible for verification, identification or computation. Signatures or account balances may be transmitted for verification from a central office to many points instantaneously, thereby eliminating the need for maintenance of large numbers of duplicate records.

Paper cutters, punches, binding equipment and folding equipment are available in a wide range of sizes for office use. Document-destroying equipment disposes of outdated paper documents by shredding or chopping. Collating equipment assembles pages of printed matter in a specific order.

Time-recording machines combine a clock mechanism with a recording device to provide a quick, correct recording of the time of occurrence of certain routine events. Time-stamping machines are manually actuated to stamp the time upon letters and documents that are inserted in the machine. Time-recording clocks record the times of arrival and departure of employees. The employee inserts a time card into the machine when he arrives and again when he departs. Job-recording clocks function in identical fashion to record time of beginning and finishing particular tasks.

(S. J. Wa.)

OFFICE MANAGEMENT. Office workers play a vital part in the over-all operation of most enterprises. They provide services of many kinds related to the preparation and transmission of information, to data processing, and to the preparation, distribution and preservation of records. They prepare and distribute statistical and analytical reports of many kinds to assist responsible officials in evaluating and directing production and selling methods, personnel practices, expansion policies and similar activities.

The importance of rapid, accurate transmission of information, both internally and externally, as well as the importance of accurate, up-to-the-minute, detailed records, to the conduct of modern business affairs can hardly be over-emphasized. Some idea of the growing importance of office workers and of office management may be gained from a study of employment data. From 1870 to 1940, the total working force in the United States increased less than four times. During the same period, the number of clerical workers increased 15 times. For the short period from 1940 to 1955, the growth in the number of clerical workers continued at a high rate. During these years the total population increased by 24%; the total working force by 38%; the number of those engaged in clerical work by 80%. With this rapid growth in the number of clerical workers, there has come a growing concern for improved office management methods. For large firms the management of office activities can no longer be ignored as it was when office costs were small, business units limited in size and external contacts restricted. The same kind of careful planning and organizing of work found in factory production should be applied also to office work, particularly when the office is large.

FUNCTIONS OF OFFICE MANAGEMENT

The functions of office management parallel those of the management of any other area of an enterprise. Broadly stated, these functions consist of planning, organizing, initiating and controlling the work to be done. They distinguish a management from a non-management activity.

The planning function of office management is primarily concerned with defining the job that needs to be done. Because the office facilitates the work of other departments or areas, those responsible for office management must decide what facilitating services to provide. Those commonly provided are handling correspondence, maintaining financial records, preparing and transmitting messages, filing, duplicating reports, calculating, checking records and performing reception duties.

The organizing function of management is primarily concerned with a definition of the relationships that exist among the various units or departments of an enterprise, as well as among the various activities that are carried on within any one of the units. For office management, this function is frequently difficult to visualize or comprehend. Activities concerned with the transmission of information and data processing are closely related to production, distribution and research. They are rarely performed exclusively by clerical workers, and they are rarely placed under the exclusive control of the office manager. As a result, the responsibility for managing office activities is shared by a number of officials, operating on the same or at different levels of the organizational structure. Nevertheless, the organization function requires that these responsibilities and interrelationships be spelled out carefully and clearly. Those responsible for office management must apportion the work that is to be done, set up lines of authority and responsibility, and integrate clerical assistants into an effective working unit.

As office activities have grown in scope and importance, they have been placed more and more under the direction of professionally trained experts in office management. There is a growing tendency to centralize and group the office activities in an enterprise under one of these experts. There is also a growing tendency to elevate the position of this expert, usually the office manager, in the total organizational structure.

The initiating function of office management is concerned with getting the job started and completed according to the plans established and the organizational pattern adopted. Management officials must assume leadership in moving ahead, in motivating others to move with them and in inspiring them to use the highest capacities they possess.

The controlling function of office management is concerned with having clerical work done satisfactorily at reasonable cost. This function includes setting standards, improving methods, measuring work and determining unit costs. When office activities are scattered throughout an enterprise, as they frequently are, this function of office management is one of utmost importance.

These four functions of office management are closely related and interdependent. For convenience, they have been explained as separate steps, but in practice no sharp lines separate them.

OFFICE MANAGEMENT ACTIVITIES

Working Space.—As a rule, the office should be located where it can best provide services to the operating departments of an enterprise. Many other factors must, of course, be considered in providing space for clerical workers: size of the force, expansion needs, need for privacy, space costs, proximity to clerical supplies, adaptability to work flow, noise control, ventilation and provision of proper light. Working conditions affect the morale of clerical workers, as well as the efficiency with which they can accomplish their tasks. For these reasons, this responsibility of office management requires constant and careful attention.

Office space must provide room for private offices, general office areas, reception or service areas, and storage areas. These areas should be organized to permit free flow of work, adequate space for each worker and ease of supervision. Floor plans and work loads must be studied carefully in order to make efficient use of space, achieve uninterrupted processing of data and provide suitable working conditions.

Furniture and Equipment.—Office equipment is purchased to save labour and time, to insure accuracy of the finished product and to relieve clerical workers of the drudgery of performing routine tasks that can be handled by machines. As the need for data has increased, the types of equipment available for office work has multiplied. Office managers must keep themselves informed on the latest developments and improvements in equipment. Studies of operations must be made to determine where additional equipment might be used. The advantages and disadvantages of using machines for particular operations must be weighed carefully.

Office Personnel.—The management of clerical workers includes selecting, training, supervising, motivating and evaluating activities. In addition, it includes the planning of personnel requirements, interviewing applicants, handling employee grievances, making job evaluations, writing job descriptions, establishing salary scales and performing a host of related duties. The office manager may have sole responsibility for these matters, or they may come under the jurisdiction of the personnel manager.

Analyzing and Improving Working Methods.—Office management is concerned with the need for finding easier and better ways of billing, using the telephone, handling correspondence, filing, preparing duplicate copies of documents and performing other office duties. Careful studies have revealed the presence of much waste and needless duplication in the performance of these duties. Techniques of studying jobs and systems through the use of work distribution and flow process charts, man and machine charts, and motion analyses have been developed and used for some time in improving factory methods. The rewards are equally significant when these techniques are applied to office methods.

As the nerve centre of an enterprise, the office is mainly concerned with accumulating and classifying information and communicating it to interested parties. The information communicated must be complete and correct. At times, it must move with great speed. The office manager is responsible for developing and using letters and other information-handling media to meet these standards.

Handling and Storing Data.—Most enterprises depend upon office management to supply records of past and present performance needed in making decisions affecting operations. Much of the work that is done in the office is concerned with the preparation, classification and storage of statistical and narrative reports. There is need for both accuracy and speed in processing these reports. Office management must meet this challenge through proper planning and the application of adequate control methods.

Office Forms.—Office forms are sometimes referred to as the raw materials of the office, and office records as the end products. Forms are the media by which all manner of data are classified, recorded, distributed, duplicated, analyzed and stored. Poorly prepared forms result in duplication, waste and confusion. A well-planned program of forms control eliminates unnecessary forms, consolidates different forms doing the same thing, designs forms that may be handled efficiently and limits the distribution of forms to essential personnel.

Budgets and Reports.—Office management efficiency is frequently judged by the costs incurred in providing needed services. Cost, then, is one of the prime factors considered in making any decision regarding the employment of office personnel, purchase of office equipment or change of method. Among the methods used to control office costs are the following: preparation of budgets in which costs, savings and benefits are summarized and charted; preparation of reports in which accomplishments and needs are set forth; preparation of manuals in which procedures and policies are described; and the establishment of office standards. Office management is directly concerned with the preparation of these reports of its activities.

Improving Office Services.—Office management must provide leadership in achieving the goal of providing efficient service at low cost by increasing the productivity of office personnel. The office manager must take the lead in developing the kind of spirit among clerical workers that results in their working vigorously with management officials in reaching common aims. Techniques that have been found to be effective in accomplishing this objective are the following: (1) The office manager must believe in himself and the people who work with him; (2) he must set a good example; (3) he must seek and use the advice of the workers he is supervising; (4) he must keep them informed; (5) he must recognize their achievements and provide adequate rewards for services performed; (6) he must make employees feel that their work is important, and that each one is part of the office team; and (7) he must make each worker feel secure in his job.

SCIENTIFIC OFFICE MANAGEMENT

Frederick Winslow Taylor, known as the "father of scientific management," was probably the first person to apply scientific principles to office work. F. B. Copley's biography of Taylor includes a "Time Note" dated about 1885 that gives piece-work rates for 17 clerical operations, the implication being that Taylor had at least studied these operations, found the best method of performing them and controlled them to the extent that he offered an incentive wage for their accomplishment. Later he suggested to his assistants that they prepare instructions and set time standards for making entries on inventory cards. He is chiefly responsible for developing the idea of using standard paragraphs for handling routine correspondence. Another pioneer, Morris L. Cooke, applied scientific management principles in 1905 to the office of the American Society of Mechanical Engineers. In 1917 J. William Schulze of the Alexander Hamilton Institute published the first book on office management, *The American Office*. In 1917 W. H. Leffingwell's book on scientific office management was published, and his ideas led the thinking in this field for the next quarter of a century. Some of the leaders in the field of office management founded the National Association of Office Managers in 1919, and four years later incorporated the organization in Delaware under the name of the National Office Management Association. Its principal purposes were stated as follows: (1) To promote a free exchange of ideas on office organization and management among member concerns. (2) To encourage the work of standardization and to determine, insofar as possible, general standards of office work applicable to all industries. (3) To initiate and effect the application of scientific methods to the problems of office organization and management.

Scientific Method and Office Tasks.—The principles and ideas developed by Taylor, with modifications and additions contributed by later leaders in the "scientific" movement, have led to the establishment of a set of fundamental principles by which tasks are accomplished most efficiently. It has become axiomatic in management circles that those responsible for managing the work of the office must understand these principles and must know how to apply them. The principles may be stated as follows:

1. A simple and precise definition of the work to be done must be established, and the conditions under which the work is to be performed must be determined.

2. Each employee must be assigned specific work to do and must be vested with the authority to do it.

3. Each employee must be informed about his relationship to others engaged in the enterprise.

4. Each employee must know how he is to perform the tasks assigned to him.

5. Each employee must be encouraged to contribute his best efforts, through positive leadership, fair treatment and encouragement.

6. Satisfactory standards for measuring output must be developed and information on such standards must be placed in the hands of employees and managing officials.

7. Each employee's work must be evaluated in terms of the standards, and the employee must be informed of results and assisted in making any needed improvements.

Scientific Method and Office Problems.—Taylor also made many studies in an attempt to throw light on the problems confronting management. In conducting these studies he used scientific methods of investigation and as a result made important contributions to management knowledge. Some of his important findings were that high wages frequently resulted in low unit costs, that co-operation between employees and management officials was needed for highest productivity and that standards were necessary to control the products or services of an enterprise.

The steps in the scientific method are described in different terms in the various published works on office management, but all agree that the method involves solving problems by taking a series of well-defined and orderly steps. Each step in the method is important and must be taken in the proper sequence if the most satisfactory solutions to problems are to be found. The steps may be stated as follows:

1. The problem must be recognized and identified. It is understood that every problem is related to other problems but for purposes of intensive study it is necessary to isolate the particular problem to be treated.

2. Preliminary analyses and observations must be made. This step frequently includes a review of other investigations of the same or similar problems. It attempts to assess the importance of the problem under consideration and to weigh the possible advantages and benefits of its correct solution.

3. A hypothesis or tentative solution to the problem must be worked out on the basis of observation and experience; the tentative solution must then be proved or disproved on the basis of careful investigation.

4. The problem under study should be divided into its component parts so that each part may be studied carefully. The problem of purchasing a new piece of office equipment, for example, includes a study of original cost, maintenance, training of operators and adaptability to the work.

5. Adequate data must be collected and classified. On the basis of the data that have been collected, an answer to the over-all problem must be formulated and then tested in new or repeated applications.

6. The solution should be adjusted and restated. On the basis of the preceding step needed changes should be made in the answer. Great care should be taken to state and view the answer accurately in relation to the problem defined at the outset.

The alternative to the use of the scientific method of solving problems of office management is the use of tradition, experience or guesswork—all of which have been used in the past but none of which offers the promise of advances that may be made under the systematic approach. In summary, it can be stated that the scientific management method is based upon the belief that there is one best way of performing an operation or one best solution to a problem, and that systematic analysis is superior to guesswork in finding that one best way or solution.

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OFFICERS, MILITARY, a term designating persons holding commissions and differentiating them, as leaders, from the enlisted or "other ranks" of a nation's armed services. The term usually refers to persons on active or full-time duty and indicates that there is a contractual arrangement between them and the state. These persons devote themselves to their country's defense as a principal and regular means of gaining a livelihood. Reserve officers and commissioned militiamen are also included as officers when on active duty, and in all nations they qualify in some measure under the term even when on an inactive status, since they give part-time service to the state under less binding contractual agreements. The term officer in the following context usually refers to the commissioned members of the regular, active armed forces, including women who hold commissions in the feminine, usually noncombatant components of the armed forces of most nations.

This article is organized according to the following outline:

I. HISTORICAL DEVELOPMENT

1. Ancient and Medieval.—Ancient armies were normally commanded by members of the nobility. In Egypt, for instance, military leaders ranked in society as the second of seven castes. In Assyria military men were the top social group in the nation. In neither of these cases could the noblemen who commanded the armies be considered officers in the modern sense that their livelihood was primarily military. Moreover, they were not bound to the state by a contract.

The citizen soldiers of both Greece and Rome were commanded by those among their number who exhibited qualities of leadership. However, these citizen soldiers eventually gave way to professional long-service regular soldiers. As a result, citizens in Greece and Rome who had a liking for military life chose it as a profession and remained in service as officers. Usually of the propertied classes or nobility, they commanded lower-class citizens of their nations, mercenaries and barbarians. Gaius Marius, about 106 B.C., opened the officer ranks to Roman citizens regardless of their social position. With the fall of Rome and the coming of the dark ages and feudalism the professional officer disappeared; not until the time of the French Revolution did military leaders come as close to the modern professional sense of the term as did officers of the Roman empire.

There was no general, long-service military class in feudal times. Each nobleman had his vassals for military duties in the short-lived campaigns of the dark ages and the early middle ages. The

main business of the knights was agriculture. The annual 40 days of military service owed by vassals to their lords prevented warfare from being more than a desultory occupation and in no way qualified the feudal nobles as professional officers.

Professionalism took its most significant step in the 15th century when free companies of Swiss, Italian and German soldiers sold their services wherever they were needed. These mercenaries were international freebooters, and their captains were competent leaders who, to some extent, qualified as officers in the modern sense. Their livelihood was warfare; they made a business of fighting, contracting with various princes or dukes for professional service. Their mercenary business passed out of existence about the middle of the 17th century with the disappearance of feudalism and the rise of dynastic standing armies.

2. 17th and 18th Centuries.—In the Thirty Years' War the modern grades or ranks of regimental officers developed in the well-organized Swedish army of Gustavus II Adolphus. He established the modern idea of the regiment with its colonel, and the battalion commanded by a lieutenant colonel, assisted by a major as the administrative chief and by an additional officer, a captain, who arranged for supplies. The companies were commanded by captains as a continuation of the free company method, while the subordinate officers in the unit were lieutenants.

It was during this period that the proprietary system replaced the obsolete combination of feudalism and free companies. Under this the colonel was the proprietor of his regiment, the captain the proprietor of his company. The king accepted them as his officers and armed them with authority to raise men. Initially under this system armies were raised for each campaign, and the regiments were made up from qualified volunteers. During the latter part of the 17th century, however, armies became permanent, or standing, and were kept up to strength by the regular influx of untrained recruits. The crown supplied the recruits and the money for maintaining the forces, the proprietorship of the colonels and captains being thus somewhat restricted.

The proprietary system gave to military office not only responsibilities but also certain profits. The officer was paid for the number of men that he mustered and was furnished other funds for their arms and food. Besides the profit resulting from economical —and sometimes parsimonious or fraudulent—discharge of his proprietary rights, the officer could sell his proprietary interest when he retired. Commissions, therefore, were valuable, and as late as 1871 could be purchased in the British army, even though the proprietary system had long since vanished. The purchase of the commission of a lieutenant colonel in a first-class regiment might cost as much as $30,000 (£6,200).

The general terminology for the grades of regimental officers having been established by Gustavus Adolphus, it remained largely for the French to develop the ranks above that of colonel.

Usually the king or prince was the "general" of a field army. The second in command was the lieutenant general, a nobleman who customarily commanded the aristocratic cavalry. A professional soldier—not necessarily a nobleman—usually commanded the infantry and was variously known as the sergeant major general or simply major general. It was his duty to form the army for battle and to take care of other administrative matters for the king or prince. (The title of sergeant major was carried through the regiments and battalions, where the sergeant major—sometimes called major or adjutant major—was the principal staff officer.) When, as was usually the case, the army was disbanded at the end of a campaign, the lieutenant general and major general had no command and thus lost their rank as well, reverting usually to their proprietary positions as colonels of permanent regiments.

Gradually, however, the title of marshal or field marshal was developing into a recognized, permanent rank in the French army. This resulted from the establishment of a permanent list of officers whose distinction and experience qualified them to serve as general, lieutenant general or major general in a field army. This marks one of the most important points in the evolution of the military officer—his permanent classification by rank and not by the actual temporary command he happened to hold. Following the establishment of the rank of marshal in the French army, there was the gradual, logical development of a list showing the precedence by rank of all officers in an army. The establishment of such general army lists naturally undermined the proprietary system of independent regiments, and this system passed out of existence for the most part in the late 18th century.

As armies grew larger in the 17th and 18th centuries, more general officers were needed. In time a lieutenant general, previously the designation for the second in command of an army, also became a permanent rank, immediately below that of marshal. The next lower grade was that of the sergeant major general, later shortened to major general. The lowest grade of general officer, that of brigadier, was created by Louis XIV.

3. French Revolution to Mid-20th Century.—During this period officer status was gradually opened to qualified soldiers in the ranks. Significantly, too, officer status was opened to a great number of technical positions unknown in warfare before the Industrial Revolution; for instance, officers supervising the production of guns and those responsible for signal communications.

In the British services prior to the 20th century, officers normally were paid so little that only the wealthy could afford commissions. Promotions from the ranks became common during World War I and soon after its termination measures were taken to extend the system to the regular army in peacetime. A limited number of young soldiers from the ranks (known as Y cadets) went each year to the royal military colleges for training as officers. In 1938 the British government made it a condition that all cadets for army commissions should serve for a short period in the ranks. The number of commissions granted from the ranks of the navy and air force was also increased. This reform in part did away with such disabilities as the low pay that required augmentation from a private income, and also eliminated the inactive status during which a regular officer had sometimes found himself on half pay. Consequently, the British officer class became more representative of the nation as a whole. Even the social barriers were broken down so that service as a British officer more closely paralleled that in the U.S. forces.

In Germany, even before the unification of the country in 1871 the influence of Prussia was pre-eminent in military affairs. This influence, which to a certain extent pervaded all Europe, continued right up to World War II. The Prussian landholding aristocracy, the Junkers, were the most powerful element of an essentially military society. Most officers came from the aristocracy of Prussia or the other German states, and by the end of the 19th century all were required to have a university degree or its equivalent. Approximately 40% came from cadet schools; the remainder had been reservists on active duty who had been recommended by their commanders as possessing the requisite military and social qualifications. The Junkers were able to assure that members of their group rose to high command and staff positions in the army. The arrogance of the Prussian officer was communicated to the rest of the German army and to the navy. There can be no question that this, as well as the Prussian emphasis on mechanical efficiency, detracted to some extent from the human qualities that have been found so essential to the making of good officers in democratic countries. Nevertheless, German thoroughness and attention to detail resulted in a high standard of efficiency throughout the entire army, and later in the German navy and air force. At the same time the German promotion system brought many brilliant and imaginative officers to positions of high command. In the development of the new German army of the Federal Republic of Germany after World War II, a conscious effort was made to eliminate the nondemocratic and mechanical characteristics of the old German officer corps, while retaining the traditionally high standards of efficiency. In this period the Germans looked to the United States for guidance in the organization of armed forces consistent with democratic principles.

The French nobility had largely been eliminated from influential military positions in the Napoleonic era. Men who might never have been more than sergeants in the armies of Louis XIV rose to be marshals under Napoleon. Against this background, the selection of officers in France during the 19th century was probably more democratic than that in any nation other than the U.S.

Nevertheless, aristocratic influences remained strong in the top command positions of the French army up to World War I. Throughout the 19th century and until the mid-20th century, French officers were well-schooled and able men, though officer positions declined in standing mainly because of the low pay.

In the far east the Japanese services were largely commanded by the nobility. Descendants of the traditional samurai class generally attained highest rank in both command and staff positions in the Japanese army and navy. A certain similarity developed between Germany and Japan in the rise of an essentially military society. Japanese officers displayed much of the arrogance found in the German armed forces of the 19th and early 20th centuries. The parallel continued after the defeat of both in World War II. Like the West Germans, the Japanese, with U.S. assistance, endeavoured to eliminate the autocratic abuses that had existed in their prewar forces, while retaining traditional military efficiency. East Germany, on the other hand, patterned its armed forces on the older German model, modified by contact with Soviet organization.

Russia, under the tsars, gave officer status almost entirely to the nobility. Before World War I the standards of the Russian officer corps were lax; there were a few capable officers but many were unbelievably careless and incompetent. This resulted in disastrous defeats in the Russo-Japanese War and in World War I. Following the Bolshevik Revolution, Lenin created an army from the proletariat, taking his leaders from among labourers and revolutionists.

During the period between World Wars I and II the Red army developed slowly but steadily, and many excellent officer schools were established. The growing efficiency and morale of the officer corps were seriously impaired, however, in the Stalinist purges of 1937. Glaring weaknesses were revealed in the Russo-Finnish War of 1939–40, but this experience enabled the Soviet leaders to make many last-minute improvements before Hitler attacked in 1941. At that time the top commanders were still the old Bolshevik leaders, but after the Red army suffered crushing defeats, these men were replaced by younger and better-trained officers. The vast area of the U.S.S.R. and the stubborn defensive qualities of the Soviet soldiers provided advantages that gave these new commanders a chance to gain experience in battle.

Soviet social and political experiments in the army were not wholly successful. After the Revolution officers and men were given common social status, but this soon proved unworkable. The trend was reversed until by mid-20th century there was a greater distinction between officers and men in the Soviet forces than in those of the western nations. The Soviet leadership was slower to acknowledge the failure of its system of political commissars. Until the early days of World War II there had been in each army unit commissars whose function was to indoctrinate the troops with Communist propaganda and to check on the political reliability of the officers. While there was a partial return to this system after World War II, these political officers no longer wielded their former power.

Officers in the U.S. services have always represented a cross section of the population and have been obtained by various systems of selection. In the early days of the republic, men ignorant of military affairs became officers through political influence. The evils of this practice were great; history mentions companies electing captains in the American Revolution on the condition that they share their pay with the other men. There were similar experiences in the War of 1812 and again to a lesser degree in the Civil War, when governors of states appointed officers in the volunteer forces, often without regard to their experience. Many of the small nucleus of regular officers who had been trained at the U.S. Military academy got their chance in the war by obtaining volunteer appointments from state governors at ranks far higher than the permanent ones they held. The experience of Gen. Philip Sheridan, who fought as a captain in the regular army for a full year before he was elevated to a colonelcy of volunteers, was common among the regulars.

After comparable experiences in the Spanish-American War, the United States made strong efforts in both World Wars I and II to select and promote officers on the basis of merit. In these wars, the higher command and staff positions were given most often to regular officers. But in World War II more than 98% of army officers and 96% of navy officers were nonregulars. Some had been reserve officers before the war, but most were essentially civilians, selected from the greatly expanded enlisted ranks and trained at officer candidate schools. A few specialists—lawyers, doctors, railroadmen, etc.—had duties almost identical with those of their civilian occupations.

During World War I the air officer, usually a pilot, played a significant role in the armed forces of all major belligerents. In Britain toward the end of World War I, and in Germany between World Wars I and II, a coequal service—the air force—was established, but air units remained elements of the armies and navies of most other major nations until after the close of World War II. In 1947 the U.S. air force became a separate entity, but in the U.S.S.R. the air force remained an integral part of the Soviet army.

II. THE OFFICER AS A LEADER

In the 20th century the forces of social evolution and revolution have tended to reduce, but not to eliminate, the traditional distinctions between officers and enlisted men in pay, social status and privileges. Nations today draw their officers from a cross section of their people and make it possible for enlisted men to become officers.

The distinction between officers and enlisted men, or "other ranks," is one primarily of professional status and responsibility. Many enlisted men of the regular services in most nations are highly skilled and trained technicians; senior noncommissioned officers are generally as dedicated to their military careers as any officer. Most enlisted men, however, lack the professional background, education and motivation that are considered to be the fundamental officer characteristics. Because of this essential difference, enlisted men under the military and civil law of most nations cannot assume the legal responsibilities of command that an officer cannot avoid.

Armed forces exist to support and to carry out national policy and particularly to defend their nations from hostile attack. It is the function of officers to provide leadership for these military establishments. This leadership is exercised in three major categories of activity: (1) the armed forces must be recruited, organized and equipped; (2) they must be trained; (3) they must be controlled and led in military operations. The objective of this exercise of leadership must be to assure success in battle, whether or not the individual officer and his men are ever actually engaged in combat.

Leadership is a concept defying precise analysis in its military as well as its nonmilitary manifestations. Through a study of history, however, it is possible to deduce certain qualities that all military leaders should possess. While the general nature of military leadership is comparable with that in any field of human endeavour, it is nonetheless distinguished by the highly specialized characteristics that the officer must possess.

1. Military Competence.—This is the first and most distinctive of military leadership qualities. It requires a profound knowledge of military theory as well as understanding and skill in applying this theory. Nothing is more difficult in the military profession. The officer may prepare for the day of battle for many years, but the exercise of his leadership in war usually occupies a relatively brief period. Obviously, then, there is an aspect of unreality in his preparation. Furthermore, what he has learned by study and artificial peacetime experience can easily become outdated before he is called upon to exercise leadership in combat. Only through alertness in responding to technological developments and by repeated training exercises can the officer hope to obtain and preserve this essential skill. His success is demonstrated by his ability to take positive action in the flexible application of technical knowledge and theoretical principles to a wide variety of specific situations.

The officer must know thoroughly the tools that will be available in war. While this naturally includes weapons and all manner of

complex equipment, the most important tools are the men he leads in battle. The officer must understand their general human and national qualities, and further must be aware of the characteristics and limitations of the specific individuals who will be under his command in battle. Knowledge of the military art, flexibility and all the other requirements of leadership avail nothing if the officer does not understand how to deal with the human beings over whom he holds a position of power. An understanding of his men does not mean that an officer must fatalistically accept their limitations. On the contrary, he should endeavour to minimize inherent weaknesses and to improve the quality of the human tools with which he must fight. This is done through training and the simultaneous achievement of high standards of discipline.

2. Training and Discipline.—In the armies of modern democratic countries discipline cannot be achieved through the so-called Prussian system of unthinking obedience from mechanical soldiers. Such a system is not compatible with democratic concepts or the requirements of modern warfare. The increasing destructiveness and efficiency of weapons has compelled increasing dispersion of land, naval and air forces in battle. In the isolation of individuals or small units there is an incessant demand for the exercise of initiative and the display of moral and physical courage that can be derived only from confidence fostered by an understanding system of discipline.

This confidence is not merely the result of thorough, painstaking training of men in the use of weapons and equipment; it stems equally from the officer's diligence in care of his men, resolute justice, creative intelligence and respect for the dignity of the individual. The object of the relationship between officers and their men is so to strengthen the will and abilities of the latter that they will be able to take voluntary action in the heat of battle. The officer-leader stands or falls on the results of those vital moments when the decision is in the hands of the men with whom he has trained and lived.

3. Character Traits.—The officer must be able to inspire in his men a desire to work together toward a common goal. This cannot be achieved either by routine performance of his duties or by trying to gain the friendship and liking of his subordinates. He must demonstrate his dedicated enthusiasm for national objectives and ideals and for the honour and glory of the organization he commands. This, combined with military competence and insistence upon high standards of discipline, will ensure the respect, confidence and loyalty of his men. Personal courage is an absolutely indispensable quality. Since the officer will have normal, human reactions to danger, he must exercise the strongest self-discipline in combat. This does not mean that he should recklessly expose himself to danger or pretend an absence of fear. He must, however, share the risks of his men, must never demand them to perform actions that he would not dare himself and must remain cool and self-possessed in combat. Finally the leader must be able to endure calamity without loss of equilibrium. He should be able to persevere in adversity and carry on with flexibility and determination to achieve assigned objectives, regardless of setbacks or even crushing defeat.

III. RANKS OR GRADES OF OFFICERS

A common pattern of officer ranks or grades has developed in the armed forces of the principal nations, despite differences in titles. The nature of the pattern, the commonest titles of ranks and grades and major differences between services and nations are shown in the table. It should be noted that officer grades in the U.S. air force are practically identical with those of the U.S. army, and that there is comparable similarity in the grades of the French army and air force.

1. Warrant Officers and Cadets.—Below the normal officer grades there are frequently two categories of ranks in which the individuals enjoy officer status but do not have full officer responsibility.

Warrant Officer.—Warrant officers' duties are generally administrative or technical in nature. It should be noted that in the British army the term warrant officer (like that of *adjudant* in the French army) applies to senior noncommissioned officers, who do not possess officer status comparable with that of U.S. warrant officers, for instance. In the Royal Navy the commissioned warrant officer enjoys full officer privileges without the full status.

Cadet.—This term generally applies to young men attending special training schools in preparation for regular careers in the armed forces. U.S. and British naval cadets are called midshipmen.

2. Company Grade Officers.—This is an army (and often air force, though not Royal Air Force) term applying to the lowest of three major groupings of commissioned officer grades. There is no comparable naval term, though members of the lower ranking group are sometimes referred to as "junior officers." The grades are as follows:

Second Lieutenant.—This officer is usually an assistant platoon commander in most armies. The equivalent Royal Air Force rank is pilot officer, while the U.S. navy equivalent is ensign.

Lieutenant.—In the U.S. army and air force this officer is a first lieutenant; in Belgium he is known as the platoon chief, which is indicative of his typical responsibility. He may also be second in command of a company. In the Royal Navy, which has no lower commissioned rank, he is a sublieutenant, while in the Royal Air Force he is a flying officer. The Soviet army has three grades of lieutenant rather than two as in most nations.

Captain.—In most armies this officer is a company commander, the title going back to the days of mercenary companies. In the British army he may sometimes be second in command of a company. This rank is equivalent to lieutenant in most navies and flight lieutenant in the Royal Air Force.

3. Field Grade Officers.—This is the U.S. army and air force term for the second major grouping of officers. In the navy and British services these grades are sometimes called senior officers. Royal Air Force rank titles in this group indicate the position normally filled by men of each grade: squadron leader, wing commander and group captain. Field officer grades are as follows:

Major.—In most armies this officer, lineal descendant of the historical sergeant major, is second in command of a battalion, though in the French army he may command a battalion, while in the British army junior majors often command companies. In navies the lieutenant commander usually commands small combat vessels, such as frigates or destroyer escorts.

Lieutenant Colonel.—In most countries this officer commands an infantry battalion, or is second in command of a regiment of more than one battalion. In the British army he also commands a cavalry, artillery, engineer, etc., regiment. The equivalent naval rank is commander, an officer who usually commands intermediate size vessels, such as destroyers, or who may be executive officer of a larger vessel.

Colonel.—In most armies this rank denotes command of a regiment or similar group. The equivalent naval rank is captain. In the British army it is often held by senior staff officers, but not by active regimental officers. The British regiment is an administrative unit and has a dignitary called the colonel of the regiment. He acts as the "father of the regiment" and is usually one of its distinguished serving or retired senior officers. Many British regiments also have a colonel in chief, who is always a member of the British, or a foreign, royal family. A few units—mostly in the territorial army—have, in addition, "honorary colonels," who are usually distinguished persons selected because of some past connection with the unit.

Brigadier.—This is a special rank found only in the British army and the armies of nations that have adopted British organization. This officer commands a brigade—the combat organization comparable to the regiment in most other armies. Some staff positions are also held by brigadiers. In the British army the brigadier is not a general officer, but is a colonel who is given special appointment with the temporary rank of brigadier while holding his specific command or staff position. The position of commodore in the Royal Navy is comparable in that it is not a separate rank, but is a special appointment of a captain.

4. General or Flag Officers.—This third and most exclusive grouping of officers includes those in senior command and staff positions. "General officer" is the army term and "flag officer" the naval term.

Corresponding Ranks in the U.S., British, French and Soviet Armed Forces

U.S. army*	U.S. navy	British army	British navy	British air force	French army	Soviet army
Warrant officer	Warrant officer		Warrant officer	Warrant officer		
Cadet	Midshipman	Cadet	Midshipman	Cadet	Cadet	Officer cadet
2nd lieutenant	Ensign	2nd lieutenant	Sublieutenant	Pilot officer	Underlieutenant	Junior lieutenant
1st lieutenant	Lieutenant (junior grade)	Lieutenant		Flying officer	Lieutenant	Lieutenant Senior lieutenant
Captain	Lieutenant	Captain	Lieutenant	Flight lieutenant	Captain	Captain
Major	Lieutenant commander	Major	Lieutenant commander	Squadron leader	Commandant	Major
Lieutenant colonel	Commander	Lieutenant colonel	Commander	Wing commander	Lieutenant colonel	Lieutenant colonel
Colonel	Captain	Colonel Brigadier	Captain Commodore	Group captain	Colonel	Colonel
Brigadier general	Rear admiral (lower half of list)			Air commodore	Brigadier general	Major general
Major general	Rear admiral (upper half of list)	Major general	Rear admiral	Air vice-marshal	Divisional general	Lieutenant general
Lieutenant general	Vice-admiral	Lieutenant general	Vice-admiral	Air marshal	Corps general	General
General	Admiral	General	Admiral	Air chief marshal	Army general	Colonel general
General of the army	Fleet admiral	Field marshal	Admiral of the fleet	Marshal of the Royal Air Force	Marshal of France	Marshal

*Ranks for officers of the U.S. air force are the same as for the U.S. army except that the highest rank is general of the air force.

Brigadier General.—Traditionally this was the title of the commander of a brigade. Brigadier generals, in armies without a brigade structure, are normally second in command of divisions, or in command of divisional or corps artillery establishments, or of specially organized task forces of several combined arms, or may hold senior staff positions. The Soviet major general is comparable to brigadier general in other armies. In the U.S. navy the rank of commodore is rarely used (though certain officers, because of the positions they hold, are given the title of commodore), and officers in the lower half of the list of rear admirals are considered to rank with brigadier generals. Air commodore is the equivalent Royal Air Force rank.

Major General.—The commander of a division is given this title in practically all armies of the world; many high general staff positions are also given this rank. In the U.S. navy, officers in the upper half of the list of rear admirals rank with army and air force major generals. In the Soviet army lieutenant generals are ordinarily the equivalent of major generals in other countries. The comparable Royal Air Force rank is air vice-marshal.

Lieutenant General.—In most armies this officer commands a corps of two or more divisions. The comparable Soviet rank is general. In most navies the equivalent rank is vice-admiral and in the Royal Air Force it is air marshal.

General.—This grade is normally identified with the commander of a field army. Senior generals may command army groups of two or more field armies, or command combat theatres of operations in wartime. The equivalent naval rank is admiral while that of the Royal Air Force is air chief marshal. In the Soviet army the comparable rank is colonel general.

Field Marshal.—In Britain this ancient rank is held by a few senior army officers. If not already a field marshal, the chief of the imperial general staff is usually made one soon after being appointed. In the Royal Navy the comparable rank is admiral of the fleet, and the air equivalent is marshal of the Royal Air Force. In the Soviet army this rank is generally held by officers commanding army groups or higher command. In France the title of *maréchal de France* (marshal of France) is purely honorary and is awarded by the French government only to especially distinguished, victorious generals.

After World War I the U.S. congress conferred the unique title of general of the armies of the United States on Gen. John J. Pershing. A comparable rank, admiral of the navy, had been given to Adm. George Dewey in 1899. The ranks of general of the army (unused since 1891) and fleet admiral were authorized by congress during World War II as the equivalent of field marshal and conferred on selected commanders: Generals George C. Marshall, Douglas MacArthur, Dwight D. Eisenhower and Henry H. Arnold (the title of whose rank was changed to general of the air force when that service was separated from the army in 1947); Admirals William D. Leahy, Ernest J. King and Chester W. Nimitz. Later Gen. Omar Bradley attained the rank of general of the army and Adm. William F. Halsey became a fleet admiral. Eisenhower, who resigned his rank to become president, was reinstated to it in 1961. (T. N. D.)

5. Brevet.—This term, a diminutive of the French *bref*, originally denoted a brief official note; more commonly it applies to a form of military commission used in the U.S. and British armies. Under the system wherein an officer was customarily promoted within his regiment or corps, a brevet conferred upon him a rank in the army-at-large higher than that held in his corps. Frequently it carried with it the pay, right to command and uniform of the higher grade. In the United States especially, brevet rank was widely bestowed as a reward for outstanding service; it became the subject of extensive confusion and controversy during the American Civil War. After 1865, U.S. brevet rank was gradually stripped of its benefits and officers were rewarded instead by decorations. (*See* MEDALS AND DECORATIONS.) Commission by brevet was declared obsolete in 1922. Special commissions bearing some of the characteristics of the brevet have been used in other armies. (F. P. T.)

IV. SOURCE OF OFFICER MATERIAL

In all major nations the primary sources of regular officers are special military, naval and air academies or colleges. These service academies, while differing among nations and services, have much in common. They are generally open to youths between 17 and 22 years of age, and all have strict physical and mental requirements for admission and require that candidates be unmarried. In addition, most nations offer opportunities to outstanding enlisted men and to graduates of universities and colleges to qualify for commissions as officers, either directly, or through the service academies or through intensive courses at officer candidate schools.

1. United States.—Regular officers in the United States services are obtained from three principal sources: from the three service academies; from civilian colleges and universities; and from among selected reserve officers. Some of the reserve officers obtain their commissions through Reserve Officer Training corps courses in civilian colleges, others through attending officer candidate schools as enlisted men.

Many regular army officers are graduates of the U.S. Military academy at West Point, N.Y. This academy, established in 1802, is one of the oldest service academies in the world. The naval equivalent is the U.S. Naval academy at Annapolis, Md., which was established in 1845. The U.S. Air Force academy was founded at Denver, Colo., in 1954, opened in 1955 and moved to permanent quarters near Colorado Springs, Colo., in 1958.

The student bodies for these academies are filled mainly by congressional appointment. The president also has a number of appointments that are often used for the sons of deceased veterans, and the regular services and the national guard have appointments open to enlisted men on a competitive basis.

All three academies offer a four-year college-type curriculum at government expense, leading to a bachelor of science degree. In addition there is intensive military instruction. The objective of the schools is to produce officers who have the qualities and character essential to their continuing development as leaders. The academies generally seek to implant a high sense of duty and patriotism, while assuring mental and physical fitness.

Upon successful completion of the four-year course the graduate is commissioned a second lieutenant in the army or air force, or an

ensign in the navy. In the 1960s West Point and Annapolis did not furnish even a majority of regular officers in the services, since far larger numbers were commissioned from civilian colleges or entered from the reserve officer group or the enlisted ranks. The Air Force academy, of course, was only beginning to supply officers for its service. Commissions in the air force and navy are also given to those who successfully pass through the flight instruction programs of these services. Although there are certain academic prerequisites (normally two years of college) time spent in the programs themselves varies with the individual's flying proficiency.

2. Great Britain.—Great Britain has obtained most of its regular officers from its military colleges. Medical, legal and some other technical officers, as in the U.S., have been obtained mostly from graduates of civilian universities. Prior to World War II, Britain had two cadet schools for its army: the Royal Military college at Sandhurst (1799) and the Royal Military academy at Woolwich (1741). Sandhurst was a school for officers of the infantry, tank corps and other line elements, while Woolwich trained artillery, engineer and signal officers.

Up to 1914 entry into these colleges was confined almost solely to the sons of upper-class parents. Between World Wars I and II, however, various changes were made and the colleges were put on a more democratic footing. By 1938 a short period in the ranks, as a prerequisite to officer candidacy, had become the rule rather than the exception. The changes of 1938 also made it possible for a youth who could meet the entrance requirements to obtain military training at government expense. Both Woolwich and Sandhurst differed considerably from the U.S. Military academy in that emphasis was upon military training, no effort being made to obtain a university degree for the cadets in the shorter, two-year course. Since the great majority of cadets had attended public schools or universities, however, by the time they received their commissions they had the equivalent of a college education. These schools furnished about three-fourths of the regular officer corps, the remainder coming from university graduates, directly from the army and from commonwealth nations.

In the post-World War II period, Sandhurst and Woolwich were consolidated into a single Royal Military academy located at Sandhurst. Because the reform of 1938 had broadened the source of applicants, there was some lowering of the standards of prior education of cadets from pre-World War II days. Consequently, there has been increased emphasis on academic subjects.

The Britannia Royal Naval college at Dartmouth (1729) and the Royal Air Force college, Cranwell (1920), the latter of which trains cadets for regular commissions as pilots and navigators, are the British naval and air counterparts of Sandhurst. Their courses are somewhat longer than at Sandhurst; otherwise they are comparable in scope and objectives. The Royal Air Force technical college at Henlow gives professional training for officers of the technical branch of the service.

3. France.—The principal source of officers for the French army is the École Spéciale Militaire, formerly located at St. Cyr, near Versailles, but moved to Brittany as the result of the destruction of its buildings in World War II. Like Sandhurst, St. Cyr (as it is still called) has a two-year course, except that selected noncommissioned officers may obtain a commission in one year of intensive study.

In past years most French artillery and engineer officers received their cadet training in a two-year course at the École Polytechnique in Paris. Polytechnique has become essentially a civilian engineering school, and by the 1960s only a few members of each class were electing to enter the military forces as a career. It is a government school, however, including military training, and a certain percentage of its graduates become reserve officers who must serve a period of active duty in the army.

The French navy obtains most of its officers from the École Navale, near Brest in Brittany, while the air force school is the École de l'Air, at Salon-de-Provence. Both schools feature three-year courses. The navy and air force, like the army, also obtain some of their technical officers from the École Polytechnique.

4. Soviet Union.—Before World War II the U.S.S.R. had no cadet colleges similar to those of the western nations. However, there were many branch officer candidate schools, including 15 for the infantry and a smaller number for the artillery. Qualified enlisted men are still allowed to compete for admission to these schools, receiving commissions after a course of three years. Some technicians, particularly engineers, are given direct commissions after university graduation.

During World War II the professionalization of the Soviet army was given impetus by the establishment of a number of Suvorov junior military academies. These schools accept boys—frequently from military families—at the age of nine or ten and subject them to seven years of training in military and secondary-school subjects, after which they are sent on to the three-year officer candidate schools. The Nakhimov schools for the navy are similar to the army's Suvorov schools.

See also MILITARY, NAVAL AND AIR ACADEMIES.

V. OFFICER TRAINING

All modern armies lay great stress on the continuous training of officers after they have received their commissions. This is particularly important because peacetime experience can never duplicate that of war and rapidly becomes outdated. Officers are schooled in the theories of tactics and strategy, in the principles of war and in the latest weapons systems and techniques whereby these theories and principles are applied in modern combat. Flexibility of mind is the goal in military education.

The army officer recently graduated from a military academy is usually given two or three years in command of a platoon of soldiers to acquaint him with the problems of leadership and to impress upon him the necessity for knowing small-unit tactics as they apply to the soldier in the ranks. Moreover, in such experience the young officer learns each soldier's job, so that he can show a rifleman or machine gunner how to handle his weapon. After a period of command, the officer may go to a school of his arm, such as infantry or artillery, to obtain a basic knowledge of its tactics and techniques. In some armies, this training of the early years is reversed on the theory that the junior officer is better qualified to command men if he has had the benefit of tactical schooling.

In general, the training of army officers runs to the following pattern in most nations: (1) basic military and academic education in military academy; (2) command at platoon level or its equivalent; (3) basic school of the arm; (4) command at the company level; (5) advanced school of the arm; (6) staff at battalion or regimental level; (7) staff college; (8) staff assignment in a higher headquarters; (9) command at the battalion level; (10) war college; and (11) the remainder of the career usually including both command and staff assignments. Into this pattern, from time to time, may come special assignments such as duty with reserve components or with a military mission in a foreign country. While the pattern of service for naval and air force officers naturally varies somewhat from that of army officers, these follow a similar scheme of rotation of duties, including school, command, staff and special assignments.

Much of the officer's training is concentrated on learning tactics and staff procedure by application so that these can be performed almost automatically. This is not to say that schooling is unthinking or adjusted to the mediocre. Rather it is based upon the requirements of service and the need for established, well-understood procedures, so that action will be prompt and efficient in the stress of combat, and to assure maximum co-ordination under any circumstances between officers who may never have had an opportunity to practise working together. Experience has proved that close adherence to a soundly formulated military doctrine is the surest guarantee of obtaining the best-trained men and of assuring uniformly high standards of training and achievement through the entire service.

1. United States.—Officer training in the U.S. services at mid-20th century followed very closely the pattern noted above. Only those officers showing the greatest potential for staff and command duties—approximately 50% of the officer corps—are selected for staff college. These are usually captains or majors in their early 30s. A smaller percentage—colonels, about 10 or 15 years older—are selected to attend the National War college, the In-

Industrial College of the Armed Forces or one of the three service war colleges. Many of these, as lieutenant colonels or commanders, have attended a joint staff college for special training in operations of the combined services.

During the first ten years of his career, an army officer who began his service in a line branch—infantry, artillery or armour—may receive specialist training in one of the technical branches, such as ordnance, signal communications or engineers. Some of these officers will transfer permanently to the service branches, with further training in civilian universities. From these, for the most part, are eventually selected the students who attend the Industrial college, where they study the economic aspects of war and industrial mobilization. There are also specialist opportunities for young navy and air force officers. Many of these young officers also complete their military schooling in the Industrial college.

2. **Great Britain.**—The British army officer at mid-century, like his U.S. counterpart, becomes a platoon commander shortly after he is commissioned. He is expected after two years of service to have a knowledge of the interior management, economy and discipline of a company. Subsequently he is required to pass professional examinations in order to qualify for promotion and in order to qualify for attendance at the higher military schools. The patterns for officers of the Royal Navy and Royal Air Force are similar.

After about eight years' service, specially selected officers attend one of the service staff colleges. On graduating, these officers can expect staff assignments, either in one of the service ministries in London or in major commands in Great Britain or overseas. There is a special staff college for joint service operations, and above that is the Imperial Defence college, equivalent to the U.S. National War college, for the study of higher strategy and military policy by officers of all services of all commonwealth countries.

3. **France.**—The French training system was the chief model for the U.S. and Great Britain. Great emphasis is placed upon qualification both in education and military training. After attending branch or specialist school, an army officer can expect to attend the École de Guerre some time between the ages of 28 and 38. This school, with its ten-month course, is designed to train officers for staff duties and the command of larger units. At about the age of 45, selected colonels attend the French war college—the École Supérieure de Guerre—for a two-year course in the higher art of war. The higher schooling of French navy and air force officers is similar.

4. **Soviet Union.**—Officers of the Soviet forces are trained at branch service schools, much as in the western democracies. Also the more capable officers are sent to staff schools and eventually the war college. A Soviet officer can count on spending almost twice as much time in schools as his western counterpart. The Soviet services place great emphasis on two items: political beliefs of the individual and ability to command troops.

VI. THE OFFICERS' SERVICE

While training requirements are similar for officers in the armed forces of all nations, there are great differences in the sort of places in which they serve and in the kind of duty they perform when not in school. The usual expectancy in most armies and air forces at mid-century was that officers would command troops or serve in combat units from one-fourth to one-half of their careers. A similar proportion of a naval officer's service would be at sea. This requirement, however, was constantly being lowered because of the growing complexity of war, which increased the demand for general staff officers and technical specialists.

The high command in most armies is normally given to the line officer, with a background in infantry, artillery or tanks, who has alternated his command experience with general staff duties. These officers will in time have taken very divergent paths from those of the technical experts, qualifying themselves in the later years of their service more as executives and administrators than as specialists in technical fields.

The duties of officers in the major countries require a certain amount of overseas service, either in military missions, strategic outposts or colonies. Accordingly, the officer alternately moves from an army post to an overseas garrison, or to a civilian community while on duty with militia or reserve units. The duties are varied and frequently stimulating because of new interests and new places.

1. **General Staff.**—An officer in this field is required to know the functions of personnel, intelligence, plans, operations, training or supply. The knowledge he brings with him of the men in the ranks assists him in determining whether his policy on paper can be carried out by men in units. Many general staff problems are concerned with political-military affairs and grand strategy. The training and background of the ordinary officer are not sufficient to equip him adequately in these matters. Consequently such jobs are assigned to officers who have demonstrated that they possess the necessary qualities of intellect, who have maintained a lively interest in world affairs and who have attained a sense of proportion in dealing with complex matters.

2. **Technical and Supply Services.**—Officers in these services may possibly be graduates of engineering schools as well as of a military academy. Their work in signal communications, ordnance or procurement of supplies brings them into frequent contact with business and industrial men. Mutual understanding by these groups is essential to the successful operation of industrial mobilization in the event of war.

3. **Methods of Promotion.**—In modern forces, officers are promoted through seniority in length of service, by selection on the basis of merit or, most frequently, by some combination of the two. For instance, most selection systems require a certain seniority before an officer can be pushed ahead of his contemporaries. In time of peace, when vacancies are few, the length of service requirements for selection may be increased. Promotion by seniority alone assures adequate reward for faithful service; it may, however, result in the promotion of less competent officers, at the same time failing to take full advantage of the potentialities of more capable, younger men.

In peacetime, promotion is normally a permanent advancement, while in wartime the tremendous expansion of the armed forces requires temporary promotions. Postwar contraction of the services often requires officers to drop back one or two grades from their advanced temporary rank. In World War II, for instance, in the U.S. services there were many cases of permanent captains who held the rank of brigadier and even major general, and many of these, despite proved ability, had to return to the grade of colonel after the war.

The armed forces of most nations use some sort of qualification report as an important basis for selecting officers for promotion. In the U.S. services these reports are submitted periodically, usually once or twice a year, and are prepared by the immediate commander or supervisor of the officer. After the next higher commander adds his comments, these reports are sent to the service headquarters in Washington, D.C., for evaluation and file. Reports are evaluated by electronic means, and each report is given a rating. The average of these ratings over a period of years largely determines whether an officer qualifies for staff college or war college, and influences his selection for promotion in the higher grades.

The British services use the qualification report system but also require a junior officer to qualify for promotion, and for attendance at staff college, by passing rigid examinations. The examination system is also used by the U.S. navy.

VII. CONCLUSION

An officer in a modern army, air force or navy has a responsible task. The lives of many of the nation's citizens depend upon his integrity, judgment and knowledge. Probably in no other field of endeavour is a leader thrust so quickly into a position of great responsibility as is the officer in time of war.

The officer is the product of his own nation's social system. But his colleagues in the armed forces of other countries share the difficulties resulting from the increasing complexity of modern warfare, and those of controlling human organizations in battle.

See also INSIGNIA, MILITARY and individual articles on various military ranks and units, as GENERAL; ADMIRAL; BRIGADE; DIVISION, MILITARY; etc.

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(T. N. D.)

OFFSET, in architecture, is a slanting plane, forming a transition between a thin wall above and a thick wall below, or between varying depths of a buttress. An offset buttress is one deeper at the bottom than at the top, with the difference between the upper and lower faces taken up by one or more offsets.

OFFSET PRINTING: *see* LITHOGRAPHY.

OGADAI (UGEDEI or OGOTAI) (1185–1241), son and successor of the Mongol emperor Genghis Khan. He was chosen for the succession by his father because of the bad feeling between his two elder brothers, Jagatai and Jochi (who died in 1227). He was the first to call himself khagan (chief khan), his father having used only the title khan. Ogadai built a capital, Karakorum, in northern Mongolia, completed the conquest of north China (but not of China south of the Yangtze), and sent armies into Iran, Iraq, Azerbaijan and Russia. The Mongols destroyed many cities in Russia between 1237 and 1241. In the latter year they also defeated an army of Poles and Germans, marched through Hungary and reached the Adriatic sea. After these events Russia remained tributary to the Mongols of the Golden Horde, ruled by the descendants of Jochi, for more than 200 years. Following Ogadai's death his widow, Toragana, ruled as regent until 1246 when she handed over the throne to Kuyuk, her eldest son by Ogadai. *See* also MONGOL EMPIRES.

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OGASAWARA-GUNTŌ: *see* BONIN ISLANDS.

OGBOMOSHO, the most northerly of the principal towns of Western Nigeria, lies in Oyo province, 55 mi. N.E. of Ibadan and about 15 mi. from the border between Western and Northern Nigeria in the Ondo hills at about 1,200 ft. above sea level in an area of savanna and farmland. It is the third largest town of Nigeria. Pop. (1961 est.) 163,483.

The town extends over a large area astride the northward trunk road, which forms its main street. It is the headquarters of the American Baptist Church in Nigeria and has a notable theological seminary on "New England" architectural lines. The Ogbomosho mosque, with its great square tower, is a prominent landmark, and other churches and mosques rise among the walled compounds of private houses in traditional Yoruba and Nigerian "Brazilian" styles. Though there is no museum, fine wood carvings and Koso drums (unique to Ogbomosho) are found, mostly in private houses. There are a grammar school, a girls' high school and a teacher-training college; also Baptist and government hospitals, a tuberculosis clinic, a leper settlement and a home for motherless babies.

The town is a road junction and stands on the main road from Lagos (154 mi.) and Ibadan (55 mi.) to Ilorin and the north. To the southeast it is linked with Oshogbo and thence to Benin and Eastern Nigeria. Farming and trading are the principal occupations and local traders travel widely. Foodstuffs exported to other parts of Nigeria include yams, cassava and guinea corn; beans, palm oil and cotton are grown for home consumption. Tobacco is grown to supply the cigarette factory at Ibadan. The town is also an important staging point and market for cattle. Locally grown cotton is used for weaving the traditional Yoruba cloth, *aso oke,* while Ogbomosho weavers also make *sanyan,* a cloth woven from silk brought from Ilorin. The indigo dyeing of cloth is performed exclusively by the women. The craft of wood carving has declined.

More than 140 different communities found asylum in Ogbomosho during the former wars with the north and this accounted for its high population. Ogbomosho was founded as a camp about the mid-17th century and enjoyed peace until the early 19th century when the Fulani swept down from the north. Many of the surrounding Yoruba towns were destroyed, including old Oyo, the original Yoruba capital, but Ogbomosho resisted the invasion with the help of its walls, parts of which still remain. (W. H. I.)

OGDEN, CHARLES KAY (1889–1957), British writer and linguist, was the originator of Basic English (*q.v.*), a minimum language sufficient for general needs selected from English. At Cambridge, after a first class in the classical tripos (1910), he founded a penny intellectual weekly, *The Cambridge Magazine,* to which Hardy, Wells, Shaw and others contributed. In 1919 he made it a quarterly to print *The Meaning of Meaning,* a study in theory of language. The chapter on definition contained the germ of Basic English, which took final form in 1928. It consists of 850 head-words, few enough to be printed on a single sheet of note paper (rules in *The System of Basic English;* usage limitations in *The Basic Words*). The system became widely known and many books were printed in it (*e.g., The Basic Bible,* 1944). In 1943 Winston Churchill appointed a committee of ministers to study extension of its use. Ogden gave evidence before this body but the attempt proved premature. His own entry in *Who's Who* reads "1944–6, bedevilled by officials." Ogden died on March 22, 1957, in London. His work remains fruitful in improved conceptions of language learning. His great collection of books on Bentham and in language theory is in the library of University college, London.
(I. A. Rs.)

OGDEN, PETER SKENE (1794–1854), British fur trader who explored much of western America in the 1820s, was born of Loyalist American ancestry, probably in Quebec. About 1810 he entered the service of the North West company and was stationed at Isle-à-la-Crosse during the period of murderous rivalry with the Hudson's Bay company. Though excluded when the two concerns merged in 1821, Ogden was admitted as a chief trader in 1823, and for six years thereafter led the company's Snake country expedition in competition with American trappers. In 1825 he reached the river in Utah that now bears his name, explored southern Oregon and northeastern California in 1826–27, discovered the Humboldt river in 1828, and in 1829 made the first reconnaissance of the eastern face of the Sierra Nevada, discovering Carson, Walker and Owens lakes.

From 1831 to 1844 Ogden superintended trade in the British Columbia area, being made a chief factor in 1835. From 1845 to his death at Oregon City, Sept. 27, 1854, he was a principal officer in the Hudson's Bay company's Columbia department, warmly remembered for having succoured the survivors of the Whitman massacre (*see* WHITMAN, MARCUS). Ogden was twice married to Indian women, having children by each. He always remained a British subject. The anonymous *Traits of American Indian Life and Character by a Fur Trader,* published in London in 1853, is attributed to him. Abstracts of his journals, with a biography by T. C. Elliott, were published in the *Oregon Historical Quarterly,* 1909–10; the Hudson's Bay Record society began publishing the complete texts in 1950. *See* also OGDEN (Utah). (D. L. M.)

OGDEN, a city of north-central Utah, U.S., in the valley of the Great Salt lake, is located about 35 mi. N. of Salt Lake City; the seat of Weber county. A typical Utah garden city, green and tree-grown, Ogden sprawls near the foot of rough-hewn Wasatch mountain peaks on an old delta of the Ogden and Weber rivers which formed under the waters of ancient Lake Bonneville and slopes toward low-lying Great Salt lake. The Ogden river, from which comes the city's name, memorializes Peter Skene Ogden (1794–1854), a British fur trader who trapped in the mountains east of the modern city in May 1825. In 1846 the mountain man Miles M. Goodyear established Ft. Buenaventura, a log stockade with adjacent irrigated garden, on the site of Ogden, which gives the city the distinction of being the oldest continuously settled community in Utah; the "Goodyear cabin" is still preserved.

Goodyear sold out to the Mormons when they arrived in 1847, and early in 1848 Capt. James Brown of the Mormon battalion was sent to take over the Goodyear property. Brownsville, as it was called for a while, was renamed Ogden after Brigham Young laid out the town in 1849, the name being selected by the legislature in 1850. The city was incorporated a year afterward, and in 1951 adopted a council-manager form of government.

After the completion of the Union Pacific railroad in 1869, Ogden became the primary rail centre of the intermountain region and a major distribution point for manufacturing, milling, canning and agricultural products, its stockyards being particularly notable. Industries include the processing of food and dairy products and the manufacture of storage batteries, jet engines, clothing and building materials. State institutions located in Ogden include an industrial school for delinquent children and a school for the deaf and blind. Weber college, founded by the Mormon church in 1889 as Weber Stake academy, and turned over to the state in 1933, was expanded from a junior to a senior college in the 1960s. Pop. (1960) 70,197; standard metropolitan statistical area (Weber county) 110,744. For comparative population figures *see* table in UTAH: *Population*. (D. L. M.)

OGHAM WRITING. The Ogham alphabet (Old Irish *ogom*) was used for writing Irish and Pictish on stone monuments; according to Irish tradition it was also used for writing on pieces of wood, but there is no material evidence for this. It consists in its simplest form of four sets of strokes or notches, with five in each set, incised in the middle or on either side of the edge of an upright stone, thus giving 20 letters; a fifth set of five, called in Irish tradition "extra letters" (*forfeda*), seems a later development. The origin of this alphabet is in dispute, some scholars seeing a connection with the runic and, ultimately, with the north

SYMBOLS OF THE OGHAM ALPHABET, USED BY THE CELTS IN BRITAIN AND IRELAND

Etruscan alphabet, while others maintain that it is simply a transformation of the Latin alphabet evolved in Ireland; the fact that signs for *h* and *z* occur in it, but are not used in Irish inscriptions, speaks strongly against a purely Irish origin. The inscriptions are very short, normally consisting of a name and patronymic in the genitive case; they are of great linguistic interest because they show an older state of the Irish language than that attested by the earliest written sources. It is certain that many of them go back to the 5th and 6th centuries, but there are no epigraphic or linguistic criteria to prevent an earlier date being suggested for some of them. Their distribution is very uneven; of the 520 recorded by R. A. S. Macalister, 200 are found in the modern counties of Cork and Kerry, in southwest Ireland, and an exceptionally interesting group are the 37 from south Wales, nearly all of which are accompanied by Latin transliterations or equivalents. The key to the Ogham alphabet was never lost and it continued to be used as a kind of cryptographic writing (scholastic oghams) during the literary period. *See* also CELTIC LANGUAGES; IRISH LITERATURE.

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OGIER THE DANE (OGIER LE DANOIS), an important character in the Carolingian cycle of French medieval epics. His historical prototype was Autcharius, vassal and liege of Pépin le Bref (Pépin III the Short) and subsequently of Pépin's son Carloman, the brother of the future Charlemagne. When Charlemagne, after Carloman's death (771), set out to annex his territories Autcharius in 771 or 772, accompanied Gerberga, Carloman's widow, and her two children to the court of Didier (Desiderius), king of the Lombards, and was with her when Charles captured Verona in 773. The fact that the French chronicles make no mention of Autcharius and that his existence is vouched for only by the *Vita Hadriani* in the *Liber Pontificalis* encourages the supposition that he was considered a rebel. All that is certain is that the *Gesta Karoli Magni* (*c.* 883) already asserts that he took refuge in Lombardy after incurring Charlemagne's wrath; it is also known that the monks of St. Faron at Meaux compiled, *c.* 1080, the *Conversio Othgerii militis*, an account of a great soldier who, with one of his companions, renounced the world to enter their monastery, and that before 1180 they had erected a tomb (still in existence in the 18th century) to their memory.

Though the *Chanson de Roland* (*q.v.*) and the *Nota Emilianense* speak of Ogier the Dane (named Oggero Spatha Curta—*i.e.*, "short-sword"—by the *Nota*) as one of the emperor's valiant warriors, many texts describe him as a rebel. The oldest of these appears to be that in the Danish *Karl Magnus Krønike* (before 1480), which relates that the pope, having summoned Charlemagne to aid him against the Saracens, was sent troops commanded by his son, Karlot, and Olger. Karlot, at first rescued by Olger, later disobeyed him and was finally killed by him in combat. Olger, condemned to three years' imprisonment, was only released when the emperor again needed his services. Charles and Olger were reconciled and Olger returned to Denmark. This narrative was recast, in whole or in part, first by Raimbert de Paris in his *La Chevalerie Ogier* (*c.* 1200–20), which includes Ogier's adventures in Italy and those relative to his reconciliation with the emperor, and then by Adenet le Roi (*q.v.*) in *Les Enfances Ogier* (*c.* end of the 13th century).

According to the *Chevalerie*, Ogier, in revolt against the emperor who had refused him justice after his son Baudouinet had been killed by Charlot, Charlemagne's son, swore an oath that he would kill Charlot in vengeance, and took refuge with the king of the Lombards, who appointed him his standard-bearer and gave him the strongholds of Montchevreuil and Castelfort. Charlemagne thereupon campaigned against Didier and Ogier, and defeated them; Ogier slew every Frenchman he encountered and fell back on Castelfort. There he was besieged for seven years. He escaped but was taken prisoner by Archbishop Turpin who handed him over to the emperor, who condemned him to death but left him in the archbishop's keeping. Turpin told Charlemagne that Ogier was dying of hunger, though he was secretly feeding him. News of Ogier's death was noised abroad; and the Saracens were emboldened to invade France, so that the harassed people bitterly deplored Ogier's disappearance. Turpin then revealed that Ogier was still alive, but Ogier refused to put himself at the head of the Christian troops unless Charlot was handed over to him. The emperor was forced to consent, but Ogier, as he unsheathed his sword to strike the young prince dead, was stopped by an angel who persuaded him that his oath would be fulfilled if he contented himself with slapping Charlot's face—which he did. Ogier then led the French into battle against the Saracens; he killed Bréhier, their leader, and was rewarded by Charlemagne with the gift, among other territories, of Hainaut and Brabant, and marriage to an English princess.

The development of these stories presents many points that remain unclarified, and Ogier's surname (the Dane), in particular, has not been satisfactorily explained (the *chansons de geste* make him the son of Gauffrey, king of Denmark). Ogier's adventures, however, became the subject of many medieval literary works. The third branch of the Norse *Karlamagnús saga*, the *Saga af Oddgeiri danska*, closely follows the narrative of *La Chevalerie Ogier*, but with greater order and concision. Ogier, called Otger Catalon, appears in stories describing the conquest of Catalonia. Under the name of Danés Urgel or Urgero, brother of the king of Dacia, he appears in three Castilian romances which were so popular in Spain that they were used by Lope de Vega in *El Marqués de Mantua*, written before 1604—a work of which Jerónimo de Cáncer's *La Muerte de Baldovinos* (1652) was a parody. In England, a later romance in alexandrines (British Museum Manuscript Royal 15 E VI) added supernatural elements derived from Celtic sources; the prose romance printed in Paris in 1495 was a version of this poem. In Italy this supernatural element was introduced

into stories of the hero's youth as well as of his manhood. The English romance is the basis of a poem in 47 cantos, *Uggeri il Danese*, several times reprinted between 1498 and 1638, as well as of a prose version; the French version is developed in a transcription in Franco-Italian, as well as in a Tuscan version of which there exist both a prose text and a text in *ottava rima*.

See also CHANSONS DE GESTE; CHARLEMAGNE LEGENDS; ROLAND, CHANSON DE.

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OGILBY, JOHN (1600–1676), British poet, translator and printer, a pioneer in the making of road atlases, was born in or near Edinburgh in Nov. 1600. His early career, as dancing master, tutor to the children of the earl of Strafford, with whom he went to Ireland (1633), deputy master of the Irish revels and successful proprietor of a Dublin theatre, ended when his finances were ruined by the outbreak of the English Civil War. Returning to England, destitute, he learned Greek and Latin and published translations of Virgil (1649), *Homer His Iliads* (1660) and *Homer His Odysses* (1665). At the Restoration, he won favour with Charles II and was entrusted with "the poetical part" of the coronation.

He returned to Ireland, where he opened another theatre, but subsequently settled in London and after the Great Fire of 1666, when he lost his property, was employed in surveying disputed [illegible] He set up as a printer with the title of "king's cosmographer and geographic printer" and produced many [illegible] for their typography and illustrations. His [illegible] . . . *a Geographical and Historical Description of the Principal Roads* (1675), which formed part of a projected world atlas, was based on his own journeys on foot, and was a landmark in accurate description of the country's roads. The maps were printed on strips, the first time this method had been used [illegible] He died in London, Sept. 4, 1676.

OGLETHORPE, JAMES EDWARD [illegible] British [illegible] gave him the [illegible] the poor [illegible] for such a colony in Georgia and arranged for the organization and financing of the undertaking. In 1733 he [illegible] In 1743 on his [illegible] he took part in the campaign against the Jacobites, but his slackness in pursuit of the retreating [illegible] brought him into disfavour with the duke of Cumberland [illegible] was tried by court-martial but acquitted. He then [illegible] liamentary career and saw no further active military [illegible] was promoted general in 1765 and became a prominent [illegible] in London and one of the friends of Dr. Johnson. He [illegible] Cranham hall, Essex, in 1785.

See A. A. Ettinger, *James Edward Oglethorpe* (1936). [illegible]

OGOOUÉ (OGOWE), a river of west central Africa, [illegible] almost its entire course through the Gabon Republic [illegible] Republic of Congo (formerly Middle Congo) on the [illegible] of the Chaillu range and enters the Atlantic south [illegible] It is about 970 km. (603 mi.) long and drains a basin [illegible] 85,000 sq.mi. At first it is a plateau river, but later [illegible] a valley which, in some places, spreads out into plains [illegible] river branches and, in others, narrows between escarpments [illegible] the Ogooué crosses the harder outcrops in a series of [illegible] way it flows from one basin to another, like that [illegible] upstream from the confluence of the Mpassa, and that [illegible] ville through which the Lolo also flows, parallel with the [illegible] before joining it. Below its meeting with the Ivindo the [illegible] turns westward and its course becomes more varied. [illegible] ing the Faré falls it forms a series of great rapids down [illegible] from its junction with the Ké and then divides into [illegible] are also broken by rapids as far as Ndjolé. Between [illegible] Ndjolé it is joined by the Offooué and the Okano. [illegible] it soon leaves the massif and crosses the lower G[illegible] ing joined by its chief tributary, the Ngounié, which [illegible] from the Chaillu range, above Lambaréné. [illegible] despite sandbanks, it is always navigable, its level [illegible] by Lac (Lake) Azingo to the north and lakes Onangué [illegible] to the south. A delta, formed chiefly of deposits [illegible] south by the cold Benguela current, spreads north of the main course.

The Ogooué has two flood seasons: March–June and [illegible] portant, November–December. Its average flow is 185,0[illegible] per second and it has plenty of water even during the low [illegible] August–September. It was formerly considered the [illegible] means of penetrating the interior from the Gabon coast. [illegible] person to explore the valley of the Ogooué was [illegible] (1857–59).

O'GRADY, STANDISH JAMES (1846–1928), [illegible] of letters, whose retelling of the Irish heroic [illegible] imagination of W. B. Yeats, T. W. Rolleston, Æ (George Russell) and others, and earned him the title of "father of the literary revival," was born at Castletown, County Cork, [illegible] 18, 1846. He graduated from Trinity college, Dublin. S. O'Halloran's *A General History of Ireland* (1778) [illegible] his interest in Irish antiquity; but it was Eugene O'Curry's *Manners and Customs of the Ancient Irish* (1873) and the author's *Lectures on the Manuscript Materials of Ancient Irish History* (1861) which gave him his first introduction to the heroic and romantic literature of Ireland. In 18[illegible] *Ireland: the Heroic Period* appeared and in 1880 it was [illegible] by *History of Ireland: Cuculain and His Contemporaries* [illegible]

The enthusiasm of Yeats and other young I[illegible] tually found O'Grady a wider audience and a [illegible] and in 1892 he published *Finn and His Companions* [illegible] two years later with *The Coming of Cuculain*. He also [illegible] eral works of historical fiction, of which *The Bog of Stars* and *The Flight of the Eagle* (1897) are prob[illegible] O'Grady's versions of Irish epic have great na[illegible] imaginative power and had a profound influence on Y[illegible] Irish writers of his time. He died at Shanklin, I[illegible] May 18, 1928.

BIBLIOGRAPHY.—Standish O'Grady, *Selected Essays* [illegible] with an introduction by E. A. Boyd (1918); H. A. O'[illegible] *James O'Grady, the Man and the Writer* (1929); P. [illegible] *Bibliography of Books Written by Standish O'Grady* [illegible]

O. HENRY: *see* HENRY, O.

O'HIGGINS, BERNARDO, (1776–1842), [illegible] Chilean independence and the head of its first national [illegible]

[illegible] Aug. 20, 1776, to an Irish father, Ambrosio O'Higgins [illegible] mother Isabel Riquelme at the village of Chillán [illegible] after advanced rapidly in the service of the Spanish [illegible] serving eventually as governor of Chile and viceroy of Peru, [illegible] headed a revolution against royal authority.

[illegible] in England, he read eagerly the revolutionary literature of the time and met various proponents of Latin-American independence, including Francisco Miranda (*q.v.*) of Venezuela. O'Higgins returned to Chile in 1802, he settled on his father's [illegible] in the southern part of the country and became an active [illegible] of a liberal organization which favoured independence. [illegible]'s invasion of Spain, which resulted in the dethronement of Ferdinand VII in 1808, encouraged a revolt in Chile, led [illegible] Martínez de Rozas and enthusiastically supported by [illegible]. Momentarily successful, this initial revolutionary effort [illegible] because of dissension among the patriots themselves and [illegible] opposition from viceregal headquarters in Peru. O'Higgins, who had advanced to the command of the rebel forces, was [illegible] defeated at Rancagua in Oct. 1814.

[illegible] and other patriots then fled over the Andes mountains [illegible] to join with the Argentine revolutionary leader José de San Martín, who planned to establish a base in Chile and then [illegible] the Spanish forces by striking at the centre of royal authority in Peru. This plan, launched in 1817 after careful but [illegible] preparations, was successful. In the course of the operations O'Higgins helped lead the revolutionary forces to victories [illegible] battles of Chacabuco in Feb. 1817 and Maipú in April 1818. [illegible] victories terminated Spanish authority in Chile, and the national independence was proclaimed on Feb. 12, 1819.

[illegible] served as supreme director of Chile, a virtual dictator from 1817 to 1823. Dedicated to the welfare of his country, [illegible] instituted reforms that aroused the opposition of the more [illegible] elements. The Roman Catholic Church objected to [illegible] to Protestants and his efforts to restrict the number [illegible] days. The landed aristocracy objected to his effort to [illegible] entailed estates. The importation of foreign books and the [illegible] on public instead of parochial education likewise drew criticism. Equally unpopular were his attempts to restrict [illegible], gambling and other amusements.

[illegible] opposition was able to force O'Higgins to resign in Jan. 1823. [illegible] the remainder of his life in Peru, where he died on Oct. 24, [illegible] remains were returned to his native land in Jan. 1869.

(W. D. Bz.)

O'HIGGINS, KEVIN CHRISTOPHER (1892–1927), [illegible] prominent in the troubled years following the [illegible] treaty of 1921, was born on June 7, 1892, at Stradbally, [illegible] county, the youngest son of Thomas Higgins. Educated at University college, Dublin, he became articled to his uncle [illegible] Healy, a solicitor in Cork. After the Easter rising in 1916 [illegible] the Sinn Fein movement and was interned. While still [illegible] was elected member of parliament for Queen's county in [illegible] the revolutionary *dáil* ministry set up in 1919 he acted as [illegible] for local government to W. T. Cosgrave. O'Higgins [illegible] the 1921 treaty with England that brought the Irish [illegible] being. He was appointed minister for economic [illegible] provisional government in Jan. 1922, and after the [illegible] Arthur Griffith and Michael Collins he became (1923) [illegible] of the executive council and minister for home [illegible] justice. O'Higgins was a member of the committee appointed [illegible] the constitution of the Irish Free State and he was [illegible] responsible for its passage through the *dáil* (lower [illegible] legislature). He created a new unarmed police force [illegible] Guards, and took strong, even ruthless, measures [illegible] order; his share of responsibility for the execution of 77 [illegible] 1922–23 was neither forgotten nor forgiven. In external [illegible] O'Higgins aimed at a united Ireland within the British [illegible] wealth. He played a prominent part in redefining commonwealth relations at the imperial conference of 1926. During [illegible] acute controversy over the taking of the oath of allegiance [illegible] members of the *dáil*, O'Higgins was waylaid by armed [illegible] on his way to Booterstown church, near Dublin, and [illegible] death (July 10, 1927). O'Higgins, a man of intellectual power and [illegible] were the primary [illegible] W. B. Yeats, who wrote of him as "a great man in the [illegible]" [illegible] IRELAND [illegible] *History*.

See T. de V. White, *Kevin O'Higgins* (1948). (P. N. S. M.)

O'HIGGINS, [illegible] province of central Chile. [illegible] 2,745 sq.mi. and the population in 1960 was 259,700. Named after Bernardo O'Higgins, [illegible] in the war of independence and first president of Chile, the province was formed in 1883, dissolved in 1927 and created again in 1934. Its departments are Rancagua, Caupolicán, San Vicente and Cachapoal.

Most of the western [illegible] O'Higgins lies in the alluvial plains of the central valley, where because of the [illegible] dry season of summer irrigation is required. Water is furnished by streams that have their sources in the snow-capped Andean cordillera. The highlands and the [illegible] support cattle and some sheep. Irrigated pastures are widely used for dairy herds and to ready beef cattle for market. Grapes, wheat, barley, legumes and corn are the principal crops. [illegible] and the provincial capital, Rancagua, pop. (1960) 53,[illegible], are the [illegible] marketing centres for O'Higgins producers.

Rancagua is 51 mi. S. of Santiago on the railroad to Puerto Montt; it is the terminus for a branch line to the intensively farmed Doñihué and Coltauco districts. A second branch line extends westward from near Rengo (10,989), a departmental capital, to serve the smaller administrative and agricultural towns of San Vicente de Tagua-Tagua and Peumo. The paved north-south highway and a number of all-year roads provide the province with good transportation facilities. There are mineral spring resorts at Termas de Cauquenes, southeast of Rancagua, and at Cachantún, southwest of the city. Rancagua, founded in 1743, is the site of a famous battle (Oct. 1–2, 1814) in the war of independence. Among its industries are the shops and foundry of the copper company, grain mills and a glass factory. Rengo manufactures matches and hardware. El Teniente, the second largest copper mine in Chile, is also located in the province. (J. T.)

OHIO, a north-central state of the United States, is bounded on the north by Michigan and Lake Erie, on the east by Pennsylvania and the Ohio river, the [illegible] boundary of the river separating Ohio from West Virginia and Kentucky, and on the west by Indiana. [illegible] is measured by its dimensions [illegible] mi. and [illegible] mi. Its area of [illegible] sq.mi. in Lake Erie and [illegible] sq.mi. of inland water surface. [illegible] Although [illegible] Ohio [illegible] first to be carved from the Northwest territory [illegible] "Buckeye state" [illegible] cardinal and the [illegible] the state flag [illegible] burgee shape [illegible]. The great seal of the state of Ohio [illegible] in the background, and [illegible] in the foreground.

PHYSICAL GEOGRAPHY

Physical Features.—Like its [illegible] Ohio's topography is a composite. [illegible] between [illegible] N. lat. and between [illegible] W. long. The [illegible] of the great glaciers of the Ice Age was largely responsible for Ohio's physical [illegible] as the ice sheets spread over the state [illegible] and created a flat or gently rolling surface noted for its fertility. The southeast, beyond the glaciers' penetration, is characterized by steep elevations, deep valleys and [illegible]

Much of this section has been relatively unexploited.

Its singular location endowed Ohio with the characteristics of three different physiographic provinces—the Lake plains, the Central plains (or central Lowland), and the Allegheny plateau. The juncture of the three sections is near Cleveland, but the last two abut approximately through the centre of the state, north to south. The Lake plains area, encompassing northwest Ohio and a strip along the Lake Erie coast, was once entirely under water. It emerged monotonously flat and swampy, and not until drainage projects were successfully undertaken in the late 19th century could its fertile soil be used to good advantage. The Central plains embrace the western and southwestern counties. Having undergone much erosion prior to the coming of the glaciers, this area was consequently rather uniformly covered by the vast ice sheets, creating a comparatively level surface with soil of considerable depth. To the east, the Allegheny plateau includes both glaciated and unglaciated areas. The counties lying south of the terminal moraine (the limit of the glaciers' advance) lack the arable soil and the extensive pasture lands of the counties of the north and west. On the other hand, the unglaciated regions offer rugged and spectacularly beautiful terrain noted especially for caves, precipitous valleys and breath-taking rock formations.

Ohio's average elevation above sea level is approximately 850 ft. The extremes, both of which occur in the Central plains, are 1,550 ft., near Bellefontaine, and 433 ft., on the Ohio river bank near Cincinnati. Most of the state rises to between 550 and 1,300 ft. in elevation.

A notable topographical feature of Ohio is the watershed which traverses the state from the middle of the western boundary to the northeast corner. Above the watershed, rivers flow north into Lake Erie. They are short and their courses are not parallel. Below it, the rivers flowing south to the Ohio river are about three times as long as their counterparts to the north, and they drain about 70% of the state's surface. Several gaps in the divide facilitated the development of transportation and, with the aid of easy portages, made possible important north-south water routes employing the Maumee and Miami rivers, the Sandusky and Scioto rivers, and the Cuyahoga-Tuscarawas and Muskingum rivers. Of lesser significance are the Huron, Vermilion and Black rivers in the north, the Olentangy, Licking, Hocking and Little Miami in central and southern Ohio, and the Grand and Mahoning in the east. The Ohio river flows for about 435 mi. through a narrow valley along southeastern and southern Ohio but it is not legally within the boundaries of the state. At various times the Ohio and some of the interior rivers have overflowed their banks, causing disastrous floods. So great a catastrophe occurred in 1913, especially at Dayton, that Ohio took steps to prevent a recurrence of the tragedy by establishing the Miami conservancy district (and later the Muskingum conservancy district). The 1914 law authorizing this action, which consisted basically of constructing a series of dams to control streams in their upper reaches, was the first of its kind in the United States. The federal government built 19 dams on the Ohio river which have also substantially reduced the flood threat. A few serious floods have occurred since 1913 but their effects have been greatly mitigated by the existence of the dams.

Excellent natural harbours have helped to make Toledo, Sandusky, Lorain and Cleveland important lake ports. In the state are more than 100 lakes exceeding 40 ac. each in size. Twenty-seven of these are natural while the rest were man-made, some of them constructed originally as canal reservoirs. The latter include 16,000-ac. Lake St. Marys (Grand Reservoir), Lake Loramie, Indian lake and Buckeye lake.

Climate.—The principal characteristics of Ohio's climate are its changeability and its extremes of temperature. The result is a seasonal variation which to some extent compensates for extremes of heat and cold, high humidity and the like. The average annual temperature is a moderate 51.2° F., with the northern section at 49° about 6° lower than the southern. In the summer, of which July is usually the hottest month, the temperature averages 71.6°, and in the winter 29.8° with January customarily coldest. The recorded extremes of −39° at Milligan in Feb. 1897, and of 113° near Thurman in July of that year and at Gallipolis in July 1934, are seldom closely approached, but it is not uncommon for the temperature to vary as much as 100° within a year. Precipitation, averaging about 38 in. per year, is slightly heavier in the summer. The 21-in. average for the six months commencing April 1 exceeds that of the rest of the year by 4 in. The south receives 44 in. of rain, snow, etc. in an average year as compared with 32 in. in the north. The average annual snowfall presents a greater contrast; only 15 in. in the southern counties, it reaches 40–45 in. in the northern, producing a state-wide average of 27.8 in. Farmers usually can expect a growing season of 150–180 days, with those close to Lake Erie enjoying nearly 200 frost-free days.

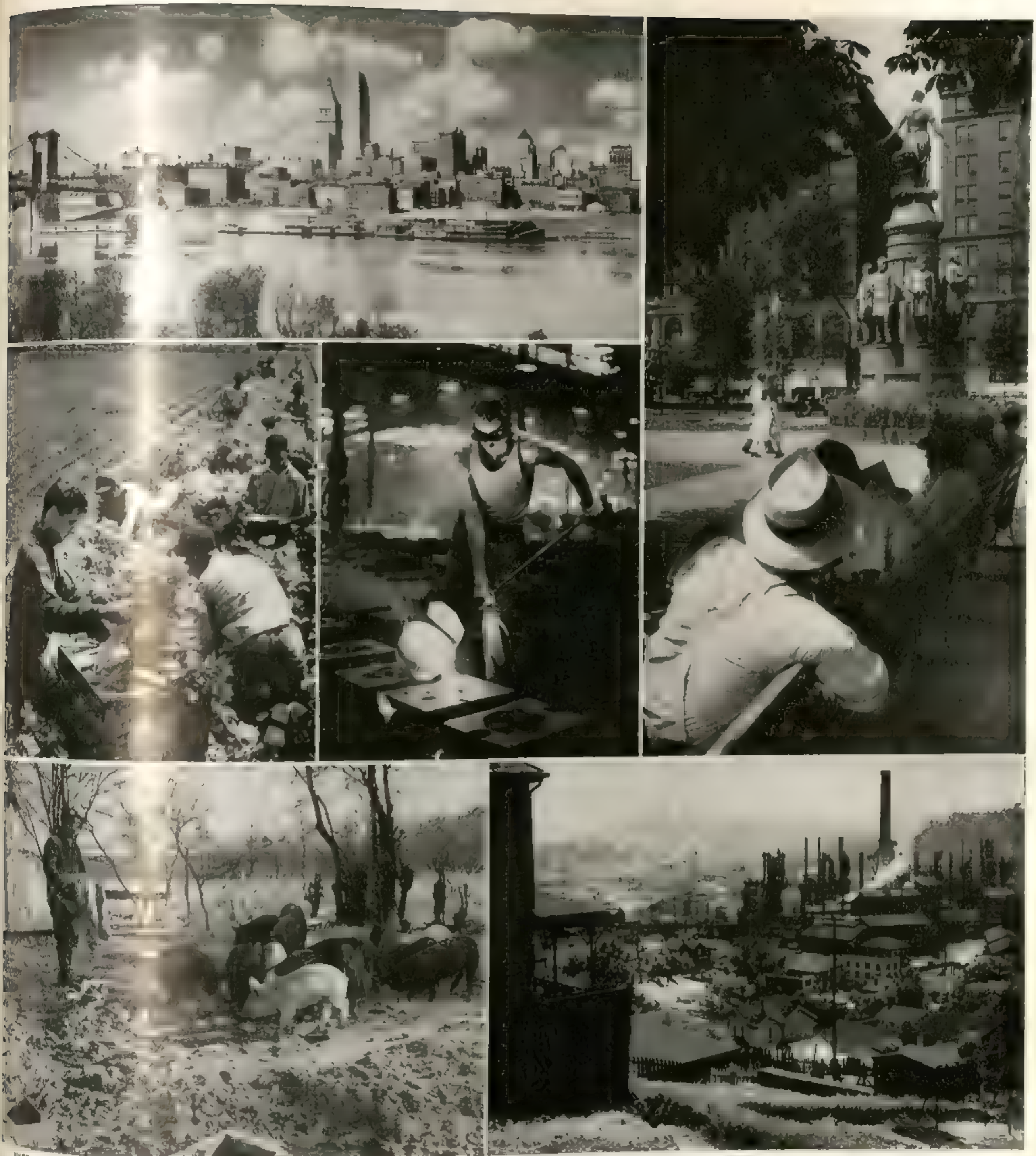
Soil.—The nature and quality of the soil differs markedly between one section of the state and another. The southeast, which was deprived of the deep and fertile drift deposited by the glaciers and in which the soil is largely residual sandstone and shale, is the least arable and productive. The glacial sandstone soil of central and northeastern Ohio supports some general farming but is best suited to grazing and pasture lands for the important dairy industry. The soil of the lower two thirds of the western half of the state, composed principally of glacial limestone, is the richest of all. To the north lies the second most prosperous agricultural area. There, after the vast swamps had been drained, the limestone soil was found to be highly productive.

Vegetation.—Dense forests formerly covered nine tenths of Ohio. Early explorers and woodsmen, as well as the first generation of settlers, literally disappeared from view after they crossed the Ohio river. So thick were the trees that for many years wisps of smoke rising here and there through the leafy overhead were the only visible signs of habitation. The most prevalent types were beech, oak, hickory, maple and chestnut, with others, especially pine, elm, ash and buckeye, occurring in smaller numbers. The forests which yielded the timber for buildings and furniture, fences and fuel, at the same time presented a serious obstacle to the settler's search for a livelihood through farming. Countless trees were burned to clear the land. Some of these have been replaced by second-growth trees, of which the commonest are oak, hickory, white elm, ash, beech, maple, willow, sycamore and yellow poplar. Most of the approximately 15% of Ohio that is woodland is set aside in protected preserves. Twenty of these are state forests, of which 35,000-ac. Shawnee State forest near Portsmouth is the largest. In addition to trees, both wild and domesticated flowers thrive throughout the state.

Animal Life.—Although some animals and birds common to Ohio as recently as the 19th century have since become extinct, at least 60 species of wild animals and about 175 species of songbirds still occur in significant numbers. Most of the animals are small—*e.g.*, rabbits, squirrels, foxes, raccoons, opossums and skunks—but there have been increasing numbers of some larger animals, including deer. Represented among the songbirds and birds of prey are most of those normally found in the temperate zone. So abundant are the 170 kinds of fish, among them bass, trout, pike, perch and muskellunge, that Ohio became the first state to remove all restrictions on fishing as to season and number and size of fish caught.

Parks.—Ohio has two national monuments: Perry's Victory monument at Put-in-Bay and the 68-ac. prehistoric Mound City group north of Chillicothe. State parks include historic, archaeological and natural history sites administered by the Ohio Historical society, as well as recreational facilities under the department of natural resources and the highway department.

Historic Sites and Museums.—Many historic sites are preserved and maintained by historical societies or other organizations. Stressing variously exhibit museums, historic buildings, research libraries and publications, numerous counties support historical societies, of which the best-known are those of Ross, Allen, Stark and Lucas counties. Of regional significance are the Western Reserve Historical society at Cleveland and the Historical and Philosophical Society of Ohio at Cincinnati. The state-supported Ohio Historical society has headquarters at the Ohio State museum at Columbus. The museum itself houses exhibits and extensive collections related to Ohio history, archaeology and natural



PHOTOGRAPHS, (TOP LEFT, LONGLEY, (TOP RIGHT) TOM O REILLY, (CENTRE LEFT) JOE MUNROE, (CENTRE, BOTTOM LEFT) PAUL S. SOMOGYI, (BOTTOM RIGHT) CARL MANSFIELD

VIEWS OF OHIO

Top left: Business district of Cincinnati, Ohio's second largest city, seen from the Kentucky side of the Ohio river

Top right: My Jewels monument on the state house grounds at Columbus. Bronze figures of Ohio statesmen and soldiers surround the base of the monument; mounted on top is a statue of Cornelia, the Roman matron

Centre left: Harvesting celery on a truck farm near Cleveland, O. Although the state's chief agricultural products are cereals and grains, it has a large fresh vegetable crop and ranks among the leaders in celery production

Centre: Pouring a lamp base at an Ohio metal company. Diversification has been an important factor in Ohio's industrial development and there are many small manufacturing centres throughout the state

Bottom left: Feeding shoats on an Ohio farm. A large percentage of the state's agricultural income is derived from livestock and poultry products

Bottom right: Mingo Junction, a steel mill and coal mining city. Iron and steel are Ohio's chief manufacturing industries

OHIO

SCENES IN OHIO

Top left: Winter sunset over the Maumee river near Toledo

Top right: Schoenbrunn memorial state park, an authentic restoration of the first village in Ohio settled in the late 18th century by David Zeisberger as a home for his Moravian missions

Centre right: A typical Sunday scene in Holmes county, centre of the second largest Amish settlement in the United States

Bottom left: Taft House museum, a gift of the Taft family to the city of Cincinnati, contains a collection of fine arts

Bottom right: Epworth Euclid church in Wade park. The area surrounding the lagoon includes the Cleveland Fine Arts garden

[illegible] and a specialized research library of more than 1,000,000 [illegible], books, periodicals, newspapers and maps. There [illegible] the *Ohio Historical Quarterly* and other peri[illegible] leaflets and books. The society administers 60 properties [illegible]out Ohio, including the birthplaces or residences of Thomas [illegible]on at Chillicothe, William T. Sherman at Lancaster, [Ruth]erford B. Hayes at Fremont, Ulysses S. Grant at Point Pleas[ant, Benj]ain R. Hanby at Westerville, and Paul Laurence Dun[bar at] Dayton. "Adena" at Chillicothe, "Glendower" at Lebanon, [the] McCook house at Carrollton are interesting architectural [illegible]. Reconstructed Schoenbrunn village and Gnadenhutten [illegible] pay reverent tribute to the Moravian missionaries and [their] Indian converts. The Indian wars are commemorated at [Forts] St. Clair, Jefferson, Recovery, Meigs and Miami and at the [site of] the battle of Fallen Timbers. Other historical state memo[rials ran]ge from the Friends' Yearly meetinghouse at Mount Pleas[ant to] the site of the battle of Buffington Island (July 19, 1863). [In addit]ion to the famous glacial grooves on Kelleys Island, the [natural] history areas include Cedar Swamp, Fort Hill and Flint [illegible]. Prominent among the archaeological sites are Ft. Ancient, [the] Serpent mound, Newark earthworks and Inscription rock on [Kelleys] Island.

The state is unique in the diversity of museums devoted to [transpor]tation. Automobiles are featured at the Thompson Auto[mo]tive museum at Cleveland (besides private collections), aircraft [at] the Air Force museum at Dayton, steamboats and other river [craft] at the River museum at Marietta, lake vessels at the Great [Lakes] Historical society's Wakefield museum at Vermilion, and lo[comot]ives, interurbans and streetcars (some operating over nearly [illegible] of track) at the Ohio Railway museum at Worthington.

HISTORY

Prehistory.—In Ohio have been found identifiable remains of [illegible] migrants who developed a culture known as the Archaic ([see] ARCHAEOLOGY: *Anglo-America: Archaic*). Dwelling prima[rily] along rivers, these people appeared in the western hemisphere [some] 5,000 to 7,000 years ago. They led a sedentary life and [produce]d artifacts fashioned from bone, shell, flint and antler, [but] did not engage in agriculture and made little pottery. Archaic [man] was the first of a series of prehistoric peoples whose occu[pation] of the Ohio region has been conclusively established. The [illegible] succeeding groups have been designated the Adena, Hope[well and] Fort Ancient cultures. From 1901 when the Adena cul[ture] was first discovered near Chillicothe, many other examples [have] been located in the state. Intensive study of such evidence [has ena]bled archaeologists and anthropologists to construct a re[veal]ing picture of the Adena people. They had flat heads, deliber[ately f]ormed in infancy, but they were more robust than their [illegible] predecessors. That they possessed more artistic skill is [evident] in the pottery and in the copper and mica ornaments [they] made. They cultivated certain vegetables, constructed cir[cular] dwellings and erected burial mounds which have inspired for [them] as well as for other prehistoric peoples the name Mound [Builders]. The Adena culture can be traced to as early as 800 B.C. [The t]erminal date for the Adena culture is A.D. 800, while the ex[tent of] the Hopewell culture which followed it range from [illegible] to A.D. 1500. The Hopewell Indians not only hunted, [illegible] and traded with other peoples, but they made and [placed] in their mounds exquisitely carved pipes and expertly [fashione]d ornaments of mica, copper, pearl and shell. The most [striking evi]dence of their culture outside of museums is the number [of re]markable effigy mounds and other earthworks they con[struct]ed. Among those still standing are Ft. Ancient in Warren [county] [and] the Newark earthworks in Licking county. (See also [HOPE]WELL; MOUND BUILDERS.)

The Hopewell people represented the apex of prehistoric cul[tural at]tainment in the Ohio valley. When they disappeared, they [illegible] Indians about whom surprisingly little is known [illegible] designated Late Woodland. For [illegible] years or [illegible] the arrival of European explorers in the Ohio re[gion] [illegible] surviving into the historic period, a people [called Fort] Ancient occupied parts of Ohio. This name has given rise to considerable confusion because the Ft. Ancient earthworks, as mentioned above, were actually built by the Hopewell and not until later occupied by the so-called Fort Ancient people. One well-supported theory is that the Shawnees were immediate descendants of the Fort Ancient group.

The French and British, upon penetrating the Ohio valley, found Indians representing four major tribes and several lesser ones. Dominating the region were the Miamis, Shawnees, Wyandots and Delawares, but they shared the scene to some extent with the Eries, Ottawas, Tuscaroras and Mingoes, or Senecas. These tribes produced some of the most famous American Indian warriors and statesmen, among them Tecumseh, Blue Jacket and Cornstalk (all Shawnee); Tarhe the Crane (Wyandot); Little Turtle (Miami); Buckongahelas (Delaware); and Pontiac (believed by some to have been an Ohio-born Ottawa). The Indians, who numbered a probable maximum of 15,000 in Ohio in the mid-18th century, resisted white settlement. Their opposition decreased after their defeat in the battle of Fallen Timbers (1794). Most tribes had departed from Ohio well before the final exodus of the Wyandots in 1842.

Exploration and Settlement.—A young Frenchman, René Robert Cavelier, sieur de La Salle, is generally acknowledged to have been the first white man to explore the Ohio country. La Salle set out from his estate near Montreal in 1669 to journey into the country south of Lake Erie. This exploration provided the basis for a French claim to the Ohio valley which was hotly contested by Great Britain through much of the following century. British assertions of ownership, as time went on, were predicated upon the increasing activity of traders. By their royal charters, which were sometimes contradictory, several colonies were granted all or part of this region. Virginia, for example, laid claim to a fan-shaped area stretching to the Pacific ocean and encompassing all of the Ohio country. Pennsylvania's charter, on the other hand, [illegible] part of the Ohio country as being under that colony's jurisdiction. The French and British competed not only for control of the land but also for the favour of the Indians. In [illegible] France took the initiative by sending Pierre Joseph de Céloron de Blainville down the Ohio river, along which he buried, at intervals, lead plates claiming French ownership. He returned to the St. Lawrence by way of the Great Miami and Maumee rivers and Lake Erie. His journey had little practical effect, however, and English traders continued their operations there. Moreover, a Virginia group known as the Ohio company in [illegible] sent Christopher Gist, a veteran woodsman and trader, into and across Ohio to the Miami river town of [illegible]. The diary Gist wrote, which has come to be regarded as one of the most important [illegible] early Ohio, provided the information his employers sought relative to the nature of the country and the Indians. His mission also aroused the [illegible] of the [illegible] traders and [illegible] of the Indians who were apprehensive of white interest in their lands. The [illegible] French rivalry grew more [illegible] during the [illegible] dispatched from Virginia in 1753 and [illegible] by George Washington [illegible] French [illegible] through the Ohio valley. Governor Dinwiddie ordered [illegible] on the site of present Pittsburgh (Feb. 1754). [illegible] French forces [illegible] Ft. Duquesne. A de[tachment of French s]oldiers was surprised and captured at Great [Meadows by Virginia troops under] Washington's command [illegible] shortly thereafter [illegible] to surrender to a larger force [illegible] the French [illegible] of the Ohio valley. This series of events [illegible] the French and Indian War [illegible]. The British [illegible] the opposition of the French and their Indian allies [illegible]. By the terms of the treaty of [illegible] France [illegible] to England its claims to Canada and the eastern half of the Mississippi valley. One of the decisive events of the war had been the [illegible] Ft. Duquesne which the British renamed Ft. Pitt for William Pitt whose brilliant statesmanship was partly responsible for the ultimate victory.

Although the French threat in eastern North America had been

removed, the Indians in this territory continued to pose a serious problem. Uniting under the leadership of the Ottawa chieftain, Pontiac, they launched a campaign in 1763 which resulted in the capture of several forts and which was broken finally by the successful defense of Detroit and Ft. Pitt. In the following year the appearance of Col. Henry Bouquet with 1,500 men at the site of present Coshocton so impressed the Indians that they agreed to terms and released more than 200 captives, some of whom had been prisoners since childhood. Anxious to prevent further trouble with the Indians and to deter the expansion of the American colonies, England issued the Royal Proclamation of 1763 forbidding settlement west of the Alleghenies. This and other acts and policies during the next decade contributed to the resentment which culminated in the American Revolution. The victory of the colonies brought not only recognition of independence but also theoretical possession of the lands east of the Mississippi. It remained for physical control to be asserted. Although not a major battleground during the American Revolution, the Ohio country was caught up in the maelstrom of Indian raids against Kentucky and Pennsylvania and retaliatory forays by Americans. It is a tragic footnote to history that the greatest atrocity of the war (and one of the most brutal massacres of all time) was perpetrated in Ohio by Americans. The Moravian Brethren, led by David Zeisberger, John Heckewelder and others, had been active in the 1770s in bringing Christianity to the Ohio Indians, primarily the Delawares. They established missions which became small Christian Indian villages, the original one in 1772 being Schoenbrunn, near present New Philadelphia (*q.v.*). Because of their pacifism and neutrality, these Indians were viewed with suspicion by both the Indians who sided with the British and the American frontiersmen. At length the converts were removed to the Sandusky region and made virtual prisoners of the Wyandots living there. Facing starvation, however, a group of them was permitted to return to the Tuscarawas river in northeastern Ohio to gather the corn they had abandoned in their fields. They were so engaged on March 7, 1782, when Capt. David Williamson and about 90 volunteer militiamen, mostly from the Pittsburgh area, arrived on the scene. Seeking revenge for recent depredations committed by other Indians, the Pennsylvanians held a kangaroo court and decreed death for the innocent Indians. The next morning, at the settlement of Gnadenhutten, the prisoners were led from their cabins in pairs and slaughtered in cold blood. Only two boys escaped the fate that befell 62 adults and 34 children. As two leading authorities on Ohio history have expressed it, "the murder by a band of frontiersmen, supposedly Christians, of a group of noncombatant neutrals who had been taught to regard nonresistance as a Christian virtue is almost without parallel" in the annals of warfare. (E. H. Roseboom and F. P. Weisenburger, *A History of Ohio*, new ed. [1953], courtesy The Ohio Historical Society.) Although Cornwallis had surrendered at Yorktown six months earlier, this massacre touched off what became known as "the bloody year" in the Ohio country. Of the incidents that followed, perhaps the most memorable was the capture of Col. William Crawford who had been elected by popular vote to carry the fight into the interior of Ohio. His command included many of Williamson's men whose presence aroused the Indians. The latter not only repelled the invasion but also captured Crawford whom they tortured unmercifully and burned at the stake in June 1782. The end of hostilities, though not the end of Indian resistance, came six months later.

The Northwest Territory.—Great Britain's cession of the area south of the Great Lakes and east of the Mississippi left the U.S. government faced with the complicated problem of providing for systematic settlement and administration. The situation was further muddled by the conflicting claims laid by several of the individual states upon the region (the Northwest territory, as it was to be designated, or, more formally, the Territory Northwest of the River Ohio). The other states demanded that title to these lands be transferred to the national government before they would agree to ratify the Articles of Confederation in 1777. New York was the first to comply, in 1780 (its claim was the most tenuous), followed by Virginia in 1784, Massachusetts in 1785 and Connecticut in 1786. Certain small areas were reserved, however, to be granted to war veterans, principally the Virginia military tract in southern Ohio and Connecticut's Western Reserve in the northeast. Two legislative measures of fundamental importance completed the foundation for the development of Ohio. These were the Land ordinance of 1785, establishing a system of surveying the land into six-mile square townships, and the Ordinance of 1787 (the Northwest ordinance), providing that a territorial government would at first administer the region, which would ultimately enjoy representative government and finally be divided into at least three but not more than five states. The pattern of settlement that followed gave Ohio a rather conglomerate population. From New England came members of the second Ohio company (*q.v.*), recently formed, who disembarked at the confluence of the Ohio and Muskingum rivers in April 1788, and founded Marietta, the state's oldest permanent settlement. This became the seat of the territorial government with the arrival three months later of Gen. Arthur St. Clair, the first governor of the Northwest territory. New Englanders, largely from Connecticut, also settled the Western Reserve, beginning with Cleveland in 1796. Meanwhile, Judge John Cleves Symmes of New Jersey headed a combine which secured a grant of approximately 250,000 ac. on the Ohio river between the Great Miami and Little Miami rivers. Cincinnati (1789) was destined to become the most important settlement in the so-called Symmes purchase. To the Virginia military tract, lying between the Scioto and Little Miami rivers, came growing numbers of Virginians, founding first Massieville in 1790, then Chillicothe in 1796 and ultimately other towns. This district would soon achieve great prominence in the development of Ohio. In addition to these relatively large groups of settlers, Ohio was peopled by Kentuckians from across the river, Pennsylvanians who moved westward, and even a sizable band of French citizens, who landed on the bank of the Ohio in 1790 and found a primitive wilderness instead of the promised civilized metropolis; they adapted to the rigorous conditions and carved out the town of Gallipolis (*q.v.*).

The treaty of Paris in 1783 removed neither of the menaces confronting Americans in the northwest. The British refused to withdraw their troops from the forts at Detroit, Sandusky, Michilimackinac and other posts on American soil. Their justification rested upon the nonpayment of private American debts to English merchants in accordance with the terms of the treaty. Continued occupancy of the forts was much to their advantage since it gave them control over the lucrative fur trade as well as the Indians who already were hostile toward the westward-moving Americans. The British finally evacuated these posts as a result of the treaty negotiated by John Jay in 1794, but by that date the Indian threat had been disposed of by the use of American arms.

Treaties made before 1790 with various more peaceful tribes were of little avail, for the bellicose Shawnees and others contended that no pact was binding unless acceptable to all the tribes. The increasing audacity of the Indians in their raids against the settlers prompted congress in 1790 to authorize the president to send the militia from Virginia, Kentucky and part of Pennsylvania to Ft. Washington at Cincinnati to launch a punitive campaign. In that year Gen. Josiah Harmar led a poorly trained and ill-equipped army as far as the site of present Fort Wayne, Ind., burning several Indian villages, but a third of his force was routed in encounters with the enemy. Harmar was exonerated personally but he was superseded in command by Gov. St. Clair in 1791. St. Clair had partially executed his plan of erecting a series of forts between the Ohio river and Lake Erie when at dawn on Nov. 4, 1791, Indians led by Little Turtle attacked without warning and decimated St. Clair's garrison. The assignment went next to Maj. Gen. Anthony Wayne, a Revolutionary War hero who had later fought the Creeks in Georgia. Wayne arrived at Cincinnati in the spring of 1793 with 2,500 men. Determined to instill discipline and to prepare his men for frontier fighting, he trained them for months before moving northward late in the year. While wintering at the newly erected Ft. Greene Ville, Wayne ordered construction nearby of another stockade, which was to be called Ft. Recovery, upon the site of St. Clair's defeat. When the British

rebuilt Ft. Miamis in 1794, Wayne countered with a new fort, appropriately named Defiance, at the junction of the Auglaize and Maumee rivers. A decisive battle put an end to the Indian menace in Ohio and opened the land to settlement. At Fallen Timbers, a site above the present city of Maumee, where numerous trees, toppled by a hurricane two years earlier, afforded the Indians effective cover, Blue Jacket waited with more than 2,000 warriors. There in less than one hour on Aug. 20, 1794, the issue was resolved, for Wayne's thoroughly trained force charged through the brush, broke the Indians' left flank and left them demoralized and beaten. Further resistance was halfhearted and ineffectual, and on Aug. 3, 1795, more than 90 Indian leaders met with Wayne and other representatives of the United States and signed the treaty of Greenville. By its terms hostilities ceased and the Indians surrendered all of the territory east and south of a line extending from the Ohio river opposite the mouth of the Kentucky north to Ft. Recovery, east to a point above Ft. Laurens, and north to Lake Erie. This treaty, a milestone in the nation's early history, was honoured by the vanquished Indians until Tecumseh went on the warpath in the War of 1812. The Indian capitulation, coupled with the provisions of Jay's treaty, at long last gave the United States actual as well as nominal jurisdiction over land it had owned since 1783. In the next quarter of a century the Indians relinquished, either by cession or by sale, the remainder of their lands in Ohio.

Statehood.—Wayne's victory so expedited immigration into the Northwest territory that Ohio's population had reached 45,365 by 1800. Meanwhile, in accordance with the Ordinance of 1787, representative government had been achieved in 1799. The lower house of the legislature consisted of 22 elected members, 15 from the counties which would ultimately become Ohio and the others from the rest of the territory. From the names submitted by the lower house, Pres. John Adams chose five to constitute the council, or upper house. St. Clair continued as governor with curtailed authority, and the first territorial delegate to congress was William Henry Harrison. Since the population requirement for statehood was only 60,000, attainment of this goal, although it was opposed by St. Clair, appeared imminent. St. Clair's determination to forestall Ohio statehood stemmed in part from his Federalist beliefs as opposed to the strong Republican tendencies prevailing among the people of the territory. He proposed a division of the territory through the Scioto valley, the stronghold of Republicanism, with seats of government at Marietta and Cincinnati and a third probably at Vincennes. St. Clair's plan was doomed, for the pro-statehood faction, led by Thomas Worthington and Edward Tiffin of Chillicothe, former Virginians, enlisted the support of Pres. Thomas Jefferson, and congress passed an Enabling act, signed by him April 30, 1802. The 35 delegates to Ohio's first constitutional convention met at Chillicothe on Nov. 1 and after only 25 days emerged with an instrument of government for the new state. The legislature convened for its initial session on March 1, 1803, the year usually regarded as the one in which statehood was actually achieved. Because it had never been so designated officially, however, the U.S. congress by joint resolution in 1953 (Ohio's sesquicentennial year) declared March 1, 1803, to be the date of Ohio's admission as the 17th state of the union. The Jeffersonian Republicans dominated the new government, with Tiffin becoming the first governor and Worthington joining John Smith of Cincinnati as the first Ohioans to sit in the U.S. senate. Jeremiah Morrow of Warren county was Ohio's lone representative in the house for five consecutive terms. The state government was established at Chillicothe, where the new state house was the first public building constructed of stone in Ohio. Apparent political chicanery moved the capital to Zanesville from 1810 to 1812. It returned to Chillicothe in the latter year but was permanently located in 1816 in the centrally located, newly platted town of Columbus.

Ohio's early history is studded with noteworthy events, some to be recalled in later years with greater pride than others. The strange and seemingly nefarious scheme of Aaron Burr, the discredited former vice-president, inspired great excitement in 1806. Using Blennerhassett Island in the Ohio river below Marietta as a base of operations, Burr mustered a small expeditionary force which aroused the suspicions of the state government. The militia was called out and boats and supplies were confiscated. The Virginia militia wrecked Harman Blennerhassett's island mansion but Burr had moved on to the southwest; he was eventually returned and tried for treason.

The War of 1812.—Ohio's geographical position gave it a degree of importance in the War of 1812. Indignant over Gen. William Hull's ignominious surrender of Detroit to the British in 1812, forfeiting control of Lake Erie and the Michigan country, and over Gen. James Winchester's disastrous defeat at the Raisin river (Monroe, Mich.) in Jan. 1813, Ohioans turned to Gen. William Henry Harrison for a restoration of American prestige. Harrison had added to his public stature two years before by a foray at Tippecanoe creek (Indiana) against Indians united under Tecumseh who, however, was absent at the time. In 1813 Harrison successfully endured a British siege of Ft. Meigs at the mouth of the Maumee river and Maj. George Croghan with one cannon and 150 men withstood an enemy assault upon Ft. Stephenson on the Sandusky river, but it was still impossible to mount an offensive until control of Lake Erie could be wrested from the British. This was accomplished in Sept. 1813, by the victory of Oliver Hazard Perry's small fleet at the battle of Lake Erie, off Put-in-Bay. Harrison pursued the advantage by invading Canada, where he registered a decisive conquest in the battle of the Thames a few weeks later. The death of Tecumseh in this battle signaled the end of the Indians' organized support of the British, and the United States controlled the west throughout the balance of the war.

The fledgling state, suffering the effects of the postwar depression, attempted to tax the Bank of the United States out of existence in Ohio in 1819. Despite the precariousness of its position because of the U.S. supreme court's affirmation of the bank's constitutionality in *McCulloch* v. *Maryland*, Ohio imposed an exorbitant tax. The case was eventually argued before the supreme court by some of the most brilliant lawyers of the day. The 1824 decision upholding the bank in *Osborn* v. *Bank of the United States* ended Ohio's venture into the field of nullification, but by that time the issue had lost much of its practical significance.

Internal Improvements.—A more judicious remedy for the economic hardships of the time (although some questioned its wisdom also) was the launching of an extensive canal system within the state. An ardent leader in the movement for internal improvements, Gov. Ethan Allen Brown (1818–22) crystallized favourable sentiment and badgered the general assembly into establishing a canal commission. He served on this commission and later on the canal fund commission which negotiated loans and disbursed money during the period of construction. Brown's role was so important that he became known as the "father of the Ohio canals," a title sometimes also bestowed upon Alfred Kelley who supervised much of the actual digging. Gov. DeWitt Clinton of New York helped to officiate at ground-breaking ceremonies near Newark on July 4, 1825. Two years later the first section of the Ohio canal was put into use and before long traffic on the entire 308-mi. waterway between Cleveland, on Lake Erie, and Portsmouth, on the Ohio river, was bringing prosperity to every locality along its route. In addition to feeders and several shorter canals, another major canal was built in the western part of the state. This, the Miami and Erie canal, joined Cincinnati and Toledo via the Miami and Maumee valleys. Ohio's canal building program was extremely costly and eventually the "ditches" were superseded by railroads, but they rescued the state from the financial doldrums of the 1820s and they were of primary importance at least until mid-19th century. Without them, the state's agricultural and commercial development would have been seriously impeded.

The American Civil War.—The second quarter of the 19th century witnessed the passing of the frontier and a growth in the number and size of towns. It was marked also by an occasional flurry of excitement, such as the Toledo war, a dispute with Michigan over the boundary between the two states. A dominating influence during this period was the worsening conflict over slavery and abolition. Ohio's zealous antislavery sentiment resulted in

disaffection from the Democratic party (the old Jeffersonian Republicans) at the end of the Jackson era, and the Whigs gained the upper hand for a time. In 1841 William Henry Harrison, a native of Virginia but long identified with Ohio, became the first president from the state. The 1850s found many constituents in Ohio for the Free-Soil and then the new Republican parties, and the state played a significant role in the Civil War. Besides furnishing such statesmen as Edwin M. Stanton and Salmon P. Chase and such military figures as Grant, Sherman and Sheridan, Ohio sent nearly 350,000 men into the Union army. Opposing the war effort were the "Copperheads" (*q.v.*) of whom the most prominent was Clement L. Vallandigham of Dayton. Although in exile, he was nominated for governor by the Peace Democrats in the critical election of 1863. His overwhelming rejection by the voters inspired President Lincoln's assertion that "Ohio has saved the Union." The only time the war actually crossed the Ohio border was in July 1863, when Confederate Gen. John H. Morgan and 2,500 men commandeered two steamboats to ferry them from Kentucky to Indiana, swept across the southeast section of the latter state and eastward through Ohio. From the time Morgan's cavalry passed through Cincinnati's suburbs, rumour ran rampant as to his objective. Fanciful assumptions to the contrary, his primary aim apparently was to create a diversion and to lessen the military pressures elsewhere. The column rode across southern Ohio, indulging in looting and some destruction along the way but refraining generally from the type of wanton depredation common to such invasions. Morgan's plan to recross the Ohio at Buffington Island was thwarted by the arrival of the pursuing Federal cavalry. From the battle that ensued, Morgan extricated 1,200 men. They staged another attempt to ford the river 20 mi. upstream but only one fourth of the force had negotiated the crossing when Federal gunboats intervened. With his remaining 900 men Morgan set out on a zigzag course northward through eastern Ohio, seeking to cross into West Virginia or Pennsylvania. Ohioans were terror-stricken at rumours of his approach—it was seldom known exactly where he was—but the raid had become a rout and Morgan surrendered on July 26 near Salineville in Columbiana county; this was the northernmost penetration by a Confederate force during the war. In late November Morgan and six of his officers escaped from the Ohio penitentiary at Columbus and made their way safely to the south.

Another dramatic incident of the war, one that occurred outside Ohio but with Ohioans in the feature roles, was the Andrews raid, or the so-called Great Locomotive Chase, in Georgia in April 1862. In this daring escapade, a score of men from Ohio units infiltrated Confederate territory to Marietta, Ga., stole a train at Big Shanty, and headed for Chattanooga, Tenn., bent upon destroying communication and transportation facilities along the way. Through the sheer determination and perseverance of the train's conductor and a series of remarkably adverse coincidences, the raiders were overtaken after 90 mi. and obliged to abandon the stolen "General." They were captured, imprisoned and subsequently convicted of espionage. The leader, James J. Andrews, and several others were hanged as spies. The survivors either escaped to freedom or were eventually exchanged. Their incredible exploit won for them promotions, an audience with President Lincoln and the first (congressional) medals of honor ever bestowed.

Emerging Political and Industrial Power.—In the postwar decades Ohio emerged as a political and industrial power, besides retaining its standing as a leading agricultural state. It sent to the White House three successive presidents—Grant, Hayes and Garfield—between 1869 and 1881. Hayes, who had been Ohio's first three-term governor, compiled the most creditable record of the three. The election of Benjamin Harrison and William McKinley in the waning years of the 19th century, and of William Howard Taft and Warren G. Harding in 1908 and 1920, respectively, gave Ohio its claim to the title "mother of presidents." Although generally Republican, Ohio voters occasionally have warmly endorsed a Democrat. The most popular of the latter since the Civil War were governors Judson Harmon, James M. Cox, Vic Donahey, George White, Martin L. Davey and Frank J. Lausche. For many years Republicans Robert A. Taft and John W. Bricker enjoyed both state and national prominence.

Industrially, Ohio has excelled in the 19th and 20th centuries in iron and steel, oil, ceramics, rubber, glass, machinery and a host of other products. Industrialization and the urban trend brought to the growing population centres immigrants from foreign lands as well as Ohioans from the farms. The number of farm families was steadily decreasing in the second half of the 20th century and a way of life was fast disappearing.

GOVERNMENT

Administration.—By mid-19th century Ohio's original constitution no longer fulfilled the needs of a rapidly expanding state. As a result, a constitutional convention met and drew up a new instrument of government which became effective in 1851. Twenty-two years later another convention wrote a constitution which was subsequently rejected by the voters. A fourth convention in 1912 decided to retain the existing constitution but submitted 41 amendments for the approval of the electorate. The 33 adopted reflected the Progressive sentiment of that era. Thus, Ohio is still governed under the 1851 constitution modified by numerous amendments.

The executive branch of the state government consists of a governor, lieutenant governor, secretary of state, treasurer, auditor and attorney general. For many years the auditor was the only one of these officials elected to a four-year term, the others being two. This situation was changed, however, by the adoption of a constitutional amendment in 1954 providing for four-year terms for all of these officers starting with the election of 1958. Democrat Michael V. DiSalle of Toledo, the 60th governor, became the first elected for four years when he was inaugurated in Jan. 1959.

The general assembly is composed of two houses, the senate and the house of representatives. Members of the latter still are chosen for only two years, but a constitutional amendment in 1956 extended the terms of senators from two to four years.

The judicial system consists of a seven-man supreme court; nine courts of appeal with three judges each; courts of common pleas; probate, juvenile and municipal courts; and justices of the peace. Judges of the supreme court are chosen by direct popular vote although until 1851 they were elected by the general assembly.

The principal units of local government are the county, township, city and village. The minimum population required for a municipality to become a city is 5,000. Official recognition as a city usually follows the decennial census but may be secured by holding a special census.

Finance.—The costs of operating Ohio's government are paid from the general revenue fund which is derived largely from taxes on cigarettes and alcoholic beverages, a 3% retail sales tax and other forms of indirect taxation. Special undertakings, such as the construction of the multimillion-dollar Ohio turnpike, are financed by bond issues. During and after World War II a vast surplus had accumulated, hailed by some as evidence of wise fiscal management, assailed by others as a "penny-wise, pound-foolish" policy because of alleged negligence of needed improvements. By the close of the 1950s this reserve had been dissipated and, partly because of a reluctance to impose new or increased taxes, the state government faced a $13,000,000 deficit. Primarily by levying higher taxes on cigarettes and gasoline and by restoring the first cent of the sales tax, this deficit was erased by Aug. 1959, and Ohio was once again out of the red. In addition to the expense of conducting the government's business and of maintaining and operating the numerous state institutions and agencies, major expenditures each year include the appropriations for education, highway construction and repair and health and welfare.

POPULATION

Since the residents of Ohio were first tabulated in a United States census in 1800, the state's population has not only increased spectacularly, but it has shifted its concentration and it has undergone significant changes in character and composition. Numbering only 45,365 in 1800, Ohioans ten years later outnumbered the residents of five of the original states. By 1830 Ohio's population had reached nearly 1,000,000, and this figure was doubled in

*Ohio: Places of 5,000 or more Population (1960 Census)**

Place	Population 1960	1950	1940	1920	1900
Total state	9,706,397	7,946,627	6,907,612	5,759,394	4,157,545
Akron	290,351	274,605	244,791	208,435	42,728
Alliance	28,362	26,161	22,405	21,603	8,974
Amherst†	6,750	3,542	2,896	2,485	1,758
Ashland	17,419	14,287	12,453	9,249	4,087
Ashtabula	24,559	23,696	21,405	22,082	12,949
Athens	16,470	11,660	7,696	6,418	3,066
Avon Lake	9,403	4,342	2,274	904	—
Barberton	33,805	27,820	24,028	18,811	4,354
Bay	14,489	6,917	3,356	751	—
Beachwood	6,089	1,073	372	225	—
Bedford	15,223	9,105	7,390	2,677	1,486
Bedford Heights	5,275	—	—	—	—
Bellaire	11,502	12,573	13,799	15,061	9,912
Bellefontaine	11,424	10,232	9,808	9,336	6,649
Bellevue	8,286	6,906	6,127	5,776	4,101
Belpre	5,418	2,451	1,717	1,317	—
Berea	16,592	12,051	6,025	2,959	2,510
Bexley	14,319	12,378	8,705	1,342	—
Blue Ash	8,341	—	—	—	—
Bowling Green	13,574	12,005	7,190	5,788	5,067
Brecksville	5,435	2,664	1,900	—	—
Broadview Heights	6,209	2,279	1,141	—	—
Brooklyn	10,733	6,317	1,108	—	—
Brook Park	12,856	2,606	1,122	861	—
Brunswick	6,453	—	—	—	—
Bryan	7,361	6,365	5,404	4,252	3,131
Bucyrus	12,276	10,327	9,727	10,425	6,560
Cambridge	14,562	14,739	15,044	13,104	8,241
Campbell	13,406	12,882	13,785	—	—
Canton	113,631	116,912	108,401	87,091	30,667
Celina	7,659	5,703	4,841	4,226	2,815
Cheviot	10,701	9,944	9,043	4,108	—
Chillicothe	24,957	20,133	20,129	15,831	12,976
Cincinnati	502,550	503,998	455,610	401,247	325,902
Circleville	11,059	8,723	7,982	7,049	6,991
Cleveland	876,050	914,808	878,336	796,841	381,768
Cleveland Heights	61,813	59,141	54,992	15,236	—
Columbus	471,316	375,901	306,087	237,031	125,560
Conneaut	10,557	10,230	9,355	9,343	7,133
Coshocton	13,106	11,675	11,509	10,847	6,473
Crestline	5,521	4,614	4,337	4,313	3,282
Cuyahoga Falls	47,922	29,195	20,546	10,200	3,186
Dayton	262,332	243,872	210,718	152,559	85,333
Deer Park	8,423	7,241	3,510	824	—
Defiance	14,553	11,265	9,744	8,876	7,579
Delaware	13,282	11,804	8,944	8,756	7,940
Delphos	6,961	6,220	5,746	5,745	4,517
Dover‡	11,300	9,852	9,691	8,101	5,422
East Cleveland	37,991	40,047	39,495	27,292	2,757
Eastlake	12,467	7,486	—	—	—
East Liverpool	22,306	24,217	23,555	21,411	16,485
East Palestine	5,232	5,195	5,123	5,750	2,493
Eaton	5,034	4,242	3,552	3,210	3,155
Elyria	43,782	30,307	25,120	20,474	8,791
Euclid	62,998	41,396	17,866	3,363	—
Fairborn	19,453	7,847	—	—	—
Fairfield	9,734	—	—	—	—
Fairview Park	14,624	9,311	4,700	642	—
Findlay	30,344	23,845	20,228	17,021	17,613
Fostoria	15,732	14,351	13,453	9,987	7,730
Franklin	7,917	5,388	4,511	3,071	2,724
Fremont	17,573	16,537	14,710	12,468	8,439
Galion	12,650	9,952	8,685	7,374	7,282
Gallipolis	8,775	7,871	7,832	6,070	5,432
Garfield Heights	38,455	21,662	16,989	2,550	—
Geneva	5,677	4,718	4,171	3,081	2,342
Girard	12,997	10,113	9,805	6,556	2,630
Grandview Heights	8,270	7,659	6,960	1,185	—
Greenfield	5,422	4,862	4,228	4,344	3,979
Greenhills	5,407	3,005	2,677	—	—
Greenville	10,585	8,859	7,745	7,104	5,501
Grove City	8,107	2,339	1,787	905	656
Hamilton	72,354	57,951	50,592	39,675	23,914
Hilliard	5,633	610	583	451	376
Hillsboro	5,474	5,126	4,713	4,356	4,535
Hubbard	7,137	4,560	4,189	3,320	1,230
Huron	5,197	2,515	1,827	1,703	1,708
Independence	6,868	3,105	1,815	1,074	—
Ironton	15,745	16,333	15,851	14,007	11,868
Jackson	6,980	6,504	6,295	5,842	4,672
Kent	17,836	12,418	8,581	7,070	4,541
Kenton	8,747	8,475	7,593	7,690	6,852
Kettering	54,462	—	—	—	—
Lakewood	66,154	68,071	69,160	41,732	3,355
Lancaster	29,916	24,180	21,940	14,706	8,991
Lebanon	5,993	4,618	3,890	3,396	2,867
Lima	51,037	50,246	44,711	41,326	21,723
Lincoln Heights (Hamilton County)	7,798	5,531	—	—	—
Lincoln Heights (Richland County)	8,004	2,722	—	—	—
Lockland	5,292	5,736	5,601	4,007	2,695
Logan	6,417	5,972	6,177	5,493	3,480
London	6,379	5,222	4,697	4,080	3,511
Lorain	68,932	51,202	44,125	37,295	16,028
Louisville	5,116	3,801	3,379	2,008	1,374
Loveland	5,008	2,149	1,904	1,557	1,260
Lyndhurst	16,805	7,359	2,391	—	—

Place	Population 1960	1950	1940	1920	1900
Madeira	6,744	2,689	1,384	600	—
Mansfield	47,325	43,564	37,154	27,824	17,640
Maple Heights	31,667	15,586	6,728	1,732	—
Marietta	16,847	16,006	14,543	15,140	13,348
Marion	37,079	33,817	30,817	27,891	11,862
Martins Ferry	11,919	13,220	14,729	11,634	7,760
Massillon	31,236	29,594	26,644	17,428	11,944
Maumee	12,063	5,548	4,683	3,195	1,856
Mayfield Heights	13,478	5,807	2,696	—	—
Medina	8,235	5,097	4,359	3,430	2,232
Miamisburg	9,893	6,329	5,544	4,383	3,941
Middleburg Heights	7,282	2,299	1,225	—	—
Middletown	42,115	33,695	31,220	23,594	9,215
Mount Healthy	6,553	5,533	3,997	2,255	1,354
Mount Vernon	13,284	12,185	10,122	9,237	6,633
Napoleon	6,739	5,335	4,825	4,143	3,639
Newark	41,790	34,275	31,487	26,718	18,157
New Philadelphia	14,241	12,948	12,328	10,718	6,213
Newton Falls	5,038	4,451	3,120	1,100	732
Niles	19,545	16,773	16,273	13,080	7,468
North Canton	7,727	4,032	2,988	1,597	—
North College Hill	12,035	7,921	5,231	1,104	—
North Olmsted	16,290	6,604	3,487	1,419	—
North Royalton	9,290	3,939	2,559	—	—
Norwalk	12,900	9,775	8,211	7,379	7,074
Norwood	34,580	35,001	34,010	24,966	6,480
Oakwood	10,493	9,691	7,652	1,473	—
Oberlin	8,198	7,062	4,305	4,236	4,082
Oneida-Rolling Mill Park	6,504	2,248	—	—	—
Oregon	13,319	—	—	—	—
Orrville	6,511	5,153	4,484	4,107	1,901
Oxford	7,828	6,944	2,756	2,146	2,009
Painesville	16,116	14,432	12,235	7,272	5,024
Parma	82,845	28,897	16,365	—	—
Parma Heights	18,100	3,901	1,330	310	—
Perrysburg	5,519	4,006	3,457	2,429	1,766
Piqua	19,219	17,447	16,049	15,044	12,172
Port Clinton	6,870	5,541	4,505	3,928	2,450
Portsmouth	33,637	36,798	40,466	33,011	17,870
Ravenna	10,918	9,857	8,538	7,219	4,003
Reading	12,832	7,836	6,079	4,540	3,076
Reynoldsburg	7,793	724	652	491	339
Richmond Heights	5,068	891	507	265	—
Rittman	5,410	3,810	2,770	1,803	—
Rocky River	18,097	11,237	8,291	1,861	1,319
Rosedale	8,204	—	—	—	—
St Bernard	6,778	7,066	7,387	6,312	3,384
St Marys	7,737	6,208	5,532	5,679	5,359
Salem	13,854	12,754	12,301	10,305	7,582
Sandusky	31,989	29,375	24,874	22,897	19,664
Seven Hills	5,708	1,350	555	—	—
Shadyside	5,028	4,433	4,048	3,084	—
Shaker Heights	36,460	28,222	23,393	1,616	—
Sheffield Lake	6,884	2,381	1,099	—	—
Shelby	9,106	7,971	6,643	5,578	4,685
Sidney	14,663	11,491	9,790	8,590	5,688
Silverton	6,682	4,827	2,907	795	—
Solon	6,333	2,570	1,508	—	—
South Euclid	27,569	15,432	6,146	1,605	—
Springfield	82,723	78,508	70,662	60,840	38,253
Steubenville	32,495	35,872	37,651	28,508	14,349
Stow	12,194	—	—	—	—
Strongsville	8,504	3,504	2,216	—	—
Struthers	15,631	11,941	11,739	5,847	—
Sylvania	5,187	2,433	2,199	1,222	617
Tallmadge	10,246	5,821	3,452	—	—
Tiffin	21,478	18,952	16,102	14,375	10,989
Toledo	318,003	303,616	282,349	243,164	131,822
Toronto	7,780	7,253	7,426	4,684	3,526
Troy	13,685	10,661	9,697	7,260	5,881
Uhrichsville	6,201	6,614	6,435	6,428	4,582
University Heights	16,641	11,566	5,981	—	—
Upper Arlington	28,486	9,024	5,370	620	—
Urbana	10,461	9,335	8,335	7,621	6,808
Vandalia	6,342	927	378	257	284
Van Wert	11,323	10,364	9,227	8,100	6,422
Wadsworth	10,635	7,966	6,495	4,742	1,764
Wapakoneta	6,756	5,797	5,225	5,295	3,915
Warren	59,648	49,856	42,837	27,050	8,529
Warrensville Heights	10,609	4,126	1,175	—	—
Washington§	12,388	10,560	9,402	7,962	5,751
Wellston	5,728	5,691	5,537	6,687	8,045
Wellsville	7,117	7,854	7,672	8,849	6,146
Westerville	7,011	4,112	3,146	2,480	1,462
Westlake‖	12,906	4,912	3,200	1,754	—
Whitehall	20,818	4,877	—	—	—
Wickliffe	15,760	5,002	3,155	1,508	—
Willard¶	5,457	4,744	4,261	3,889	2,348
Willoughby	15,058	5,602	4,364	2,656	1,753
Willowick	18,749	3,677	915	—	—
Wilmington	8,915	7,387	5,971	5,037	3,613
Wooster	17,046	14,005	11,543	8,204	6,063
Worthington	9,239	2,141	1,569	705	443
Wyoming	7,736	5,582	4,466	2,323	1,450
Xenia	20,445	12,877	10,633	9,110	8,696
Youngstown	166,689	168,330	167,720	132,358	44,885
Zanesville	39,077	40,517	37,500	29,569	23,538

*Populations are reported as constituted at date of each census. †Known as North Amherst in 1900. ‡Known as Canal Dover prior to 1920. §Known as Washington Court House prior to 1950. ‖Known as Dover prior to 1950. ¶Known as Chicago Junction prior to 1920.
Note. Dash indicates place did not exist during reported census period, or data were not available.

the next 20 years. It passed 3,000,000 in 1880; 4,000,000 in 1900; 5,000,000 before 1920; and 6,000,000 before 1930. It was just short of 7,000,000 in 1940 and 8,000,000 in 1950; and by 1960 it had soared to 9,706,397. With the growth of cities and the exodus from the farms, the population by 1960 was more than 70% urban. As a whole, the state in 1960 had a relatively high population density of about 235.5 persons per square mile, but this figure was multiplied many times in the several large cities, with greater Cleveland's density highest at more than 2,000. This development is in great contrast to the middle of the 19th century when 85% of Ohio's inhabitants lived on farms. Despite the general increase in population after 1950, 18 of Ohio's 88 counties (all but two of them in the south and southeast) not only failed to attract new residents but actually suffered a decline in numbers.

Throughout most of the 19th century, Ohio's original predominantly Anglo-Saxon stock was supplemented by additional immigrants from Great Britain, Ireland and Germany. In 1900 Ohio's foreign-born population consisted of 204,160 Germans and approximately the same number from all other nations combined. The percentage of foreign-born fluctuated little, amounting to between 11% and 14% in the period 1860 to 1920, after which it declined. The sharp increase in eastern European immigrants, however, boosted the number of Hungarians, Poles, Italians, Austrians and Russians nearer to the declining number of Germans. Italians, Czechoslovakians and Yugoslavians continued to increase, especially in manufacturing centres such as Cleveland in which by 1920 one third of the people were foreign-born. This development had a pronounced effect on both political and cultural patterns in such cities.

Similarly, the Negro population has risen steadily. In 1920 the number of Negroes in Ohio (186,187) far exceeded that of the foreign-born from any single country. In the four decades that followed this figure increased by more than four times, while the percentage rose to 8.1% of the total population.

Restrictions on immigration since the 1920s have substantially reduced the foreign-born in Ohio to about 4%, so that approximately nine of every ten Ohioans are native white.

EDUCATION

State School System.—Historically, the principle of public-supported schools was established in Ohio in the 1820s, but it was not fully implemented until many years later. Public elementary schools were widely accepted by the time of the Civil War, preceding by nearly a half century general adoption of the public high school. As the 20th century gained momentum, the long-familiar one-room school gradually disappeared from the Ohio countryside, superseded by consolidated schools serving larger areas. The number of school districts was reduced by 33%, from more than 1,500 to about 1,000 in one decade after World War II. In 1921 school attendance for children between the ages of 6 and 18 was made compulsory. The system is administered by a superintendent of public instruction and a 23-member elected state school board created by the general assembly in 1955.

Colleges and Universities.—There are so many colleges and universities in Ohio (more than 50) that every resident lives within a few miles of at least one institution of higher learning. Of these, six receive financial support from the state. Ohio university at Athens was chartered in 1804, opened its doors five years later, and progressed from academy-type instruction to the standards of a full-fledged college about 1822. Miami university at Oxford followed a similar pattern, undergoing a formative stage from 1809 to 1824 when it achieved collegiate standing. Ohio State university, at Columbus, opened in 1873 as the Ohio Agricultural and Mechanical college, changed its name five years later and went on to become the largest of the group and one of the nation's leading universities. Kent State university at Kent and Bowling Green State university at Bowling Green were normal schools which gained university status in 1935. Central State college, at Wilberforce, after nearly a century as the education and industrial arts section of Wilberforce university (for Negro students) became a separate institution in 1950. Of Ohio's other colleges and universities three are municipally operated, by Akron (founded 1870), Cincinnati (1819) and Toledo (1872), while a considerable number are denominational, among them Baldwin-Wallace college (1845) and Ohio Wesleyan university (1842, Methodist), Xavier university (1831) and John Carroll university (1886, Roman Catholic), Denison university (1831, Baptist), Wittenberg university (1845, Lutheran) and Wilmington college (1863, Quaker). Western Reserve university (1826) at Cleveland is nonsectarian. Oberlin college (1833, nonsectarian) had the distinction of being the first coeducational college in the nation.

HEALTH, WELFARE AND CORRECTIONS

The director of public welfare has under his general control administration of poor relief; aid to dependent children and to the aged, the blind and the disabled; maternal and child health and child welfare services and services for crippled children; state hospitals for the mentally ill, epileptics and tubercular patients, institutions of the feeble-minded; a soldiers' and sailors' home, industrial schools for boys and girls; reformatories for men and women; a prison farm and penal honour camps; and Ohio penitentiary.

Ohio has launched a program to rectify conditions in its state mental hospitals. These institutions house nearly 30,000 inmates besides another 8,000 in state schools for retarded children, a total which is more than triple the number of prisoners in the Ohio penitentiary and the other penal institutions. The annual expenditures for the social and welfare programs and institutions (including general relief, aid for the aged, unemployment compensation and others, in addition to mental and correctional) nearly equal the entire cost of operating the public school system in the state.

THE ECONOMY

Living Conditions.—The steady decline in the number of farms in Ohio has been reflected in the occupational structure in the second half of the 20th century. By the early 1960s only about one out of every 25 wage earners was engaged in farming, unlike a few generations previously when agriculture provided occupations for a majority of the state's citizens. A significant side light on this is that at least half of the farming population worked at other jobs part of the time; a third worked off the farm more than 100 days per year. The number of employees in manufacturing was about ten times as large, outnumbering all other groups. They were followed by the categories of trade, service and professional and transportation, communication, etc. Economic conditions were generally good and wages high. In per capita personal income Ohio ranked among the top 20% of the states.

Agriculture.—Although as individual entities Ohio's farms were disappearing at the rate of about 1% per year in the second half of the 20th century, nearly half the state's land surface was still in crop lands and three fourths of the 88 counties were rural in character. Agricultural production continued high, the chief products being corn, oats, hay, soybeans, tobacco, wheat, rye barley, potatoes, apples, peaches, grapes, pears, sugar beets and maple syrup. Ohio ranked among the leading states in its annual yield of corn, oats and hay, producing, for example, about 8% of the nation's corn. In livestock, cattle were the most valuable as well as the most numerous except for hogs. Sheep, chickens and turkeys also were raised in large numbers.

Industry.—Ohio manufacturing plants and factories, mills and foundries not only provided employment for two fifths of the working force in the 1960s but also supplied the world with diverse and useful products. The principal centres of industry are Cleveland, Akron, Youngstown, Cincinnati, Columbus, Toledo, Lorain Dayton, Canton and the Ohio river cities from East Liverpool down to Marietta. Some cities have been noted primarily for one industry: Akron for rubber; Dayton for cash registers; and East Liverpool for clay products. One fifth of the nation's production of iron and steel came from the mills of Cleveland, Lorain Youngstown, Steubenville, Canton, Bellaire and Ironton. Chemical industries gave new vitality to the river valley in the vicinity of Marietta. Akron enabled Ohio to produce one fourth of the nation's rubber products. Also from Ohio came at least 10% of

all the machinery, transportation equipment, primary metals, fabricated metal products and stone, clay and glass products manufactured in the United States. Other industries produced significant totals of electrical machinery, furniture, petroleum and coal products, chemicals, food products and paper.

Minerals.—Land that at first seemed valuable primarily for farming and timber was found by 1850 to hold beneath its surface vast reserves of salt, copperas (ferrous sulfate, or green vitriol), gypsum, limestone, sandstone and coal, and clay suitable for pottery. By mid-19th century Ohio was fourth among the states in the quantity and value of salt produced. As early as 1840, about 125,000 tons of bituminous coal were being mined annually in eastern and southeastern Ohio. A century later, the state stood among the top six coal producers in the country. Petroleum, natural gas, cement, gravel and building stone all came to be recognized as important natural resources. Ohio still has great deposits of some of these. It is estimated that coal yet unmined may total as much as 50,000,000,000 tons, 5% of the nation's entire reserve. Ohio holds enough rock salt (2,000,000,000,000 tons) to supply the United States, at the present rate of use, for 150,000 years. Two principal petroleum fields have been located in the state, in the northwest and the southeast. About 1900 Ohio was one of the leading oil producers. Of the 200,000 wells drilled since 1860, approximately 14,000 are still active. In roughly the same period, about 175,000 natural gas wells produced more than 2,000,000,000,000 cu.ft., the peak year being 1915 with 79,000,000,000 cu.ft. About 7,000 gas wells are still producing, most of them in the eastern hill country. In the second half of the 20th century Ohio's mineral production has averaged between 12th and 15th in the nation in value, producing about 2% of the total. It has ranked first in the output of lime and fire clay and among the highest in the production of limestone, sandstone, sand and gravel, cement, stone and salt (about 15% of the U.S. total in salt).

Transportation and Communication.—Nature provided the best arteries of transportation in Ohio's early days in the waters of Lake Erie and the Ohio river, as well as in some of the smaller rivers within the state. These secondary streams were important for many years, and the sight of a steamboat far inland was not unusual. The use of the Ohio river declined during several decades of the 20th century, but it has been revitalized and cargo carried on river barges has increased to more than 60,000,000 tons annually.

The canals, discussed earlier, facilitated travel and shipping and contributed greatly to Ohio's economic well-being. Even before the canals' completion, however, early attempts at railroad building were underway, and in 1836 one railroad was completed between Toledo and Adrian, Mich. The middle years of the 19th century brought intense activity in this field, resulting in an intricate network of railroads throughout the state. This hastened the demise of the canals as an important and practical means of travel and transport. A phenomenon of transportation appeared in the early 20th century in the mania for the construction of interurban electric railways. Providing rapid and easy transportation between cities (and sometimes with those in neighbouring states), the interurbans enjoyed a meteoric existence, reaching their zenith in 1917 and then plummeting to obscurity with the advent of the automobile and bus.

Early roads often followed old Indian trails and were quite primitive in character. Dirt was the predominant surface, relieved occasionally by log (or corduroy) roads. The first significant highway-building project was the extension of the National road across Ohio from Wheeling, W.Va., through Zanesville and Columbus to Springfield between 1825 and 1837, and ultimately westward to Indiana and beyond. In the 1950s Ohio focused its attention on the dire need for new modern express highways. The first fruit of this effort was the 241-mi. Ohio turnpike, opened Oct. 1, 1955. Many miles of major expressways have been completed each year, in addition to which several of the larger cities have undertaken construction of systems speeding traffic through or diverting it around congested areas. The state is crisscrossed by nearly 85,000 mi. of highways outside municipalities, of which about 16,000 mi. are state routes, the rest county or township.

Railroads have leveled off at approximately 8,400 mi. while the number of licensed airports has risen to about 100. Lake shipping is busiest at Toledo, Cleveland, Lorain, Ashtabula, Sandusky, Conneaut and Fairport. The completion of the St. Lawrence seaway stimulated commerce on the Great Lakes and brought numerous foreign ships to Ohio ports. The flags of Japan, the Netherlands, Sweden, and other foreign nations are familiar sights on the same waters over which only three centuries ago canoes carried the expedition of La Salle.

See also references under "Ohio" in the Index.

BIBLIOGRAPHY.—E. H. Roseboom and F. P. Weisenburger, *History of Ohio*, new ed., includes annotated bibliography (1953); Ohio State Archaeological and Historical Society, *History of the State of Ohio*, ed. by Carl Wittke, 6 vol. (1941–44); Alfred J. Wright, *Economic Geography of Ohio* (1957). *See* also the manuscripts, records and other primary materials preserved by historical societies, libraries and governmental agencies.

Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures are summarized annually in the *Britannica Book of the Year*, American edition. (J. S. St.)

OHIO COMPANY, in American colonial history, the name of two companies organized in the 18th century for the colonization of the Ohio valley. The first Ohio company was chartered in 1749, partly to aid in securing for the English control of the valley, which was then in dispute between England and France, and partly as a commercial project for trade with the Indians. The company was composed of Virginians, including Thomas Lee and the two brothers of George Washington (Lawrence, who succeeded to the management upon the death of Lee, and Augustine); and of Englishmen, including John Hanbury, a wealthy London merchant. It received a grant of about 200,000 ac. at the forks of the Ohio river, now the site of Pittsburgh, Pa. In 1752 the company had a pathway blazed between the small fortified posts at Will's creek (Cumberland), Md., and at Redstone creek (Brownsville), Pa., which it had established in 1750. The company's uncompleted fort at the forks of the Ohio was captured by the French in 1754. The Ohio company was finally merged in the Walpole company (an organization in which Benjamin Franklin was interested), which in 1772 received from the British government a grant of a large tract lying along the southern bank of the Ohio as far west as the mouth of the Scioto river. The Revolutionary War interrupted its efforts at colonization.

The second company, known as the Ohio Company of Associates, was formed at Boston in 1786 by veterans of the Revolutionary War who hoped to use their depreciated continental certificates at par value for purchase of a large tract of land in the Ohio country. The leaders in the movement were Rufus Putnam, Benjamin Tupper, Samuel Holden Parsons and Manasseh Cutler. Cutler was selected to negotiate with congress and seems to have helped to secure the incorporation in the ordinance of 1787 for the government of the Northwest territory the paragraphs that prohibited slavery and encouraged public education. On Oct. 27, 1787, Cutler and Maj. Winthrop Sargent, who had joined him in the negotiations, signed two contracts with the government. One was for the absolute purchase for the Ohio company, at 66⅔ cents an acre, of 1,500,000 ac. of land lying along the north bank of the Ohio river, from a point near the site of the present town of Marietta, O., to a point nearly opposite the site of the present town of Huntington, W.Va. The other was for an option to buy all the land between the Ohio and the Scioto rivers and the western boundary line of the Ohio company's tract, extending north of the tenth township from the Ohio; according to the records, this tract was preempted by "Manasseh Cutler and Winthrop Sargent for themselves and others"—actually for the Scioto company. On the same day Cutler and Sargent "for themselves and associates" transferred to William Duer, then secretary of the treasury board, and his associates "one equal moiety of the Scioto tract of land mentioned in the second contract," it being provided that both parties were to be equally interested in the sale of the land, and were to share equally any profit or loss. Colonists were sent out by the Ohio company from New England, and Marietta, the first permanent settlement in the present state of Ohio, was founded in April 1788.

The Scioto company failed and left a bad name in history be-

cause of its involvement in the scandalous deception of a group of French colonists, some of whom settled at Gallipolis, O. Nor did the Ohio company prosper. It ultimately obtained about half of the land called for in the contract. However, the company did have a large influence on American history. Cutler and his associates had insisted that the congress make provision for the government of the western territory, and they can thus be credited with having stimulated the adoption of the Northwest ordinance. Moreover, as part of the contract, the Ohio associates were granted two townships of land from the public domain for the establishment of a university. Ohio obtained possession of this land after it became a state; and most of the other public-land states that entered the union after Ohio asked for and got similar or larger grants for state universities.

Bibliography.—E. J. Benton (ed.), "Side Lights on the Ohio Company of Associates, from the John May Papers," *Western Reserve Historical Society Tracts*, no. 97 (1917); A. B. Hulbert (ed.), *The Records of the Original Proceedings of the Ohio Company* (1917); Herbert T. Leyland, "The Ohio Company," *Historical and Philosophical Society of Ohio, Quarterly Publication*, vol. xvi, no. 1 (1921); L. Mulkearn (ed.), *George Mercer Papers Relating to the Ohio Company of Virginia* (1954); C. E. Carter (ed.), *The Territorial Papers of the United States*, vol. 2 (1934). (V. C.)

OHIO RIVER, the principal eastern tributary of the Mississippi river, U.S. It is formed by the confluence of the Allegheny and Monongahela rivers at Pittsburgh, Pa., and flows northwest nearly to the west border of Pennsylvania, south-southwest between Ohio and West Virginia, west by north between Ohio and Kentucky and west-southwest between Indiana and Illinois on the north and Kentucky on the south. The Ohio contributes more water to the Mississippi than any other tributary (basin 203,900 sq.mi.); its volume (231,000 cu.ft. per second) is 3½ times that of the next largest stream, the Missouri. Despite seasonal fluctuations which may reach flood proportions, its fairly uniform flow has supported an important commerce since first settlement began. In all its 975.5 mi., the Ohio has a total fall of only 429 ft., considerably less than some of its tributaries—the Big Miami, for instance, has a fall of 600 ft. in only 160 mi.

The Ohio valley floor is narrow, with an average width of less than ½ mi. between Pittsburgh and Wheeling; from Cincinnati to Louisville it averages a little over 1 mi. and below Louisville it is somewhat greater. There are islands in the river, varying in size from 1 to 4,000 ac. The one major hazard to navigation, the Falls of the Ohio, is at Louisville, where locks take care of a descent of about 24 ft. within a distance of 2½ mi.

Floods.—The Ohio and several of its tributaries have long been known for floods, such as those at Dayton and Johnstown (*qq.v.*). In Jan. 1937, an especially destructive flood set a record for high stages on that part of the river between Point Pleasant, W.Va., and the mouth of the Ohio and on the tributaries entering from the south. Fluctuation in stream level at Cincinnati may be 80 ft., with an average of one flood (varying crest) each 18 months. The Ohio valley lies in the path of prevailing cyclonic storms, annual precipitation averages about 40 in., with rainfall heavier from January to May, when runoff is greatest. On the tributaries of the Ohio, there is no definite flood season.

Tributaries.—Neither the Ohio nor its numerous tributaries has had much water power development, important exceptions being the Tennessee and Cumberland rivers. Nevertheless, several tributaries have been significant in other ways. Within the Ohio system are three major groups of tributaries, each contributing in its own way to the development of the nation's heartland. First of these is the extensive system of headwaters, second the northern tributaries and third the southern tributaries. The first to affect settlement policy were the northern tributaries. The divide between the Great Lakes and Ohio river drainage is not far south of the lakes margin; the tributaries from the north follow roughly parallel courses to the Ohio. The French from the St. Lawrence valley claimed, but were unable to hold, the major valleys between the Great Lakes and Ohio drainage. Since settlement began in 1787, the vitality of these trade routes has grown.

Robert Cavelier, Sieur de La Salle, asserted that he discovered [illegible] Ohio and descended it until his course was obstructed by a fall, said to be the falls at Louisville (*see* Kentucky: *His*[illegible]; Ohio: *History*). In the 1750s its strategic importance [illegible] struggle of the French and the English for possession of the [illegible]terior of the continent became fully recognized. By the tr[illegible] 1763 ending the French and Indian War, the English finally [illegible] undisputed control of the territory along its banks. By the [illegible] of 1783 the entire Ohio country became a part of the United [illegible] and by the famous ordinance of 1787 the north side was open [illegible] settlement. Most of the settlers entered the region by the [illegible] waters of the Ohio and carried much of their market produce [illegible] the Ohio and Mississippi to New Orleans. On any map of [illegible] railroad traffic, the Muskingum, Hocking, Scioto, Miami, W[illegible] and Illinois river valleys localize enormous tonnages; only the Illinois now supports water-borne commerce.

A series of river improvements and basic changes in tow[illegible] and barges have enabled the headwater and Kanawha river[illegible] move an expanding tonnage to the Ohio. For more than a centur[illegible] the federal government has made improvements and it is vir[illegible] all the work of the U.S. army corps of engineers. The U.S. [illegible] guard confines its attention to licensing commercial pilots [illegible] erecting the signs and lights for safety in navigation. The river itself remains a part of the states on its south bank.

Improvements.—The improvement of the Ohio for commerce has lagged behind the improvement in towboats and barges [illegible] carry the ever-growing freight. The channel is 9 ft. de[illegible] there are 46 low-level, movable or roller type dams and their [illegible] each 600 ft. long and 100 ft. wide. A program was initiated [illegible] 1955 to reduce the number to 19, each with 1,200-ft. locks [illegible] such installations, locking time is reduced by more than 33[illegible] traffic costs are reduced 50%.

Use.—Ohio river towboats vary in characteristics depending upon the type of service for which they are designed; [illegible] them used for medium- or long-haul service for coal and genera[illegible] cargo are fairly uniform. A typical towboat is a twin-screw [illegible] h.p. diesel-powered boat 150 ft. long, 35 ft. in the beam [illegible] drawing 7 ft. of water when loaded. Multiple screws are the rule since they allow the application of greater power in shallow [illegible] and also provide the superior steering characteristics essential [illegible] river navigation.

Barges appear on the rivers as the hodge-podge or mixed [illegible] and the more common specialized tow. One towboat will [illegible] 20 barges, 4 barges wide and 5 long, putting them through a [illegible] lock in 2 lockages. Coal and coke make up 55% of the [illegible] tonnage and petroleum and its products 20%; the rest is iron [illegible] steel, chemicals, sand and gravel, sulfur, automobiles and m[illegible]laneous products. There is little grain.

There is no authorized program for the development of hy[illegible] electric power in the Ohio basin proper, but during and [illegible] World War II the Ohio valley has experienced a marked [illegible] in industrialization. Aluminum, chemicals, steel, atomic en[illegible] and electric power plants are important examples of this gr[illegible] To a river already badly polluted by factories, coal mines and [illegible] sewage, these industries aggravate the problem. One impo[illegible] step to alleviate this situation has been the eight-state ratif[illegible] (1948) of the Ohio River Valley Water Sanitation compact pa[illegible] by the U.S. congress in 1940.

See Tennessee River; Mississippi River; *see* also references under "Ohio River" in the Index.

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OHIO STATE UNIVERSITY, a state-supported, co[illegible]tional institution of higher learning, founded by statute in [illegible] and opened at Columbus, O., in 1873. *See* Ohio: *Education*.

OHM, GEORG SIMON (1787–1854), German phy[illegible] whose most important contribution was Ohm's law of elect[illegible] duction, was born at Erlangen on March 16, 1787, and wa[illegible]

ed at the university there. He became professor of mathematics the Jesuits' college at Cologne in 1817 and at the polytechnic of Nürnberg from 1833 to 1849. In 1849 he was appointed fessor at Munich, where he died on July 7, 1854. His writings were numerous, but, with one important exception, not of the first order. The exception is his pamphlet, published in Berlin in 1827, with the title *Die galvanische Kette mathematisch bearbeitet.* This work, the germs of which had appeared during the two preceding years in the journals of J. Schweigger and J. Poggendorff, greatly influenced the theory and applications of current electricity. (*See* ELECTRICITY: *III. Direct-Current Circuits: Ohm's Law.*) The most important part of the pamphlet is summarized in what is now known as Ohm's law. (*See* INSTRUMENTS, ELECTRICAL MEASURING.) This work was so coldly received that Ohm's feelings were hurt, and he resigned his post at Cologne. At this time his work began to be recognized, he was awarded the Copley medal of the Royal society in 1841 and was made a foreign member of that society in 1842. In addition to a number of papers on mathematical subjects, Ohm wrote a textbook, *Grundzüge der Physik* (1854).

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OHMMETER, an instrument used for measuring electrical resistance. *See* INSTRUMENTS, ELECTRICAL MEASURING: *Resistance Measurements: Ohmmeter.*

OHRID (OCHRID), a town and *srez* (district) in the Socialist Republic of Macedonia, Yugos. The town (pop. [1961] 16,626), 70 mi. S.W. of Skopje, is situated at the northeast of Lake Ohrid (Ohridsko Jezero) on the old Roman road, the Via Egnatia, that leads to Bitola and Greece. The lake, 2,280 ft. above sea level, with an area of 134 sq.mi. and a maximum depth of 935 ft., lies amid magnificent mountain scenery and is famous for its salmon trout. Its southwestern part is in Albania, and the Black Drin flows out of it to the north. In classical times called Lychnidus, Ohrid derives its present name from the crag (*hrid*) on which the picturesque old town stands. At the summit is the ruined fortress dating chiefly from the period when Ohrid was the capital of the Bulgarian tsar Samuel (980–1014). Among the Byzantine churches in the town are the cathedral of St. Sophia, with 11th-century frescoes, and St. Clement's, built 1295, also with medieval frescoes. The 10th-century monastery of St. Naum, about 16 mi. to the south, close to the Albanian border, crowns a prominent crag above the lake. The inhabitants of Ohrid are mainly occupied in agriculture, fishing and tourism, the town being the chief resort of Macedonia. It is linked by air (summer only), rail and road to Skopje.

St. Clement (d. 916), a disciple of SS. Cyril and Methodius, was the first Slav bishop of Ohrid, which later was the patriarchal see of Bulgaria (*c.* 980–1014), and then an archbishopric (1014–1767). (V. DE.)

OILBIRD (GUACHARO; *Steatornis caripensis*), the sole member of the family Steatornithidae, found in tropical America from Colombia, Venezuela, Trinidad and the Guianas to Brazil and Peru. As big as a crow, the bird has plumage in blended tints of chocolate and gray, barred and penciled with dark-brown or black and spotted in places with white. The oilbird is nocturnal, slumbering by day in deep and dark caverns, in which it nests. Toward evening it awakes and, with a croaking and clattering that has been likened to the sound of castanets, leaves its retreat. The natives kill great numbers of these birds by entering the cave with torches and knocking down the birds with long poles. The birds are then rendered to provide an oil used for cooking and for lighting; hence the common name oilbird. In Trinidad young oilbirds are esteemed as a great delicacy for the table. Studies show that this bird, like the bats, uses echolocation, a "natural sonar," to avoid obstacles while flying in the darkness of caves. This form of navigation is otherwise unknown in birds. (HT. FN.)

OIL CAKE, a feeding stuff of great value, prepared from the residue resulting from the crushing of various oilseeds. For details *see* FEEDS, ANIMAL; COTTONSEED; LINSEED AND LINSEED OIL; COPRA.

OIL CITY, a city of Venango county in northwestern Pennsylvania, U.S., is situated on a bend of the Allegheny river at the mouth of Oil creek, about 75 mi. N. of Pittsburgh, and is divided into three hillside parts by the river and creek. Once the site of a Seneca Indian village, Oil City was founded in 1860, following the drilling of the world's first oil well at Titusville, 16 mi. up Oil creek on Aug. 27, 1859. It was incorporated as a borough in 1862 and as a city in 1871. Along with the Pennsylvania oil industry, it reached its high point between 1860 and 1870 with boats plying the shallow river, taking millions of barrels of oil to Pittsburgh. For many years the city's oil exchange set the world's price of oil. Industries include oil refineries, machine shops and the manufacture of steel drums and tubing, tin cans, bottles, gas engines, pumping machinery, and other oil-well supplies. For comparative population figures *see* table in PENNSYLVANIA: *Population.* (W. A. C.)

OIL ENGINE: *see* INTERNAL-COMBUSTION ENGINE.

OIL HEATING, DOMESTIC: *see* HEATING AND VENTILATION.

OIL PAINTING, TECHNIQUE OF. This article deals with the materials and methods necessary for artistic expression in oil colours, a medium which consists of pigments ground in drying oils.

For discussions of the history of painting, *see* PAINTING; LANDSCAPE PAINTING; PORTRAIT PAINTING; STILL-LIFE PAINTING; MURAL PAINTING; for a discussion of the paints that are used to cover interior or exterior surfaces, *see* PAINT.

The practices of the artist are guided by principles that are based on the accumulated experiences of centuries, aided to some extent by research data from the laboratories of the industrial paint field and those of the museum technologists. The artist is perforce a craftsman. He must be adept in the selection and the specialized use of his materials for more than one reason. He must be able to control his paints so that he can obtain the effects with which he expresses himself. He is profoundly concerned with the permanence of his paintings because a work of art is intended to maintain its original condition as long as is possible. Another of his major concerns is appropriateness: the proper choice or selection of materials, methods and techniques to fulfill his purposes to the best advantage.

Among several accepted, standard methods that have been developed to meet the various requirements for easel painting, oil painting has occupied a pre-eminent position for five centuries. It is universally preferred by artists and their patrons. Other mediums have qualities more appropriate for the expression of particular styles or particular works. Water colour, for instance, has its special working method and its sparkling effects; it lends itself to outdoor sketching because the materials required are simple and portable. Fresco has outstanding mural qualities; tempera, pastel and encaustic have their own special characteristics.

Oil painting, however, combines such a number of advantages that it has retained its outstanding position and has survived through centuries of changing art forms. Most of the paintings in museums, collections and in the everyday world of art are oils; the very word painting implies oil painting. (*See* also ENCAUSTIC PAINTING; FRESCO PAINTING; GOUACHE; PASTEL; TEMPERA; WATER-COLOUR PAINTING.)

TECHNIQUE

The painter has two means of depicting forms in art: line or contour, and tonal masses or colour splotches. Either can dominate his results, or they can be balanced so that they contribute equally. The work of the early tempera painters can be characterized as predominately linear; sometimes this quality is called "dry." Subsequent "juicier" styles of painting have a looser, more spontaneous effect; forms in general are more rotund and flowing and less angular, and tonal masses contribute more to the final effect.

Technically, the artist has two means of applying colour: the

opaque brushstroke, in which the paint effectually hides the ground and depends on the direct reflection of light from its surface for its effects; and the transparent glaze, in which an underpainting or ground contributes to the final effect (*see* GRISAILLE). Each technique is valuable to the painter, but the colour effects of one cannot be duplicated by the other. Opaque painting utilizes white pigment for its whites and pale tints. Painting that employs thin, transparent layers uses a paler underpainting or a brilliant, white reflective ground for its pale tints. Glazing consists of placing thin, transparent colour over a dry underpainting; the effect is somewhat as if coloured cellophane were placed over a surface; many variations and delicate manipulations may be achieved with skilled application.

While each painting method may have superlative attributes, oil painting permits virtually every technique to be successfully applied and even combined in the same work. In general, there is no longer an insistence on the degree of excellence in all of the attributes of a painting that was once demanded; no one expects a single picture to have everything. A superlative degree of technical accomplishment is frequently sacrificed for balance or for an aesthetic emphasis.

There are many reasons for the adoption and continued use of oil paints. The outstanding facility with which fusion of tones or colour is achieved makes it unique among fluid mediums; at the same time, satisfactory linear treatment and crisp effects are easily obtained. Opaque, transparent and translucent painting all lie within its range. It is unsurpassed for textural variation, the manipulation of smooth and rugged, thick and thin, uniform or varied surfaces. Skill in handling can be acquired after a reasonable amount of training and experience. In painting with the water mediums there is a very definite (and frequently erratic) colour change when the paint dries, but with oil paints, the colour the artist puts down on the canvas is the colour of the finished painting. The widest range of styles is possible, from the most simple to the most complex visual effects. Linen canvas is lightweight, it has a desirable texture, and its resilience to brushstrokes appeals to many painters.

All traditional painting mediums are equally permanent when the pictures are given the care normally given to works of art. However, some are fragile (*e.g.*, pastels) and will not stand wear and tear or abuse as well as oil paintings.

MATERIALS

When painted with bad materials oil paintings on aging will suffer defects and blemishes, such as embrittlement, cracking, darkening or yellowing, which can be avoided by observing the rules of correct craftsmanship. Artists' materials have been necessarily of superlative quality, prepared with the utmost striving toward perfection. Although a fine painter is not made by fine materials, the artist is nevertheless severely handicapped if his materials are inadequate. The use of substandard materials for economic reasons has been since ancient times a temptation that artists have had to overcome.

Artists' oil colours are made by mixing dry powder pigments with selected refined linseed oil to a stiff paste consistency and grinding it by strong friction in steel roller mills. The action of the mills is squeezing, not crushing; the object is to disperse the tiny individual pigment particles throughout the oil, rather than to grind them down in size, since for the most part they are sufficiently fine at the start. The consistency of the colour is important; the universal use of tube colours demands that they be uniform within well-established limits. The standard is a smooth, buttery or short paste, not stringy or long or tacky. When a more flowing or mobile quality is required by the artist, a fluid painting medium must be mixed with it. It is important that this be a time-tested, reliable material, for many 18th- and 19th-century paintings have deteriorated because of the use of facile but improper additives.

Traditional practice is based on the use of pure linseed oil colours judiciously thinned with a little turpentine. Technical practices degenerated decidedly during the 18th century; the older traditions of craftsmanship declined with the end of the apprentice system, the new availability of ready-made materials (even though their ingredients were generally of better quality than the older ones) and the new conceptions of artistic purposes. The necessity for improvement became urgent. Sound traditional practices continued, but many painters who desired to emulate the techniques of admired painters of the past, falsely believed that such effects were due to secret recipes that had become lost. The search for the secrets of the old masters led to the adoption of a number of complex painting mediums, mixtures of cooked varnishes, oils and driers, mostly of 18th-century origin taken from the practices of craft or trade painters and decorators. The most prominent of these was a jellylike medium with the strange name of megilp, which conferred the most facile and versatile brushing qualities to oil colour. Others of equal infamy were the asphalts or bitumens and certain unsound pigments, such as Vandyke brown and emerald green.

Unfortunately, cracking, darkening and subsequent ruination was the fate of every area of a painting where these materials were used; they were responsible for much of what conservators call "inherent vice" in a decrepit painting.

Authoritative opinion holds that technical secrets could not have been the sole property of any individual; all of his colleagues, students and helpers would be acquainted with them. The performances of the great masters were largely dependent upon personal attributes that cannot be duplicated by anything that comes out of the varnishmaker's kettle.

PIGMENTS

A pigment is a finely pulverized, insoluble material used to impart its colour effect to another substance. The same materials are used as pigments in all sorts of paints. For artists' use, pigments must conform to rigid requirements. They must possess the highest degree of colour stability under all conditions to which a work of art may be exposed; they must be brilliant, pure, chemically true to type, smooth and fine. Paint pigments do not dissolve in their liquid vehicles but remain suspended in them. Soluble colouring matters are called dyes; these impart their colour effects to materials by staining them or being imbibed by them. Dyes no longer have much use in oil paints; formerly the list of approved pigments contained many lake colours, which were made by fixing dyes on colourless powders. There is a class of white or almost white powders that become colourless or nearly so when mixed with oils, such as chalk, whiting, clay, alumina hydrate and blanc fixe (precipitated barium sulfate). They are called inert pigments, a term that refers to their lack of colouring power, not their chemical stability. Besides being used as extenders or adulterants they also have a few useful purposes in some paints. Formerly artists used many organic pigments of vegetal and animal origin. Now only two organic pigments are approved for permanent painting, alizarin and phthalocyanine, both of synthetic origin. All other approved colours are inorganic or "mineral" colours.

Pigments are either processed from coloured ores, earths or rocks, or they are manufactured by chemical means from raw materials which are not in themselves colouring matters. The approved palette for oil painting consists of:

Reds: Indian red, light red, alizarin crimson, and cadmium light, cadmium medium, cadmium deep and cadmium maroon.

Blues: ultramarine, cobalt, cerulean, manganese and phthalocyanine.

Yellows: cadmium light, cadmium medium, cadmium deep, cadmium orange, ochre, raw sienna, Mars, Naples, cobalt and strontium.

Greens: green earth, viridian, cobalt and chromium oxide.

Browns: raw and burnt umber, burnt sienna and burnt green earth (transparent brown).

Violets: Mars, cobalt and manganese.

Blacks: Mars, ivory and lampblack.

Whites: flake, zinc and titanium.

Unlike some of the other painting materials, there are few difficulties or unsolved problems in regard to pigments. Their history is well documented; it goes far back and it may be followed

"Venus and the Lute Player" by Titian (c. 1490–1576), Venetian; an early example of the use of oil paints in a manner still influenced by the basic principles of tempera

"Madonna and Child" by Giovanni Bellini (c. 1430–1516), Venetian; a work begun in tempera and finished with oil and oleoresinous glazes

Detail from "Hendrickje Stoffels" by Rembrandt van Rijn (1606–69), Dutch; oil

EARLY DEVELOPMENTS IN OIL PAINTING TECHNIQUE

Hand of a nymph, a detail from "Primavera" ("Spring") by Sandro Botticelli (1444–1510), Florentine; tempera

St. Elizabeth, a detail from "Madonna and Child with Saints and a Donor" by Jan van Eyck (c. 1385–1441), Flemish; oil-glazed tempera

OIL PAINTING, TECHNIQUE OF

"Malle Babbe" by Frans Hals (c. 1580–1666), Dutch. An example of Hals' bold, expressive brushwork

"Atalanta and Meleager" by Peter Paul Rubens (1577–1640), Flemish. Solidly painted in oil with careful attention to brilliance of effect and longevity of the work

"Fantasia in Blue" by Hans Hofmann, U.S. An example of the thick impastos and bravura application that characterized much 20th-century painting

"Mary Edwards" by William Hogarth (1697–1764), English. An excellent example of 18th-century English portraiture

FURTHER DEVELOPMENTS IN OIL PAINTING TECHNIQUE

"Self-Portrait" by Thomas Su (1783–1872), U.S. An early Amer-ican experimental work, attempting to emulate the luminous effects of earlier painters

through Greek, Roman, medieval, Renaissance and modern times. The brilliance, permanence and other qualities of pigments have steadily improved; most modern pigments are superior to the older ones. However, artists in every age have had to select a permanent palette and to resist the temptation to use superbrilliant colours with fugitive results.

The written history of pigments includes, besides many brief references in nontechnical writings, some specialized accounts. The *History of Stones* of Theophrastus (*c.* 300 B.C.) tells how cinnabar (native vermilion) is obtained from inaccessible cliffs by shooting arrows to dislodge it, and how roasting red earth alters its shade, a recent discovery at that time. Another classical source is the *Natural History* of Pliny, an encyclopaedic work of the first century, which contains a good deal about pigments. Some of it was written from personal observation but much of it was compiled from various sources including literal translations of some of Theophrastus' chapters. Some of Pliny's technical descriptions are models of accuracy, some are vague and ambiguous, and some are fantastic tales. He describes perfectly the manufacture of white lead (flake white), one of the first synthetic pigments, a process still in use. He admonishes artists to return to the simple palette of the Greeks whose paintings were so superior, and he deplores the Roman tendency to use such novelties as "the slime of India's rivers (indigo) and the corrupt blood of her dragons and elephants." Dragon's blood is a colour obtained from the fruit of an Asiatic tree. Pliny solemnly said it was the blood of the dragon mingled with that of the elephant; whenever they met they engaged in mutually mortal combat, the dragon crushing the elephant in its coils and being crushed in turn as the elephant fell.

The medieval period saw the introduction of vermilion, an improved synthetic counterpart of the ancient cinnabar. The fabulous *azzuro oltremarino* ("blue from beyond the sea") or ultramarine blue was obtained by a lengthy and complex processing of lapis lazuli, a semiprecious stone that came by trade routes from Afghanistan. Lapis ultramarine was the most costly of medieval and Renaissance materials; it was worth well over its weight in gold. For fine work it replaced all the inferior blues; princes and popes doled it out to their painters and there are tales of how lavishly the artists washed their brushes, subsequently to reclaim a pinch of the precious stuff from the wash water for their own use.

Less desirable blues served everyday purposes until the second quarter of the 19th century when a process for the manufacture of ultramarine was developed. Its discovery began with the casual observation of a blue deposit on the soda furnaces in a French chemical plant, and soon thereafter a process was worked out so that this once-treasured rarity became a mass-produced item, the standard blue of commerce and the arts.

In the early years of the 18th century, prussian blue was accidentally discovered when a colour chemist who had been given a wrong chemical for an experiment on a red pigment, poured the unsuccessful batch onto other waste material. Prussian blue is notable as the first completely documented pigment; its date and place of discovery, discoverer and development are all covered in contemporary scientific journals. Prussian blue has several shortcomings, but it is relatively cheap and still survives in industrial use. Despite its poor qualities, artists used it until an accidental blue product was obtained in England in 1935 from the production of alkyd resins. It was soon developed into the useful, permanent phthalocyanine blue, a perfect replacement for Prussian blue in colour and physical characteristics. The painter's palette is enriched from time to time when a pigment with known good qualities, because of its commercial usefulness, becomes economically feasible to produce.

In 1942, after conferences held in New York between artists' colour manufacturers and artists' groups, the national bureau of standards promulgated a voluntary agreement known as Commercial Standard CS 98–42 for Artists' Oil Paints. This set of specifications, based on research done by the then-existing Federal Art project, established standards and provided tests for physical and colour properties, performance and composition. Its official pigment nomenclature alone brought order to a previously confused and chaotic situation that had plagued artists for centuries and had resisted all former proposals for reform. A single pigment used to be known under as many as a half-dozen names, and entirely different pigments went by the same name. Whimsical names were in wide circulation. Since the agreement, artists' tube colours which are guaranteed to meet or exceed the requirements of CS 98–42 are so labeled. (Copies of the Standard may be procured from the superintendent of documents, Washington, D.C.) (*See* also COLOUR.)

Vehicles, Mediums and Thinners.—A vehicle is the liquid component of a prepared paint; it serves to bind the pigment into a durable paint film, to cause it to adhere to the canvas and to allow manipulation of the paint with the painter's brush. A painting medium is a liquid with binding and adhesive properties similar to those of the vehicle. The medium is added to a paint to alter its brushing or manipulative properties. A thinner is a completely volatile liquid whose sole function is to dilute a paint to a more fluid consistency so that it may be spread out more thinly. The thinners used with artists' oil paints are pure gum turpentine and its perfectly acceptable petroleum substitute, mineral spirit.

In order to accelerate drying, a siccative or liquid drier is sometimes used. The one universally approved siccative is cobalt drier, used sparingly in minimum amounts; it replaces the old lead and manganese siccatives.

The vegetable drying oils do not dry like water paints, which lose the bulk of their volume by evaporation. On exposure to air these oils solidify without appreciable loss in volume by chemical changes (oxidation and polymerization); afterward they cannot be reliquified by any means.

Modern fine tube colours are carefully compounded with a minimum oil content; excess oil is one cause of afteryellowing and structurally defective paint films. Furthermore, it will not perform like the blended mediums; hence, straight oil is not used as a painting medium. Poppy, walnut and other drying oils are no longer used in oil colours, except for a small percentage of poppy oil sometimes added by manufacturers in grinding certain pigments to improve consistencies. Mastic and copal varnishes have likewise been outmoded for some time. Megilp, previously mentioned, consists of mastic varnish mixed with oil cooked with lead driers.

The standard technique for best results in regard to permanence has always been to use straight oil colours with the occasional use of a little thinner. But for thin glazes and for special techniques which require a more fluid, mobile consistency and an especially facile handling, mediums are added. There are quite a few on the market, but many artists prefer to mix their own. A good recipe is: one fluid ounce of stand oil, one fluid ounce of damar varnish, five fluid ounces of pure gum turpentine and a small amount (about ten drops) of cobalt drier. Stand oil is a traditional material, a nonyellowing, heat-thickened (polymerized) linseed oil.

The aim in the formulation of such materials is to produce a liquid which will overcome the natural buttery quality of the colour, permit it to be manipulated in the desired manner and leave the final paint film no weaker nor less flexible than the original paint. (*See* OILS, FATS AND WAXES.)

Brushes.—The brush is the item of the artist's equipment in which inferior materials are least likely to produce desired results. Brushmaking is a highly skilled craft that has come through ages of development. In the midst of mechanized production it survives as a handicraft industry. Each brush is made with careful attention.

The top-grade brushes are made in two types: red sable, made from the tail hairs of the kolinsky or red Tartar marten; and bristle, made from a superlative grade of bleached white hog's bristles. Since the early 1940s supplies of the best bristles, which come from eastern European and north Asiatic sources, have been difficult to maintain, although there has been no lowering of workmanship. Very good bristle brushes are not common.

The tips of hairs and bristles are never cut; all trimming and

shaping is done from the other end. Red sable hair has a minute bulge in the middle and tapers to a very sharp point. The hog's bristle is forked or branched at the tip; this is called the flag. Bristle brushes come in numbered sizes in each of four regular shapes: round (pointed), flat, bright (flat shape but shorter and less supple) and oval (flat but bluntly pointed). A poor flat brush will splay like a broom; a good one yields a controllable line and maintains its shape in use because it is skillfully constructed, with incurving bristles set at its edges. Round brushes are generally associated with the earlier painters; flat ones with the more recent past. Red sable brushes are widely used for the smoother, less robust type of brush stroking; they also come in corresponding shapes. Artists also use some supplementary styles, especially for the manipulation of paint after it has been brushed on; for example, the badger-hair blender, which looks something like a shaving brush, is tapped, clean and dry, perpendicularly against the wet surface. A different grade red sable brush, with ox-hair mixed with the sable, is sometimes chosen when very springy, resilient stroking is required. The water-colour brush, a short-handled, round, pointed red sable brush of special construction, is sometimes also useful in small sizes for small, precise work in oil. The painting knife, a finely tempered, thin, limber version of the artist's palette knife, is a convenient tool for applying oil colours in a robust manner. It did not come into wide use until the 19th century, but had a forerunner in the *cestrum* used in encaustic painting (*q.v.*). Artists have learned how to use the painting knife to obtain a number of textural effects, both rough and smooth, keeping the thickness of the paint within safe limits, so that it will survive without cracking. (*See* also BRUSH.)

Painting Grounds.—The surface on which the artist paints and the support or backing for it must be selected with care. The survival of the work, the ease of its execution and the final visual effect are all profoundly involved in this selection. The standard ground for oil painting is a canvas made of pure European linen, of strong, close weave. It is coated with a white oil priming and stretched on a wooden stretcher frame or chassis. Modern stretchers are machine-made so that the tongue-and-groove mitred corners of the strips are interchangeable. The inner corners are provided with slots for wooden wedges, which, when tapped with a hammer, tighten the canvas. For larger sizes, extra-heavy custom-made stretchers of more sturdy construction are available, with crossbars if desired.

Stretchers are beveled slightly to prevent their inner edges from being noticeable through the canvas. In France, the chassis (assembled stretcher), stretched canvases and picture frames are available by number in 57 stock sizes: 19 lengths in three different proportional widths, *figure*, *paysage* and *marine*. For example, number 20F, roughly equivalent to the popular 24 × 30, is 73 × 60 cm., 20P is 73 × 54 and 20M is 73 × 50. In the U.S. and Great Britain it is customary to sell stretcher bars separately and canvas by the roll.

When the artist makes his own canvas he tacks the linen to the stretcher and then sizes it with a weak solution of hide glue to protect it from the oil. It has been known from earliest times that linen in direct contact with oil will decompose on aging. A white lead-in-oil priming is then applied in one or two coats. When, as is more often the case, the canvas is bought ready-made by the roll, the quality of the linen and priming should be carefully examined.

If rigidity and smoothness are preferred to springiness and texture, a wooden panel may be used with an oil priming or a gesso ground. Gesso, a mixture of chalk and glue, is too inflexible for use on cloth. The panel may be a well-made maple or birch plywood or a wallboard with the trade-marked name of Standard Presdwood, which has the advantage of uniformity of structure. Many other supports, textile and metal, have been tried, but few of these are in general use or have wide approval. Cotton canvas, often used by art students, has several shortcomings and is definitely inferior to linen in every requirement.

Varnish.—A coat of picture varnish is usually given to a finished oil painting. This is necessary to protect the painting from atmospheric attacks, from minor abrasions and an injurious accumulation of dirt. It also brings the surface to a uniform lustre, and brings the tonal depth and colour intensity to those originally created by the artist with wet paint. A correctly painted oil painting should be moderately glossy. Formerly, a highly reflectant gloss was considered in good taste, but, except in very low-keyed works, in dark intense paintings or in revarnishing old paintings that have large areas of blackish tones, a glassy shine is no longer widely admired.

When a layer of dust and dirt accumulates on a painting it becomes powerfully adhesive and behaves much as though it were adsorbed into the surface. If the surface is simply oil paint, the removal of this embedded grime presents a serious problem and its effect is sometimes ruinous. If the painting is protected by a coating of picture varnish, cleaning by the removal of part or all of the varnish film is a relatively safe and easy procedure. (*See* PAINTINGS, CONSERVATION OF.)

Some 20th-century painters, especially those who do not favour the deep, intense type of colouring, have wanted a mat or lustreless finish in oil paintings, but this seems unobtainable by any means if the longevity of the painting is to be considered. It is well known in the industrial paint and enamel field that lustreless finishes are obtained only at a definite sacrifice of durability.

An acceptable, mat varnish for permanent easel painting has not been invented, although there are some that are adequate for decorative work or other purposes for which permanence is a secondary consideration. Oil painting in the past was never intended to be other than glossy; admiration for this quality was one of the attributes which contributed to its adoption. Other types of painting, water colour, gouache, tempera, casein, fresco and pastel, have dead mat or semimat finishes. The aqueous paints in comparison to oil have powerful, gluelike binders; their chief ingredient (water) evaporates, leaving no surplus vehicle to surround or encase the pigment in a transparent pellicule or film, as oil paint does. They therefore have a different optical effect on the pigments. The gloss of an oil painting is a natural function of the medium.

The two approved varnishes which come nearest to fulfilling most of the ideal requirements for a picture varnish are damar (a solution of a pale East Indian resin in turpentine) and acrylic (a solution of a water-white synthetic resin). Two outmoded picture varnishes still in circulation are mastic (made from a resin from the Mediterranean countries) and copal (a cooked linseed-oil varnish containing a very hard African resin). Both of the latter are relatively dark in colour and turn brown or brownish-yellow upon aging. Copal has the additional disadvantages of cracking with age and of becoming difficult to remove when it needs replacement. Besides picture varnish the artist may use a very dilute resin solution known as retouch varnish. This is not a finish; it is employed as an extremely weak or attenuated covering to bring out the natural wet gloss and colour effect when work is resumed on a painting that has dried and become sunken-in. It is intended to be used for this one purpose and is not supposed to form an appreciable film or layer, or to give permanent finish or protection.

Paintings are varnished as soon as they are completely and thoroughly dry. When thick, glassy coats of mastic or copal were in vogue, artists waited for months before varnishing to avoid any physical injury to the soft paint layers by the contraction of the varnish. (*See* also VARNISH.)

HISTORY

The practice of easel painting with oil colours stems directly from 15th-century tempera painting techniques; its development can be followed without interruption. Oils, varnishes and oil colours were known and used for several decorative and protective purposes long before their adoption by artists. Drying oils are described in manuscripts by ancient and medieval writers; oil as a painting medium is mentioned in the treatise of Theophilus (11th century).

Well known to all students of early painting methods is the

book of Cennino Cennini (*see* TEMPERA), a 14th-century painter whose practices descend directly from Giotto's studio; there are several references to the preparation of oil painting materials and the methods used for various purposes. One chapter (no. 89) is titled "How to work in oil on a wall, on a panel, on iron or wherever you please." Numerous other references are found in old expense accounts, for instance: "The King to his treasurer and chamberlains. Pay from our treasury to Odo the goldsmith and Edward his son one hundred and seventeen shillings and tenpence for oil, varnish and colours bought, and for pictures executed in the Queen's Chamber at Westminster . . . May 25th to June 11, 1239."

Basic improvements in the refinement of linseed oil and the availability of volatile solvents or thinners for varnishes and oil paints after 1400 coincided with a need for some other medium than pure egg-yolk tempera to meet the changing requirements of the Renaissance. The new demands were particularly exemplified in Venetian painting. Painting developed away from the dry, linear effects that had prevailed; the new materials allowed new techniques of handling colour, tonal masses and depth of colour. At first oil paints and varnishes were used to glaze tempera panels, painted with their traditional linear draftsmanship. The work of Antonello da Messina, Domenico Veneziano, and the technically brilliant, jewellike portraits of the 15th-century Flemish painters were done this way. Among the earliest of these oil-glazed tempera paintings were the works of Jan van Eyck of Bruges (1385?–1441) and his brother Hubert. In 1550 Giorgio Vasari published his *Lives of the Painters*, in which he credited "Giovanni da Bruggia" with the "invention" of oil painting. This statement made such a strong impression, on Flemish and Dutch historians in particular, that the belief that the Van Eycks were the first artists to discover that one could make paint with linseed oil, persisted for centuries. Scholars since 1781 have shown that although Jan van Eyck, one of the great masters of all time, was important in the history of painting, oil painting was neither his invention nor that of any individual, but was the result of a long, gradual development. In the lives of the painters who lived nearer his own day and in his technical chapters "The Three Arts of Design," Vasari records information of great value; his direct, factual statements about 16th-century technical practices refute those who hold that there are lost secrets of the old masters.

In the 16th century oil colour emerged as the basic painting material in Venice. Artists had to learn gradually how to assure themselves of permanent results and how to develop fluent control. Since their traditions developed from tempera painting, they first relied on glazes and on carefully and deliberately planned cartoons and underpaintings, retaining many of the cardinal principles of the older technique. This type of painting utilized the effects of the drawing and underpainting which were never entirely obscured.

The emphasis on the oil glazes increased until the overpaintings gradually became more solid and direct, and the dry or linear character gave way to a more balanced combination of line and tonal effects, the latter obtained by use of directly applied, opaque colour areas or splotches. This progression can be followed in the lifetime of one artist, Giovanni Bellini (*c.* 1430–1516), who worked at first in pure egg tempera, then passed through an intermediate stage in which he must have used some oily ingredient, then covered his works with thin oily glazes and finally employed heavier oil coatings.

The work of Titian (*c.* 1487-90–1576) and Tintoretto (1518–94) carried on the development and during the 16th and 17th centuries most of the technical possibilities of oil painting were explored, at least in principle. Later investigations that were made into specific recipes for the oily mediums used by the masters of this period, brought about very involved, confused and contradictory interpretations, discussions and arguments, in the 18th and 19th centuries.

In the early years of oil painting, so many mixtures of oils and varnishes were tried and recorded in manuscripts, so many were subsequently discarded when their lack of permanence was established and so many recipes designed for trade or decorative uses later passed as artists' mediums that it is doubtful whether anyone can make any really authoritative statements or generalizations on exactly who used what and when.

By the end of the 16th century, artists had become proficient in the exploitation of the basic characteristics of oil painting; the means of expressing personal techniques, while ensuring longevity, had been learned. Linen canvas, after a long period of development, replaced wooden panels as the most logical and popular support. Cennini discusses the use of colours on linen and hempen cloth on wooden stretchers, and on banners, standards and trappings. It was adopted for easel paintings, because oil paint has sufficient elasticity to give permanent results when properly applied upon it.

Velázquez (1599–1660), who can be said to represent the culmination of the Venetian tradition, is usually cited as the first master whose technique can be copied by simple, direct oil painting, as it was later practised. His direct uncomplicated use of colour and his bold, bravura brushstrokes have frequently been emulated, especially in portraiture. Peter Paul Rubens (1577–1640), who represents the culmination of the Flemish school, was a prodigious painter of the very highest personal attainments. His studio has been called a picture factory because of his output and because he employed so many colleagues and students as assistants. He charged a higher fee for paintings entirely executed by his own hand, but boasted that no painting left his possession without being gone over by himself, at least in its salient points. Much is known of his manner of working and his basic techniques, some of it from his own writings. The technical significance of Rubens as an influence on later painters is the manner in which he loaded or piled up his whites and pale colours, opaquely, in juxtaposition to thin, transparent darks and shadows. He is also admired for another and sketchier style of handling. Over a brilliant, reflective white ground, he laid a cool, gray transparent film of paint (*imprimatura*); on this he painted a fully modeled monochromatic underpainting in a thin, translucent brown. Brilliant colours were then stroked in with a light, sure touch. Painters of this period sometimes employed coloured grounds, particularly in earth reds, but Rubens' combination of the reflective white and a transparent veil of colour utilized the technical advantages of both.

A third great master of oil-painting technique of this period is Rembrandt (1606–69) who can be considered to represent the culmination of the Dutch school. His technical effects had perhaps the most profound influence of all on later painters, particularly his brushwork, his handling of paint textures and surfaces, and his paint quality and visual effects. A single brushstroke sometimes reveals an effective depiction of rotundity of form and a textural depth combining the rough and the smooth and the thick and the thin. The system of loaded whites and transparent darks, so pronounced in Rubens, is enriched by further touches of broken opaque strokes, which do not obscure the underlying colours, in addition to glazed effects and blendings. Rembrandt left no record of his materials, but he is presumed to have used much stand oil, a heat-processed or polymerized linseed oil for which the Dutch have long been famous.

Other basic influences on the techniques of later easel painting are the smooth, thinly painted, deliberately planned, tighter styles of painting. These were never discarded; they have continued to have their followers in every generation. Bold, crisp brushstrokes and any areas or spots raised considerably above the level of surrounding colour are called impasto. A great many admired works were executed with smooth gradations and blends of tones to achieve rotund forms and subtle colour variation. The paintings of Jan Vermeer (1632–75) may be cited as examples. His direct painting is combined with restrained and subtle blends without diminishing the forcefulness of the work.

An interesting effect seen in some old paintings is called *pentimento* ("repentance"). Because of changes in the refractive index of linseed-oil films after aging, it is possible for thinly painted layers to become transparent, revealing forms that had been covered over.

There are numerous examples in galleries, in which the artist had used thin overpaintings of paler colour to obliterate dark forms that in time became visible in a ghostly manner. Examples are found among the thinly painted Dutch panels of the 17th century, especially where the checkerboard marble floors they were so fond of depicting have come through thinly overpainted figures and objects. Painters have learned to avoid *pentimenti* by scraping away dark markings before overpainting with paler colours or by making the overpainting sufficiently opaque to preclude this occurrence.

Painting in the 20th century has created many technical problems. In addition to traditional art forms, many new schools have arisen. The technical requirements of some of these are well served by the materials and technical means of the past; others cannot be realized by the use of paints that were developed specifically for the craftsmanship and painterly qualities associated with traditional techniques.

The demands of French Impressionist painting had coincided with improvements in paint-grinding machinery that permitted the manufacture of artists' oil colours to a more buttery or less mobile consistency. Some abstract painters, and to some extent contemporary painters in traditional styles, have expressed a need for an entirely different plastic flow or viscosity than can be had with oil paint and its conventional additives. Some require a greater range of thick and thin application and a more rapid speed of dry. Some artists have used the traditional materials in unorthodox ways, such as mixing coarsely grained materials with their colours to create new textures; some have used oil paints in enormously heavier thickness than has been considered safe. Abandoned techniques have been revived to cope with such problems and experimental paints based on synthetic resins have been tried. *See* also PAINTINGS, CONSERVATION OF.

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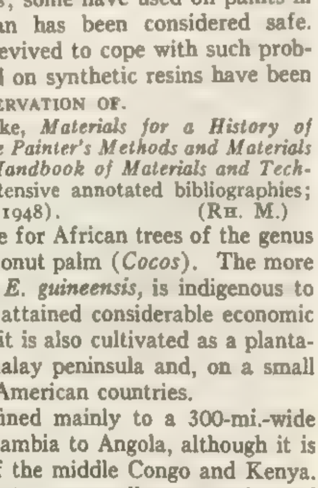
OIL PALM, the common name for African trees of the genus *Elaeis*, botanically allied to the coconut palm (*Cocos*). The more widely known of the two species, *E. guineensis*, is indigenous to tropical west Africa, where it has attained considerable economic importance as a source of oil, but it is also cultivated as a plantation crop in Indonesia and the Malay peninsula and, on a small scale, in some Central and South American countries.

The oil palm in Africa is confined mainly to a 300-mi.-wide region along the coast from the Gambia to Angola, although it is also found in the forest regions of the middle Congo and Kenya. It is a light-demanding species but grows well on a variety of deep, well-drained, neutral or alkaline soils. In maturity it may attain a height of 100 ft. but normally has a stem of no more than 30 ft., which bears at the summit an irregular crown of feathery leaves, each of from 10 to 15 ft. in length and pinnately divided into 50 or more lance-shaped leaflets. The numerous flowers are crowded on a short spadix and develop into a large ovate fruit cluster that may contain more than 1,000 drupes, varying in colour from a deep yellow to a dark red-brown. Mature palms bear from two to six bunches of fruit, each normally weighing between 10 and 35 lb., approximately one-third of which consists of stems or bracts.



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FRUITING OIL PALM (ELAEIS GUINEENSIS)

The individual fruit is 1–2 in. long and ¾–1 in. in diameter, its weight varying from 3 to 25 g. The fibrous pericarp, or outer fleshy portion of the fruit, yields between 30% and 70% of its weight as palm oil, while the kernels in the endocarp are approximately 50% by weight of palm kernel oil. Palm oil, deep yellow to red-brown and butterlike in consistency, is used chiefly in making soaps, candles and lubricating greases and in processing tinplate and coating iron plates; palm kernel oil, of a different chemical constitution, is a thick, light yellowish oil, used primarily in the manufacture of edible products such as margarine, chocolate confections and pharmaceuticals. The kernel cake residue is a good cattle feed and fertilizer.

The weight ratio of pericarp to kernels varies considerably, from the thick-shelled variety *macrocarpa*, whose pericarp composes about 50% of the weight of the fruit, to *pisifera*, a form with no pericarp at all. The variety *dura*, with a pericarp about 30% of the weight of the fruit, is the one commonest in western Africa; in Malaya selection has produced *dura* trees that yield more oil than those in Africa. Research into the improvement of *E. guineensis* strains has been concentrated mainly upon the thick pericarp varieties and, in particular, upon dwarf varieties which facilitate harvesting of the fruit.

See also OIL PLANTS; OILS, FATS AND WAXES.

See West African Institute for Oil Palm Research, *Quarterly Progress Report* (1953); W. H. Chandler, *Evergreen Orchards*, 2nd ed., pp. 416–422 (1958). (H. F. C. G.; X.)

OIL PLANTS. Oil has been obtained from plants since the beginnings of recorded history. Its first uses were probably for illumination, anointing and cooking. The discovery that linseed oil would mix with pigments to make an excellent artist's paint undoubtedly encouraged the tremendous increase in painting during the Renaissance. Castor oil was used before the petroleum era as a lubricant for wheels of carts and wagons.

Margarine as a butter substitute was developed in France in the 19th century. By the second half of the 20th century annual world production of vegetable oils was more than 32,000,000,000 lb. (in the U.S., more than 1,000,000,000 lb. being used for margarine alone).

This article identifies the sources of oil in plants and the important oil plants and plants from which oil is extracted as a by-product, and discusses uses of oils and oil plant by-products, improvements in oil plants and trends in production.

Additional information on uses will be found in separate articles on products, as MARGARINE; PAINT, etc., and by-products, as COTTONSEED; FEEDS, ANIMAL; etc. *See* also TROPICAL AGRICULTURE and articles on individual trees and plants, as OIL PALM; SOYBEAN, etc.

Sources of Oil in Plants.—All living plant cells contain some oil. This is true not only of the higher plants but also such primitive plants as bacteria, algae and fungi. When oil is present in large amounts in tissue it usually functions as a food reserve. Oil will produce about two and one-half times more calories than the same weight of carbohydrate.

Oil in large amounts is found usually in the seeds of plants, and occasionally in the fleshy part of the fruit, as in the olive and oil palm. Seeds may contain from 1% to over 60% oil, most species having rather large amounts. The oil functions as a reserve of high-energy food for use by the germinating seed (starch has a similar function in starch-storing species such as wheat and corn). In seeds large amounts of oil are associated with large amounts of protein, which makes oilseeds an important source of protein for livestock feeds. (*See* also NUT.)

Roots are not normally a site of oil storage, the oil content rarely going above 10% on a dry-weight basis. One exception is the sedge, *Cyperus esculentus*, native to southern Europe and Africa. This plant produces small tubers or underground stems which, when dry, may contain 20% to 36% oil. This oil is similar to rice-bran oil or olive oil. Other vegetative (as opposed to reproductive) parts of plants usually have less than 5% oil on a dry-weight basis. The vegetative parts of some plants, however are important sources of volatile or aromatic oils used in perfumes or flavours. (*See* ESSENTIAL OIL.)

Some fungi produce large numbers of fat globules, the amount reaching as high as 50% on a dry-weight basis. During World Wars I and II, when fats were scarce in many countries, there was considerable interest in fungi as a source of oil. Research is

Germany indicated that a species of *Fusarium* would produce an oil similar to olive and peanut oils.

Important Oil Plants.—Many plant families have contributed species, ranging in size from the palms to small herbaceous types such as flax, that have been used as a source of oil. Oil crops include plants over a wide range of domestication. At one extreme are babassu, oiticica and the species that yield mowrah and shea butter; these grow only in the wild state. The oil palm and castor bean grow wild and are also cultivated. The coconut, many trees such as tung and olive and all herbs utilized for their oil are cultivated. In fact very few of the herbs in their present form would survive in the wild.

Most of the more important oil crops are found in tropical and semitropical areas. Actually one-half to one-third of the vegetable oils for export have come from the tropical areas of west and central Africa and the area of Indonesia, the Philippine Islands and Malaya. In cool temperate areas the oil crops are flax, rape, mustards and sunflower. These crops of cool temperate areas are often used in hot and semitropical areas also, where they may be grown during the cooler part of the year. For example, rape is grown in Canada and northern Europe, and is at the same time one of the important oil crops of India.

The oil palm produces the highest oil yields of any crop, 2,880 lb. of oil per year per acre having been obtained in Sumatra (by way of contrast the average yield of linseed oil and soybean oil in the United States is less than 300 lb. per acre). Heavy investments, however, are necessary to establish palm plantations, and they do not bear for at least four or five years after planting. They also require much hand labour. Castor beans under good cultural conditions have given up to 2,000 lb. of oil per acre.

The production of other oil crops from trees, such as tung and olive, present some of the same advantages and disadvantages as the palms. Tung and olive trees are slow to get established, but once in production they require little upkeep. They are not readily adapted to mechanical harvesting, though some equipment is available to remove olives from the trees. Castor beans may be grown as a perennial tree in the tropics but as an annual in temperate areas.

Most of the herbs are adapted to production with mechanical equipment. Perilla, sesame, rape and the mustards tend to shatter their seed at harvest time, and have not been harvested too successfully with combine harvesters. For some, such as the castor bean, specially designed harvesters have been developed.

In recent years there has been increased interest, particularly in the United States, in oils for edible purposes that are high in linoleic acid, a polyunsaturated fatty acid. This stimulated a corresponding interest in safflower oil with a high ratio of linoleic acid to saturated fatty acids (about 9:1) and corn oil with a ratio of 5:1. Safflower was a new crop to North American agriculture and had become established because of the superior qualities of its oil in paints and varnishes.

Oils as By-products.—Several of the oils are by-products. The most important of these is cottonseed oil, obtained by processing cottonseed (*q.v.*). Soybean oil might also be considered a by-product of the production of the seed for the protein meal; certainly the crop usually could not be grown profitably for its oil alone. Mustards are grown primarily as a condiment; the oil is a by-product. Corn oil is obtained as a by-product of industries using corn for its starch, and rice oil is recovered from the bran after its removal from the seed in the production of polished rice. Oil is often taken from the seeds of grapes in the wine industry and from the seeds of fruits such as peaches, apricots and cherries in the canning industry. Even weed seeds removed from cereal grain in large terminal elevators may be processed for the oil that some of them contain—the seeds of wild radish and wild mustard are examples.

Tall oil, a by-product of the manufacture of kraft (sulfate) process paper from wood pulp, has been used in paints, linoleum, soaps and emulsifiers. The yield of oil totals about 70 lb. for every ton of pulp produced, but the amount is influenced by the species of pine and the method of pulp manufacture.

Uses.—Vegetable oils are used principally for food, for soap and detergents, for paint and related products and for a variety of industrial items. The iodine value of the oil is usually a measure of its utilization; a low iodine value is characteristic of oils used for food and soap, and a high iodine value of oil that is employed in paint and industrial products. Oils with intermediate iodine values, such as soybean and sunflower oil, are more flexible in their use. (*See* also OILS, FATS AND WAXES.)

Among food products that contain large amounts of vegetable oil are shortening, margarines and salad and cooking oils. The availability and price of oils will determine which is used; soybean oil and cottonseed oil are used extensively in the United States, sunflower oil in the U.S.S.R. and Argentina and coconut oil in many countries. Even linseed oil may be used as a food oil if supplies of the more common food oils are scarce. With the increased use of coal-tar- or petroleum-derived detergents, the volume of vegetable oil used in soaps decreased in the late 1950s. Large amounts of detergents, however, were made from coconut oil. Linseed oil has long been an important ingredient of paint and varnish (*qq.v.*), though its tendency to yellow with age has discouraged its use in light-coloured paints and clear varnishes. Soybean oil, tung oil and dehydrated castor oil are used in many paint products. Rubber-base paints are easier to apply in many situations and have tended to displace in part those made from oil. However, recently developed paints with a vegetable oil base are convenient to handle, in that brushes may be cleaned in water. Other products made from vegetable-oil products are linoleum, oil cloth, printing inks and plastics. Sebacic acid, important in the manufacture of nylon, is made from castor oil. Castor oil when sulfonated is used in the textile-dyeing industry. Palm oil is extensively used in tin-plating.

Technology has expanded the utilization of oil crops. Hydrogenation, the addition of hydrogen ions to saturate the carbon chain structure of oils, permitted the hardening of liquid oils into solid fats. Dehydration of castor oil enabled its utilization in the making of paint products. Fractionation permitted the division of oils into two or more components, each useful for specific purposes. But while technology extended the utilization of vegetable oils, it also developed competing nonvegetable products.

Some vegetable oils are interchangeable, and in the second half of the 20th century a rapidly expanding technology was making them even more so. Cottonseed oil may be substituted for coconut oil or soybean oil in many products, and safflower oil may be substituted for linseed oil. Dehydrated castor oil may function in place of tung oil in some paint mixtures. The effect of similarities in oils and of technological developments is to keep the prices of oils more or less the same, unless one is needed for a specific product.

In addition to their use as sources of oil, most of the oil crops have other commercial uses. Peanuts may be grown for their edible oil or they may be roasted and used as nuts or made into peanut butter. (*See* PEANUT.) Sunflower seeds often serve for similar purposes. The coconut is a staple food in many tropical areas. Soybeans may be grown as a vegetable, as a hay or as a soil-improvement crop. Flaxseed may be a by-product of the culture of flax for its fibre; the flax (linseed) varieties grown for oil are too short to give a satisfactory fibre for linen, but they are used in paper manufacture. The dried and highly coloured blossoms of safflower are used in some areas as a source of dye to colour cloth and foods. Sesame and poppy seeds are used for decoration and flavour in bakery products.

By-products.—The most important by-product of oilseeds is the residual meal or cake remaining after the extraction of the oil. Indeed, the value of the meal frequently determines the agricultural and commercial success of an oil crop. Usually the meal is used as a protein concentrate in feeding livestock and poultry. As a consequence the value of the meal is frequently measured by the protein content and quality. Where the residual meal is poisonous to animals, as it is with castor beans and tung nuts, it can be used only as an organic fertilizer. Considerable amounts of oilseed protein are also used for industrial purposes. Soybean meal is used in plywood adhesives, and an increasing amount of protein is utilized in the manufacture of synthetic fibres.

Improvements in Oil Plants.—Plant breeders are aiding the advance of some oil crops toward domestication. Castor beans, essentially a wild plant of tropical and semitropical areas, after 1940 rapidly moved toward the status of a cultivated crop; varieties that have nonshattering capsules, that are uniform for plant and seed size and that are much shorter than the wild types were developed. Improved sesame varieties that do not shatter also became available.

The area of adaptation of oil crops was in the meantime being extended. In the United States, for example, the area of soybean production increased in 20 years from about 1,500,000 ac. in 1924 to more than 27,000,000 ac. by the 1960s, mostly because adapted varieties were developed for many areas. The development of safflower varieties with high oil content and high yield permitted the establishment of this crop in the United States. Earlier maturity was developed in several oil crops, which promised to extend the area of production—a particularly important development for countries having a cool temperate climate.

Among the established oil crops seed yield and oil content were being increased to permit higher yields of oil per unit area. Where diseases became a problem, which was inevitable when large areas were grown to a single crop, efforts were required to develop resistant varieties. More attention was given to the fatty acid components in the oil of different varieties, since markets were becoming more specific in their requirements.

Trends in Production.—Production of vegetable oils increased about 50% between 1920 and 1950, much of this increase following the introduction of the plantation system in the Netherlands East Indies and the use of better varieties of oil palm.

There is a tendency for nations to try to become self-sufficient in their supply of vegetable oils. This tendency encouraged the increase in acreages of rape, sunflower and soybeans in Canada after World War II. Sunflowers became an important oil crop in Argentina and Chile. After 1930 the United States became increasingly self-sufficient in its supply of soybean and linseed oils. As tropical countries develop higher standards of living the supply of oil for export will decrease unless the acreages of oil crops are extended. It appeared likely, however, that the tropics would remain an important source of oils for export; yields of oil were high, and there were large areas of land in the tropics that could still be developed agriculturally.

See also agriculture sections of articles on individual producing countries.

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(P. F. K.)

OIL REFINING: *see* PETROLEUM.

OIL RESERVES SCANDAL (U.S.). The oil reserve scandal of the early 1920s, usually referred to as the "Teapot Dome" scandal, enmeshed certain high officials in the administration of Pres. Warren G. Harding in charges of corruption and misappropriation involving the nation's oil reserves. Pursuant to a 1910 act of congress, certain oil-bearing federal lands had been set aside and designated by the U.S. government as naval oil reserves. Reserve no. 1 embraced 38,000 ac. of public and private lands in Elk Hills, Calif. (1912); reserve no. 2 contained 30,000 ac. of public and private lands in the Buena Vista Hills, Calif. (1912); and reserve no. 3, Teapot Dome, Wyo., contained 9,321 ac. of public lands (1915). In an act of June 4, 1920, congress directed the secretary of the navy to conserve the properties and lease them if necessary for protection against drainage by adjoining private lands. The policy reflected by the acts and reserves was to "maintain a great naval petroleum reserve in the ground."

Soon after his inauguration, President Harding on March 5, 1921, appointed Albert B. Fall as secretary of the interior and Edwin Denby as secretary of the navy. On May 31, 1921, at the instance of Secretary Fall, President Harding signed an executive order transferring the administration of the naval petroleum reserves from the secretary of the navy to Fall as secretary of the interior. Secretary Fall thereafter entered secret negotiations with H. F. Sinclair of the Mammoth Oil company; on April 7, 1922 Fall issued, without competitive bidding, a lease covering all of the lands in reserve no. 3 (Teapot Dome) to the company, granting it the exclusive right to take and dispose of oil and gas from the reserve. No imminent danger existed that the oil would be lost by drainage. Secretary Fall in 1921 and 1922 also secretly negotiated contracts and leases with E. L. Doheny covering lands in reserves no. 1 and 2, executed in 1922 with the Pan American Petroleum and Transport company and the Pan American Petroleum company, both controlled by Doheny. All of these leases and contracts were also signed by Secretary of the Navy Denby, but the courts found that Denby was passive throughout and had signed under misapprehension and without full knowledge of their contents.

The leases and contracts came under investigation by committees of the U.S. senate, where it was disclosed that shortly after the signing of the Teapot Dome lease, Fall and members of his family received from an unknown source more than $200,000 in Liberty bonds under circumstances indicating that the bonds came from a company organized by Sinclair and others receiving benefit from the lease. Also, it appeared that prior to the execution of the Pan American contracts and leases, Doheny, at Fall's request, sent $100,000 in currency to Fall as a "loan" which had not been repaid.

On Feb. 8, 1924, a joint resolution passed by congress stated that it appeared from the evidence that the leases and contracts negotiated by Fall with Sinclair and Doheny were executed under circumstances indicating fraud and corruption, without authority on the part of the officers purporting to act for the United States and in defiance of the settled policy to maintain in the ground a great reserve supply of oil adequate to the needs of the navy. It declared the contracts and leases to be against the public interest and directed the president to institute suits to cancel them and to prosecute any civil or criminal actions that might be warranted.

Cancellation of the leases and contracts was later confirmed in separate cases by the U.S. supreme court. The court ruled that the leases and agreements were made fraudulently and that the executive order of May 31, 1921, transferring the administration of the reserves to the secretary of the interior was illegal. In criminal actions Doheny and Sinclair were acquitted of charges of bribery and criminal conspiracy, but Fall was convicted of accepting a bribe in connection with the Elk Hills lease and served a prison term.

(N. E.)

OILS, FATS AND WAXES, as they will be discussed in this article, occur in plants and animals as esters of alcohols and straight-chain carboxylic acids containing even numbers of 12 or more carbon atoms. They are insoluble in water and are oily or greasy to the touch. Fats and oils are esters (glycerides) of glycerol, a three-carbon, straight-chain alcohol with three hydroxyl groups. Waxes are esters of alcohols other than glycerol which contain, in most cases, only one hydroxyl group but occasionally two such groups. The wax alcohols are either (1) sterols such as cholesterol; or (2) straight-chain alcohols with even numbers of carbon atoms above 14, such as cetyl alcohol, $CH_3(CH_2)_{14}CH_2OH$. The carboxylic acids that occur in plant and animal oils, fats or waxes are called fatty acids.

The term oils is used in a generic sense to describe all substances that are greasy or oily fluids at ordinary temperatures. The term also can refer (1) to the individual fatty or fixed (*i.e.*, nonvolatile) oils such as olive or soybean oils; (2) to the hydrocarbon or mineral oils and derivatives such as petroleum, shale oils, oils from the low-temperature distillation of coal, fuel oils and lubricating oils; and (3) to the odoriferous volatile oils usually called essential oils, such as oil of cloves. The mineral or hydrocarbon oils (*see* COAL TAR; PARAFFIN HYDROCARBONS; PETROLEUM) and the volatile oils (*see* ESSENTIAL OIL) do not come within the scope of this article.

The information in the present article is supplemented by presentations in many other articles. For example, the article OIL PLANTS discusses the source and use of vegetable oils and many of their by-products. Separate articles will be found on many of

the individual oils, fats and waxes or their sources; *e.g.*, BEESWAX; BUTTERFAT; CASTOR OIL; COD-LIVER OIL; COPRA; COTTONSEED; LARD; LINSEED AND LINSEED OIL; OLIVE OIL; PEANUT; SAFFLOWER; SOYBEAN. Additional information on the chemistry of oils, fats and waxes appears in such articles as CARBOXYLIC ACIDS: *Specific Carboxylic Acids;* ESTERS; GLYCEROL; OLEIC ACID; PALMITIC ACID; STEARIC ACID.

Classification.—The substances considered here, as noted above, may be divided into two large classes: (1) oils and fats; and (2) waxes. The distinction between the two classes is based on their chemical composition. The oils and fats consist primarily of glycerides that are esters formed by the union of three molecules of fatty acids with one molecule of glycerol.

$$\begin{array}{l} CH_2OH \\ | \\ CHOH \\ | \\ CH_2OH \\ \text{Glycerol} \end{array} + \begin{array}{c} 3C_{15}H_{31}COOH \\ \\ \text{Palmitic acid} \end{array} \rightarrow \begin{array}{l} CH_2OCOC_{15}H_{31} \\ | \\ CHOCOC_{15}H_{31} \\ | \\ CH_2OCOC_{15}H_{31} \\ \text{Tripalmitin} \end{array}$$

Formation of a simple glyceride

Oils are usually liquid at ordinary temperatures, such as 25° C. (77° F.); fats are solid at this temperature. However, there is no basis for chemical distinction between the two. The difference is only a physical one that can be removed by changing the environment.

Use of the word fat to include both fats and oils is becoming common, especially among chemists. Thus, both soybean oil and tallow would be considered fats. This terminology avoids confusion with nonfatty oils. No sharp distinction can be made between fats and oils, because at sufficiently low temperatures all oils will solidify and at even moderately elevated temperatures all fats will liquefy. Moreover, a fat is never entirely solid except under unique circumstances. Fats have been defined as plastic solids consisting of a mixture of crystalline particles and liquid oil.

Lipid (lipide) is a much broader term that may be used to include all the ether-soluble, water-insoluble substances obtainable from plant and animal sources. W. R. Bloor's definition (1943) of lipids has been accepted generally in the United States. A modified and abbreviated form follows: (1) Simple lipids are esters of fatty acids and various alcohols, classified as (*a*) fats and oils, *i.e.*, glycerides (fatty acid esters of glycerol); and (*b*) waxes, *i.e.*, fatty acid esters of alcohols other than glycerol. (2) Compound lipids are esters of fatty acids and alcohols containing additional groups, divided into (*a*) phospholipids (phosphatides), *i.e.*, fatty acid esters containing a phosphoric acid group (they also usually contain a nitrogenous group); (*b*) glycolipids, *i.e.*, compounds that consist of fatty acids, a carbohydrate and a nitrogen-containing compound but no phosphoric acid group; and (*c*) others, such as sulfolipids and aminolipids. (3) Derived lipids are compounds derived from the preceding groups and having the general properties of the lipids; the derived compounds include (*a*) fatty acids; (*b*) alcohols, including glycerol, sterols and the long-chain alcohols from the waxes; and (*c*) others, such as some hydrocarbons like squalene found in fish livers, and nitrogenous bases from the phospholipids.

The fats comprise one of the three great classes of food. Nearly all cells contain fat, protein and carbohydrate. Fat is sometimes called nature's storehouse of energy because on a weight basis it contains more than twice as much energy as does carbohydrate or protein. It is probably as depots of concentrated energy that fats appear in plant reproductive organs such as pollen grains and seeds. It is this fat that man recovers from plants for use as food or in industry. The fat content of the nonreproductive tissue of plants is usually so low that recovery is impracticable. Yet much of man's dietary fat comes from natural foodstuffs without being separated from the other plant materials with which it occurs. The proportion of fat in these foodstuffs varies from 0.2% in white potatoes to 70% in some nut kernels.

More than 90% of the fat recovered in the world is obtained from about 20 species of plants and animals. Most of this separated fat is used eventually as human food. Consequently, fat technology deals largely with the separation and processing of fats into forms acceptable to the various dietary customs in the countries in which they are to be used.

History of Use.—Man has used many natural fats for both food and nonfood purposes since prehistoric times. The Egyptians, for example, used olive oil as a lubricant to aid the moving of heavy building materials. They also made axle greases from fat and lime mixed with other materials for use on chariots as early as 1400 B.C.

George Sarton in *Introduction to the History of Science* (1931) gives many examples of the early use of fats up to the middle ages. Homer mentioned oil as an aid to weaving and Pliny talked about hard and soft soaps. Candles and lamps using oil, tallow or beeswax have been used for thousands of years.

Waxes and oils that dried to hard films were used in protective or decorative coatings on walls and mummy cases, and as waterproofing agents on ships at early dates. The form of painting known as encaustic employed a mixture of pigments in natural waxes. Tempera, another early form of painting, might be considered a forerunner of the modern emulsion paints. It was a water emulsion of wax or oil and pigments stabilized with vegetable gums or egg yolk.

Apparently the first mention of the use of a drying oil as a protective coating was made by Aetius in about the 6th century A.D., when he commented that certain nut oils dry to form a protective coating. Following that period, the art grew rapidly. Transparent varnishes were made of linseed oil and natural resins. However, chemical driers were not used until much later when Hubert and Jan van Eyck reportedly used them in the early 15th century.

The primary basic uses of fats for nonedible purposes remain much the same as centuries ago although the efficiencies and proficiencies of use have improved. The commercial uses of fats have increased in number as understanding of the chemical nature of fats has expanded. K. W. Scheele discovered in 1779 that glycerol could be obtained from olive oil by heating it with litharge, but it was not until about 1815 that Michel Eugène Chevreul (1786–1889) proved the chemical nature of fats and oils, which he described in his classical work, *Recherches chimiques sur les corps gras d'origine animale* (1823, reprinted 1889). At about the same time (1819) J. J. E. Poutet isomerized oleic acid to elaidic acid, and C. A. Gusserow (1828) separated unsaturated liquid acids from the solid acids. After World War I organic chemists gained extensive knowledge first of fatty acid compositions and then of glyceride compositions. Growth of the chemical industry stimulated a simultaneous expansion of the use of fats as raw materials and as intermediates for scores of new chemicals. Modern application of many organic chemical reactions to fats and fatty acids formed the foundation of a new and rapidly growing fatty chemicals industry.

Functions in Plants and Animals.—The universal distribution of fats in plant and animal tissues suggests physiological roles that go beyond their function as a fuel supply for the cells. In animals the most evident function of fats is that of food reserve to supply energy (through subsequent enzymatic oxidation). The storage of fat in vegetable seeds can be similarly explained on the basis that it is a food reserve for the embryo. However, it is not so easy to account for the presence of large quantities of fat in the pericarp of such fruits as olives, avocados and palms; this fat is probably destroyed before the seed germinates.

Fats, and especially the waxes, fulfill other valuable functions in plants and animals. Subcutaneous deposits of fat insulate animals against cold because of the low heat transfer rate of fat, a property especially important for animals living in cold waters or climates, *e.g.*, whales, walruses and bears. Beeswax prevents dilution or contamination of concentrated sugar solutions in the comb. Waxes, and in some cases fats, secreted on the surface of plant leaves protect the underlying tissues against loss of or access of water. Apples, citrus fruits and melons have a natural protective wax coating.

Fats that have been separated from tissues always contain small quantities of closely associated nonglyceride lipids such as phospholipids, sterols, vitamins A, D and E, and various carotenes

and carotenoids. Many of these substances are vital emulsifying agents or growth factors. These minor constituents probably are present in the fats as a result of their physical solubility, and thus fats serve as carriers for these substances in animal diets.

Many animals require some fat containing one or more of the essential fatty acids (linoleic, linolenic and arachidonic) to prevent the physical symptoms of essential fatty acid deficiency manifested by skin lesions, scaliness, poor hair growth and low growth rates. The so-called essential fatty acids must be supplied in the diet since they cannot be synthesized in the body.

Synthesis and Metabolism in Living Organisms.—Formation of fats in seeds and fruits occurs late in the ripening process. Sugars and starches predominate in fruits, seeds and sap in the unripe condition. These apparently are converted by enzymatic direction during the maturing process to fatty acids and glycerol, which then form glycerides. Studies with radioactive tracer techniques confirmed the synthesis of fats from carbohydrates in both plants and animals. In fact, it was shown by the use of labeled acetate that any food source from which acetate may form as an intermediate metabolite can thus be converted to fatty acids in at least some animal tissues. It was further demonstrated that acetate can be converted to cholesterol in animal tissue. It is noteworthy that, almost without exception, natural fats contain only fatty acids with an even number of carbon atoms. These acids apparently are built up of two-carbon units. Although the preponderance of 18-carbon fatty acids had suggested the hypothesis that fats are derived from the C_{18} nucleus of polysaccharides or perhaps from three molecules of glucose, discoveries through tracer studies seem to indicate the build-up from the two-carbon acetate units. Since acetate can be formed in oxidative processes from fats, proteins or carbohydrates, it is thus possible for fats to be synthesized indirectly from any of these sources. The formation of double bonds in the fats synthesized from acetate is accomplished (probably in the liver) by various enzymatic dehydrogenation and hydrogenation systems.

Utilization of stored fat by plant embryos had not been entirely explained by the 1960s. However, it was found that in germinating embryos the glycerides are hydrolyzed by lipolytic (fat-splitting) enzymes to glycerol and fatty acids. These may pass through two- and four-carbon oxidative processes to form intermediate metabolic products that can be oxidized further to carbon dioxide and water or can be converted to carbohydrates, which may then pass through the many steps of carbohydrate metabolism.

In animal digestive tracts, the fats in foods are emulsified with digestive secretions containing lipase, which hydrolyzes at least part of the glycerides. The glycerol, partial glycerol esters, fatty acids and some glycerides then are absorbed through the intestinal epithelium and are at least partially recombined to form glycerides and phospholipids. The fat, in the form of microscopic droplets, or chylomicrons, is transported in the blood and chyle to points of use or storage. The fat of an individual animal may vary according to the composition of fats in the food. For instance, body fats of swine that were fed cod-liver oil had soft fats characteristic of the diet, and cows receiving coconut oil or fish oil produced milk fats similar to the dietary sources. Fats used by or stored in animal tissues come from two sources—diet and enzymatic synthesis. Thus, the endogenous fat enzymatically synthesized from carbohydrates or proteins is characteristic of the species of animal, whereas, the exogenous fat resynthesized from the food fats is characteristic of the dietary fat. Mammary glands apparently have enzymatic systems that can produce fats quite different from those stored in adipose tissue. Even so, milk fats still can reflect characteristics of ingested fats.

The manner in which fat reserves are circulated to the organs where metabolism occurs is incompletely understood. Radioactive tracer studies provided some insight into this complicated process. It has long been established that when mobilization of reserve fat takes place the stream is directed primarily to the liver, where fatty acids may be partially desaturated; *i.e.*, hydrogen is removed from the fatty acid chains to produce unsaturated linkages. This facilitates subsequent oxidation in other tissues. Fatty acids also may be oxidized directly in the various tissues as well as in the liver. Fatty acid metabolism is presumed to be by oxidation in successive two- and four-carbon stages. Intermediate products could be acetoacetate and acetate groups. If the mechanism is faulty, acetone is formed and excreted (acetonuria). The final products of normal metabolism are carbon dioxide and water. (*See* also BIOCHEMISTRY: *Fats and Amino Acids*; METABOLISM: *Fats*.)

Chemical Composition of Fats.—Although natural fats consist primarily of glycerides, they contain many other lipids in minor quantities. For example, corn oil may contain glycerides plus phospholipids, glycolipids, phosphoinositides (phospholipids containing inositol), many isomers of sitosterol (a plant steroid), several tocopherols (vitamin E), vitamin A and dozens of carotenoids and chlorophyll compounds, as well as many products of decomposition, hydrolysis, oxidation and polymerization of any of the natural constituents.

Since the glycerides, which make up 90% to 99% of most individual fats or oils of commerce, are esters formed by three fatty acid molecules combining with one molecule of glycerol, they may differ not only in the fatty acids that they contain but also in the arrangement of the fatty acid radicals on the glycerol moiety. Simple triglycerides are those in which each molecule of glycerol is combined with three molecules of one acid, *e.g.*, tripalmitin, $C_3H_5(O{\cdot}CO{\cdot}C_{15}H_{31})_3$, the glyceryl ester of palmitic acid, $C_{15}H_{31}COOH$. Only a few of the glycerides occurring in nature are of the simple type; most are mixed triglycerides; *i.e.*, one molecule of glycerol is combined with two or three different fatty acids. Thus, stearodipalmitin, $C_3H_5(O{\cdot}CO{\cdot}C_{15}H_{31})_2(O{\cdot}CO{\cdot}C_{17}H_{35})$, contains two palmitic acid radicals and one stearic acid radical. Likewise, oleopalmitostearin, $C_3H_5(O{\cdot}CO{\cdot}C_{15}H_{31})(O{\cdot}CO{\cdot}C_{17}H_{33})(O{\cdot}CO{\cdot}C_{17}H_{35})$, contains one radical each of oleic, palmitic and stearic acids. Each mixed triglyceride containing three different acid radicals has three different isomeric forms depending on which acid is linked with the centre carbon

TABLE I.—*Common Fatty Acids*

Common name	Systematic name	Formula	Carbon atoms	Double bonds
Caprylic	Octanoic	$C_7H_{15}COOH$	8	0
Capric	Decanoic	$C_9H_{19}COOH$	10	0
Lauric	Dodecanoic	$C_{11}H_{23}COOH$	12	0
Myristic	Tetradecanoic	$C_{13}H_{27}COOH$	14	0
Palmitic	Hexadecanoic	$C_{15}H_{31}COOH$	16	0
Stearic	Octadecanoic	$C_{17}H_{35}COOH$	18	0
Arachidic	Eicosanoic	$C_{19}H_{39}COOH$	20	0
Oleic	9 Octadecenoic	$C_{17}H_{33}COOH$	18	1
Linoleic	9,12 Octadecadienoic	$C_{17}H_{31}COOH$	18	2
Linolenic	9,12,15-Octadecatrienoic	$C_{17}H_{29}COOH$	18	3
Eleostearic	9,11,13-Octadecatrienoic	$C_{17}H_{29}COOH$	18	3
Ricinoleic	12 OH,9 Octadecenoic	$C_{17}H_{32}OCOOH$	18	−OH+1
Arachidonic	5,8,11,14-Eicosatetraenoic	$C_{19}H_{31}COOH$	20	4

(β-position) of the glycerol molecule and which acids are in the outside (α or α') positions. Similarly, each mixed triglyceride containing two radicals of one acid and one radical of a second acid has two isomeric forms.

Monoglycerides and diglycerides have only one or two fatty acid radicals, respectively, and are seldom found in natural fats except as the products of partial hydrolysis. However, they are easily prepared synthetically and have important applications mainly because of their ability to aid in the formation and stabilization of emulsions. As constituents of shortening in baked products they increase loaf volumes and retard staling.

The characteristics of glycerides are determined by their component acids. In considering the composition of a glyceride it is particularly important to distinguish between the saturated acids (such as palmitic or stearic, which have relatively high melting temperatures), and the unsaturated acids (such as oleic or linoleic, which are low melting and chemically much more reactive because of their double bonds). (For a discussion of the difference between saturation and unsaturation *see* HYDROCARBON: *General Structure*.)

The glyceride composition of natural fats tends to follow the rule of even distribution developed by T. P. Hilditch and his

TABLE II.—*Saturation and Unsaturation in Fatty Acids*

CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-$COOH$
Lauric acid
(A saturated fatty acid with 12 carbon atoms)
$CH_3(CH_2)_7CH=CH(CH_2)_7COOH$
Oleic acid
(An unsaturated fatty acid with one double bond and 18 carbon atoms)
$CH_3(CH_2)_4CH=CHCH_2CH=CH(CH_2)_7COOH$
Linoleic acid
(An unsaturated fatty acid with two double bonds and 18 carbon atoms)
$CH_3CH_2CH=CHCH_2CH=CHCH_2CH=CH(CH_2)_7COOH$
Linolenic acid
(An unsaturated fatty acid with three double bonds and 18 carbon atoms)
$CH_3(CH_2)_4CH=CHCH_2CH=CHCH_2CH=CHCH_2CH=CH(CH_2)_3COOH$
Arachidonic acid
(An unsaturated fatty acid with four double bonds and 20 carbon atoms)

associates, who proposed that each of the individual fatty acid radicals in a fat is apportioned evenly among the different glyceride molecules. Consequently, specific acids present in quantities less than one-third of the total acids are inclined to appear singly in the glycerides, and it is necessary to have an acid present in a quantity greater than two-thirds of the total acids before any simple triglycerides would be present. Vegetable seed fats tend to follow this rule much more closely than do animal fats. The latter even tend to have their saturated acids closely grouped. Beef tallow may contain 15% of simple fully saturated triglycerides even though it contains only 55% of saturated fatty acids.

Some fats tend to follow the pattern of random distribution of fatty acids in their glycerides. In this pattern, the acids are distributed among the glycerides as if there were no directing influences and they had organized themselves by chance alone. Fats that are heated in the presence of certain alkaline catalysts, such as sodium methylate (sodium methoxide), "rearrange" themselves to follow more closely the system of random distribution. Physical properties are often significantly altered. For example, some shortening manufacturers in the United States rearrange the molecules in lard and other fats to make improved shortenings.

Physical and Chemical Properties.—Fats and oils may be divided into animal and vegetable fats according to source. Further, they may be classified according to their degree of unsaturation as measured by their ability to absorb iodine at the double bonds. This degree of unsaturation determines to a large extent the ultimate use of the fat as shown in Table III. Oils having iodine values higher than about 150 (and therefore a high degree of unsaturation) are generally called drying oils and are used primarily in protective coatings Those having iodine values of 100 to 150 are considered as semidrying and may be used either for food or in protective coatings. The nondrying oils, with the lowest amount of unsaturation, have iodine values generally below 100 and are used mainly in foods, soaps, chemicals and specialty products.

As indicated in Table III, liquid fats (*i.e.*, vegetable and animal oils) have the highest degree of unsaturation, while solid fats (vegetable and animal fats) are highly saturated. The degree of unsaturation in fatty acids used as foods drew wide attention in the 1960s because of the possible relationship between saturated fats, cholesterol and atherosclerosis. Some authorities suggested that the amount of unsaturated fats in the diet should be increased as a means of reducing the incidence of atherosclerosis. Dietary interest was focused on the polyunsaturated fatty acids—those with two or more double bonds in each molecule. The chief polyunsaturated acids considered in this connection were linoleic (two double bonds), linolenic (three) and arachidonic (four). The oils with the highest ratios of polyunsaturated to saturated (P/S ratio) acids are, in decreasing order, safflower, corn, cottonseed and soybean.

Solid vegetable fats melting between 20° and 35° C. are found mainly in the kernels and seeds of tropical fruits. They have relatively low iodine values and consist of glycerides containing high percentages of saturated acids such as lauric, myristic and palmitic. Fats from fruits of many members of the palm family, notably coconut and babassu oils, contain large amounts of combined lauric acid. Most animal fats are solid at ordinary temperatures; milk fats are usually characterized by the presence of short-chain carboxylic acids (butyric, caproic and caprylic).

Specific gravities of oils and fats range from 0.913 (rape oil) to 0.975 (Japan wax, myrtle wax); for most fats the value is 0.915 to 0.945. Some oils that contain acids with asymmetric carbon atoms, notably those of the castor oil and chaulmoogra groups, rotate the plane of polarized light.

Fats are practically insoluble in water and, with the exception of castor oil, are insoluble in cold alcohol and only sparingly soluble in hot alcohol. They are soluble in ether, carbon disulfide, chloroform, carbon tetrachloride, petroleum benzin and benzene. Oils and fats have no distinct melting points or solidifying points because they are such complex mixtures of glycerides having dif-

TABLE III.—*Sources, Iodine Value and Uses of Principal Oils and Fats*

Oil or Fat	Principal sources of raw material	Iodine value	Principal uses
Vegetable Oils			
Drying oils			
Perilla	China, Korea, Japan, India	193–208	Paint, varnish
Linseed	Argentina, India, North America, U.S.S.R.	175 205	Paint, varnish, linoleum, printing ink
Tung	China, Japan, U.S.	160–175	Paint, varnish
Oiticica	Brazil	139–155	Paint, varnish
Semidrying oils			
Poppyseed	Levant, India	123–143	Salad oil, artists' oil, soft soap
Safflower	U.S., India	130–150	Salad oil, paints, resins
Soybean	U.S., China, Manchuria	125–140	Food, paint, resins, chemicals
Maize (corn)	U.S., Argentina, Europe	115–130	Food
Sunflower	South America, U.S.S.R.	120–140	Food
Cottonseed	U.S., India, Egypt, Mexico	100 116	Food, soap
Sesame	India, etc., Egypt, Levant	103–118	Food, soap
Rape (colza)	E. India, Europe	94–102	Food, lubricant
Nondrying oils			
Almond	S. Europe, N. Africa	93–100	Perfumery, pharmacy, food
Arachis (peanut)	India, W. Africa, China, U.S.	85 100	Food
Olive	Mediterranean countries, U.S.	75–95	Food, soap, lubricating, pharmacy
Castor	E. India, Mediterranean, Brazil, U.S.	80–90	Medicine, lubricant, chemicals
Animal and Marine Oils			
Marine oils			
Sardine	West coast of North America, Japan	170–190	Resins, leather currying, linoleum, paints, food
Menhaden	Atlantic coast of North America	140–173	
Herring	North Sea, Japan	120 145	Leather currying, paints, food
Cod liver	North Sea, E. coast North America	120–180	Vitamins, leather currying
Shark liver	Coasts of North America	100 115	Vitamins, leather currying
Seal	Arctic and Antarctic seas	127–147	Food, leather currying, soap
Whale	Arctic and Antarctic seas	110–150	Food, soap, fibre dressing, leather currying, greases
Dolphin, jaw and body oils	. . . .	33, 99–126	Lubricating oil for delicate machinery
Porpoise, jaw and body oils	. . . .	36, 119	
Terrestrial animal oils			
Neat's-foot	U.S., South America, Europe	65–75	Lubricating, high-grade leather dressing
Vegetable Fats			
Mahua (Illipé) butter	India, Malaya	53–67	Food, soap, candles
Shea butter	W. Africa, Sudan	53–65	Food, soap, candles
Palm oil	W. Africa	50–60	Soap, candles, tinplate industry
Cacao (cocoa) butter	W. Indies	32–41	Chocolate, pharmacy, perfumery
Babassu oil	W. Africa	9–18	Food, soap
Coconut oil	Philippine Islands, E. Indies, Ceylon, Oceania, South American coasts	8–10	Food, soap, chemicals
Japan wax	China, India, Japan	5–17	Polishes
Animal Fats			
Lard	U.S., Central Europe	45 70	Food, soap, pharmacy, chemicals
Bone	U.S., India, Europe	46–56	Soap, candles
Tallow, beef	Argentina, U.S.	30–45	Food, soap, candles, chemicals
Tallow, mutton	Australasia	25–45	Food, soap
Butter	U.S., N.W. Europe, Australasia, Canada	25–40	Food

TABLE IV.—*Fatty Acid Composition of Certain Fats and Oils*
(Numbers represent percentage by weight of total fatty acid content)*

Fatty acids	Normally Solid Fats								Vegetable Oils														Marine oils		
	Vegetable				Animal				Nondrying					Semidrying					Drying						
	Coconut	Palm	Babassu	Cocoa butter	Butter	Lard	Beef tallow	Mutton tallow	Olive	Castor	Peanut	Rape	Sesame	Cottonseed	Corn	Sunflower	Soybean	Safflower	Oiticica	Perilla	Linseed	Tung	Whale	Fish	Seal
Caprylic	5–10		4–7		1–2																				
Capric	5–11		3–6		2–3																				
Lauric	45–50		44–46		2–5																				
Myristic	18–20	1–3	15–20		8–15	1–2	2–6	1–4	1			1		1–2	1–2	1–2	1–2	1					4–9	6–8	3–5
Palmitic	5–10	35–43	6–9	25–30	25–30	25–30	24–33	20–28	5–15		17–12	1	6–8	18–25	7–11	5–8	6–10	5–7	6–8	3–6	4–6	4–6	10–20	10–26	8–18
Stearic	1–4	3–5	3–5	30–35	9–11	12–18	14–29	25–33	1–4	1	2–6	1–2	2–5	1–2	3–4	3–5	2–4	1–2	4–6	2–5	2–3	2–3	2–4	1–3	1–3
Arachidic											1–3		1								1				
Oleic	6–8	34–56	14–19	35–40	18–32	47–58	35–45	26–47	67–83	6–10	30–58	25–30	45–50	17–37	25–45	15–30	20–30	10–23	4–6	4–11	13–28	4–10	33–38		
Linoleic	1–3	9–11		2–4	2–4	6–13	1–3	3–5	7–12	4–5	21–37	14–15	40–45	44–55	50–57	50–75	50–58	69–79		31–45	15–22	8–15			
Linolenic						1	1					1–4					4–9			44–50	46–61				
Eleostearic																						71–82			
Ricinoleic										85–90															
Arachidonic						1	1	1–2																	
Other	1–2	1–2	1–2		10–15	2	1	2	1	1–2	2–3	†	2–3	1–2	1–2	1–2	1–2		‡				§	‖	

*These are typical data compiled from many sources; specific analyses vary considerably depending on the source of the fat or oil.
†43%–57% erucic acid. ‡73%–83% licanic acid. §13%–18% palmitoleic, 10%–20% C_{20}, 5%–12% C_{22} unsaturated acids. ‖High percentages of C_{18}, C_{20} and C_{22} acids with two, four and six double bonds.

ferent melting points. Glycerides themselves, further, have several polymorphic forms with different melting or transition points. The freezing points of the oils range from a few degrees above zero to about 30° C. below zero. At low temperatures (*e.g.*, 12° C. for cottonseed oil), solid portions, termed tristearin, or stearin, separate from many oils. The tristearin is filtered or settled out; the clear fraction, which will remain limpid at low temperatures, is called winter oil, or winterized oil.

Fats can be heated to between 200° and 250° C. without undergoing significant changes provided contact with air or oxygen is avoided. On being heated above this temperature the more unsaturated oils gradually polymerize and become considerably more viscous. When this is done commercially in the protective coating industry it is called bodying. Castor oil, when heated to high temperature or under suitable conditions in the presence of catalysts, loses a molecule of water from each ricinoleic acid radical to form what is called dehydrated castor oil. Above 300° C. fats may decompose with the formation of acrolein (decomposition product of glycerol), which has the pungent odour of burning fat. Hydrocarbons also may be formed at high temperatures.

On exposure to air, oils and fats gradually undergo certain changes. The drying oils absorb oxygen (dry) and polymerize readily; thin layers form a skin or protective film. The semidrying oils absorb oxygen more slowly and are less useful as paint oils; still, sufficient oxygen is absorbed in time to produce distinct thickening and some film formation. Oxidation of the semidrying oils is accelerated by spreading the oil over a large surface; on greasy cloths, for example, oxygen absorption may proceed so rapidly that spontaneous combustion ensues. The nondrying oils, of which olive oil is typical, do not oxidize readily on exposure to air although changes do take place gradually, including slow hydrolysis (splitting to fatty acids and glycerol) and subsequent oxidation. This slow oxidation causes disagreeable smell and taste described by the term rancidity. The chemical reactions involved have been widely studied. Numerous antioxidants (*q.v.*) retard the oxidation leading to rancidity.

Fats are readily hydrolyzed. This property is extensively used in the manufacture of soaps and in the preparation of fatty acids for industrial applications. Fats are hydrolyzed by treatment with water alone under high pressure (corresponding to a temperature of about 220° C.) or with water at lower pressures in the presence of caustic alkalies, alkaline earths or basic metallic oxides that act as catalysts. Free fatty acids and glycerol are formed. If sufficient alkali is present to combine with the fatty acids, the corresponding salts (known popularly as soaps) of these acids are formed, such as the sodium salts (hard soap) or potassium salts (soft soaps). (For detailed descriptions of the methods employed in commercial hydrolysis, *see* CANDLE; SOAP.)

Extraction.—Fats may be recovered from oil-bearing tissues by three general methods with varying degrees of mechanical simplicity: (1) rendering; (2) pressing with mechanical presses; and (3) extracting with volatile solvents.

Rendering.—The crudest method of rendering oil from oleaginous fruits, still practised in some countries, consists of heaping them in piles, exposing them to the sun and collecting the oil that exudes. In a somewhat improved form this process is used in the preparation of palm oil; the fresh palm fruits are boiled in water and the oil is skimmed from the surface. Such processes can be used only with seeds or fruits (such as olive and palm) that contain large quantities of easily released fatty matter. The rendering process is applied on a large scale to the production of animal fats such as tallow, lard, bone fat and whale oil. It consists of cutting or chopping the fatty tissue into small pieces, which are boiled in open vats or cooked in steam digesters. The fat is gradually liberated from the cells and floats to the surface of the water, where it is collected by skimming. The membranous matter (greaves) is separated from the aqueous (gluey) phase by pressing in hydraulic or screw presses; additional fat is thereby obtained. The residue is used for animal feed or fertilizer.

Pressing.—With many oil-bearing seeds and nuts, rendering will not liberate the oil from the cellular structures in which it is held. In these cases the cell walls are broken by grinding, flaking, rolling or pressing under high pressures to liberate the oil. Many different mechanical devices have been used. The most primitive method was to crush seed in mortars until the oil exuded. The lever and wedge, one step more advanced and employed for centuries, are still used in some primitive places. The Romans developed a screw press, which Pliny described, for the production of olive oil. Centuries ago, the Chinese employed the same series of operations followed in modern pressing mills, viz., bruising or grinding the seeds in stone mills, heating the meal in open pans, then pressing out the oil in a wedge press. The Dutch or Stamper press invented in the 17th century was used almost exclusively in Europe for pressing oilseeds until the early part of the 19th century, when the hydraulic press was developed. The modern screw press replaced many of the hydraulic presses because it is a continuous process, has greater capacity, requires less labour and will generally remove more oil.

The general sequence of modern operations in pressing oilseeds, nuts, etc., is as follows: (1) remove all loose metal by passing the seeds over magnetic separators; (2) decorticate where necessary and remove the shells or hulls; (3) convert the kernels or meats to coarse meal by grinding between grooved rollers or with special types of hammer mills; and (4) press in hydraulic or screw presses with or without preliminary heating, depending on the type of oil-

bearing material and the quality of oil desired. Oil expressed without heating contains the least amount of impurities and is often of edible quality without refining or further processing. Such oils are known as cold-drawn, cold-pressed or virgin oils. Pressing the coarse meal while it is heated removes more oil and also greater quantities of nonglyceride impurities such as phospholipids, colour bodies and unsaponifiable matter. Such oil is more highly coloured than cold-pressed oils. Residual meals are generally used for cattle feed or fertilizer.

Solvent Extraction.—Cakes obtained by pressing operations still retain 3% to 15% of residual oil. In cases where the value of the oil is considerably greater as oil than as a part of the meal, it is desirable to obtain more complete extraction with solvents. Modern commercial methods of solvent extraction use volatile purified hydrocarbons, especially the various grades of petroleum benzin (commonly known as petroleum ether, commercial hexane or heptane). The use of chlorinated solvents to decrease the fire and explosion hazard did not prove satisfactory. Trichloroethylene was used in several plants until it was found that it reacted with some meals, *e.g.*, soybean meal, and made them toxic to some animals. In large-scale operations solvent extraction is a more economical means of recovering oil than is mechanical pressing. In the United States there are many instances of simple petroleum benzin extraction of seeds, mainly soybeans. For seeds or nuts containing a higher oil content than soybeans it became customary to press the material in screw presses to remove a large proportion of the oil before extraction. Prepressing also ruptures the cellular structures of oil-bearing materials so that most of the residual oil is easily removed with solvents.

A typical extraction system consists of (1) removing hulls or cortex in cracking, aspirating or screening operations; (2) cracking or rough grinding the kernels, meats or prepressed cake; (3) flaking the small pieces between smooth flaking rolls; (4) extracting the oil with solvent; (5) separating the meal, or marc, from the oil-solvent solution, called miscella; and (6) removing the solvent from both the oil and the marc. The marc may be toasted or pelletized, or both, for use in animal feeds. Most extracted meals contain less than 1% of residual oil. The percentage varies depending upon the amount of prepressing, the type of material being extracted and the efficiency of the extracting system.

An interesting combination of solvent extraction and rendering is the azeotropic rendering process. In this process, a chlorinated solvent is mixed with wet fresh tissue and the mass is heated to the boiling point of the azeotropic mixture of solvent and water. When condensation occurs, the azeotrope separates; water is drawn off and the solvent is returned to the extraction system. The resulting product consists of a dry (low moisture) extracted meal and miscella containing most of the fat. The high cost of chlorinated solvents proved a disadvantage, but the process possesses promising potentialities because of its ability to prepare extracted animal or fish meals that have not been subjected to high temperatures.

Processing.—The extent of processing applied to fats depends upon their source, quality and ultimate use. Many fats are used for edible purposes after only a single processing step—*i.e.*, clarification by settling or filtering. Most cold-pressed oils (for example, cold-pressed olive, peanut and some coconut oils) can be used in food products without further processing. Tremendous quantities of butter and lard are used without special treatment after churning or rendering. However, the growing demand for bland-tasting and stable salad oils and shortenings led to extensive processing techniques. But, in the less industrialized countries processing often is limited by lack of facilities and added costs.

Refining.—The nonglyceride components contribute practically all of the colour and flavour to fats. In addition, such materials as the free fatty acids, waxes, colour bodies, mucilaginous materials, phospholipids and gossypol (a yellow pigment found only in cottonseed oil) contribute other undesirable properties in fats used for edible purposes and to some extent for industrial applications. Many of these can be removed by treating the fats at 40° to 85° C. with an aqueous solution of caustic soda (sodium hydroxide) or soda ash (sodium carbonate). The refining may be done in a tank (in which case it is called batch or tank refining) or in a continuous system. In the former system the aqueous emulsion of soaps formed from free fatty acids along with other impurities (soapstock) settles to the bottom and is drawn off. In the continuous system the emulsion is separated with centrifuges. After the fat has been refined, it is usually washed with water to remove traces of alkali and soapstock. Oils that have been refined with soda ash or ammonia generally require a light rerefining with caustic soda to improve colour. After water-washing, the oil may be dried by heating in a vacuum or by filtering through a dry filter aid material. The refined oil may be used for industrial purposes or may be processed further to edible oils. Usually, the refined oils are neutral (*i.e.*, neither acidic nor alkaline), free of material that separates on heating (break material), lower in colour, less viscous and more susceptible to rancidity.

Other refining techniques that have been employed include the use of sulfuric acid instead of alkaline agents. This technique removes or destroys many of the impurities in the oils without removing the free fatty acids. For industrial oils, such as linseed oil, that are not required to be low in fatty acids, acid refining is sometimes advantageous. Steam refining, consisting of blowing clean steam through oil at high temperature and under vacuum, may sometimes be used on oils, such as coconut oil, that contain few phospholipids or other impurities; or it may be used on oils that have been treated with acetic anhydride to remove the phospholipids and other impurities. Steam blowing removes most of the free fatty acids. Other refining agents that have been used include petroleum benzin, ammonia, magnesium and calcium oxides, ion exchange resins and certain organic bases.

Water refining, usually called degumming, consists of treating the natural oil with a small amount of water followed by centrifugal separation. It is applied to many oils that contain phospholipids in significant amounts. Its purpose may be to recover the phospholipids or to degum the oil, or both. Phospholipids from oils such as corn (maize) and soybean oils may be dried (commercially, these products are called lecithin) and used as emulsifiers in such products as margarine, chocolate products and emulsion paints. The degummed oil may be used directly in industrial applications, such as in paints or alkyd resins, or refined with alkalies for ultimate edible consumption.

Bleaching.—In cases where further colour removal is desired, the fat may be treated with any of dozens of chemical and physical bleaching agents. Chemical treatments include the use of air and light, sodium dichromate and acid, permanganates, hypochlorites, metallic persalts and peroxides. They are not usually used on products destined for edible purposes. Physical adsorption methods involve treating hot oils with activated carbons, fuller's earths or activated clays. Many impurities including chlorophyll and carotenoids are adsorbed onto the agents and removed by filtration. Bleaching by any of these means reduces the resistance of oils to rancidity. When many oils are heated to more than 175° C., a phenomenon known as heat bleaching takes place. Apparently the heat decomposes some pigments, such as the carotenoids, that are present.

Destearinating or Winterizing.—It is often desirable to remove the traces of waxes (probably cuticle wax from seed coats) and the higher-melting glycerides from fats. Waxes can generally be removed by rather rapid chilling and filtering. Separation of tristearin, or stearin, usually requires very slow cooling in order to form crystals that are large enough to be removed by filtration. Thus linseed oil may be winterized to remove traces of waxes that otherwise interfere with its use in paints. Tristearin may be removed from fish oils to separate the solid glycerides that would detract from its use in paints and alkyd resins. At the same time, fish tristearin is more suitable than whole oil for edible purposes. Cottonseed and peanut oils may be destearinated to produce salad oils that remain liquid at low temperatures. Tallows and hydrolyzed animal fats may be destearinated for simultaneous production of hard fats (high in stearic acid content for special uses such as in making candles) and of liquid oil called oleo oil.

Hydrogenation.—For most edible purposes and for some com-

mercial applications it is desirable to produce solid fats. Many shortenings and margarines contain hydrogenated (hardened) oils as their major ingredients. The development of margarine and shortening products resulted from the invention by Wilhelm Normann of a successful method for converting low-melting unsaturated fatty acids and glycerides to higher-melting saturated products. The process consists of the general reaction discovered by P. Sabatier and J. B. Senderens of the addition of hydrogen in the presence of a catalyst to the double (unsaturated) bonds. Thus, oleic or linoleic acid (or their acid radicals in glycerides), which are normally liquid at room temperature, can be converted to stearic acid or the acid radical by the addition of hydrogen.

In commercial practice, hydrogenation is usually carried out with vigorous agitation or hydrogen dispersion with a narrow range of catalyst concentration (about 0.05% to 0.10% of finely divided nickel suspended on kieselguhr, or diatomaceous earth) in a steel pressure reacting vessel. The ordinary ranges of temperature and pressure are 100° to 200° C. and 0 to 60 lb. per square inch, respectively. These conditions can be controlled to make the hydrogenation reaction somewhat selective; *i.e.*, to add hydrogen to the linolenic (three double bonds) and linoleic (two double bonds) acid radicals before adding to the oleic (one double bond) acid radicals. The most unsaturated fatty acid groups are most easily hydrogenated and thus react first with the hydrogen if conditions are right. In cases where very hard fats with low amounts of unsaturation are desired and selectivity is unimportant, higher temperatures and pressures are employed to shorten the reaction time and to use partially spent catalyst that would otherwise be wasted. After hydrogenation the hot oil is filtered to remove the metallic catalyst for either reuse or recovery.

During the catalytic treatment another reaction also takes place —the isomerization of unsaturated fatty acid radicals to form iso-oleic, isolinoleic, etc., groups. These isomers have higher melting points than do the natural acids. Thus they contribute to the hardening effect. They can be detected by infrared analysis but not by determination of iodine value. (*See* also HYDROGENATION; MARGARINE.)

Uses.—It is virtually impossible to enumerate in detail the many applications of fats. However, in Table III the principal uses of some typical oils and fats are given. Most of the high-quality fats can be and are used for edible purposes such as margarine, shortenings, cooking fats and salad oils. The next largest use for fats is for soap. However, after World War II synthetic detergents manufactured from petroleum products supplanted much of the soap, especially in the United States. Some hard fats, tallows and beeswax are still used in candle manufacture, but petroleum waxes also took over a large share of candle production. Considerable quantities of specialty oils and sulfonated oils are used in leather dressing and textile manufacture. Some oils have properties of medicinal value. For example, castor oil has a strong purgative action; fish liver oils are sources of vitamins A and D; and others such as lard, olive oil and almond oil serve as vehicles in pharmaceutical preparations. Linseed, tung and other drying oils and large quantities of soybean oil are used in paints, varnishes, linoleums (linseed, mainly) and alkyd resins. The latex emulsion paints containing products derived principally from petroleum oil began to find widespread acceptance for interior finishes in the U.S. in the late 1940s. This trend, which spread to other countries in the 1950s and included emulsion paints for outside use, displaced large volumes of the drying oils in protective coatings. Competition of products from petroleum encouraged (and forced) the development of new products and new markets for glyceride oils. Among the new derivatives were drying oil products that could be thinned with water.

A new industry based on the manufacture of chemicals from fats was started just prior to World War II and grew rapidly after the war. Fats were hydrolyzed to glycerol and their fatty acids fractionated by vacuum distillation, by solvent segregation or by both. This made available commercial quantities of relatively pure single fatty acids. From the fatty acids dozens of products such as long-chain alcohols, amines, amides, esters, nitriles and ketones were made. These chemicals could be used for many applications directly or as chemical intermediates in the manufacture of other products such as detergents, plasticizers, special lubricating oils, polyamide resins and special thixotropic (gel) paints. Other modifications of the glycerides themselves through such chemical processes as epoxidation, copolymerization, rearrangement, chlorination, vinylation and acetylation promised more new industrial products.

Production.—The principal countries and regions producing various oil-bearing materials (seeds, nuts, etc.) are given in Table III. In many cases the fats are not extracted in the countries of origin; instead, the raw materials are exported. Thus, Marseilles became a centre for coconut oil trade; Liverpool, Hull and Hamburg-Harburg developed into centres of oilseed expression, etc. However, the development of industry in tropical countries and the high cost of transportation led to increased production of oils and fats in the countries of origin. Statistics on world production of oil-bearing materials and extracted oils are sometimes incomplete, but data are available in the publications of Frank Fehr and Co. (*Annual Review of Oilseed and Oil Markets*, the Congress of International Association of Seed Crushers, the U.S. department of agriculture, the Food and Agriculture Organization of the United Nations and trade returns of various countries.

Waxes.—Waxes differ from fats chemically in that they are fatty acid esters of monohydroxy alcohols instead of glycerol. A few are esters of dihydroxy alcohols. Moreover, their physiological function as a protective coating on cuticles of leaves and fruit appears to be different from that for fats because waxes rarely occur as cell constituents. The waxes are difficult to saponify in contrast with the relative ease of saponification or hydrolysis of glycerides. Many of the waxes melt at high temperatures (*i.e.*, between about 35° and 100° C.) and form hard films that can be polished to a high gloss; therefore, they are used in many kinds of polishes. Their other physical properties are similar to those of the fats. They are soluble in the same solvents and leave grease spots on paper.

TABLE V.—*Some Alcohols and Fatty Acids Found in Natural Waxes*

Name	Formula	Wax
Palmitic acid	$C_{15}H_{31}COOH$	Spermaceti, beeswax, Japan wax
Cerotic acid	$C_{25}H_{51}COOH$	Beeswax, montan wax, carnauba
Melissic acid	$C_{29}H_{59}COOH$	Beeswax, montan wax
Cetyl alcohol	$C_{16}H_{33}OH$	Spermaceti, porpoise oil
Octadecyl alcohol	$C_{18}H_{37}OH$	Spermaceti
Oleyl alcohol	$C_{18}H_{35}OH$	Spermaceti, porpoise oil
Ceryl alcohol	$C_{26}H_{53}OH$	Insect wax
Myricyl alcohol	$C_{30}H_{61}OH$	Beeswax, carnauba wax
Cholesterol		Wool wax

The fatty acids found in waxes are almost always saturated. They vary from lauric to octatriacontanoic ($C_{37}H_{75}COOH$). The saturated alcohols of the $C_nH_{2n+2}O$ series from C_{12} to C_{36} have been identified in various waxes. Several dihydric (two hydroxyl groups) alcohols have been separated, but they do not form a large proportion of any wax. Also, several unidentified branched-chain fatty acids and alcohols have been found in minor quantities. Several cyclic sterols (cholesterol and analogues) make up major portions of wool wax.

Only a few vegetable waxes are produced in commercial quantities. Carnauba wax, which is very hard and is used in some high-gloss polishes, is probably the most important of these. It is obtained from the surface of the fronds of a species of palm trees native to Brazil. A similar wax, candelilla wax, is obtained commercially from the surface of the candelilla plant, which grows wild in Texas and Mexico. Sugar cane wax, which occurs on the surface of sugar cane leaves and stalks, is obtainable from the sludges of cane juice processing. Its properties and uses are similar to those of carnauba wax, but it is normally dark in colour and contains more impurities. Commercial production of other waxes such as rice wax and grain sorghum wax proved unsuccessful. Other cuticle waxes occur in trace quantities in vegetable oils such as linseed, soybean, corn (maize) and sesame. They are undesirable because they may precipitate when the oil stands at room temperature, but they can be removed by cooling and filtering. Cuticle wax accounts for the beautiful gloss of polished apples.

Beeswax, the most widely distributed and important animal wax, is softer than the waxes mentioned above and finds little use in gloss polishes. However, it is used for its gliding and lubricating properties as well as in waterproofing formulations.

Wool wax, the main constituent of the fat that covers the wool of sheep, is obtained as a by-product in scouring raw wool. When it is purified it is called lanolin and is used as a pharmaceutical or cosmetic base because it is easily assimilated by the human skin. Sperm oil and spermaceti, both obtained from sperm whales, are liquid at ordinary temperatures and are used mainly as lubricants.

See also references under "Oils, Fats and Waxes" in the Index.

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OIL SHALE: *see* FUELS: *Liquid Fuels: Carbonization.*

OISE, a *département* of northern France, was formed in 1790 mainly from northern districts of the historic Île-de-France (*q.v.*), with the addition of adjacent parts of Picardy (*q.v.*). It is bounded north by Somme, east by Aisne, south by Seine-et-Marne and Val-d'Oise, and west by Eure and Seine-Maritime. Area 2,261 sq.mi. Pop. (1962) 481,289. The *département* is traversed from northeast to southwest by the middle course of the Oise river from above Noyon, past Compiègne, where it receives the Aisne, its most important tributary, to below Creil. To the southeast, where residual sands overlie the Tertiary limestone platform, are extensive forests (Compiègne, Senlis and Chantilly) with summer retreats and outlying residential settlements for Parisians. In the forest of Compiègne the spot where the armistice was signed in Nov. 1918 is commemmorated. Northwest of the Oise valley the chalk appears from beneath the Tertiary rocks along an irregular margin and the ground rises up the valley of the Thérain tributary to the hills of Bray. Wheat, sugar beet and fodder crops are extensively grown, especially where cappings of *limon* provide rich soil, and a heavy density of cattle is maintained. Along the valley floors are meadows and market gardens. By the Oise there is contact with the Seine system and with the waterways of the industrial northeast. Creil, on the Oise, is an industrial town with a large electric-power station, and, with neighbouring Montataire, it has metallurgical industries. At Thourotte Chantereine there are glassworks, and elsewhere a variety of light industries is represented. The textile industry is important at Beauvais (*q.v.*), which also manufactures brushes, combs, buttons, and other articles of ivory, bone, mother-of-pearl and plastics. Beauvais, the departmental capital, is the centre of the bishopric. The old part of the city was largely destroyed by air attack in 1940.

Other centres of *arrondissements* are Clermont, Compiègne and Senlis (*qq.v.*). The *département* comes under the court of appeal at Amiens and for educational administration is under the *académie* of Paris. (AR. E. S.)

OISE RIVER, of northern France, 188 mi. long, flows from the Belgian frontier southwest to join the Seine at Conflans, 40 mi. below Paris. Rising in Belgium on the western flank of the Ardennes at a height of nearly 1,000 ft., the Oise enters France within 10 mi. of its source and traverses the impervious clay country of Thiérache, now a district of intensive dairy farming. There it collects numerous small headwaters and its important left-bank tributary, the Serre. Below Guise it follows a braided course in its flat, alluvial valley, and enters the northern part of the Tertiary limestone platform of the Île-de-France. It flows through well-wooded country, its valley being flanked by the forests of St. Gobain, Compiègne, Senlis and Chantilly, which occupy extensive patches of residual sands overlying the limestones. Above Compiègne it receives its main tributary, the Aisne, from the east and, below the industrial town of Creil, the Thérain from the northwest. It approaches the Seine past Pontoise in a trenchlike valley that separates Vexin from the Île-de-France.

The Oise is an important link in the canal system between the navigable waterways of the Seine system, focusing upon Paris, and the heavily industrialized districts of northeast France and Belgium. (AR. E. S.)

ŌITA, Japanese prefecture (*ken*) of northeastern Kyushu. Area 2,437 sq.mi.; pop. (1960) 1,239,655. Its interior is dominated by complex mountainous terrain, and most human activity centres on small coastal plains. The long, irregular coastline is marked by deep-cut Beppu bay and the rounded Kuni-zaki peninsula. Most Ōita inhabitants are farmers who raise subsistence and some cash (tobacco, reeds, citrus fruit and cattle) commodities. Forestry (bamboo and cryptomeria) flourishes in the mountains. A little industry is found in the main coastal cities (cotton textiles, metals, cement and chemicals). Beppu is among Japan's most famous hot spring resorts.

ŌITA, the prefectural capital and largest (pop. [1960] 124,807) city is located on the southern coast of Beppu bay. It reached its greatest fame in the 16th century but declined in the Tokugawa period. It is mainly an administrative, commercial and educational centre, with few industrial establishments. (J. D. EE.)

OJIBWA, an ethnic group of American Indians speaking an Algonkian language, now found widely dispersed in both Canada and the United States. When first reported in the *Jesuit Relations* (1640), they occupied a comparatively restricted region near the St. Mary's river and in the upper peninsula of Michigan, but moved west as the fur trade expanded. They fought the Dakota with firearms obtained from the French, driving them from Mille Lacs and occupying the northern part of Minnesota. In Canada some Ojibwa penetrated beyond the woodlands and reached the country west of Lake Winnipeg, where they were influenced by the manner of life found in the prairie tribes. Called Saulteurs by the French traders, they continue to be called by the name Saulteaux in Canada. The meaning of the name Ojibwa, usually rendered "to roast until puckered up," refers to the puckered seam characteristic of their moccasins. The appellation Chippewa was officially adopted in the publications of the Bureau of American Ethnology, and actually is a corruption of Ojibwa.

In the United States the Ojibwa constitute one of the largest remnants of the aboriginal population. During the period of the 1960s the U.S. department of the interior reported Chippewa on reservations in the states of Michigan, Minnesota, Montana, North Dakota and Wisconsin. Altogether, they probably numbered more than 30,000, possibly 80% of them being of mixed blood. In Canada there were approximately 20,000 Ojibwa, although the number of their reservations in the provinces of Ontario, Manitoba and Saskatchewan outnumber those in the U.S. five to one. (*See* ALGONKIAN TRIBES; INDIAN, NORTH AMERICAN.)

Originally forest dwellers, hunters and gatherers of wild rice, the Ojibwa have made varying social adjustments to the contemporary world just as they did in their historic past to the different circumstances in which they found themselves. At no time have they been a politically unified nation, their traditional social organization being adapted to group living in small local bands. Because of the great popularity of Longfellow's *The Song of Hiawatha* (1855), based on Henry R. Schoolcraft's study of

Ojibwa mythology while living at Sault Ste. Marie, Mich., in the early 19th century, the Ojibwa have achieved a romantic fame in literature, unique among the peoples of North America.

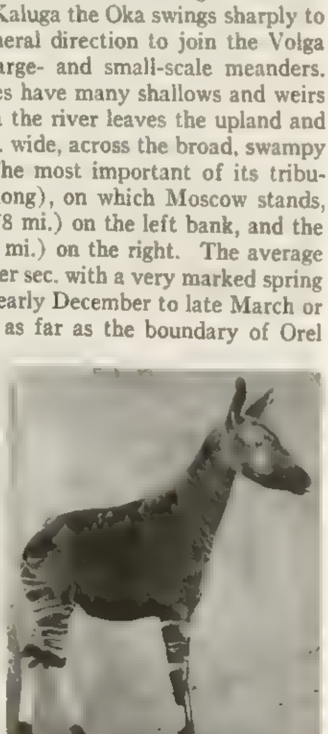
See H. Hickerson, *The Southwestern Chippewa* (1962); E. S. Rogers, "Changing Settlement Patterns of the Cree-Ojibwa of Northern Ontario," with bibliography, *Southwestern Journal of Anthropology*, vol. 19 (spring 1963). (A. I. H.)

O.K., a colloquial expression, also written okay, used to indicate approval, is probably more widely understood than any other word or phrase in any language. It originated in the United States, but for a full century, despite the popularity and almost universal use of the term, its origin remained obscure. From 1840, which most authorities accepted as the date of its first appearance in print, the term moved rapidly into the everyday language of all the English-speaking peoples. During World War I it became widely known in Europe, at least on the level of vernacular, and in World War II it was carried by U.S. and British troops into practically every part of the world.

Until the 1940s there were many theories about the origin of O.K. One of the most popular ideas was that it originated in the Choctaw word *oke,* a term of approval; several dictionaries used this derivation, qualified with "probably." Another popular theory held that the initials represented *oll korrect,* this gross misspelling being attributed to both John Jacob Astor and Andrew Jackson.

The disputes over the origin of O.K. apparently were ended in 1941 when Allen Walker Read showed that the term derived from the Democratic O.K. club, a political group in New York city supporting Martin Van Buren for the presidency in 1840. The initials came from "Old Kinderhook," a nickname for Van Buren derived from the name of the New York village where he was born. From this beginning as a political rallying cry, O.K. quickly took its place in the language.

OKA, a river in central European Russian Soviet Federated Socialist Republic, U.S.S.R., and the largest right-bank tributary of the Volga, is 919 mi. long and drains a basin of 94,595 sq.mi. It rises in the Central Russian upland (Sredne-Russkaya Vozvyshennost) and flows north in a fairly narrow and winding entrenched valley past Orel and Kaluga. At Kaluga the Oka swings sharply to the east and continues in this general direction to join the Volga at Gorki, although with many large- and small-scale meanders. Both the upper and middle courses have many shallows and weirs have been built. Beyond Kashira the river leaves the upland and flows, in a flood plain about 12 mi. wide, across the broad, swampy depression of the Meshchera. The most important of its tributaries are the Moskva (312 mi. long), on which Moscow stands, Klyazma (402 mi.) and Ugra (278 mi.) on the left bank, and the Moksha (433 mi.) and Upa (210 mi.) on the right. The average annual discharge is 43,437 cu.ft. per sec. with a very marked spring maximum. Freeze-up lasts from early December to late March or early April. Navigation extends as far as the boundary of Orel *oblast* and the river is an important artery for grain and lumber.


W. SUSCHITZKY

OKAPI (OKAPIA JOHNSTONI)

Another Oka river rises in the Eastern Sayan mountains (Buryat Autonomous Soviet Socialist Republic) and flows for about 600 mi. past Zima to join the Angara river at Bratsk in Irkutsk *oblast.* (R. A. F.)

OKAPI (*Okapia johnstoni*), a large cud-chewing mammal allied to, but smaller than, the giraffe, inhabiting the Semliki forest of the Congo. It was unknown to science until 1900. The neck and legs are shorter than those of the giraffe and the shoulder height of females, which are larger than males, is a little more than five feet. The body is plum coloured, the sides of the face dull reddish, the upper parts of the legs irregularly barred with black and white, and the shanks white with black fetlock rings. The ears are large and the horns, confined to males, are short and covered with skin, except at the tips.

The okapi is a shy, nocturnal animal that lives singly or in pairs; it browses on leaves in the dense forest, where its only enemies appear to be the pygmy hunters. Living okapis have been exhibited in many zoological gardens and have been successfully bred in captivity. The female comes into heat approximately every 40 days. The young, born after a gestation period of about 425 days, is nursed by the mother for three to four months. See also RUMINANT. (L. H. M.)

OKAYAMA, Japanese prefecture (*ken*) of western Honshu, bordering the Inland sea. Area 2,726 sq.mi.; pop. (1960) 1,670,454. It has a predominantly agricultural economy, and rice, grapes, peaches, rush (for matting) and other cash crops are grown in the southern districts. Farm techniques and the degree of mechanization are among the most advanced in Japan. Life in the interior mountains is poor and largely dependent upon forestry and small-scale cattle raising. Steadily increasing manufacturing is concentrated in such southern cities as Okayama, Kurashiki (synthetic fibres) and Tamanoi (shipbuilding). Salt fields, used to extract salt from sea water, line the seacoast.

OKAYAMA city, the prefectural capital (pop. [1960] 260,773) is located in the central Okayama plain astride the Asahi river. An old castle town of the Ikeda clan, it dominates prefectural life. A major marketing centre, Okayama has excellent rail connections with cities on the Inland sea, Sea of Japan and Shikoku (via ferry). Since its river port is shallow, it uses Tamanoi as its outport. Industry includes the manufacture of agricultural machinery, cotton and man-made textiles, and rubber goods.

Okayama university is noted for its medical college. Kōrakuen, laid out in 1786, is one of Japan's three most celebrated public gardens. (J. D. E.)

OKAZAKI, a textile-manufacturing city and commercial centre of the west Mikawa plain, central Honshu, Japan. Pop. (1960) 166,095. The town developed around Okazaki castle after its construction in 1455. During the Tokugawa period (1600–1876) it prospered as one of the 53 stage towns on the Tokaido (Tokyo-Osaka) route. Okazaki refused to allow the Tokaido railway to pass through the city in 1888.

For some years the town declined. Later it was connected with Nagoya and Toyohashi by rapid-transit lines and its economy was revived. In the 1960s there were about 300 small spinning mills and 3 large, modern textile plants; other factories produced foods, machinery, chemicals and fabricated metals. (R. B. H.)

OKEECHOBEE, LAKE, the second largest fresh-water lake wholly within the United States, is located 40 mi. W.N.W. of Palm Beach, Fla. Bearing the Seminole Indian word for "big water," it has a shoreline of 135 mi., a length of 35 mi. and including three small islands covers an area of 700 sq.mi. The surface is 12.5 to 15.5 ft. above mean sea level depending upon the water supply; the mean depth is 7 ft. and the maximum depth 15 ft.

The chief source is the Kissimmee valley watershed, immediately to the north, which drains into a chain of lakes that in turn empties into the Kissimmee river as it flows southward almost 100 mi. to Lake Okeechobee. Before the construction of adequate levees and a regulatory outlet system, the overflow produced by the rainy season flooded surrounding areas and spilled over southward into the Everglades (*see* EVERGLADES).

First plans for drainage were made in 1881 when Hamilton Disston of Philadelphia purchased from the state 4,000,000 ac., much of it in the Lake Okeechobee area, which he contracted to reclaim. His death in 1896 halted the operations. In 1904 Napoleon B. Broward won the governorship on a spectacular platform of draining the Everglades. Begun by Broward, this undertaking was continued until Sept. 1928, when hurricane winds flooded the area. Subsequently the federal government aided the reclamation project. A levee 85 mi. long was constructed along the southern shore and at other low stretches; its height varies but averages about 34 ft., approximately 20 ft. above the usual lake level. Pumping stations, spillways, hurricane gates and locks also were provided.

In 1937 a 155-mi. cross-state waterway from Stuart on the Atlantic ocean across Lake Okeechobee through the Caloosahatchee river to the Gulf of Mexico was completed. Lake communities include Pahokee, Belle Glade, Lake Harbor, Clewiston, Okeechobee and Canal Point. A Seminole Indian reservation is located on the northwest shore of the lake. The Lake Okeechobee region is also a part of the Central and Southern Florida Flood Control district. Further improvements to the Lake Okeechobee levee system and to its regulatory outlet works are included in the project. (A. J. H.)

OKEFENOKEE (OKEFINOKEE), a famous U.S. primitive swamp and natural wildlife refuge of southeastern Georgia and northern Florida, is a shallow, saucer-shaped depression approximately 20 mi. wide and 40 mi. long, covering about 600 sq.mi. The swamp is about 60 mi. inland from the Atlantic coast in Brantley, Clinch, Ware and Charlton counties in southeastern Georgia, and Columbia and Baker counties in northern Florida. Low, sandy Trail Ridge forms the eastern swamp boundary and prevents drainage toward the Atlantic. The swamp is partially drained by the Suwannee and St. Marys rivers. Included are low, sandy ridges, wet, grassy savannas, small islands called "hummocks" surrounded by marshes, and extensive "prairies" or dark-water areas covered by thick undergrowth and trees. Narrow channels of open water are interlaced among hummocks, prairies and wet savannas to form a bewildering maze. Vegetation is dense in the swamp. There are giant tupelo and cypress trees festooned with Spanish moss, brush and vines; where sandy soil is above the water, pines predominate. Exotic flowers abound, including floating hearts, lilies and rare orchids. The swamp is populated with deer, bear, raccoons, alligators, snakes and many varieties of fish, turtles and lizards. There are at least 200 different species of birds, including the ibises.

In 1937, 331,900 ac.—including most of the swamp in southeastern Georgia—were set aside as the Okefenokee National Wildlife refuge. The entrance to the refuge is at Waycross, Ga. Boat tours, trestle walks and alligator-hunting boat excursions are among the tourist attractions. (M. C. P.)

OKEGHEM, JEAN D' (JOHANNES) (*c.* 1420–*c.* 1495), Flemish composer and singer, known for his church music and chansons. His earliest recorded appointment was as a singer at Antwerp cathedral from 1443 to 1444. He served in a similar capacity in the chapel of Duke Charles of Bourbon from 1446 to 1448 and at a later date in the royal chapel. He acted as chaplain and composer to three successive kings of France (Charles VII, Louis XI and Charles VIII) and by 1465 was given the title of *maître de la chapelle du roy*. As treasurer of the wealthy abbey of St. Martin at Tours, he was the recipient of a handsome salary which became the object of a pun by Erasmus, who referred to the *aurea vox Okegi* (the golden voice of Okeghem). He died at Tours about 1495.

Like many of his Flemish contemporaries, Okeghem was a great traveler and made the maximum use of his visits to distant cities to improve his musical knowledge. He knew Gilles Binchois of Burgundy and mourned his death in a lament of touching beauty; in turn he received during his lifetime the musical tributes of A. Busnois and L. Compère, and after his death the moving *Déploration* of Josquin Després.

Okeghem was a follower of Guillaume Dufay and John Dunstable, and, if his mature work sounds richer than theirs, it is because instrumentally supported vocal lines were being gradually modified so as to make way for sonorous choral harmony, and not because he invented (as is sometimes claimed) a polyphonic texture knit together by constant melodic imitation. There is hardly any imitation in his magnificently austere *Missa pro defunctis* and only the slightest trace of canon, a device of which he was supreme master.

His ten motets include favourite Marian texts such as *Ave Maria*, *Salve regina* and *Alma redemptoris mater*, as well as a complete setting of the responsory *Gaude Maria*. Fourteen Masses have survived, but two consist of Kyrie, Gloria and Credo only, while another has only the first two sections. He often uses pre-existent material, as in the Masses based on chansons: "Fors seulement," "De plus en plus" and "Au travail suis." The *Missa prolationum* and the *Missa cuiusvis toni* are both, in different ways, examples of Okeghem's highly developed contrapuntal and canonic technique. There are also about 20 chansons. Two volumes of a complete edition of Okeghem's works, edited by Dragan Plamenac, were published by the American Musicological society (1947 and 1959). (D. W. ST.)

O'KELLY (Irish O CEALLAIGH), **SEAN THOMAS** (1882–1966), Irish statesman, one of the founders of Sinn Fein, president of Ireland from 1945 to 1959. He was born in Dublin on Aug. 25, 1882. His education was partly private, partly at the O'Connell schools, Dublin. Later he was for some years an assistant in the National Library of Ireland. He became associated with Arthur Griffith (*q.v.*) in the editing of various Irish journals in 1905, and acted as honorary secretary of Sinn Fein from 1908 to 1910. He was also a formative influence in the Gaelic league, of which he was general secretary (1915–20). From 1913 onward he was active in raising the Irish Volunteers and, during the Easter rising of 1916, fought as a staff captain in the general post office, Dublin. On the collapse of the rising, he was imprisoned until the following year.

In the Sinn Fein election of 1918 which swept away the old Irish Nationalist party, he was returned for College Green division (Mid-Dublin), Dublin city, and was subsequently elected speaker of *dáil éireann*. From 1918 to 1945 he represented at intervals various divisions of Dublin in *dáil éireann*. In 1919 he was accredited by the *dáil* to the peace conference in Paris as envoy of the government of the Irish republic; later he acted in the same capacity at Rome and Washington. In June 1945 he was elected president of Ireland for a term of seven years; and in May 1952 was re-elected unopposed for a further term of seven years—his unopposed return being a tribute of affection and respect from the Irish people. On the conclusion of his second term of office (June 1959) he withdrew from public life. He died in Dublin on Nov. 23, 1966. (D. L. I.)

OKEN, LORENZ (1779–1851), German naturalist, whose real name was OCKENFUSS, is remembered not only for his several solid achievements in the advancement of biology but also for his participation in the abortive physio-philosophical movement called *Naturphilosophie* in Germany in the early 19th century. He was born at Bohlsbach, Baden, on Aug. 1, 1779. He studied at Würzburg and Göttingen, where he became *Privatdozent*, and in 1807 was appointed professor extraordinarius of medical sciences at Jena. His inaugural discourse on the signification of the bones of the skull, based upon a discovery he had made in the previous year, was delivered in the presence of Goethe, as privy councilor and rector of the university, and was published in the same year.

In 1816, at Weimar, he began to publish the periodical *Isis*, but comments on politics led to his removal from Weimar. He continued to publish the *Isis* at Rudolstadt until 1848. In 1821 Oken promulgated the idea of annual general meetings of German naturalists and medical practitioners, the first meeting being held in Leipzig in 1822. After teaching at the University of Munich (1828–32), he transferred to the professorship of natural history at the University of Zürich, where he served until his death, in Zürich, Aug. 11, 1851.

Oken's writings display his philosophical kinship with Kant and Schelling and bare his reliance on deductive logic. For example, he theorized that the head was a repetition of the trunk—a kind of second trunk, with limbs and other appendages. A priori postulates of this kind prevented his making any real contributions to the science of comparative anatomy. (K. P. S.; X.)

OKHOTSK, SEA OF, a part of the northwestern Pacific ocean, bounded east by the Kamchatka peninsula and the Kuril Islands, south by Hokkaido, Jap., and west by the island of Sakhalin and the shore of continental Asia from the Amur estuary to the mouth of the Penzhina river. Area 613,838 sq.mi. and maximum depth 11,069 ft. The northern part has a continental climate with an average annual temperature of −5° to −6.7° C. (23° to 20° F.); in January and February, the coldest months, the temperature averages −22.6° to −23.7° C. (−9° to −11° F.).

Ice forms in late October or early November and much of the sea is covered by March, the ice limit running from southern Sakhalin to southern Kamchatka. In April the ice breaks up and usually disappears by June, except for the Gulf of Sakhalin, where it may linger until August. The influx of waters from the Pacific, especially between the eastern and central Kurils, forms a powerful north-flowing current in several branches in the east, while in the west a similar south-flowing current is supplemented by drainage from the mainland. The sea is linked with the Sea of Japan by the Tatar and Sōya straits. Magadan on the northern shore and Korsakov (formerly Otomari) on south Sakhalin are the chief ports. The fisheries provide about one-tenth of the total catch of the U.S.S.R., mainly salmon, and also herring and crab; the catch is canned in factory ships. (R. E. F. S.)

OKI-GUNTŌ, a group of Japanese islands, lying in the Sea of Japan due north of the Honshu prefecture of Shimane, of which they form a part, 36° N. and 133° E. The group consists of one large island, called Dōgo, and three smaller isles—Chiburi-shima, Nishino-shima, and Nakano-shima—which are collectively known as Dozen. These four islands have a coastline of 223 mi., an area of 134 sq.mi., and a pop. (1960) of 41,639. The chief town is Saigō on the island of Dōgo, about 40 mi. distant from the port of Sakai in Shimane.

The region is celebrated in Japanese history not only because the possession of the islands was much disputed in feudal days but also because a former emperor and an emperor were banished there by the Hōjō regents in the 13th century.

OKINAWA, a pre-World War II Japanese prefecture, is composed of the island groups (Nansei-Shotō in Japanese; Ryukyu Islands in English) stretching from Japan to Formosa. The Ryukyus came under U.S. control by the 1951 Japanese peace treaty; Japan kept residual sovereignty. The northern island groups, Ōsumi, Tokara and Amami, reverted to Japan by 1954. The southern groups, the Okinawa and the Sakishima islands, remained under U.S. control. Three-fourths of the inhabitants are farmers or fishermen. Sweet potatoes and sugar cane are the main crops. The islands suffer from chronic overcrowding. The largest (454 sq.mi.) island, Okinawa (pop. [1960] 698,590), has 80% of the Ryukyu population, as well as some of the largest U.S. military bases in the western Pacific. Its principal city, Naha, once the capital of the Japanese Okinawa prefecture, is the seat of the U.S. military government and the native Ryukyu government, a 29-member legislature with a chief executive appointed by U.S. authorities. For the battle of Okinawa, *see* WORLD WAR II: *The War in the Pacific.* (J. D. EE.)

OKLAHOMA, popularly called the "Sooner state," is a west south-central state of the United States, admitted to the union in 1907 as the 46th state. It is bounded on the north by Colorado and Kansas, on the east by Missouri and Arkansas, on the south and west by Texas and on the far west (panhandle) by New Mexico. The area is 69,919 sq.mi., including more than 1,000 sq.mi. of water surface (artificial lakes and ponds); it ranks 18th among the states in size. The capital is Oklahoma City, located in the centre of the state. The name Oklahoma, a Choctaw Indian term meaning "red people," was first applied to the Indian Territory in 1866. The popular name "Sooner state" was derived from the term "sooner," referring to a person who entered and staked a claim for land sooner than the law stipulated when the central part of the Indian Territory was opened to homesteading in 1889. The Oklahoma state motto is *Labor omnia vincit* ("Labour Conquers All Things"). The flag has a blue field on which is a circular rawhide shield, superimposed on the face of which is a peace pipe crossed by an olive branch. The state floral emblem is the mistletoe, the tree the redbud, the bird the scissor-tailed flycatcher, the song "Oklahoma" (from the musical *Oklahoma!*).

PHYSICAL GEOGRAPHY

Physical Features.—The topographical features of Oklahoma (between approximately 33° 38′ and 37° N. lat. and 94° 26′ and 103° W. long.) range from wide treeless plains in the west to rugged, heavily wooded mountains in the east. The altitude varies from 4,978 ft. above sea level on the summit of the Black Mesa, a volcanic tableland 700 ft. above the valley floor of the Cimarron river, in the northwestern corner of the panhandle, to 350 ft. above sea level on the bank of the Red river in the southeastern corner of the state.

There are four mountain regions in the eastern and southern parts of Oklahoma. The western fringe of the Ozark mountains (*q.v.*) in the northeast extends nearly halfway across the state in a chain of low sandstone hills gradually decreasing in height westward. These hills include such well-known features as Claremore mound, Concharty hills, Council hill and Shawnee hills. The Ouachita range, crossing the eastern boundary, lies in southeastern Oklahoma; in this region, noted for its scenic beauty, are mountains of appreciable heights, the highest being Rich mountain, 2,950 ft. above sea level, in Le Flore county. The Arbuckle mountains in the south-central part of the state have summits of moderate altitude. Between the valleys of the Red and Washita rivers west of the 98th meridian are the Wichita mountains, in which, among several well-known peaks, are Mt. Scott (2,464 ft.), Mt. Sheridan and Saddle mountain.

The plains region of western Oklahoma has widely distributed gypsum deposits, and many parts of the area are characterized by deeply eroded streams, fantastically weathered outcrops and bold hills. The Glass mountains located near the Cimarron river in Major county are typical of gypsum scenery. A striking feature in the northwest is the Big Salt plain in Woodward county, one of four such plains; it is almost level, varying in width from ½ mi. to 2 mi. and extending 8 mi. along the Cimarron river.

Following the general slope of the land, most of the important streams flow from northwest to southeast. The Arkansas river enters the state near the 97th meridian, flows generally southeast and leaves near the centre of the eastern boundary. Its tributaries from the north and east are small but important streams—Verdigris, Grand (or Neosho) and Illinois; from the west it receives much larger streams—Salt Fork, Cimarron and the Canadian with its numerous tributaries. The southern part of the state is drained by the Red river and its tributaries, the North Fork, Washita, Blue, Boggy and Kiamichi. Another important stream in the southeast, with its tributaries the Mountain Fork and other clear-flowing creeks, is Little river which empties into Red river east of the Oklahoma boundary, in Arkansas.

Climate.—The climate of Oklahoma is continental, with wide variations of temperature and humidity. The western and central parts are generally cooler and drier than the eastern section. At Boise City, in the northwest, the average annual daily temperature is about 55° F. (about 13° C.) and the annual rainfall is 16.51 in.; while at Idabel, in the southeast, the average annual daily temperature is about 63° F. and the annual rainfall is 46.53 in. At Oklahoma City in the centre of the state the average annual daily temperature is 60° F. and the average annual rainfall is 30.22 in. The highest temperature recorded in the state was 120° F. (about 49° C.) in the summer of 1936, in widely separated places; the lowest temperature recorded was −27° F. (−33° C.) at Vinita in 1905.

Soil.—The greater part of the soil in Oklahoma is residual, partaking of the character of the rocks from which it was derived, found in a number of soil areas that in general correspond to the topography of the region. The most fertile is the black limestone soil found in abundance in the Ozark and especially the Arbuckle mountain regions, where the Arbuckle limestone lies 6,000–8,000 ft. thick, one of the heaviest limestone ledges in the world. A stiff clay soil is found in the east where clay and shale characterize the surface rocks of the great coal fields that lie north and south of the Ouachita range. In the central part of the state and its adjoining sections, the soil is highly fertile and of a deep red colour derived from the brick-red shales and clays of the rocks known as red beds.

Vegetation.—Eastern Oklahoma was originally covered with forest growth, with small prairie areas interspersed. Since it is well within the humid region, vegetation is practically identical with that of other states of the central and lower Mississippi valley. Principal trees in this eastern section of the state are several species of oak and hickory (including the pecan), besides walnut,

elm, sycamore, gum, ash bois d'arc (or Osage orange), red cedar, pine, cypress and many others. In the central part of the state timber growth is generally limited to narrow fringing belts of a few species of trees along the streams—elm, cottonwood, hackberry, chinaberry, hickory and walnut. Blackjack, post oak and hackberry and hickory grow in the sand-hills region. The distribution of trees is even more limited in the western part of the state, where the thorny mesquite is found along some of the streams and flat prairies. In this semiarid western region, dwarf species of oak, walnut and hackberry are sometimes found.

Wild fruits and berries include plum, crab apple, cherry, blackberry, dewberry, raspberry, gooseberry, currant, grape, strawberry, huckleberry, persimmon, papaw and others.

There are many species of native grasses in Oklahoma. Grasses grow tall in the eastern and central parts of the state, bunch grass being commonest. Bluestem is scattered widely throughout the prairies. Western Oklahoma was often called the short grass country, for there were found the dwarfish, low-lying buffalo, mesquite and grama grasses. Buffalo grass was the commonest native grass in this semiarid region, furnishing excellent pasturage under all range conditions, summer and winter, growing low and thick and forming a heavy sod carpet on the ground.

Animal Life.—Oklahoma was once a great hunting ground. Buffalo were originally found in all parts of the state, and enormous herds roamed over the western plains until a comparatively late date in history. Other important species of animals that were plentiful in the region included elk, deer, antelope, bear, panther or cougar, wildcat, timber wolf, coyote, fox, beaver, otter, muskrat, mink, squirrel, badger, skunk, raccoon, opossum, jack rabbit and prairie dog.

A very large number of birds, resident and migratory, have been found in Oklahoma. The country teemed with wild turkey, prairie chicken and bobwhite quail. Great flocks of the now-extinct passenger pigeon and the Carolina parakeet once were found in this region. Hawks and turkey buzzards are the commonest types of large birds; smaller birds include the mockingbird, robin, meadow lark and cardinal.

The Wichita Mountains Wild Life refuge, established in 1902 as a national preserve of 58,000 ac., is noted for fine herds of buffalo, elk and the now rare Texas longhorn cattle. The state game and fish commission supervises a number of smaller game preserves over the state, for deer, turkey and quail. The commission in 1930 established the Great Salt Plains Wild Life Refuge in Alfalfa county, where a large salt lake reservoir is a sanctuary for migratory waterfowl.

Parks and Recreation.—The construction of large lakes along streams in the U.S. flood control program and the establishment of state parks in Oklahoma brought great changes in living conditions in the surrounding areas after 1930, with millions of visitors coming to the state annually for fishing and water sports. The largest artificial lakes are Lake Eufaula, its several arms extending a distance of more than 130 mi. along the Canadian river and its tributary streams in McIntosh, Pittsburg and Haskell counties; Lake Texoma extending more than 100 mi. along the Red and the Washita rivers; Lake O' The Cherokees, more than 65 mi. along the Neosho river; Fort Gibson lake, more than 40 mi. along the Arkansas and the Cimarron rivers; and Lake Ten Killer, more than 25 mi. along the Illinois.

Oklahoma state parks in scenic or historic areas include Alabaster Caverns and Boiling Springs, in Woodward county; Beavers Bend park, a primitive forest area, McCurtain county; Greenleaf Lake park, southeast of Muskogee; Lake Murray park, near Ardmore in the old Chickasaw Nation; Osage Hills park in Osage county, this county comprising the former Osage Indian reservation; Robbers Cave park, Latimer county; Quartz Mountain park at Lake Altus on the north fork of the Red river; Roman Nose park, named for a noted Cheyenne chief, Blaine county; Sequoyah park on Fort Gibson reservoir east of Wagoner; Lake Wister park, Le Flore county; Lake Clayton Recreation Area in the Kiamichi mountains, Pushmataha county; Boggy Depot Memorial park, Atoka county, site of historic town (1837) in the old Choctaw Nation, once its capital and a main stop on the first U.S. Overland Mail stage route between St. Louis and San Francisco (1858). National historic landmarks include Fort Gibson (1824) stockade restoration, Cherokee county; Fort Washita (1842) 80 ac., restoration and ruins, Bryan county; and Custer Battle (1868) site, Roger Mills county. The Ouachita National forest, Le Flore county, is noted for the Choctaw Skyline drive, a scenic highway 50 mi. along the top of the Winding Stair mountains. Platt National park, Murray county, famous for medicinal springs, comprises an area ceded to the United States out of Choctaw and Chickasaw tribally owned lands in 1902.

The Oklahoma Historical society, in Oklahoma City, maintains museum and library collections of original artifacts, relicts, documents and rare books relating to both history and prehistory of the state. The last log-cabin home (1843) of Sequoyah, famous as the creator of the Cherokee alphabet, is a historic shrine in Sequoyah county. Museums of history in the state include Gilcrease Institute of Art and History, Tulsa; Stovall museum, Norman; U.S. Artillery and Missile centre, Fort Sill; Wooleroc museum, Bartlesville; Cowboy Hall of Fame and Western Heritage center, Oklahoma City; Will Rogers Memorial museum, Claremore; Panhandle Historical museum, Goodwell; the American Indian Hall of Fame and the Indian city, both in Anadarko; Five Civilized Tribes museum, Muskogee; and Great Plains museum, Lawton.

HISTORY

Prehistory.—Archaeological excavations have brought to light evidences of human occupancy within the boundaries of the state more than 10,000 years ago. The steep banks of some streams in the Ozark hills in the northeast and in the Panhandle northwest furnished rock ledges and caves for the dwelling places of ancient peoples. Hard rock formations, especially flint, furnished spear points for hunting. Stone spear points, probably those of Clovis man, known to have lived earlier than Folsom man, were found near the skeleton of a mammoth excavated in Caddo county. Excavation of the floors of caves in the western part of the Panhandle has brought up the utensils of an agricultural people of 4,000 years ago. Some of their basketry, small bags of skin for holding seeds and fur lined moccasins were found, as well as stone scrapers and knives and wooden drills for starting fire. Pieces of crude pottery, kernels of corn and corn cobs, bone fishhooks and implements of animal bones and deer antlers used for growing corn have been found in the Ozark caves. Spiro mound, of about A.D. 850, near the town of Spiro in Le Flore county, has yielded spectacular evidence of the culture of an ancient people that built this great temple mound and other mounds in the vicinity. A long list of articles taken from the temple mound includes huge ceremonial pipes of stone carved in human and animal effigies; smaller clay and stone pipes; fine pottery molded in art forms; cedar masks and basketry; woven materials of buffalo hair, furs and feathers; polished stone implements; shell gorgets etched with ancient designs; pearl and stone beads; and large conch shells with etchings that show the life of the people of the mounds. An eagle design on copper plate, copper axes and copper covered ear-spools give evidence that the use of metal was known.

The Indian Territory.—The Spanish expedition led by Francisco Vázquez de Coronado in his exploration of the Great Plains in 1541 followed a direct route southwest across the Oklahoma panhandle. Three centuries later this route approximated that of the Santa Fe trail (*q.v.*), traces of which are visible in Cimarron county. Oklahoma, a part of Louisiana, was under the influence of the French during the 18th century, and many French names of mountains and streams dating from that period may be seen on maps of the state.

Oklahoma east of the 100th meridian became known as the Indian Territory after the act of congress of May 28, 1830, which provided for removal of the Indian tribes living east of the Mississippi river to lands in the west. Five large tribes, later known as the Five Civilized Tribes—Choctaw, Creek (or Muskogean), Seminole, Cherokee and Chickasaw (*qq.v.*)—were removed from the southeastern states to the Indian Territory (1830–42), where

they settled on large tracts owned by them under patents from the government, as provided in different treaties from 1820 to 1837. These tribes established their own governments as nations, with written laws, courts of justice and elected officers. They maintained schools and fostered churches, missions and printing presses for newspapers and books in the native languages. The five Indian capitals and dates of establishment, at some of which old buildings stand, were Nanih Wayah (1834), Choctaw Nation, site 2 mi. from the last capitol building, near Tuskahoma (in present Pushmataha county); Tahlequah (1839), Cherokee Nation (in present Cherokee county); Tishomingo (1856), Chickasaw Nation (in present Johnston county); Okmulgee (1867), Creek Nation (in present Okmulgee county); and Wewoka (1869), Seminole Nation, this tract comprising Seminole county in the state.

American Civil War.—The people of the Indian nations and their governments were southern in their background and institutions. Some of the Indian leaders were wealthy owners of Negro slaves and plantation properties in the valleys of the Arkansas and Red rivers. But while there was strong feeling for the South and the seceding states, especially in the Choctaw Nation, there also was widespread sentiment for neutrality and staying out of the "white man's war" under such leaders as Chief John Ross of the Cherokee Nation and the venerable Opothleyahola of the Creek Nation. The United States had guaranteed the Indian nations military protection against their enemies; however, at the outbreak of the Civil War all U.S. troops were withdrawn from the Indian Territory to Kansas, leaving the ungarrisoned posts open to occupation by Confederate troops from Texas and Arkansas. By Oct. 1861 Albert Pike, appointed commissioner at Richmond, Va., had concluded treaties of alliance between the Five Civilized Tribes and the Confederate states; similar treaties also had been made with other tribal groups in the Indian Territory. During the summer and autumn of 1861, the Indian nations organized their forces for military service in the Confederate army.

Division among the Indian peoples in their sympathies between the northern and southern states began in the Creek Nation under the leadership of Opothleyahola, who refused to recognize the Confederate-Creek treaty. Setting out with about 5,000 followers for the wild country in the Cherokee outlet east of the Arkansas river, he was followed and attacked three times by Confederate troops (white and Indian). His forces were defeated in the third fight (battle of Chustenahlah, Dec. 26, 1861), and his followers, including some Seminoles, fled destitute in a winter storm to Kansas, where they became refugees within the Union lines. Confederate Indians from several other tribes soon went over to the Union side and were organized in Kansas as Indian home guard regiments in the U.S. army. Federal forces entered the Indian Territory and took over Ft. Gibson late in 1862, this post remaining the stronghold of the Federals until the end of the War.

Ft. Washita with its outpost and commissary at Boggy Depot was the Confederate stronghold. Troops and scouting parties of both armies swept back and forth across the county in the Arkansas River valley from Fort Smith west and north to the Kansas and Missouri lines. There were many engagements and skirmishes and countless "brush" fights. The major battle in the Indian Territory was fought at Honey Springs (in present McIntosh county) on July 17, 1863, when 3,000 Federal troops under the command of Maj. Gen. James G. Blunt forced the retreat of Brig. Gen. D. H. Cooper's Confederate forces. The outstanding Confederate victory was the capture of a Federal wagon train worth more than $1,500,000, in the second Battle of Cabin Creek (in present Mayes county) on Sept. 19, 1864, by Confederate troops under the command of Brig. Gen. Stand Watie of the Indian brigade and Brig. Gen. R. M. Gano of the Texas brigade. The war was one of attrition in the Indian nations, leaving the people impoverished and their institutions wrecked. The Cherokee country, the Creek and the Quapaw northeast were scenes of desolation. While many Confederate Indian officers were cited for bravery and gallantry in action during the War, only the Cherokee leader Stand Watie attained the rank of brigadier general. He was the last general officer of the Confederacy to surrender at Doaksville, Choctaw Nation, on June 23, 1865.

Postwar Period.—New treaties with the Five Civilized Tribes, demanded by the federal government, were signed at Washington in 1866. While each of these dealt with local conditions and problems as a result of the war there were some general provisions common to all: the abolition of slavery; rights of way granted for the building of two railroads (one north to south and one east to west); plans for the organization of the territory as a federal commonwealth with a legislative body composed of delegates from each of the Indian nations and tribes within its borders; and the cession of the western tribal lands (western Indian Territory) to the United States, this provision being in retaliation for the recent alignment of the tribes with the Confederate government. These land cessions, involving millions of acres, meant great changes throughout the region. The five Indian governments continued in greatly reduced areas in eastern Indian Territory, and social conditions changed from a pastoral to the beginnings of an industrial society. Towns and villages sprang up beside the railroads where settlers came to live as owners of stores and other small enterprises.

The ceded lands in western Indian Territory were assigned by the government as reservation tracts for Indian tribes brought there from many parts of the United States. The new reservations bordering the Five Civilized Tribes on the west (now central Oklahoma) were assigned to tribes from Kansas and adjoining states, including Osage, Kaw, Sac and Fox, Shawnee, Potawatomi, Ponca, Pawnee and others. Farther west in the territory were the big reservations assigned the Plains tribes—Comanche, Kiowa, Kiowa-Apache, Cheyenne, Arapaho.

During the first years, some of the leaders of the latter tribes were imbued with the spirit of the Indian wars on the Great Plains, and military campaigns were undertaken against some of the tribal bands. The last of the warring Plains tribes was the Quahadi band of Comanche under Quanah (later noted as Chief Quanah Parker), who came in from the Staked Plains of Texas and surrendered at Ft. Sill in June 1875. From this time, except for some local trouble with part of the Kiowa and the Cheyenne, the tribes of the Great Plains settled down to reservation life that continued until their lands were opened to homesteading and became a part of Oklahoma Territory.

Among several military posts established after the Civil War in western Indian Territory, Ft. Sill (1869) has been continuously garrisoned since. After World War II it became the largest artillery and missile centre in the United States.

Homesteading.—After the building (1872) of the Missouri, Kansas and Texas, the first railroad through Indian Territory, colonies of "boomers" from the states attempted to establish homesteads on a central tract (1,887,880 ac.) left unassigned for Indian reservation purposes. Boomer colonies for several years were ejected by U.S. troops because delegations of Indian leaders of the Five Civilized Tribes repeatedly went to Washington to point out that their tribal lands and properties remained in jeopardy. Until the government cleared the title of the Creek and Seminole owners of the unassigned land tract by due process of law, no patent to homestead claims could be given. Finally congress granted an appropriation to fulfill the terms of the Creek and Seminole treaties; this was followed within a few weeks by the proclamation of Pres. Benjamin Harrison opening the unassigned land to white settlement by a run for homestead claims to begin at noon on April 22, 1889. Evening of this opening day saw the unassigned land peopled by thousands who had made the run from its borders, and the tent cities of Guthrie and Oklahoma City growing. The region was without a regular system of government until the congressional act of May 2, 1890, provided the organization for the western half of the Indian Territory as Oklahoma Territory with Guthrie as the capital. The Indian Territory throughout its history was never organized under regular territorial government; the eastern half (1890–1907) remained the last Indian Territory, the land owned by the governments of the Five Civilized Tribes except for the northeast Quapaw agency region.

OKLAHOMA

The state capitol building, Oklahoma City, at night. Oil derricks, like the one at right, tap pools of oil that lie beneath the capitol grounds

Wheat farms west of Yukon, Okla. Soil and climate combine to make the state a leading wheat producer

Skyscrapers in Oklahoma City

The business district of Tulsa, the second largest city of the state

SCENES IN OKLAHOMA

BY COURTESY OF (TOP) THE OKLAHOMA PLANNING AND RESOURCES BOARD, (CENTRE LEFT) STANDARD OIL COMPANY (N.J.), (CENTRE RIGHT) SANTA FE RAILWAY; PHOTOGRAPH, (BOTTOM) EWING GALLOWAY

OKLAHOMA

Beginning of the race for homestead sites in the Cherokee Outlet at noon, Sept. 16, 1893. For this "run," the largest in Oklahoma history, an estimated 100,000 persons gathered at the borders of the 6,000,000-ac. tract purchased from the Cherokee Nation

Chimney rock, Cedar canyon, near Freedom, in the northwestern part of the state. The area contains several unusual structures created by the erosion of layers of rock, clay and mineral salt deposits

Replica of the stockade and barracks at Ft. Gibson, at one time the principal military base for control of the Indian territory, and an important trading centre throughout the 19th century

Will Rogers Memorial museum at Claremore erected by public subscription and state funds in 1938

The Municipal building, Oklahoma City, one of four city and county buildings which comprise the civic centre of the state capital

HISTORIC AND MODERN VIEWS OF OKLAHOMA

BY COURTESY OF (TOP) OKLAHOMA HISTORICAL SOCIETY, (CENTRE LEFT, CENTRE RIGHT, BOTTOM LEFT) OKLAHOMA PLANNING AND RESOURCES BOARD; PHOTOGRAPH, (BOTTOM RIGHT) AUTHENTICATED NEWS

which was owned by several remnant tribes including Quapaw, Wyandot, Seneca and allied Indian bands. Members of all Indian tribes were allotted land in severalty, and all Indian reservations and governments were closed by 1907. Millions of acres of Indian reservation lands had been opened to white settlement and organized as part of Oklahoma territory.

Land openings were made by run into the Iowa, the Sac and Fox, and the Potawatomi-Shawnee reservations (now in five counties and parts of counties) on Sept. 22, 1891; the Cheyenne-Arapaho (now in eight counties and parts of counties) on April 19, 1892; the Pawnee, the Tonkawa and the Cherokee outlet (now in seven counties) on Sept. 16, 1893; and the Kickapoo (now in part of two counties) on May 25, 1895. The last great land opening was by "land lottery" for 160-ac. tracts in the Wichita-Caddo and Comanche-Kiowa-Apache country on Aug. 6, 1901. The Comanche-Kiowa "Big Pasture" of 500,000 ac. was sold in 160 ac. tracts to the highest bidders in 1906. The "Big Pasture" covered parts of present Comanche, Cotton and Tillman counties.

Statehood.—When congress authorized the admission of Oklahoma and Indian territories as one state, the people including the Indians voted approval of a constitutional convention (composed of 100 Democrats and 12 Republicans) which met at Guthrie on Nov. 20, 1906. The constitution framed by this body was approved by a vote of the people on Sept. 17, 1907, and the state of Oklahoma was admitted to the union by proclamation of Pres. Theodore Roosevelt on Nov. 16, 1907.

Operation of the coal mines in the McAlester and Lehigh fields had been the leading industrial development for over 30 years until the discovery of oil in 1905, in the Glenn Pool 10 mi. S. of Tulsa. The Glenn Pool touched off development of the great mid-continent field. The petroleum industry in the first 50 years of Oklahoma statehood contributed enormous revenue to the state government and its institutions. Very low prices of crude oil and waste in oil production aggravated conditions at the beginning of the nationwide depression (1933) and brought about enactment by the state legislature of the proration law of April 10, 1933, limiting production to proportional shares of capacity. This law became a pattern for other states and the federal government.

The federal government's depression emergency program was needed mostly in the eastern and southern parts of the state. It was during this period that John Steinbeck's novel *The Grapes of Wrath* popularized the term "okies," portraying poverty-stricken farm families from the Arkansas river region in eastern Oklahoma on their migration route to California.

The Oklahoma national guard, organized in territorial days, was inducted into active service in the U.S. army, as part of the 8th corps area in the 45th division (Thunderbird division), on Sept. 16, 1940, and served in the European campaigns during World War II. Soldiers from all parts of the United States were trained at Ft. Sill and approximately 28 army camps and 13 naval bases were established in different parts of the state.

One of the continuing state questions was the prohibition of the sale of liquor, which dated from 1834 when the congressional law regulating trade and intercourse throughout the Indian Territory was passed. Oklahoma Territory had been open for the sale of liquor to 1907, though the territorial enabling act (1890) had provided the continuance of prohibition for 21 years in the Indian Territory and on any Indian reservation tract. Prohibition for the new state had been voted by the people in the election of 1907. The prohibition clause finally was stricken from the state constitution by vote in the election of April 7, 1959. Under a liquor control act of the state legislature, the alcoholic control board set up state regulations for the operation of retail liquor stores.

Politics.—Oklahoma has remained consistently Democratic in politics but with a strong Republican minority, Democratic electors having been chosen in ten presidential elections and Republican electors in five; Warren G. Harding carried the state in 1920, Herbert Hoover in 1928, Dwight D. Eisenhower in 1952 and 1956 and Richard M. Nixon in 1960. All U.S. senators from Oklahoma were chosen by the Democratic party except three who won on the Republican ticket in 1920, 1924 and 1942. All governors of the state were elected on the Democratic ticket, until the election of the first Republican governor, Henry Bellmon, in 1962, and the second, Dewey F. Bartlett, in 1966. The state senate was never controlled by Republicans, and the state house of representatives had a Republican majority only in 1920.

GOVERNMENT

The Oklahoma constitution adopted in 1907 contains many provisions that in older states were left to legislation. Amendments may be submitted through a majority of the members elected to both houses of the legislature or through a petition signed by 15% of the electorate, and a proposed amendment is adopted if it receives a majority of the votes cast at a popular election. General elections are held in even-numbered years; party candidates for state, district, county and municipal offices, and U.S. senators and congressmen are chosen at primary elections.

Executive.—The executive authority of the state is divided among 12 elected officials, including the governor, lieutenant governor, secretary of state, treasurer, auditor, attorney general, superintendent of public instruction, chief mine inspector and commissioner of charities and corrections. They are elected for terms of four years. By constitutional amendment ratified in 1966 the governor may serve two consecutive four-year terms. Other elected officials are the three members of the corporation commission (one elected every two years for a six-year term), the clerk of the supreme court and four assistant mine inspectors. Administrative work is also done by more than 60 officers, commissions, departments and boards.

Legislative.—The legislature is made up of 48 senators and 99 representatives. Annual sessions were adopted (1966) beginning in 1967. One-half of the senators and all representatives are elected every two years. Apportionment of the legislature was the subject of much litigation; the 1964 election was ordered held under a stand-by measure devised by the state supreme court pending appeal before the U.S. supreme court of a plan basing districting in the senate and the house entirely on population.

Judicial.—For the administration of justice there were established a supreme court, composed of nine justices elected for terms of six years; a supreme court commission, which was discontinued after its work was completed; a criminal court of appeals composed of three justices elected (one each two years) for terms of six years; 31 district courts, each with one or more justices elected for terms of four years; superior courts in certain of the more populous counties, with a judge elected for a term of four years; a county court in each county, with one judge elected for a term of two years; and municipal courts in the cities. A district attorney system was provided by law of the state legislature in 1965.

Local Government.—The general management of county affairs is entrusted to three commissioners elected by districts. The other county officers are a sheriff, attorney, judge, clerk, court clerk, treasurer, assessor, surveyor, superintendent of public instruction and public weigher. They are chosen for terms of two years in each of the counties at the general elections.

Finances.—Revenues for state and local purposes are derived almost wholly from separate sources. The greater part of the state's revenue is derived from a gross production tax on minerals; motor vehicle licenses; insurance fees; gasoline, sales, inheritance and income taxes; and departmental collections. Revenue for local purposes is obtained chiefly from tax levies on personal and real property; there are no state levies on property, tax levies being made only by the counties, townships or cities and towns and school districts. A legislative act in 1965 enabled cities to adopt a city sales tax, with the proceeds to be used for the improvement of the city government. Oklahoma City was the first city to approve the new tax. Chief state expenditures are for highways, education, debt amortization and service and penal institutions.

POPULATION

The population of Oklahoma and Indian territories in 1890 was 258,657. A special census gave a population of 1,414,177 in the new state in 1907. The population in 1910 was 1,657,155; in

*Oklahoma: Places of 5,000 or More Population (1960 census)**

Place	Population				
	1960	1950	1940	1920	1900†
Total state	2,328,284	2,233,351	2,336,434	2,028,283	398,331
Ada	14,347	15,995	15,143	8,012	3,257‡
Altus	21,225	9,735	8,593	4,522	1,927‡
Alva	6,258	6,505	5,055	3,913	1,499
Anadarko	6,299	6,184	5,579	3,116	2,190‡
Ardmore	20,184	17,890	16,886	14,181	8,759‡
Bartlesville	27,893	19,228	16,267	14,417	4,215
Bethany	12,342	5,705	2,590	485	—
Blackwell	9,588	9,199	8,537	7,174	2,283
Broken Arrow	5,928	3,262	2,074	2,086	1,383‡
Chickasha	14,866	15,842	14,111	10,179	7,862‡
Claremore	6,639	5,494	4,134	3,435	2,064‡
Clinton	9,617	7,555	6,736	2,596	1,278‡
Cushing	8,619	8,414	7,703	6,326	226
Del City	12,934	2,504	—	—	—
Duncan	20,009	15,325	9,207	3,463	2,451‡
Durant	10,467	10,541	10,027	7,340	4,510‡
Edmond	8,577	6,086	4,002	2,452	965
Elk City	8,196	7,962	5,021	2,814	2,195‡
El Reno	11,015	10,991	10,078	7,737	3,383
Enid	38,859	36,017	28,081	16,576	3,444
Frederick	5,879	5,467	5,109	3,822	2,036‡
Guthrie	9,502	10,113	10,018	11,757	10,006
Guymon	5,768	4,718	2,290	1,507	839‡
Henryetta	6,551	7,987	6,905	5,889	1,051‡
Hobart	5,132	5,380	5,177	2,936	3,136‡
Holdenville	5,712	6,192	6,632	2,932	1,868‡
Hugo	6,287	5,984	5,909	6,368	2,676‡
Lawton	61,697	34,757	18,055	8,930	5,562‡
McAlester	17,419	17,878	12,401	12,095	8,144‡
Miami	12,869	11,801	8,345	6,802	1,893‡
Midwest City	36,058	10,166	—	—	—
Muskogee	38,059	37,289	32,332	30,277	14,418‡
Norman	33,412	27,006	11,429	5,004	2,225
Oklahoma City	324,253	243,504	204,424	91,295	10,037
Okmulgee	15,951	18,317	16,051	17,430	2,322‡
Pauls Valley	6,856	6,896	5,104	3,694	2,157‡
Pawhuska	5,414	5,331	5,443	6,414	2,408‡
Perry	5,210	5,137	5,045	3,154	3,351
Ponca City	24,411	20,180	16,794	7,051	2,528
Pryor Creek	6,476	4,486	2,501	1,767	1,113‡
Sand Springs	7,754	6,994	6,137	4,076	—
Sapulpa	14,282	13,031	12,249	11,634	4,259‡
Seminole	11,464	11,863	11,547	854	206‡
Shawnee	24,326	22,948	22,053	15,348	3,462
Stillwater	23,965	20,238	10,097	4,701	2,431
Tahlequah	5,840	4,750	3,027	2,271	1,916‡
The Village	12,118	—	—	—	—
Tulsa	261,685	182,740	142,157	72,075	7,298‡
Vinita	6,027	5,518	5,685	5,010	3,157‡
Warr Acres	7,135	2,378	—	—	—
Wewoka	5,954	6,747	10,315	1,520	794‡
Woodward	7,747	5,915	5,406	3,849	2,018‡

*Populations are reported as constituted at date of each census. †1900 census figures are for the Territory of Oklahoma. ‡1907 special census for Territory of Oklahoma, 1900 figures not available.
Note: Dash indicates place did not exist at reported census, or data not available.

1940, 2,336,434; in 1950, 2,233,351 (4.4% less than in 1940; and in 1960, 2,328,284 (4.3% more than in 1950).

The 1960 urban population of Oklahoma comprised 1,464,786 persons, or 62.9% of the total. The state has three standard metropolitan statistical areas, which are Lawton, Oklahoma City and Tulsa. These areas had a total population of 1,021,610 or 43.9% of the total population of the state in 1960.

The population of the state in 1960, distributed by colour was 90.5% white, including a large number of persons of American Indian descent; 6.6% Negro; 2.9% other races, mostly full-blood American Indian.

The number of households in 1960 was 734,593, as compared with 663,262 in 1950; the average population per household had declined from 3.4 in 1950 to 3.1 in 1960. Of the total number of employed 9.4% was engaged in agriculture, 4.5% in mining and oil production, 7.2% in construction, 13.2% in manufacturing and 23.1% in transportation and trade.

Oklahoma's population is cosmopolitan in its ethnic origins, with nearly every nationality represented, though the largest number of persons is of American colonial descent. The percentage of American Indians is high, persons of full blood and mixed Indian-white numbering about 400,000. The state's population of foreign descent (largely German) includes families and groups that came to Oklahoma Territory with the opening of new lands (1889–1906); another large foreign element came to the coal mining region along the railroad in eastern Indian Territory in the 1880s. The Negro population in Oklahoma increased after World War II, especially in the urban centres, but basically it consists of descendants of Negro freedmen of the Indian nations, who after the Civil War remained in the country on freedman land allotments under the terms of the treaties of 1866. Groups of Negroes came from the southern states from time to time in the period of railroad building, and others were brought to work in the mines during the coal strikes in the early 1890s. One band of Negroes migrated from southern states, chiefly Louisiana and Texas, soon after the Civil War, and located in the unassigned lands near present Guthrie, where many of their descendants still live.

The decline in the state's population figures seen in 1950 was a result principally of changes in agricultural life; costly mechanization of farming operations, necessity of soil conservation practices in many localities and the reduction of cotton acreage in cotton-growing regions caused families to leave their farms.

EDUCATION

Public Schools.—The public school system in Oklahoma is administered by the state and county superintendents of public instruction. Total annual enrollment (elementary and high schools) was approximately 500,000 in the 1960s; total expenditures were about $200,000,000.

There had been no statewide general tax increase in the state since the 1930s and annual expenditures per pupil were $352, as compared with a national average of $452; average annual salaries for classroom teachers were $5,160, as compared with a national average of $6,220. After four Oklahoma Education association-sponsored petitions to provide more money for education had failed to pass in general elections, in 1965 the National Education Association was asked to apply sanctions warning out-of-state teachers against accepting jobs there. The state legislature enacted as an emergency measure a 25% increase in the biennial education budget, the largest increase in Oklahoma's history. Also, the state constitution was amended to permit local school districts to raise their taxes for schools by ten mills, and the sanctions were lifted.

Higher Education.—The Oklahoma State System of Higher Education, administered by the Oklahoma State Regents for Higher Education, has as members all state-owned senior colleges and junior colleges and one independent senior college.

The University of Oklahoma was established by the first legislative assembly of Oklahoma Territory in 1890, and opened at Norman in 1892. It is governed by a board of seven regents, appointed by the governor and confirmed by the state senate. It includes schools or colleges of arts and sciences (1892), pharmacy (1893), fine arts (1899), engineering (1904), education, graduate, law (1909), business administration (1923), university (1942), and schools of medicine (1900, Norman; 1910, Oklahoma City) and nursing (1911). The University of Oklahoma press established in 1928 is outstanding in the publication of books, covering many regional subjects and a variety of offerings including English literature, international biography and linguistics. The university owns and operates an AM and FM radio station.

Oklahoma State University of Agriculture and Applied Science at Stillwater was chartered as an agricultural and mechanical college in 1890. It comprises colleges of agriculture, arts and sciences, engineering, education, business, home economics, veterinary medicine, a technical institute and a graduate school and schools of hotel and restaurant administration and architecture.

Other state institutions of higher education include Oklahoma College of Liberal Arts (formerly Oklahoma College for Women) at Chickasha (1908); Panhandle Agricultural and Mechanical college at Goodwell (1909); Langston university at Langston (founded for Negroes in 1897); and six state-owned senior colleges at Ada, Alva, Edmond, Durant, Tahlequah and Weatherford. Oklahoma Baptist university at Shawnee (1910), independent, also is a member of the state system.

Independent colleges and universities include Oklahoma City university (Methodist, 1904); University of Tulsa (Presbyterian, 1894); Benedictine Heights college, Tulsa (Roman Catholic, 1955, outgrowth from Guthrie, 1917); Phillips university, Enid (Disciples of Christ, 1906); and Bethany-Nazarene college, Bethany (Church of the Nazarene, 1909).

HEALTH, WELFARE AND CORRECTIONS

The state constitution provided for the election of a state com-

missioner of charities and corrections to supervise and inspect charities and institutions of correction. The state maintains mental hospitals at Norman (with annex at Lexington), Vinita and Supply; sanatoriums for tuberculosis patients at Clinton and Talihina; a state school for feeble-minded children at Enid; a state school for mentally retarded white children at Pauls Valley; a state hospital and also consolidated Negro institutions for deaf, blind and orphans at Taft.

State penal institutions include Taft Training school for girls (near Taft), "Girls Town" (near Tecumseh), Helena State school for boys (near Helena), Boley State school for boys (at Boley), Taft State Children's home (near Taft), Whitaker State Children's home (near Pryor). The state penitentiary is located at McAlester and the state reformatory at Granite. Two subdivisions of the penitentiary are the vocational training school near Stringtown, and McLeod Honor farm near Ferris, both in Atoka county.

Of the state's 77 counties, about 50 have full-time health departments serving 80% of the state's population; a number of these provide full-time medical service.

The Oklahoma department of public welfare administers the programs for dependent children, the aged, the disabled, the blind, child welfare, crippled children and rehabilitation.

ECONOMY

Agriculture.—Oklahoma was a great cattle country before the first opening of land to white settlement in April 1889, and thereafter agricultural development was rapid, with millions of acres of former Indian lands added to Oklahoma Territory in eight other openings at different times. By the 1960s there were about 84,000 farms and ranches having a total of almost 40,000,000 ac. Nearly two-thirds of farms and ranches were owned by their operators. Oklahoma began its second 50 years of statehood with improved technology that kept agriculture as its most important single pursuit, soil conservation methods contributing largely to this.

Soil erosion, which began to show up even before statehood—because of early, wasteful farming methods on wide grasslands that should never have known a plow—amounted to a blight by the 1930s, aggravated by the great drought. Northwestern and western Oklahoma counties were included in the "dust bowl" region. State conservation laws in 1925 provided for protection of wildlife and promotion of forestry, irrigation and flood control. The program was expanded by the creation of the state soil commission in 1937, to co-operate with farmers in contour cultivation and terracing of farm lands and planting of cover crops to keep the soil from washing away. By the 1960s this commission had brought over 95% of the state's area within soil conservation districts under the organization and control of local farmers and ranchers.

Reclamation work to reduce flood damage along the rivers and streams has been a vital part of the water resources program in the state, in which flood control, irrigation and municipal water supply have been combined in one project. By the 1960s over 100,000 ac., principally in western Oklahoma, were irrigated. The sprinkler system of irrigation is used in some parts of eastern Oklahoma for the growing of small fruits and vegetables as well as corn and cotton, and in the panhandle, largely a livestock-growing region, for feed and forage crops.

Of cash crops, wheat is by far the most important; Oklahoma is the U.S. third most important wheat-producing state. Though wheat replaced cotton as the leading crop in the 1930s, cotton growing remains important. Other significant crops are hay, oats, peanuts, corn, sorghum, rye, pecans and a variety of fruits. Broom corn and grain sorghums were also important cash crops.

The beef cattle industry is the largest source of agricultural wealth in Oklahoma. Beef cattle, numbering well over 4,000,000, comprise chiefly Herefords, Aberdeen Angus and Shorthorn. Grazing is most important in the south-central part of the state and in the Blue Stem Bowl region in Osage county. Other livestock, raised in much smaller numbers, include hogs, sheep, horses and mules. Chickens number 3,000,000.

Lumber.—Timber is an important resource in southeastern Oklahoma. The lumber and wood products industry (excluding furniture manufacture) is valued at approximately $8,000,000 annually.

Minerals.—Oklahoma is widely known as an oil-producing state, and indeed petroleum is by far its most valuable mineral resource, being valued at around $700,000,000 annually (figure includes also natural gas, liquefied petroleum gas and natural gasoline). Oklahoma ranks about third in production among the states; it also ranks third in number of producing wells. Producing regions extend over most of the counties, generally from the north-central to the southwestern parts of the state, with a large natural gas field in the western part of the panhandle. Tulsa, the oil centre of the state, is situated near the central part of the north-central producing region; Duncan, in Stephens county, is a centre in the oil-producing region of the southwest.

In addition to fuel minerals, Oklahoma also has large reserves of metallic and other nonmetallic minerals. Among those of value to the state are zinc, dolomite, granite, lead, salt, sand and gravel, limestone and sandstone, tripoli, clays, glass sand, germanium, chat (coarse tailings from lead and zinc ores), volcanic ash, sulfur, gypsum, asphalt and ground silica. Mineral industries based on these are an important source of riches. Ada, in Pontotoc county, is noted for its great cement plants and as a centre in a region that produces petroleum, natural-gas liquids, stone, sand and gravel and clays.

Helium is found in the Oklahoma panhandle. This region, with limited fields extending into the Texas panhandle and the southern border of Kansas, comprises the only area in the United States and possibly in the world where helium is found in sufficient quantities for commercial profitable extraction. The helium plant at Keyes, Cimarron county, constructed in 1959 for the U.S. bureau of mines, was the second such plant in the United States.

Manufactures.—Manufacturing is a third mainstay in Oklahoma's economy, being based on agricultural and mineral wealth. Agricultural products provide raw materials for meat packing, canning, flour milling, feed manufacturing and textile plants; mineral wealth supplies raw materials and fuels for refining, smelting, glassmaking, petrochemical and other industries. About 95,000 persons are employed in manufacturing, the plants tending to be concentrated in the northeastern and central parts of the state.

Transportation and Communication.—Total railroad mileage is more than 5,000 mi., reaching every part of the state. The State Highway commission is responsible for more than 10,000 mi. of primary highway system. The larger cities are served by major airlines. The navigation features of the multiple-purpose Arkansas river project are being developed to link Oklahoma with the U.S. inland waterway system.

See also references under "Oklahoma" in the Index.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments. (M. H. W.)

OKLAHOMA CITY, capital of Oklahoma, U.S., and its largest city, the seat of Oklahoma county, is located on the North Canadian river at the approximate geographic centre of the state. Through annexations, it became the largest city in the U.S. in area (641.1 sq.mi. in 1964). Pop. (1960) 324,253, an increase of 33.2% over 1950; standard metropolitan statistical area (Canadian, Cleveland and Oklahoma counties) 511,833, an increase of 30.4%.

Oklahoma City's exact location was dictated by the existence

of a siding on the Atchison, Topeka and Santa Fe railway, originally intended for military use and known as Oklahoma station (1887). By sundown of the day the area of central Oklahoma (1,887,640 ac. known as the Oklahoma country) was opened for settlement (April 22, 1889), approximately 10,000 persons had congregated to stake land claims at a townsite adjoining the railroad stop. A provisional town government was instituted by mass meeting in May of 1889 but it was not until May 2, 1890, that formal statutory law came upon the organization of Oklahoma territory. While the name Oklahoma City was in popular use from the earliest day, the U.S. post office department did not adopt the name until 1923. A council-manager form of government, adopted in 1927, was continued under a new charter approved April 5, 1957.

The economy has been based upon agriculture, distribution and industry, and every federal census has shown substantial gains in population (for comparative population figures *see* table in OKLAHOMA: *Population*). Annual rainfall in the area is 30.22 in. and it is one of the few places where the cotton and wheat belts overlap; the city has long been an important shipping point for both crops and also for cattle. The first major urban development reached a climax in 1910, the year Oklahoma City was designated the state capital; in the three preceding years the population had doubled. After 1910 state employees increased the population and the city also benefited from the World War I boom. The first meat-packing plants were established about this time and with the coming of additional railroads wholesale trade increased.

The first well in the Oklahoma City oil field came in on Dec. 4, 1928. Characteristics of the oil industry there were the productivity of the wells; the enormous gas pressures, resulting in more than one spectacular mid-city fire; and the then unprecedented depths (4,000–7,000 ft.) of the wells. Because of the fire hazard city ordinances were passed limiting the drilling zone in the city; it was subsequently enlarged and in 1936 was further expanded to include drilling on the state capitol grounds. In the latter part of the 20th century there were in the metropolitan area about 1,800 producing wells, approximately 1,400 within the city limits.

The city enjoys diversified industry; principal products are in aircraft, petroleum refining, oil field and telephone exchange equipment, meat packing and steel fabrication. Oklahoma City is one of the nation's foremost aviation centres, with Tinker air force base, a large air matériel depot and a federal aviation agency centre for the training of students in all phases of department of commerce aviation management and technical skills.

Educational facilities include, in addition to the usual public and parochial schools, Oklahoma City university (Methodist, 1904) and the medical centre of the University of Oklahoma, which includes schools of medicine and nursing, the university hospital, a crippled children's hospital and a speech and hearing clinic. Also on the grounds are a Veterans administration hospital and the Oklahoma Medical Research institute (privately owned and operated) and its adjacent research hospital.

The civic centre includes a modern auditorium which seats 6,000 persons. Residential housing is predominantly ranch and early American in style. The city has a symphony orchestra and is the headquarters for the state library and the state historical society, which contains an outstanding collection of American Indian archives. The state fair is held there and the city is also the site of the Cowboy Hall of Fame and Museum. (GE. H. S.)

OKMULGEE, a city of east-central Oklahoma, U.S., is located 37 mi. S. of Tulsa; the seat of Okmulgee county. Capital of the Creek Nation from 1868 until Oklahoma achieved statehood in 1907, Okmulgee, a Creek word meaning "bubbling water," began to be settled by whites in the last decade of the 19th century. In 1904 oil was discovered in the vicinity and with its development, beginning in 1907, the small cattle and agricultural community boomed. Incorporated in 1908, the city adopted a council-manager form of government in 1954. In the second half of the 20th century it was the centre of an important oil-producing area. Agricultural products included beef and dairy cattle, poultry, peanuts, cotton and corn. Manufactures included petroleum and meat products, oil field equipment, glass and furniture.

Located there is the school of technical training, a branch of Oklahoma State university. The Creek Indian council house (1878), now an Indian museum, stands in the heart of the city. For comparative population figures *see* table in OKLAHOMA: *Population*. (J. D. Mo.)

OKOVANGO (OKAVANGO, Portuguese CUBANGO), a river in central Africa, about 605 mi. in length, rises in Angola about 10 mi. E. of Vila Nova on the Benguela railway. Near Caiundo, about 200 mi. from the source, the river passes from the ancient crystalline rocks of the Angolan highlands to the Kalahari formation and flows on this formation for most of the remaining 400 mi. of its course. In many places the river has cut several hundred feet into the Kalahari system exposing hard beds of calcrete or silcrete which, as at Runtu, on the Southwest African border, form bluffs or cliffs where they have been undercut by erosion at a bend. Below the Popa falls, about 10 mi. below Andara, the river forms a series of stairlike rapids, falling about 10 to 15 ft.

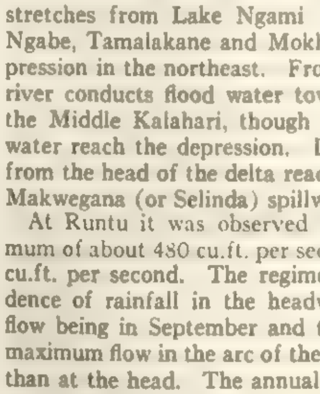
Between Runtu and Andara the Okovango receives the Cuito, which rises in the Kalahari sand and flows for nearly 450 mi. to join the main stream in an extensive flood plain. On the south side of the river the tributary channels are generally dry courses, the strongest of them being the Omuramba Omatako, which occasionally brings water to the Okovango.

For about 170 mi. below the Popa falls the river has formed a great swamp tract, the first 90 mi. of which is between about 3 and 8 mi. wide, spreading out to form a great delta, about 80 mi. long (from northwest to southeast) and 120 mi. wide (from southwest to northeast). From west to east the main distributaries are: the Taokhe, the Jiao, the Ng-gokha and the Mochaba. These flow into the channel forming the arc of the delta, which stretches from Lake Ngami (*q.v.*) in the southwest along the Ngabe, Tamalakane and Mokhokelo channels to the Mababe depression in the northeast. From the arc of the delta the Botletle river conducts flood water toward the Makarikari depression in the Middle Kalahari, though only during very high floods does water reach the depression. During very high floods, too, water from the head of the delta reaches the Linyanti marshes along the Makwegana (or Selinda) spillway.

At Runtu it was observed that the flow varied from a minimum of about 480 cu.ft. per second to a maximum of about 20,000 cu.ft. per second. The regimen corresponds closely to the incidence of rainfall in the headwater catchment basin, the lowest flow being in September and the highest in March or April, the maximum flow in the arc of the delta being about five months later than at the head. The annual discharge of the river at the head of the delta is estimated to be about 11,000,000 ac.-ft.

See A. L. Du Toit, *Report of the Kalahari Reconnaissance of 1925* (1925); L. A. Mackenzie, *Report of the Kalahari Expedition, 1945* (1946), A. G. Stigand, "Ngamiland," *Geogr. J.*, vol. lxii (1923); C. F. Rey, "Ngamiland and the Kalahari," *Geogr. J.*, vol. lxxx (1932); J. H. Wellington, *Southern Africa*, vol. i (1955). (J. H. Wn.)

OKRA, a herbaceous, hairy, annual plant (*Hibiscus esculentus*) of the mallow family (Malvaceae), of the old world tropics and widely cultivated or naturalized in tropical and subtropical countries. The leaves are heart-shaped, three to five lobed; the flowers are yellow with a crimson centre. The fruit or pod, the *bendikai* of the Europeans of southern India, is a tapering, ten-angled capsule, four to ten inches in length (except in the dwarf varieties), and contains numerous oval, dark-coloured seeds, hairy at the base. Only the tender, unripe fruit, called gumbo, is eaten, either pickled or prepared like asparagus. It is also an ingredient in various dishes (*e.g.*, the gumbos of the southern United States); and because of the large amount of mucilage it contains, it is extensively used for thickening



BY COURTESY OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

OKRA (HIBISCUS ESCULENTUS) SHOWING PODS IN PRIME CONDITION FOR USE AS FOOD

broths and soups. The fruit is grown on a large scale in the vicinity of Istanbul. In some countries the seeds are used as a substitute for coffee. From their demulcent and emollient properties, the leaves and immature fruit long have been in repute in the east for use in poultices and fomentations.

The musk mallow or abelmosk (*Hibiscus moschatus*), a related plant indigenous to India and cultivated in most warm regions of the globe, is a low, slightly woody plant, bearing a conical five-ridged pod about three inches in length, within which are numerous brown reniform seeds, smaller than those of *H. esculentus*. The seeds possess a musky odour caused by an oleoresin and are known to perfumers under the name of ambrette, now mostly of synthetic origin. The seeds are used in Africa as beads. The plant yields an excellent fibre and, being rich in mucilage, is employed in upper India for clarifying sugar. The best-perfumed seeds are reported to come from Martinique.

ŌKUBO TOSHIMICHI (1830–1878), one of the Japanese samurai leaders who in 1868 overthrew the shogunate and re-established the government of the emperor (*see* JAPAN: *History*). Ōkubo immediately became a dominant member of the new government formed under the emperor. After a brief government mission abroad he returned convinced of the necessity of Japan's rapid economic development. To this end he supported the establishment of technical schools, the holding of scientific and technical exhibitions, the giving of loans and subsidies to private business, and the building and management of factories by the government.

In 1873 he split with the great Saigo, one of his fellow clansmen of Satsuma, over policy toward Korea. Saigo supported a policy of conquest; Ōkubo argued that priority should be given to internal reform and development. Ōkubo's views prevailed and were adhered to until 1894, long after his death. Saigo left the government and returned to his native Satsuma to arouse the clansmen. In the troubles which soon followed the foreign policy split, Ōkubo was the chief opponent of Saigo, who led the Satsuma rebellion. The suppression of the rebellion brought upon Ōkubo the personal revenge of Saigo's sympathizers, and he was assassinated in 1878 by six clansmen. Thus Ōkubo, one of Japan's greatest leaders, was in a sense a martyr to his progressive views of government and foreign policy. (T. C. SH.)

See M. Iwata, *Ōkubo Toshimichi: The Bismarck of Japan* (1964).

ŌKUMA SHIGENOBU, MARQUIS (1838–1922), Japanese statesman and prime minister of Japan during the first part of World War I, was born in the Kyushu fief of Saga, the son of a specialist in gunnery. After a conventional education, Ōkuma turned to western (Dutch) studies under the tutelage of the missionary Guido Verbeck. Ōkuma and his friends were not able to persuade their lord to join the great southwestern fiefs in the Restoration movement of 1868, and as a result they took second place to leaders from those fiefs in the new Meiji government. Ōkuma's ability and courage, however, made up for some of these disadvantages, and he played an important role in politics. From 1869 to 1881 he was principally responsible for the modernization and reorganization of Japan's fiscal system.

In 1881 Ōkuma responded to an imperial request for recommendations by presenting the draft of a constitution but his colleagues considered it radical and ill-advised. As he was about to be forced from office he exposed flagrant corruption in proposed sales of government property in Hokkaido. His action precipitated the Meiji emperor's promise of a constitution by 1889. Ōkuma then formed a political party, the *Kaishintō* (Progressive party), and challenged Itagaki Taisuke's leadership of the parliamentary movement. He also purchased the newspaper *Hōchi shimbun* and founded what became Waseda university in 1882.

Ōkuma several times interrupted his campaign against the government to give full co-operation to his former colleagues. In 1888 he became foreign minister in the Kuroda cabinet, but resigned the following year after an attack by an ultranationalist that nearly cost him his life. In 1896 he served again as foreign minister, and two years later he and Itagaki joined forces to form the Constitutional Government party (*Kenseitō*). The new party was permitted to form a government with Ōkuma as prime minister (1898) but it foundered over patronage disputes. In 1907 Ōkuma retired from politics to devote his full time to Waseda university, only to be recalled as prime minister in 1914. During this, his last premiership, Japan entered World War I and experienced a great economic boom. Efforts to force China to make long-term grants of Russian and German concessions the Japanese had taken over led to the Twenty-one Demands of 1915. These made Japan the object of the rising tide of nationalist indignation that stirred China after World War I. Ōkuma resigned in 1916 and retired from politics because of ill-health. He died on Jan. 10, 1922, at Tokyo. *See* also JAPAN: *History*. (M. B. J.)

OLAF (OLAFR; O. E. ANLAF), two kings of the Norse kingdoms of Northumbria and Dublin.

OLAF GUTHFRITHSON (d. 941) became king of Dublin on the death of his father in 934. He was continually involved in plunder in Ireland till Aug. 937, when he led a considerable force to England and was joined by Constantine of Scotland and Owain of Strathclyde. The confederacy was defeated by Aethelstan at Brunanburh, and Olaf fled to Ireland. There he was again occupied with plunder till 939, when he seized York. He entered into a vigorous campaign in the midlands in 940. Edmund I, who had succeeded Aethelstan in 939, hastened to meet him, and a treaty was concluded which gave Olaf Northumbria and part of Danish Mercia. Olaf died in 941 while plundering at Tyninghame near Dunbar.

OLAF SIHTRICSON (d. 981), nicknamed Cwaran ("of the sock" or "sandal"), was, like Olaf Guthfrithson, held in Irish tradition to be a great-grandson of Ivar (Imhar). He may have been present at Brunanburh in a subordinate capacity. He succeeded to Northumbria on the death of Olaf Guthfrithson, while Blacare, another son of Guthfrith, took the kingdom of Dublin. In 942 Olaf's power in the midlands was destroyed by Edmund, and in 943 he was deposed by the Northumbrians, who appointed one Raegnald in his place. Olaf and Raegnald now sought the friendship of Edmund and were baptized. They perhaps attempted to rule jointly, but in 944 Edmund expelled them both from Northumbria. Olaf fled to Ireland and was allowed by Blacare to assume the kingship of Dublin. He ruled turbulently for some years, and then in 949 he returned to Northumbria and became king, but was driven away in 952. His reign fell between the two reigns of Eric Bloodaxe. In his absence, Blacare had ruled Dublin but had fallen in battle (948) with Congalach, king of Ireland. Olaf re-established himself at Dublin (*c.* 951) and had an eventful reign. Congalach fell in battle against him in 956. In 980, however, Olaf suffered a disastrous defeat from Maelsechlain, afterward king of Ireland, at Tara, and withdrew on pilgrimage to Iona, where he died in 981.

Northumbrian coins minted for both Olafs are extant.

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OLAF (OLAV), the name of several kings of Norway.

OLAF I TRYGGVESSON (*c.* 964–1000), king of Norway from 995 to 1000, was a great grandson of Harald I Haarfager and the son of Tryggvi Olafsson, a petty king of southeastern Norway. Olaf was born shortly after his father had been killed by one of the sons of Eric "Bloodaxe." His mother, Astrid, fled and, according to the story, Olaf reached the court of Vladimir the Saint in Russia while still a child. A contemporary poet says that he left Russia at an early age and lived for some years as a Viking, pillaging the coasts of the Baltic and the British Isles.

According to one version of the Anglo-Saxon Chronicle, Olaf was leader of the Viking army which defeated and killed the famous Anglo-Saxon chieftain Byrhtnoth in the battle of Maldon (991). In 994, with the help of Sweyn I, king of Denmark, Olaf besieged London. The city resisted and the Vikings retired to pillage southeastern England, subsequently concluding a treaty with Aethelred II. Olaf was already a Christian, but it is not known when or where he had been converted. According to a medieval legend, now proved fictitious, he had been baptized by a hermit in the Scilly Isles. He was confirmed at Andover after

the treaty of 994, and Aethelred was his sponsor.

In 995 Olaf sailed to Norway. The heathen ruler, Haakon the Great, had grown unpopular, and Olaf was quickly proclaimed king. His short reign was among the most memorable in the history of Norway.

The medieval historians of Iceland and Norway depict Olaf as single-minded in his devotion to the Christian cause, converting his subjects ruthlessly, by persuasion, persecution and guile. In fact, he had little influence in the interior of Norway, although the people of the coastal districts were compelled to submit to baptism. It was said also that Olaf caused the conversion of the Norse settlements in Orkney, the Faeroe Islands and Greenland. Although he never went there, his influence on Iceland was most radical and lasting. At his instigation, Christianity was made the official religion of that country in the year 1000.

Olaf's reign ended abruptly in this same year. Although the circumstances are not clear, it is plain that Sweyn I of Denmark and Olaf Skötkonung of Sweden had allied against Olaf Tryggvesson. Olaf had sailed to Wendland (Poland) in his mighty ship the "Long Serpent," accompanied by a magnificent fleet. After some negotiations with Boleslaw I, king of Poland, Olaf turned back, but was waylaid by Sweyn and his allies near the island of Swold (or Svold), said to lie off the coast of Wendland. Olaf's heroic defense and death were widely celebrated by the poets of the north.

Olaf II Haraldsson (*c.* 995–1030), king of Norway from 1015 to 1030 and the country's patron saint, was a descendant of Harald I Haarfager. Olaf grew up a pagan and, in early youth, lived as a Viking in Scandinavia and the Baltic lands. In 1009, the contemporary poets imply, Olaf landed at Sandwich in the great Danish army commanded by Thorkel the Tall. He engaged in several battles against the English (1009–11) and later went to France and probably to Spain. He was baptized in Rouen (*c.* 1013), and this was the turning point in his career. He returned to England in 1014 and soon afterward sailed to Norway to assert his claims to the throne.

Olaf reached Norway at a propitious moment. The country had lost its independence on the death of Olaf Tryggvesson and was now divided. Southern regions were subject to the king of Denmark and some of the eastern ones to the king of the Swedes. The west was ruled by Jarl Eric, son of Haakon the Great, who acknowledged the suzerainty of the king of Denmark. Eric was now abroad, and his son, Haakon, and brother, Sweyn, were quickly defeated by Olaf's forces and driven into exile. Olaf was master of all Norway by 1016. He proved to be a hard ruler and an ardent protagonist of the Christian religion. Although Norway had been Christian in name since the reign of Olaf Tryggvesson, Christian religion had hardly penetrated beyond the coasts, and pagan worship persisted. Olaf had brought clerics from England, and he set out to organize the church in Norway, probably on the English model.

Olaf appealed to national sentiment, but many chiefs resented his interference and revolted. He had also to face trouble with foreign monarchs. Early in his reign he conflicted with his namesake Olaf Skötkonung, king of the Swedes, but later (1019) he made peace with him, having married his daughter, Astrid. His differences with Canute, king of England and Denmark, were more serious. When Canute pressed his claims to the overlordship of Norway, Olaf concluded an alliance with Anund, Olaf Skötkonung's son and successor. Together they plundered Danish provinces (1026), but Canute surprised and repelled them with a large fleet at the mouth of the Holy river (Helge Å), to the east of Skaane. In 1027 Canute sent agents to Norway to incite chieftains against Olaf, and in 1028 he went to Trondheim himself and was proclaimed king. Olaf fled to Russia, where he remained until 1030. He then returned to Norway through Sweden, and his old ally Anund supplied some troops. Olaf's army was of poor quality, and he was killed when he met a well-organized and greatly superior force at Stiklestad, about 40 mi. from the city of Trondheim.

No battle in Norse history made a deeper impression on popular imagination than that at Stiklestad. In the heat of it, the sun was eclipsed, from which it may be deduced that it was fought on Aug. 31, 1030, and not on July 29, as the chroniclers say. Miracles were claimed to have occurred immediately after the king's death, and a year later, it was said, his body rose whole and uncorrupt to the surface of the ground. His cult spread rapidly throughout Norway and far beyond it. In fact, Olaf exercised a far greater influence after his death than he did while alive. His feast day is July 29, the traditional date of his death.

Olaf III Haraldsson (d. 1093), nicknamed "the Quiet" (*Kyrri*), was king of Norway from 1066 to 1093. Olaf had followed his father, Harald III Hardraade, on the expedition to England on which Harald was killed in 1066. After his father's death Olaf ruled jointly with his brother Magnus (d. 1069) and then as sole king. His reign was one of the longest, most prosperous and least eventful in the history of Norway. He built a number of churches and founded several towns, including Bergen. He won great popularity and was remembered for generosity and benevolence toward his subjects.

Olaf Magnusson (*c.* 1099–1115), illegitimate son of Magnus II Barfot, is often counted in regnal lists of Norway as Olaf IV. On the death of his father in 1103, he was proclaimed king jointly with his elder brothers, Eysteinn and Sigurd, who administered Olaf's share of the kingdom until his death.

Olaf IV (1370–1387), king of Denmark from 1376 to 1387 and of Norway from 1380 to 1387, was the son of Haakon VI and of Margaret, daughter of Valdemar IV, king of Denmark. After Valdemar's death in 1375, Olaf was elected (1376) king of Denmark and succeeded his father as king of Norway in 1380. The government of Norway was conducted by a state council, but power was largely in the hands of Olaf's mother, who planned to unite Norway, Sweden and Denmark. Olaf attained majority in 1385 but died two years later. (G. T.-P.)

Olav V (1903–), king of Norway from 1957, the only child of Prince Charles of Denmark (afterward King Haakon VII) and Princess Maud, youngest daughter of Edward VII of England, was born at Appleton House, near Sandringham in England, on July 2, 1903, two years before his father's election to the throne of Norway. He received the name of Olav on his arrival in Norway in 1905. Olav attended the Norwegian Military Academy from 1921 to 1924 and then went to Balliol College, Oxford, until 1926. He early distinguished himself as a ski-jumper in the Holmenkollen competition, and as a yachtsman was successful in many regattas and at the Olympic Games in 1928. On March 21, 1929, he married Princess Martha (1901–54) of Sweden. There were three children of the marriage, two daughters, and a son, Harald (b. Feb. 21, 1937). In 1940, when the Germans invaded Norway, Prince Olav escaped from Oslo with his father and the latter's ministers, with whom he finally reached England; and in June 1944 he was named head of the Norwegian armed forces.

Olav returned to Norway in May 1941, to act as regent till his father returned in June. He was regent again from June 1955, when his father had an accident, to Sept. 21, 1957, when he became king on his father's death. He made many visits to foreign countries; *e.g.*, to France and to Great Britain in 1962 and to Yugoslavia in 1966. (G. M. G.-H.)

OLAF Skötkonung (*c.* 995–1022), king of Sweden, son of Eric the Victorious. At home he followed a Christian policy without enforcing conversion, while his foreign policy was consistent opposition to the growth of a strong Norwegian state. Hence he joined King Sweyn I of Denmark in a victorious war against Norway in 1000, and married his illegitimate daughter Holmfrith to Sweyn Jarl, one of the Danish viceroys in Norway. His attitude softened in the reign of Olaf II Haraldsson, who married his other illegitimate daughter, Astrid. His legitimate daughter, Ingigerth, married Yaroslav, grand duke of Kiev. (Al. C.)

OLANCHO, a large department in southeastern Honduras that includes nearly 22% of the national area. Pop. (1961) 110,744, of which almost 80% was rural. Juticalpa, the departmental capital and largest town (pop. 7,210 in 1961), is connected with the national capital, Tegucigalpa, by an all-weather road 130 mi. long. The mountainous western third of the department has most of the population; the rest of the area consists mostly of very rainy forested lowlands with no roads and few people. Agri-

cultural production is largely in the mountain valleys; the department ranks first in Honduras in the production of cattle and swine, and third in output of coffee, cotton and beans. Other significant products are corn, rice, potatoes, gold and handicraft articles. (C. F. J.)

ÖLAND, a Swedish island in the Baltic sea, stretches for 85 mi. along the east coast of the southern extremity of Sweden from which it is separated by Kalmar sound which is from 5 to 15 mi. wide. After Gotland it is the largest Swedish island, with an area of 520 sq.mi.; its greatest breadth is 10 mi.: pop. (1960) 23,265. The centre of the island is more densely populated than either end. The only large town is Borgholm, with 2,488 inhabitants.

The island consists for the most part of Silurian limestone, and thus forms a striking contrast to the granitic, gneissic mainland. The limestone is burned for lime as well as being cut and polished. Down the west side runs a limestone ridge, rising usually in terraces, but at times in steep cliffs, to a height of 200 ft.; and along the east side there is a parallel ridge of sand, resting on limestone, never exceeding 90 ft. These ridges, known as the Western and Eastern Landborgar, are connected toward the north and the south by belts of sand and heath, and the hollow between them is occupied by a desolate and almost barren tract. The southern portion, or Alvaret, presents a surface of bare limestone characteristically weathered. Outside the ridges Öland is wooded, while the narrow strip of alluvial coastland is good agricultural country. There are a few small streams on the island and one lake, Hornsjö, about 3 mi. long.

For administrative purposes Öland is included in the Kalmar län (county). From the raid of Ragnar Lodbrok's sons in 775 onward Öland is frequently mentioned in Scandinavian history, and especially as a battleground in the wars between Denmark and the northern kingdoms. In the middle ages it formed a separate legislative and administrative unit. A number of monuments of unknown age exist, including stones (*stensättningar*) arranged in groups to represent ships. Borgholm has one of the finest castle ruins in Sweden. The town was founded in 1816, but the castle, dating at least from the 13th century, was one of the strongest fortresses and afterward one of the finest palaces in the country. The inhabitants were formerly styled Öningar, and show considerable diversity of origin in the matter of speech, local customs and physical appearance.

OLAUS MAGNUS: *see* MAGNUS, OLAUS.

OLBERS, (HEINRICH) WILHELM (MATTHÄUS) (1758–1840), German astronomer, who paid special attention to comets and the minor planets, was born on Oct. 11, 1758, at Arbergen, a village near Bremen, where his father was minister. He studied medicine at Göttingen, 1777–80, attending at the same time Kaestner's mathematical course. In 1779 he devised a new method of calculating cometary orbits. The treatise containing this important invention was made public by Baron von Zach under the title *Ueber die leichteste und bequemste Methode, die Bahn eines Cometen zu berechnen* (1797). A table of 87 calculated orbits was appended, enlarged by Johann Encke in the second edition (1847) to 178 and by Johann Galle in the third (1864) to 242. In 1781 Olbers settled as a physician in Bremen, where he practised until his retirement on Jan. 1, 1823. The greater part of each night was meanwhile devoted to astronomy, the upper portion of his house having been equipped for use as an observatory.

The comet of 1815 (period 74 years) bears his name in commemoration of its detection by him. He also took a leading part in the discovery of the minor planets, rediscovering Ceres on Jan. 1, 1802, and discovering Pallas on March 28 following. His hypothesis of their origin by the disruption of a primitive large planet (*Monatliche Correspondenz*, vi, 88) seemed to gain confirmation by the finding of Juno by C. L. Harding, and of Vesta by himself in regions indicated by the hypothesis. Olbers' theoretical investigation of the brightness of the sky to be expected on the hypothesis of an infinite static universe of stars is of great importance to modern cosmology. (*See* J. E. Bode, *Astronomisches Jahrbuch*, p. 110, 1826, and H. Bondi, *Cosmology*, pp. 19–26, 1952.)

Olbers died at Bremen on March 2, 1840. He was twice married, and one son survived him.

See C. Schilling, *Wilhelm Olbers, sein Leben und seine Werke* (1894 and 1900); Olbers' unique collection of works relating to comets now forms part of the Pulkovo library.

OLD-AGE PENSIONS: *see* PENSION; SOCIAL SECURITY.

OLD BELIEVERS (RASKOLNIKI ["Schismatics"], STAROVERI, STAROOBRYADTSI) separated from the main Russian Orthodox Church at the time of the reforms of Patriarch Nikon (*q.v.*; 1652–67), who aimed at a return to the Greek liturgical tradition. The Old Believers, notably the archpriests Neronov and Avvakum Petrovich (*q.v.*), supported the "old rite," consisting of many purely local Russian developments. However, in a series of councils culminating in that of 1666–67 the patriarch prevailed and the schismatics were excommunicated and severely persecuted. They were most numerous in the inaccessible regions of north and east Russia (but later also in Moscow itself), and were important in the colonization of these remote areas. Opposed to all change, they strongly resisted the western innovations introduced by Peter I, whom they regarded as Antichrist. Having no episcopal hierarchy they split into two groups: the *Popovtsi*, who sought to attract ordained priests and were able to set up an episcopate in the 19th century; and the *Bezpopovtsi*, who renounced both priests and sacraments. Out of both groups have developed many other sects, some with very extravagant practices. Enmity between the tsarist state and church and the Old Believers continued in varying degrees of violence up to the edict of toleration, April 17, 1905.

Most of the groups of Old Believers survived the Revolution (1917) and the branches of the *Popovtsi* that had established their own hierarchies succeeded in becoming registered and thus officially recognized by the Soviet state. Those known to be in existence are the convention of Belaya Krinitsa with its centre in the Rogozhski cemetery, Moscow (estimated membership 800,000); the Old Believer church of the Ancient Orthodox Christians (derived from the so-called *Beglopopovshchina*, "fugitive priests"), with its centre at Kuibyshev; and the Edinovertsi, a group dating from the early 19th century that is under the jurisdiction of the Moscow patriarchate and has a church in Moscow.

Two large communities of *Bezpopovtsi* in Moscow, the Preobrazhenskoe (Transfiguration) cemetery group and the so-called Pomortsi, together with those in Lithuania (centred in Vilnius) and in Latvia (centred in Riga), as well as numerous small groups elsewhere, are officially recognized. They were allowed to publish a church calendar in 1962. Little is known, however, of the Old Believer settlements supposed to exist in Siberia, the Urals, Kazakhstan and the Altai. Some Old Believers outside Russia have been resettled: 1,250 from China in Brazil (1958–61), and, from Turkey, 1,000 back to the Soviet Union and in 1962, under sponsorship of the Tolstoy foundation, 250 to the United States. These groups have remained especially faithful to their 17th-century way of life, and like all Old Believers have a remarkably efficient economic management.

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OLDBURY, a municipal borough (1935) of Worcestershire, Eng., lies 6 mi. W. of Birmingham by road. Pop. (1961) 53,948. It is an old "burh," so named by the Anglo-Saxons who found it an ancient and possibly deserted British settlement. It was crown property until 1214. Architecturally "Ye Big House" (1705) is a fine example of the Queen Anne period and the Courthouse is early 19th century. There are 12 parks and recreation grounds, a sports centre, and a golf course. The town has a variety of industries, the principal ones being steel tubes and chemicals, including plastics. Oldbury is linked to surrounding areas by a comprehensive omnibus service and two passenger railway stations with goods yards. (K. PE.)

OLDCASTLE, SIR JOHN (*c.* 1378–1417), English Lollard leader, was the son of Sir Richard Oldcastle of Almeley, Herefordshire. He took part in the Scottish campaign of 1400, and sat in parliament for Herefordshire in 1404. His service in the Welsh

wars won him the friendship of Henry, prince of Wales. In 1408 he married Joan, heiress of John, 3rd Lord Cobham, of Cooling castle, Kent, and in her right was summoned to parliament as a baron in 1409. Warned about his Lollard activities by Archbishop Arundel of Canterbury in 1410, Oldcastle was summoned before convocation in March 1413, when fresh evidence came to light. His connection with the new king earned him every consideration, but he did not respond to Henry V's personal appeals to submit, and, on Sept. 23, he was brought to trial. He proved an obdurate and conscientious heretic: he rejected transubstantiation and denied the necessity of penance and confession, declaring that popes, cardinals and bishops could not dictate belief on such matters. He was convicted as a heretic on Sept. 25, but the king granted a stay of execution for 40 days. On Oct. 19 Oldcastle escaped from the Tower and took refuge with a Lollard bookseller of Smithfield, named William Fisher. There he planned a desperate adventure. Conspirators dressed as Twelfth Night mummers were to seize the king at Eltham palace, in Kent, while Lollards from all over the country were summoned to assemble at St. Giles's fields, near Temple Bar on the night of Jan. 9–10, 1414. The response was small; the king, forewarned by his agents, removed to London, and the assembled Lollards were easily captured or dispersed. Oldcastle himself escaped into the Welsh marches, and for nearly four years evaded capture. He was taken, after a fight, near Welshpool in Nov. 1417. Parliament formally reiterated his condemnation, and on Dec. 14 he was hung above a slow fire, which consumed him "gallows and all." His deep religious conviction and personal bravery command respect, for few Lollards of his class were prepared to suffer for their belief; but his abortive rising weakened his cause by branding it as treasonable.

In *The Famous Victories of Henry V*, the source play for Shakespeare's *Henry IV*, Sir John Oldcastle appears briefly as a friend of Prince Hal and has apparently been engaged with him in robbing the king's tax receivers. Shakespeare kept the name in the first version of *Henry IV*, but changed it to Falstaff before the play was registered in 1598, probably because of protests by the 7th or 8th Lord Cobham. In a play registered as *The First Part of the History of the Life of Sir John Oldcastle, Lord Cobham* in 1600, Sir John appears as a generous and loyal nobleman, the prestige of whose support is sought by dynastic opponents of the Lancastrian regime as well as by Lollard rebels.

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(C. D. R.)

OLD CATHOLICS is the name commonly given to, and accepted by, groups of western Christians who believe themselves to maintain in complete loyalty the doctrine and traditions of the undivided church but who separated from the see of Rome after the first Vatican council of 1869–70.

Origins.—The steady process of centralization in the see of Rome and in the person of the pope, which has marked the later history of the church in the west, has naturally led to recurrent opposition. This has taken a variety of forms—for instance, conciliarism in the 15th century and Jansenism in the 17th. A new wave of opposition was released by the plans for the first Vatican council and the promulgation of the doctrine of the infallibility of the pope in 1870 (*see* COUNCIL: *First Vatican Council* [*1869–70*]; INFALLIBILITY; VATICAN COUNCILS). There was widespread hostility to these plans, the most notable figure being the church historian J. J. I. von Döllinger (*q.v.*), who was one of the most outstanding Roman Catholic scholars of the period. After the council, all the bishops of the opposition one by one gave in their adhesion to the new dogma. Döllinger remained obdurate and in course of time was excommunicated by name. He himself took no part in the formation of separatist churches, but it was largely as a result of his wise advice and prudent guidance that Old Catholic churches came into being in a number of countries—Germany, Switzerland, Austria and elsewhere. As no bishop had joined any of these groups, recourse was had to the Jansenist church in Holland, which had maintained a somewhat precarious existence in separation from Rome since the 18th century but had preserved an episcopal succession recognized by Rome as valid though irregular. The first consecration of the new order was that of Joseph H. Reinkens to be bishop in Germany carried out by Bishop Heykamp of Deventer on Aug. 11, 1873. Rather later and for similar reasons, though with a certain national emphasis, the Polish National Catholic Church came into being in the United States and Canada. The episcopal succession was transmitted to this church in 1897 by Bishop E. Herzog of Switzerland.

Organization.—In 1889 the Union of Utrecht was formed and the declaration of Utrecht, issued in that year by the Old Catholic bishops, is the charter of Old Catholic doctrine and polity. To the union adhere: the Jansenist Church of Holland, with three bishops and about 12,000 members; the Old Catholic Church of Germany, with two bishops and about 40,000 members; the Christian Catholic Church of Switzerland, with one bishop and 30,000 members; the Old Catholic Church of Austria, with one bishop and about 40,000 members; the Polish National Catholic Church with five bishops and 250,000 members, mostly in the eastern part of the United States. The Old Catholic churches in Poland, Czechoslovakia and Yugoslavia suffered severely during and after World War II. The name "Old Catholic" is sometimes used of other small sects directed by *episcopi vagantes* (*q.v.*), unrecognized bishops; but this is an inaccuracy.

The chief authority in the Old Catholic churches is the conference of bishops. The archbishop of Utrecht exercises a kind of honorary primacy. Each diocese has its synod, with full participation of both clergy and laity in every aspect of the life of the church, including the election of bishops.

Theological Position.—Döllinger at the start laid down the vocation of the Old Catholic churches in three propositions: (1) "to bear witness *for* the truth and *against* new-fangled errors, especially the disastrous and arbitrary development of new articles of the faith; (2) gradually to bring into being a Church which will be more closely conformed to the ancient undivided Church; (3) to serve as an instrument for a future great reunion of separated Christians and Churches."

Taking these principles as their basis, the Old Catholics deny that they teach anything which is contrary to the doctrine and traditions of the Catholic Church. They accept the Scriptures, the Apostles' and Nicene creeds and the dogmatic decisions of the first seven ecumenical councils. They uphold the conciliar basis of the church and accord a high place to tradition, regarding it as the means by which the purity and completeness of the truth revealed in Scripture is safeguarded in the church. They accept seven sacraments as of permanent obligation in the life of the church. The episcopate is accepted according to the Cyprianic doctrine as a gift given by God to the church, in which all Catholic bishops share equally, having been admitted thereto by bishops who themselves stand in unbroken historical succession from the time of the apostles.

Many differences in practice, some perhaps introduced under Protestant influence, separate Old Catholics from Roman Catholics. By adopting in all countries the use of the vernacular in public worship, the Old Catholics accepted what at the time was regarded as one of the fundamental principles of the Protestant Reformation. Confession to God in the presence of a priest is not obligatory. Celibacy of the clergy was made optional in Germany in 1878 and in Holland in 1923.

Ecumenical Relationships.—The third of Döllinger's principles pledged the Old Catholics from the start to work persistently for Christian union. This was stressed at the first Bonn conference on Christian union, held in 1874, and was repeated at all the international Old Catholic congresses, held at intervals of roughly five years. The *Internationale Kirchliche Zeitschrift* (founded in 1893 as the *Internationale Theologische Zeitschrift*) renders unique service as a reliable and unprejudiced sourcebook on interchurch relationships throughout the world. In 1931, by the agreement of Bonn, full intercommunion was established between the Church of England and the Old Catholic churches; this was followed in 1946 by a similar agreement between the Polish National

Catholic Church and the Protestant Episcopal Church in the United States. Most of the Anglican churches have accepted these agreements; through mutual participation in episcopal consecrations rather more than half the Anglican episcopate in the world has the Old Catholic as well as the Anglican episcopal succession. The Old Catholic Churches also share in the work of the World Council of Churches. *See* also ECUMENICAL MOVEMENT.

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OLD CHURCH SLAVONIC, one of the southern group of the Slavic languages (*q.v.*). In 862 Prince Rostislav of the Great Moravian state moved to counter the influence of the German clergy in his domains and appealed to Constantinople for Christian missionaries who could preach to his people in their own tongue and train a native priesthood. The Greeks responded by sending the brothers Constantine (better known by the name Cyril, which he assumed when he was shorn monk) and Methodius, who were natives of Salonika and knew the Slavonic dialect of that region (*see* CYRIL AND METHODIUS, SAINTS). It was doubtless on the basis of that dialect, for which Cyril created a special alphabet, that the brothers undertook the great task of founding the first Slavonic literary language, translating into it the religious texts needed for their mission. Since the oldest extant manuscripts date from more than a century later, none of their writings have survived in their original form, and it is possible to reconstruct only incompletely the language used by them and their immediate disciples—a language which, moreover, quickly adopted varying norms in the early centres of Slavonic literary culture.

The general term "Church Slavonic" (as in "Croatian Church Slavonic" and "Russian Church Slavonic") is used to cover these various developments, through which the Cyrillo-Methodian linguistic tradition has exerted a powerful influence on the modern literary languages of the Orthodox Slavs. The name "Old Church Slavonic" (or, somewhat misleadingly, "Old Slavonic" or "Old Bulgarian") is reserved for the fairly faithful, but not entirely homogeneous, reflection of that tradition found in a small number of South and West Slavonic texts antedating the 12th century. These include translations from a Roman Sacramentary (*Kiev Fragments*), the four Gospels (*Codex Zographensis, Cod. Marianus*), the Evangeliarium or liturgical Gospel readings (*Cod. Assemanianus, Sava Book*), the Psalter (*Psalterium Sinaiticum*), the Euchologium (*Euch. Sinaiticum*), the Menaea (*Cod. Suprasliensis*) and homiletic literature (*Glagolita Clozianus*). Of these most important manuscripts, two (*Sava, Suprasliensis*) are written in Cyrillic, the others being in the Glagolitic alphabet.

The fact that Cyril and Methodius could successfully import their language into West Slavonic territory indicates how closely Slavonic linguistic unity was still maintained in the 9th century. Indeed, in many respects Old Church Slavonic (O.Ch.S.) coincides with a reconstruction of Common Slavonic (C.S.). It has, for example, preserved the nasal vowels in their Common Slavonic distribution: *cf.* C.S. **rǫka, *pętь*, O.Ch.S. *rǫka, petь*—Russian *ruká, pjat'*, Polish *ręka, pięć*. The jers (ъ, ь)—which have normally, in the modern Slavonic languages, coalesced with other vowels or disappeared, depending on their position—are regularly maintained in all positions in O.Ch.S. and kept distinct from the other vowels: *cf.* O.Ch.S. *sъnъ, dьnь*, Russian *son, den'*, Serbo-Croatian *sȁn, dân*, Bulgarian *sъn, den*. The vowel *jat'* (*ě*) is likewise distinguished from the other vowels: *cf.* O.Ch.S. *lěto*, Pol. *lato*, Ser.-Crt. *lȇto, ljȇto, lȉto*. In its morphology, the language is equally conservative. At the same time, O.Ch.S. shares certain characteristic phonological developments with other South Slavonic dialects, notably (1) its treatment of so-called *tort*-groups (C.S. *o* or *e* plus following *r* or *l* between consonants), (2) elimination of C.S. *d* or *t* before *l* and (3) palatalization of velars before reflexes of *woi*:

(1) C.S. **golva, *bergъ*; O.Ch.S. *glava, bregъ*; Bulg. *glavá, brjag*: *cf.* Russ. *golová, béreg*; Pol. *głowa, brzeg* and Czech (resembling South Slavonic) *hlava, břeh*.

(2) O.Ch.S. *moliti sę*, Ser.-Crt. *mòliti se*: *cf.* Pol. *modlić się*; Cz. *modliti se* and Russ. (resembling South Slavonic) *molít'sja*.

(3) O.Ch.S. *cvětъ*; Ser.-Crt. *cvêt; cvȉjet, cvît*: *cf.* Pol. *kwiat*; Cz. *květ* and Russ. (resembling South Slavonic) *cvet*.

The reflexes of C.S. *tj* and *dj* are *št* and *žd* (*cf.* Bulgarian), except in the *Kiev Fragments*, which have (along with a few other West Slavonic traits) *c* and *z*. For this feature, therefore, the usage of Cyril and Methodius cannot be reconstructed with certainty. *See* also BULGARIAN LANGUAGE; SLAVIC LANGUAGES.

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OLDENBARNEVELT, JOHAN VAN (1547–1619), Dutch statesman, the architect of the 12-year truce of 1609 between the Netherlands and Spain and the great victim of the political crisis of 1610–19, was born at Amersfoort on Sept. 14, 1547. After studying law at Louvain, at Bourges and at Heidelberg and traveling in France and in Italy, he settled down to practise in the law courts at The Hague. In religion a moderate Calvinist, he became a zealous adherent of William I the Silent, prince of Orange. In the earlier period of the revolt of the Netherlands against Spanish rule (*see* NETHERLANDS, THE: *History*), he served as volunteer for the attempted relief of Haarlem (1573) and again at Leiden (1574). In 1576 he became pensionary of Rotterdam. He was active in promoting the Union of Utrecht (1579) and the decision of the estates of Holland and Zeeland to offer William the title of count. On the assassination of William (July 1584) he persuaded the estates of Holland to appoint the youthful Maurice (*q.v.*) of Nassau as stadtholder and captain general, which they finally did in Nov. 1585. During the governorship of the earl of Leicester (Robert Dudley), Oldenbarnevelt led the estates of Holland in their opposition to the governor's policies.

Appointed land's advocate of Holland (*see* PENSIONARY) in 1586, Oldenbarnevelt rapidly became the leading statesman of the United Provinces. In close collaboration with Maurice he strengthened the republic internally and internationally and provided the financial and political means for Maurice's military triumphs in the following years. An important diplomatic success of his was the alliance with France and England (1596), which amounted to factual recognition of the republic's independence.

As long as the war against Spain lasted, the stadtholder and the advocate acknowledged each other's responsibilities and collaborated in harmony. In 1605, however, Oldenbarnevelt decided that the war should be brought to an end, since Henry IV of France had already made peace with Spain in 1598 and James I of England had followed his example in 1604. Complicated negotiations ensued between the states-general (dominated by Oldenbarnevelt), the leading statesmen of the southern Netherlands and the French mediator Pierre Jeannin. Within the republic, Oldenbarnevelt's peace policy was supported by the majority of the estates of Holland; but Maurice and his cousin William Louis, stadtholder of Friesland, together with the military and naval leaders and the strict Calvinist clergy, vigorously objected to it on the ground that Spain was merely seeking an interval for recuperation; and in Holland itself the prospect of having to stop fighting the Spaniards in the West Indies alarmed Amsterdam, which was becoming interested in that area. Oldenbarnevelt—through whose initiative the Dutch East India company had been formed in 1602—was fully aware of the importance of colonial trade; but he refused at this time to let this motive determine the question of peace or war. When he saw that peace could not be made, he agreed to a truce, which was concluded for 12 years on April 9, 1609. By this truce Dutch independence was recognized, at least temporarily, by Spain and the southern Netherlands.

During the truce the conflict between Arminians and Gomarists within the Calvinist church led to grave disturbances (*see* ARMINIANISM). Oldenbarnevelt upheld the cause of the Arminians

and was himself backed by the group which had enabled him to conclude the truce of 1609; *i.e.*, by the estates of Holland except Amsterdam. He tried to keep the conflict within certain limits; he refused to allow the convening of a national synod, because it would obviously have produced a majority against the Arminians; and he even forbade preachers in Holland to treat of disputed subjects from their pulpits (1614). This led to the expulsion of the recalcitrant Gomarists from towns where the urban government favoured the Arminians.

Not until July 1617 did Maurice declare himself for the Gomarists. This was a decisive step, since Maurice, as captain general of Holland, had military power and could rally those who had already opposed Oldenbarnevelt over the truce: the majority of the states-general, Amsterdam and, of course, the most orthodox Calvinists, who constituted a numerical majority in the church. Oldenbarnevelt, now on the defensive, sought to reassert himself by a counterattack and persuaded the estates of Holland to pass his "Sharp Resolution" of Aug. 4, 1617. This authorized the towns in the province to raise their own militias, which would not be subject to the captain general and so could protect the Arminians; and it also ordered the soldiers of Holland's regular army to obey the estates only. Then Maurice, whose authority was thus contested, took action to make sure that all the other provinces were prepared to follow him. On Aug. 28, 1618, the states-general granted him dictatorial power to solve the problem; and next day he had Oldenbarnevelt and his collaborators put into prison. The resistance of Holland soon collapsed.

The states-general in Feb. 1619 created a special court of 24 members to try Oldenbarnevelt, who defended himself with great dignity and acumen but was found guilty of high treason and condemned to death (May 12). On May 13, 1619, the old statesman was executed in The Hague, a victim not so much of injustice as of a political conflict that could not be settled so long as the republic's vague constitution allowed contradictory interpretations.

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(E. H. K.)

OLDENBURG, a former German state, successively a countship, a duchy, a grand duchy and a *Land* before it became an administrative district of Lower Saxony (*q.v.*) in 1946. At its greatest extent, between 1854 and 1937, Oldenburg had an area of 2,480 sq.mi., comprising the main body of the territory and two exclaves, Lübeck-Eutin (209 sq.mi.) and Birkenfeld (194 sq.mi.). During this period the main body was bounded north by the North sea and encircled landward by Hanover (Prussian from 1866) except in the east, where it had a short frontier with Bremen. Its capital was Oldenburg (*q.v.*) on the lower Hunte river. Wilhelmshaven (*q.v.*), bought by Prussia in 1853, was restored to Oldenburg in 1937, when Lübeck-Eutin and Birkenfeld were transferred to Schleswig-Holstein and to the Prussian Rhine province respectively.

History.—In Carolingian times lordships in the area were held by the family of the Saxon duke Widukind, whose grandson Walbert founded the abbey of Wildeshausen, on the middle Hunte, in A.D. 851. By 1108, however, a certain Count Egilmar I had his seat at Oldenburg; and his descendants won practical independence after the fall of the Saxon duke Henry the Lion (1180), though they were not officially enfiefed as immediate vassals of the *Reich* till 1531. The nucleus of the countship lost territory through partitions between branches of the dynasty and could expand only slowly. Stedingen (on the lower Weser) was won through the crusade against the Stedingers in 1234; Friesische Wehde (Varel, Bockhorn and the country to the west) was gradually annexed in the 100 years from 1386; and Butjadingen and Stadland (between the Jade and Weser estuaries) were added in 1517–23. The archbishops of Bremen, the bishops of Münster, the counts of East Frisia and the Hanseatic city of Bremen obstructed Oldenburg's expansion.

Christian of Oldenburg became king of Denmark in 1448 and duke of Schleswig and count of Holstein in 1460 (he was also king of Norway from 1450 and of Sweden for a few years from 1457; *see* CHRISTIAN I of Denmark). In 1454 he ceded Oldenburg to his brother Gerhard (abdicated 1483; d. 1500). Gerhard's great-grandson John (d. 1603), count from 1573, acquired the lordship of Jever, west of the Jade estuary, in 1575. John's son Anton Günther (d. 1667) made good his claim to the free lordship of Knyphausen (1624) and, by remaining neutral in the Thirty Years' War, obtained from the Holy Roman emperor Ferdinand II the right of levying tolls from ships passing Elsfleth on the Weser. With no legitimate offspring, Anton Günther left Jever to the house of Anhalt-Zerbst, and Knyphausen, Varel and other titles to his bastard Anton I, count of Aldenburg. The residue, bequeathed to Denmark and to Holstein-Gottorp, was acquired by Denmark exclusively in 1676.

Christian VII of Denmark in July 1773 ceded Oldenburg to his distant cousin Paul, the future emperor of Russia, in exchange for the latter's title to Holstein-Gottorp; and in Dec. 1773 Paul gave Oldenburg to his grandfather's first cousin, Frederick Augustus, bishop of Lübeck, for whom in 1774–77 the Holy Roman emperor Joseph II erected Oldenburg into a duchy. As William, duke from 1785, was feebleminded, his cousin Peter of Holstein-Gottorp became regent. In the Napoleonic period Peter, with rights of his own to the episcopal principality of Lübeck, obtained for Oldenburg in 1803 not only Wildeshausen (from Hanover) but also Cloppenburg and Vechta (from secularized Münster) on renouncing the Elsfleth toll; but he was expelled by the French in 1806 and again, after restoration (1807), in 1810. He returned as regent in 1813; and the congress of Vienna granted the personal title of grand duke to William (who made no use of it) in 1815. The principality of Birkenfeld, on the Nahe river, was made over to Oldenburg in 1817; and Jever, which Russia had inherited from Anhalt-Zerbst in 1793, and which Peter had been administering from 1813, was ceded to Oldenburg in 1818. Peter, having succeeded William as duke in 1823, died in 1829, whereupon his son Augustus (d. 1853) proclaimed himself grand duke and his possessions a grand duchy. A patron of literature and of the drama, Augustus granted Oldenburg a constitution in 1849. Knyphausen and Varel were bought back from the counts of Bentinck (successors of the Aldenburgs) in 1854.

Oldenburg supported Prussia in the Seven Weeks' War (1866) and became a member of the North German confederation (1867) and of the German empire (1871). Frederick Augustus I (1852–1931), grand duke from 1900, abdicated in Nov. 1918; and Oldenburg became a *Land* of republican Germany. The *Land* elected a Nazi government in 1932; and Hitler made the city of Oldenburg the capital of a *Gau* extending over large parts of adjacent regions. At the end of World War II the British first installed Theodor Tantzen, a veteran of the republican era, as prime minister (May 1945), then merged Oldenburg into Lower Saxony (Nov. 1946). The Evangelical Lutheran Church of Oldenburg, however, remained independent under its own bishop, while the Roman Catholics were governed by the bishop of Münster's *Offizial* at Vechta.

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(W. G. Fr.)

OLDENBURG, a city of Germany which after the partition of the nation following World War II was in the *Land* (state) of Lower Saxony in the northwestern part of the Federal Republic of Germany. It lies between Bremen and Emden on a crossing of the Hunte river about 12 mi. S.W. of its confluence with the Weser. Pop. (1961) 125,198. One of the oldest settlements in the region, it was first mentioned as a town in 1108. City status was granted in 1345 by Count Conrad I. Much of the old quarter was destroyed by fire in 1615, but the Lamberti church (1270) on the central market place survives. Formerly the seat of the grand dukes of Oldenburg, the city has a state theatre, museums, art galleries, botanical gardens, a library, academies of engineering, administration and economy, and numerous schools. Oldenburg is the market centre for the surrounding farming district; auctions

of cattle and horses are held. It has one of the largest factories for meat products in Europe; other industries include shipbuilding, glassmaking and textile manufacture. Accessible by ships of up to 1,500 tons from the Weser estuary, Oldenburg is linked by inland waterways with the Ruhr and is a rail and road junction. It is the headquarters of an administrative district.

(H.-G. RE.)

OLDHAM, JOHN (1653–1683), English poet and satirist, one of the pioneers of Augustan poetry, was born at Shipton Moyne, Gloucestershire, on Aug. 9, 1653. His father was rector of Long Newnton, Wiltshire, under the Protectorate and was ejected from his living in 1662. He had, however, "a small estate, and with the keeping of a school he had a handsome livelyhood." Oldham was educated at Tetbury school, Gloucestershire, and matriculated at St. Edmund hall, Oxford, on June 17, 1670. He took the B.A. degree in 1674 and returned home, probably to teach at his father's school. In 1676 he became an usher at Croydon school under the headmastership of John Shepheard.

His poems attracted the attention of the earl of Rochester into whose mouth he had placed some verses "supposed to be written by ye Court Hector." Rochester visited him at Croydon and is said to have "much delighted" in his poetry. Oldham's imitation of Moschus' elegy on Bion contains a touching expression of his gratitude to Rochester. In Nov. 1677 he attempted, apparently unsuccessfully, to win recognition at court by writing a poem on the marriage of the Princess Mary to William of Orange.

Oldham left Croydon for Reigate in Feb. 1679 (Old Style, 1678), to become tutor to the grandson of Sir Edward Thurland. He continued at Reigate till 1681, when he is said to have come to London and "set up for a wit." Later he was a tutor to a son of Sir William Hicks, and "at his leisure hours . . . applyed himself to the study of physic." When this tutorship ended he again betook himself to London and it was probably at this time that he met John Dryden, who lamented that Oldham was "too little, and too lately known" by him. He was introduced to William Pierrepont, earl of Kingston, and for a time "lived with him in great respect" at his house at Holm Pierrepont near Nottingham, where he died of smallpox in Dec. 1683. He was mourned by Dryden in a noble elegy.

Oldham has a notable place in the development of Augustan poetry. The four *Satyrs Upon the Jesuits* (1681), including "Garnet's Ghost," previously published as a broadsheet in 1679, constitute his most celebrated, but by no means his best, work. They are forceful, but inflated and melodramatic. With Rochester, Oldham is one of the pioneers of the "imitation" of classical satire in English, and his "imitations" of Horace, Juvenal and Boileau contain some admirable writing. There is vigour, wit and a fine note of independence in almost everything he wrote.

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OLDHAM, a municipal, county and parliamentary borough of Lancashire, Eng., 7 mi. N.E. of Manchester. Pop. (1961) 115,346. Area 8.3 sq.mi. The town, which lies high near the source of the small Medlock river, is a modern industrial town that takes its name from the Oldham family, who, in the middle ages, held Werneth hall as their manor house. From the Oldhams was descended Hugh Oldham, who died bishop of Exeter in 1519. Linen manufacture was introduced in Oldham in 1630, when it was an agricultural town producing wool, but with the adoption of Richard Arkwright's inventions and the discovery that the moist climate was extremely suitable for cotton-spinning, the cotton industry grew with great rapidity. Oldham is now one of the chief cotton-spinning towns in the world. Its second largest industry is engineering, chiefly textile engineering, and it also produces cloth of various kinds.

The parish church of St. Mary was a medieval chapel rebuilt in 1476, and again in 1833 in the Early English style. Other public buildings and institutions include the town hall, with tetrastyle portico; the central public library, art gallery and museum, opened in 1895; and the county court. The Hulme grammar school was founded in 1606; Henshaw's Bluecoat school was opened in 1834; the Lyceum, which has schools of art and music, was founded in 1839; the Hathershaw Technical High school and Oldham College of Further Education (which superseded the old Technical college) were opened in 1954.

Alexandra park, which covers 60 ac., stands on a picturesquely undulating and terraced site. Werneth park contains a study centre and natural history museum. There are thrice-weekly markets in the town and two of the biggest fairs in the county are held there in June and September. Oldham, incorporated in 1849, became a county borough in 1888. The parliamentary borough has returned two members since 1832.

OLD POINT COMFORT, a spit of land on the southeastern tip of the peninsula between the James and York rivers in Virginia, U.S., commanding the entrance to Hampton Roads and the James river. Its strategic importance was apparent to the earliest colonists, who named it Poynt Comfort because of its sheltered harbour and established the first fortifications there in 1608.

Fort Monroe, last of a series of forts on the point, is a moated and stone-walled fort covering 63 ac., built by the government from 1819 to 1834.

During the American Civil War the Confederacy considered Fort Monroe too strong to attack and it served the Union as a base of operations for McClellan's peninsular campaign (1862) and for a series of expeditions against Confederate ports. Following the war, Jefferson Davis was imprisoned there for two years. Long a coast artillery post, Fort Monroe, after World War II, became headquarters for (successively) the army ground forces, the army field forces and the continental army command.

In 1820 a tavern was opened at Old Point to serve the men constructing the fort. The location proved attractive and by 1828 the tavern had been replaced by a hotel. This was the first of a succession of hotels, some very elaborate, that made Old Point Comfort one of Virginia's best-known resorts. (M. BR.)

OLD TESTAMENT: *see* BIBLE.

OLDYS, WILLIAM (1696–1761), English antiquary and bibliographer, one of the first to discuss earlier English writers critically. Born July 14, 1696, probably in London, he was the natural son of William Oldys, a distinguished lawyer. He lost money in the South Sea Bubble (*q.v.*) and spent some years (1724–30) in Yorkshire, often as the guest of his friend the earl of Malton. In 1727 he began to annotate a copy of Gerard Langbaine's *Dramatick Poets* (1691) with notes which had been transcribed from the original (preserved in the British museum, London) by many later commentators. In 1731 he sold his collection of books and manuscripts to Edward Harley, earl of Oxford, who became his patron and in 1738 appointed Oldys his literary secretary. Oldys' best work was a *Life of Raleigh* prefixed to his edition of Raleigh's *History of the World* (1736). In 1737 the *British Librarian*, which lists and comments on a selection of rare and valuable books, appeared.

After the earl's death in 1741, Oldys was a booksellers' hack for 14 years. With Samuel Johnson he edited the *Harleian Miscellany* (1744–46), a collection of tracts and pamphlets from the earl's library, and he contributed 22 articles to *Biographia Britannica* (1747–60). In 1751 Oldys was sent to the Fleet prison for debt, remaining there until 1753, when his debts were discharged by the duke of Norfolk, who appointed him Norroy king-of-arms in May 1755. He was modest, kindly, "critical as well as erudite" and tireless in his researches, writing his notes on slips of paper collected in small bags suspended about his room, thus accumulating much biographical material useful to later authors. His last published work was a *Life of Charles Cotton*, prefixed to an edition of the *Compleat Angler* (1760). Oldys died in London, April 15, 1761.

See I. D'Israeli, *Curiosities of Literature*, second series, vol. iii (1823); J. Yeowell, *A Literary Antiquary* (1862).

OLEANDER, the common name for any of the ornamental evergreen shrubs of the genus *Nerium*, belonging to the dogbane family (Apocynaceae; *q.v.*) and having a poisonous milky juice. The best known is the common oleander (*N. oleander*), often called rosebay, a native of the Mediterranean region, characterized by its tall shrubby habit and its thick lance-shaped opposite leaves. The flowers are borne in terminal clusters and are of a rose colour, rarely white. The hairy anthers adhere to the thickened stigma. The fruit or seed vessel consists of two long pods, which liberate a number of seeds, each of which has a tuft of silky hairs. The oleander was known to the Greeks under three names (viz., *rhododendron*, *nerion* and *rhododaphne*) and is well described by Pliny the elder, who mentions its roselike flowers and poisonous qualities. The common oleander has long been cultivated in greenhouses, and numerous varieties, differing in the colour of their flowers, which are often double, have been introduced. The sweet oleander (*N. indicum*) is a smaller plant with vanilla-scented flowers. In warm countries oleanders are widely grown outdoors.

JOHN H. GERARD

OLEANDER (NERIUM OLEANDER)

OLEASTER (Russian Olive; Trebizond Date) (*Elaeagnus angustifolia*), a handsome deciduous Eurasian tree, 15 to 20 ft. high, commonly cultivated as an ornamental and as a hedge and windbreak plant. It belongs to the oleaster family (Elaeagnaceae). The brown, smooth branches are more or less spiny; the narrow leaves are light-green above and silvery below, due to a hairy covering. The small fragrant yellow flowers, which are borne in the axils of the leaves, are silvery-scaled on the outside, as also are the one-half-inch-long, yellowish, egg-shaped fruits, which are sweet but mealy.

OLEFIN, or alkene, in organic chemistry, is the generic name given to an unsaturated hydrocarbon containing one or more pairs of doubly linked carbon atoms (*see* also Hydrocarbon). The unsaturation is represented by a double bond, C = C, which indicates the point of unsaturation and of reactivity in the molecule. The olefins are classified in either one or both of the following ways: (1) a cyclic or an acyclic (aliphatic) olefin is one in which the double bond is located between carbon atoms forming part of a cyclic or of an open-chain grouping, respectively; (2) a mono-, di-, tri- or polyolefin is one in which the number of double bonds per molecule is respectively one, two, three or an unspecified number greater than two.

The diolefins (or tri- or polyolefins) may be classified according to the relative positions of the double bonds as: (*a*) "cumulated" or "contiguous diolefins," or "allenes," containing the two double bonds adjacent to each other as in allene, or 1,2-propadiene, ($CH_2=C=CH_2$); (*b*) "conjugated diolefins," in which the double bonds are separated by one single linkage as in 1,3-butadiene ($CH_2=CH-CH=CH_2$); (*c*) "isolated diolefins," in which the double bonds are separated by at least two single linkages as in 1,4-pentadiene ($CH_2=CH-CH_2-CH=CH_2$).

The terms aliphatic, aryl, cyclic, etc., are used to indicate the form of the carbon skeleton. The terminations -ene, -diene, -triene, etc., in the systematic Geneva system of nomenclature, identify the individual hydrocarbons of mono-, di- or triolefinic structure. Sometimes the ending -ylene is given to identify a monoolefin, *e.g.*, ethylene, propylene, etc. The position of the double bond or bonds is indicated by a numerical prefix or suffix.

Olefins containing from two to four carbon atoms per molecule are gaseous at ordinary temperatures and pressures; those containing five or more carbon atoms are usually liquid at ordinary temperatures. They are only slightly soluble in water. The physical constants of some aliphatic olefins are given in the following table. In general, the boiling points are very close to those of the saturated hydrocarbons having the same carbon skeleton; the densities are slightly higher.

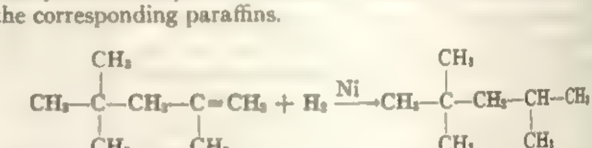
Name	Formula	Melting point °C.	Boiling point °C.	Density d_4^{20}
Ethylene	$CH_2=CH_2$	−169.4	−103.9	
Propene	$CH_3-CH=CH_2$	−185.2	−47.6	
1-Butene	$CH_3-CH_2-CH=CH_2$	−190	−6.3	
1-Pentene	$CH_3-(CH_2)_2-CH=CH_2$	−138.0	30.1	0.6410
1-Hexene	$CH_3-(CH_2)_3-CH=CH_2$	−141.0	63.7	0.6734
1-Heptene	$CH_3-(CH_2)_4-CH=CH_2$	−120.0	92.8	0.6968
1-Octene	$CH_3-(CH_2)_5-CH=CH_2$	−102.1	121.6	0.7159
1-Nonene	$CH_3-(CH_2)_6-CH=CH_2$	−88.0	145	0.7315

Monoolefins (aliphatic) have the general formula C_nH_{2n}; they are not found in nature. They are formed in large quantities during the cracking of petroleum oils to produce gasoline (*q.v.*). The olefins thus obtained are mixed with other types of hydrocarbon, from which they are separated either by physical or by chemical means.

Olefins may be prepared by the dehydration of the corresponding alcohols, removal of hydrogen halides from alkyl halides, pyrolysis of the corresponding acetates or by synthetic methods, such as:

$$CH_2=CH-CH_2Br+RMgBr \longrightarrow CH_2=CH-CH_2-R+MgBr_2$$

The principal reactions of olefins are those of the addition of various elements or groups to the two doubly linked carbon atoms. Hydrogen reacts with olefins, under the influence of catalysts such as platinum black or finely divided nickel, to form the corresponding paraffins.

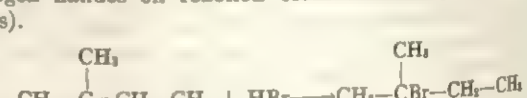


2,4,4-Trimethyl-1-pentene "diisobutylene" — 2,2,4-Trimethylpentane "isooctane"

Halogens such as chlorine, bromine and iodine add to the doubly linked carbon atoms to yield dihaloparaffins.

$$\underset{\text{2-Butene}}{CH_3-CH=CH-CH_3} + Cl_2 \longrightarrow \underset{\text{2,3-Dichlorobutane}}{CH_3-CHCl-CHCl-CH_3}$$

Hydrogen halides on reaction form monohaloparaffins (alkyl halides).

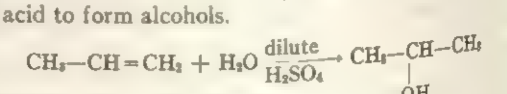


2-Methyl-2-butene — 2-Methyl-2-bromobutane

Hypochlorous or hypobromous acids combine with olefins to produce the corresponding halohydrins.

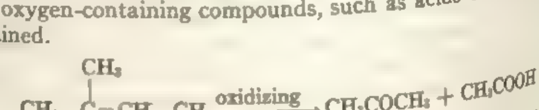
$$\underset{\text{Ethylene}}{CH_2=CH_2} + HOCl \longrightarrow \underset{\text{Ethylene chlorohydrin}}{CH_2Cl-CH_2OH}$$

Water reacts with olefins in the presence of catalysts such as sulfuric acid to form alcohols.



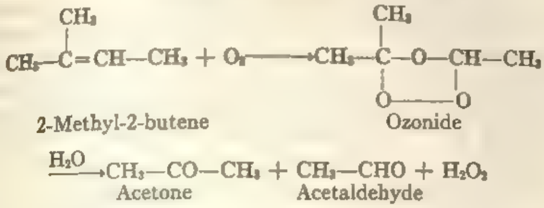
Propene — Isopropyl alcohol

Oxidation of olefins with dilute potassium permanganate results in the addition of two hydroxyl groups at the point of unsaturation to form glycols. Under the influence of stronger oxidizing agents or more drastic conditions, the double bond is ruptured and oxygen-containing compounds, such as acids or ketones, are obtained.



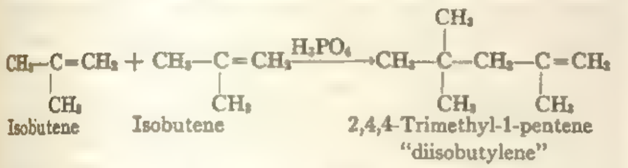
2-Methyl-2-butene — Acetone — Acetic acid

Ozone reacts with olefins in solution to form an ozonide, which, when isolated in pure form, is explosive; by treatment of the ozonide with water, the originally unsaturated carbon-carbon linkage is ruptured with the formation of aldehydes and ketones.



This reaction is employed, in particular, for the determination of the structures of olefins.

In the presence of certain catalysts, two or more molecules of olefin combine to form polymers. (*See* also POLYMERIZATION.)



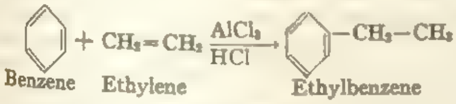
Olefins react in the presence of catalysts with organic compounds such as isoparaffins, aromatic hydrocarbons and phenols to form addition products of great industrial importance, which are used in the manufacture of aviation gasoline, synthetic rubber, detergents and plastics.

Olefins react with carbon monoxide and hydrogen under pressure in the presence of a cobalt catalyst to form aldehydes and alcohols (oxo process).

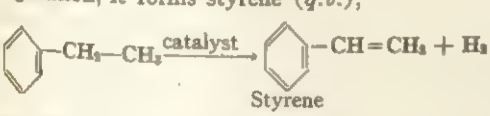
Ethylene (*q.v.*; or ethene), $CH_2=CH_2$, is the first member of the olefin series. It is one of the dominant raw materials in the organic chemical industry. A large proportion is converted into industrial ethyl alcohol and derivatives thereof.

The following are some of the commercial products obtained from ethylene: ethylene glycol (CH_2OH-CH_2OH) is produced via ethylene oxide ($\underset{O}{CH_2-CH_2}$) by selective oxidation of ethylene. Polyethylene is a plastic material of great commercial use. It can be made either at elevated pressures (1.000 atm.) and temperatures in the presence of minor amounts of peroxides, or at low pressures and low temperatures in the presence of a catalyst composed of titanium tetrachloride and metal alkyls or at medium pressures and temperatures, using chromium on silica-alumina base.

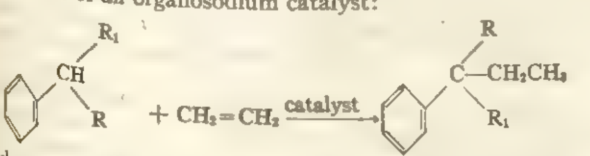
Ethylbenzene is a product of interaction of ethylene and benzene;



on dehydrogenation, it forms styrene (*q.v.*),

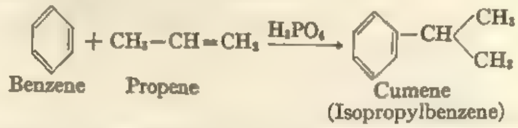


one of the important starting materials for both synthetic rubber and various plastics. Ethylene reacts with alkylbenzenes in the presence of an organosodium catalyst:



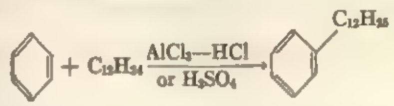
Ethylene is also used as a general anesthetic and as an agent to hasten the ripening of bananas, citrus fruits, bulbs and potatoes.

Propene (propylene), $CH_3-CH=CH_2$, is used for the synthesis of isopropyl alcohol ($CH_3-CHOH-CH_3$), which on dehydrogenation forms acetone ($CH_3-CO-CH_3$), one of the more important solvents. Propene is made to react with benzene to form cumene,



an important intermediate in the commercial manufacture of phenol and acetone.

Propene is polymerized commercially under pressure in the presence of silicophosphoric acid to form nonenes (C_9H_{18}) and dodecenes ($C_{12}H_{24}$). The nonenes are added to gasoline. The dodecenes are caused to react with benzene in the presence of a catalyst to form dodecylbenzenes:



The dodecylbenzenes are the major intermediates in the manufacture of household detergents (*see* also DETERGENTS AND WETTING AGENTS: *Types of Detergents*).

Butenes (butylenes) are used for the synthesis of butyl alcohols (C_4H_9OH). Butenes react with isobutane in the presence of sulfuric acid or hydrogen fluoride to form octanes; the latter are important constitutents in high-octane gasolines.

n-Butenes are dehydrogenated to form butadiene.

$$\underset{\text{1-Butene}}{CH_3-CH_2-CH=CH_2} \xrightarrow{\text{catalyst}} \underset{\text{1,3-Butadiene}}{CH_2=CH-CH=CH_2} + H_2$$

Isobutene polymerizes at $-78°$ C. in the presence of Friedel-Crafts type catalysts ($AlCl_3$, $FeCl_3$, etc.) to a high molecular weight hydrocarbon that is used for the manufacture of butyl rubber from which inner tubes for tires are made.

The sources of the normal-chain (*i.e.*, straight-chain) olefins are animal and vegetable waxes and oils. These are converted into alcohols, from which the corresponding olefins are obtained.

Diolefins (C_nH_{2n-2}) (dienes, alkadienes) containing conjugated double bonds are the most useful members of this series; they undergo reactions similar to those of the monoolefins.

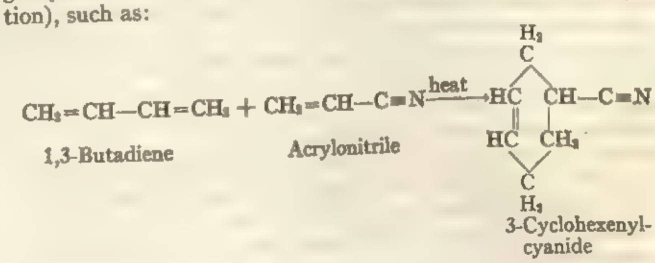
When the addition reaction to conjugated diolefins is carried out stepwise, the addenda are often attached to the first and fourth carbon atoms of the conjugated system rather than to adjacent carbon atoms; such a reaction as this is called 1,4-addition.

$$\underset{\text{1,3-Butadiene}}{CH_2=CH-CH=CH_2} + Br_2 \longrightarrow \underset{\text{1,4-Dibromo-2-butene}}{BrCH_2-CH=CH-CH_2Br}$$

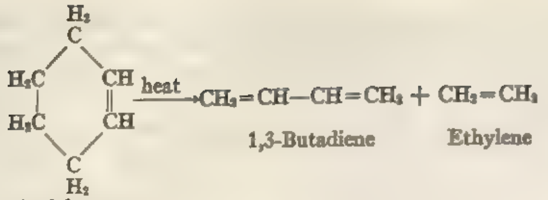
The conjugated dienes react with compounds containing the

$$>C=C< \quad \text{(particularly } >C=C-\overset{|}{C}=O,\ >C=C-C\equiv N, \text{ etc.)}$$

group with the formation of cyclic compounds (Diels-Alder reaction), such as:



1,3-Butadiene ($CH_2=CH-CH=CH_2$) melts at $-108.7°$ C., boils at $-4.5°$ C.; it can be obtained in the laboratory by cracking cyclohexene,



Cyclohexene 1,3-Butadiene Ethylene

by dehydration of 1,3-butene glycol,

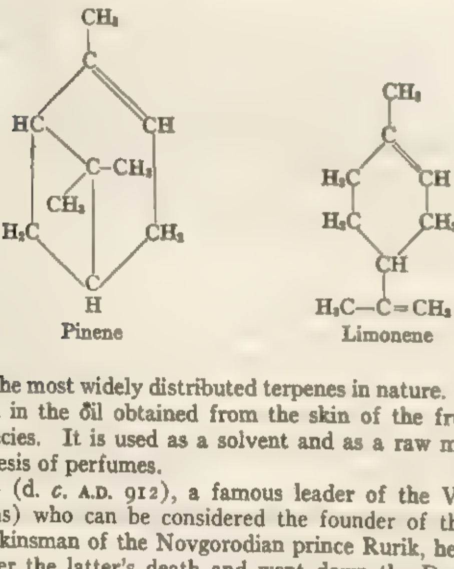
$$HOCH_2-CH_2-CHOH-CH_3 \xrightarrow{Al_2O_3} CH_2=CH-CH=CH_2 + 2H_2O$$

1,3-Butene glycol 1,3-Butadiene

Butadiene is prepared commercially by dehydrogenation of normal butenes. During World War II a substantial amount of butadiene was also produced by catalytic treatment of ethyl alcohol. Butadiene in conjunction with styrene is the main component in the manufacture of synthetic rubber. (*See* also BUTADIENE.)

Isoprene (2-Methyl-1,3-butadiene) ($CH_2=C(CH_3)-CH=CH_2$) melts at $-146.8°$ C., boils at $34.1°$ C., d_4^{20} 0.6805. It is a building unit for naturally occurring products such as rubber and terpenes; these products, on pyrolysis, yield isoprene. Isoprene changes into rubberlike compounds when heated under pressure, or when treated with sodium or peroxides.

Cyclic Olefins.—Of the cyclic olefins, those belonging to the class of terpenes (*q.v.*) with the formula $C_{10}H_{16}$ are the most abundant in nature. They are divided into (*a*) bicyclic monoolefins (bicyclic monoterpenes), of which pinene, the main constituent of turpentine oil, is the most important representative; (*b*) monocyclic diolefins (monocyclic monoterpenes), of which limonene



Pinene Limonene

is one of the most widely distributed terpenes in nature. Limonene is present in the oil obtained from the skin of the fruits of the citrus species. It is used as a solvent and as a raw material for the synthesis of perfumes. (H. Ps.)

OLEG (d. *c.* A.D. 912), a famous leader of the Vikings (or Varangians) who can be considered the founder of the Russian state. A kinsman of the Novgorodian prince Rurik, he left Novgorod after the latter's death and went down the Dnieper river with his Varangian retinue, seizing Smolensk and Kiev.

Having made Kiev his capital, Oleg expanded his authority both west and east of the great Volkhov-Dnieper waterway, uniting the local Slavic and Finnish tribes under his rule, and became the undisputed ruler of the great Kievan-Novgorodian state. He defeated the Khazars and delivered several Slavic tribes from dependence on them. Turning his attention southward, he undertook a well prepared expedition against Constantinople (*c.* 905) and forced the Byzantine government to sue for peace and to pay a large indemnity. In 907 his plenipotentiaries in Constantinople concluded a trade agreement with the imperial government; and in 911 a new treaty was concluded regulating commercial relations between the two states and providing for the legal protection of foreign merchants.

As a result of Oleg's military and diplomatic successes, trade with Byzantium became a permanent factor in Kievan Russia's economic life.

See *The Russian Primary Chronicle*, Eng. trans. by S. H. Cross and O. P. Sherbowitz-Wetzor (1953); G. Vernadsky, *The Origins of Russia* (1959). (S. G. Pu.)

OLEIC ACID is the most widely distributed of all the fatty acids (*see* CARBOXYLIC ACIDS) and apparently occurs to some extent in all oils and fats. In oils such as olive, palm, peanut and sunflower-seed it is the principal acid obtained by saponification. Oleic acid, $CH_3(CH_2)_7CH=CH(CH_2)_7CO_2H$, like other fatty acids, does not occur in the free state but is normally found as an ester of glycerol; *i.e.*, as a glyceride or as an ester of a long-chain alcohol.

Oleic acid I Elaidic acid II

Oleic acid is a solid with a low melting point; two crystalline forms (α-form, melting point 13.4° C. and β-form, melting point 16.3° C.) are known. It is a long-chain carboxylic acid; its molecule contains one double bond between C_9 and C_{10} with the cis configuration. The structure of oleic acid (I) may be deduced from the following reactions. Treatment with selenium or oxides of nitrogen partially transforms it into the trans-isomer, elaidic acid (II). The arrangement of its 18 carbon atoms and the position of the double bond is demonstrated by its catalytic hydrogenation to stearic acid, $CH_3(CH_2)_{16}CO_2H$; its oxidative cleavage to nonanoic (pelargonic) acid, $CH_3(CH_2)_7CO_2H$, and azelaic acid, $HO_2C(CH_2)_7CO_2H$. When oleic acid is heated with alkali, migration of the double bond occurs giving the $\alpha{:}\beta$-unsaturated acid, $CH_3(CH_2)_{14}CH=CHCO_2H$, and this on further heating with alkali gives palmitic acid, $CH_3(CH_2)_{14}CO_2H$.

Oleic acid shows the standard reactions of a carboxylic acid and a disubstituted ethylene, including the formation of a dibromide with bromine and a glycol with dilute aqueous potassium permanganate.

See K. S. Markley, *Fatty Acids, Their Chemistry and Physical Properties* (1947); A. E. Bailey, *Industrial Oil and Fat Products* (1945). (W. D. Os.)

OLEN, a legendary poet and prophet, reputed author of certain hymns to Apollo, sung at Delos in historical times. Boio, a Delphic poetess, portrayed him as a Hyperborean (*see* HYPERBOREANS), founder of the oracular shrine at Delphi, first prophet there and inventor of the hexameter. Herodotus made him a Lycian (as follower of Apollo Lukeios). Whether any real person lies behind these stories is unknown.

OLEOMARGARINE: *see* MARGARINE.

OLÉRON, ÎLE D', an island located in the Bay of Biscay, off the west coast of France north of the Gironde estuary and in Charente-Maritime *département*. Pop. (1954) 13,901. It is about 100 sq.mi. in extent, and is aligned northwest-southeast for about 20 mi. The Pertuis de Maumusson, separating it from the mainland, narrows to less than one mile. The limestone basis of Oléron outcrops to form cliffs on the north, but most of the island is flat and bordered by dunes within a fringe of reefs and enclosing extensive marshes. Oyster culture is practised along the southeast coast. Le Château d'Oléron, the chief port, facing the mainland, is surrounded by 17th-century fortifications. Five miles farther south is the resort, St. Trojan-les-Bains. Another bathing resort is St. Denis, and in the centre of the island is the market town, St. Pierre (pop. [1962] 1,423). Oléron, called Uliarus Insula by the Romans, formed part of the duchy of Aquitaine and passed to the French crown in 1370. It gave its name to the medieval maritime code, *Jugements ou Rôles d'Oléron*, which formed the basis of subsequent French naval statutes. (AR. E. S.)

OLEŚNICKI, ZBIGNIEW (1389–1455), Polish cardinal and statesman who exercised great influence under the first two kings of the Jagiello dynasty, was born at Sienno, near Sandomierz, of the family of the lords Dębno of Oleśnica. Starting his political career in the royal chancellery, he was acting as King Wladyslaw II Jagiello's secretary during the battle of Grunwald in 1410, when

he saved the king from a direct onslaught. Having visited Rome in 1411, he chose priesthood in 1412 and became bishop of Cracow in 1423. A member of the king's council, he led the conservative wing of the nobility and in 1430 secured a limitation of the royal power in return for the Poles' recognition of the child Wladyslaw III) as his father's eventual successor. Meanwhile, as an opponent of the Hussite movement in Poland, he promoted the interests of the papacy and the designs of Sigismund of Luxembourg, king of Hungary and German king, on Bohemia. On the other hand he wanted the incorporation of Lithuania into Poland and so opposed Sigismund when the latter proposed a royal crown for the Lithuanian prince Vytautas (1429). After Wladyslaw II Jagiello's death (1434) Oleśnicki virtually ruled Poland: he crushed the pro-Hussite movement led by Spytko of Melsztyn (1439) and acquired the duchy of Siewierz for his own bishopric (1443). He supported the Council of Basel against Pope Eugenius IV, though Eugenius created him cardinal in 1439.

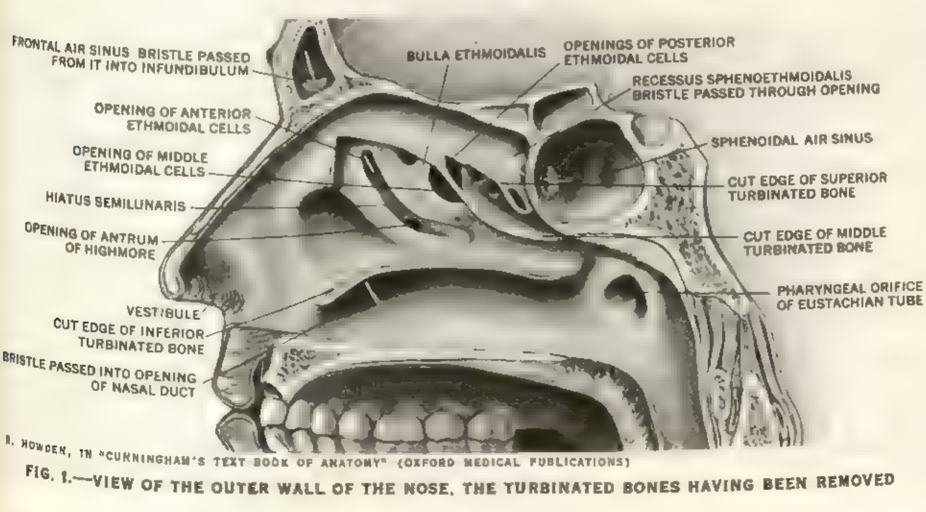
When Wladyslaw III (Ulászló I of Hungary from 1440) was killed on his crusade in 1444, Oleśnicki continued in power till Casimir IV received the Polish crown in 1447. Casimir organized the group of "young barons of the realm" to oppose him and, against his advice, achieved the incorporation of Prussia into Poland (1454). Oleśnicki, who had at last received his cardinal's hat from Pope Nicholas V in 1449, died at Sandomierz on April 1, 1455. (A. Gi.)

OLFACTORY SYSTEM, the structures that serve the sense of smell. The system consists of the nose and the nasal cavities, which in their upper parts support the olfactory mucous membrane for the perception of smell, and in their lower parts act as respiratory passages. This article deals with the anatomy of the olfactory system and its nervous pathways; for physiology, *see* SMELL AND TASTE.

The bony framework of the nose is part of the skull (*q.v.*), but the outer nose is supported only by bone above; lower down its shape is kept by cartilaginous plates. The expanded lower part of the side of the nose, the ala, is formed only of skin, both externally and internally, with fibrofatty tissue between the layers. The nasal cavities are separated by a septum covered in its lower two-thirds by thick, highly vascular mucous membrane composed of columnar ciliated epithelium with masses of acinous glands embedded in it, while in its upper part it is covered by the less vascular but more specialized olfactory membrane. Near the front of the lower part of the septum a slight opening into a short blind tube, which runs upward and backward, may sometimes be found; this is the vestigial remnant of Jacobson's organ. The supporting framework of the septum is made up of ethmoid above, vomer below and the septal cartilage in front. The outer wall of each nasal cavity is divided into three meatuses by the overhanging turbinated bones. Above the superior turbinated bone is a space between it and the roof known as the recessus sphenoethmoidalis, into the back of which the sphenoidal air sinus opens. Between the superior and middle turbinated bones is the superior meatus, containing the openings of the posterior ethmoidal air cells, while between the middle and inferior turbinated bones is the middle meatus, which is the largest of the three and contains a rounded elevation, the bulla ethmoidalis. Above and behind this is often an opening for the middle ethmoidal cells; below and in front runs a deep sickle-shaped gutter, the hiatus semilunaris, which communicates above with the frontal air sinus and below with the opening into the antrum of Highmore or maxillary antrum. The inferior meatus is below the inferior turbinated bone, and, when that is lifted, the valvular opening of the nasal duct (*see* EYE, HUMAN) is seen. The roof of the nose is narrow, and here the olfactory nerves pass in through the cribriform plate. The floor is wider so that a coronal section through each nasal cavity has roughly the appearance of a right-angled triangle.

Embryology.—In the third week of intrauterine life two nasal pits appear on the under side of the front of the head; they are the first appearance of the true olfactory region of the nose, and some of their epithelial lining cells send off axons (*see* NERVOUS SYSTEM: *Nerve Cells*) which arborize with the dendrites of the cells of the olfactory lobe of the brain and so form the olfactory nerves. Between the olfactory pits the broad median frontonasal process grows down from the forehead region to form the dorsum of the nose (*see* fig. 2) and the anterior part of the nasal septum, while outside them the lateral nasal processes grow down and later on meet the maxillary processes from the first visceral arch. In this way the nasal cavities are formed, but are separated from the mouth by a thin bucconasal membrane which eventually is broken through; after this the mouth and nose are one cavity until the formation of the palate in the third month. In the third month Jacobson's organ may be seen as a well-marked tube lined with respiratory mucous membrane; no explanation of the function of Jacobson's organ in man is known, and it is probably entirely atavistic. At birth the nasal cavities are shallow from above downward, but rapidly deepen till the age of puberty.

Comparative Anatomy.—In the lancelet there is a ciliated pit above the anterior end of the central nervous system, which is probably a rudiment of an unpaired olfactory organ. In the Cyclostomata (lampreys and hags) the pit is at first ventral, but later becomes dorsal and shares a common opening with the pituitary invagination. It furthermore becomes divided internally into two lateral halves. In fishes there are also two lateral pits, the nostrils of which open sometimes, as in the sharks and rays, onto the ventral surface of the snout, and sometimes, as in the higher fishes, onto the dorsal surface. Up to this stage the olfactory organs are mere pits, but in the Dipnoi (mudfish) an opening is established from them into the front of the roof of the mouth, and so they serve as respiratory passages and organs for the sense of smell. In the higher Amphibia the nasal organ becomes included in the skull and respiratory and olfactory parts are distinguished. In this class, too, turbinal ingrowths are found, and the nasolachrymal duct appears.

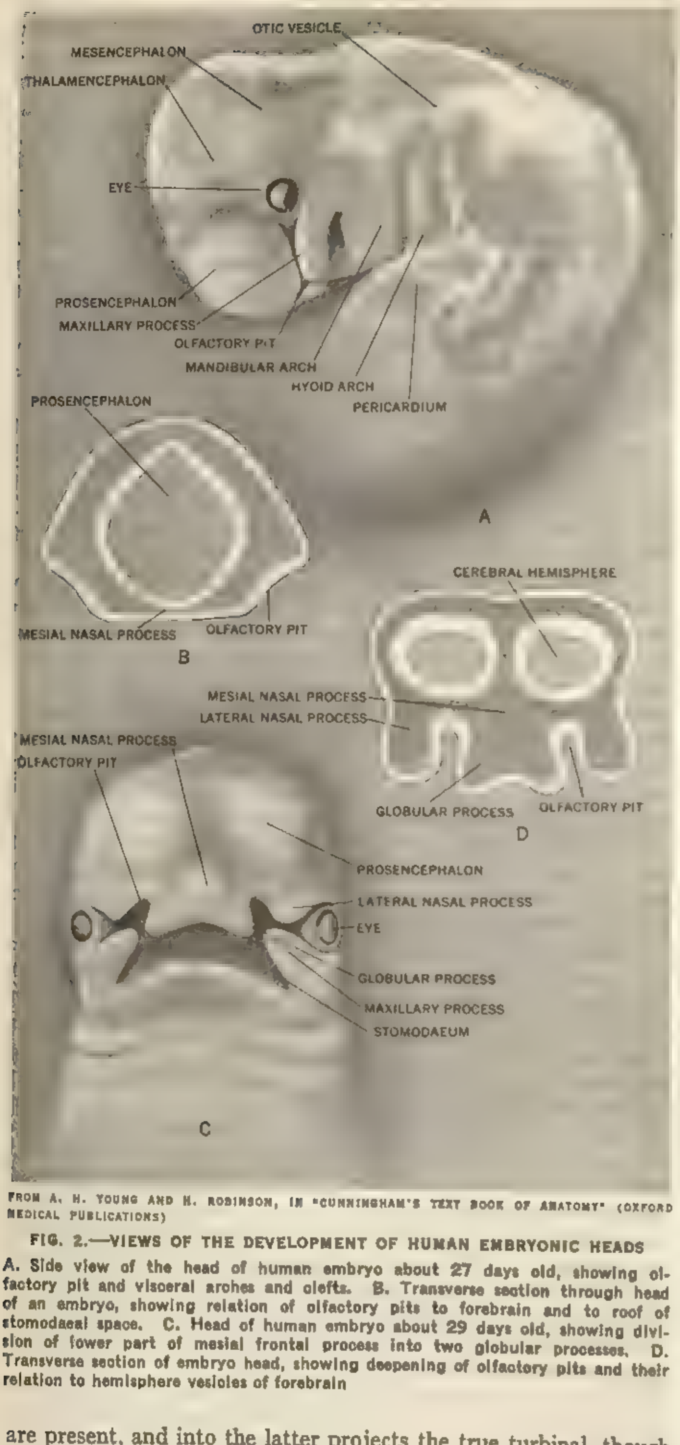


FROM R. HOWDEN, IN "CUNNINGHAM'S TEXT BOOK OF ANATOMY" (OXFORD MEDICAL PUBLICATIONS)

FIG. 1.—VIEW OF THE OUTER WALL OF THE NOSE, THE TURBINATED BONES HAVING BEEN REMOVED

In the lizards, among the Reptilia, the olfactory and respiratory parts are very distinct, the latter being lined only by stratified epithelium unconnected with the olfactory nerves. There is one true turbinal bone growing from the outer wall, and close to this is a large nasal gland. In crocodiles the hard palate is formed, and there is henceforward a considerable distance between the openings of the external and internal nares. In crocodiles, also, air sinuses are first found extending from the olfactory cavities into the skull bones.

The birds' arrangement is very like that of the reptiles; olfactory and respiratory chambers



FROM A. H. YOUNG AND H. ROBINSON, IN "CUNNINGHAM'S TEXT BOOK OF ANATOMY" (OXFORD MEDICAL PUBLICATIONS)

FIG. 2.—VIEWS OF THE DEVELOPMENT OF HUMAN EMBRYONIC HEADS

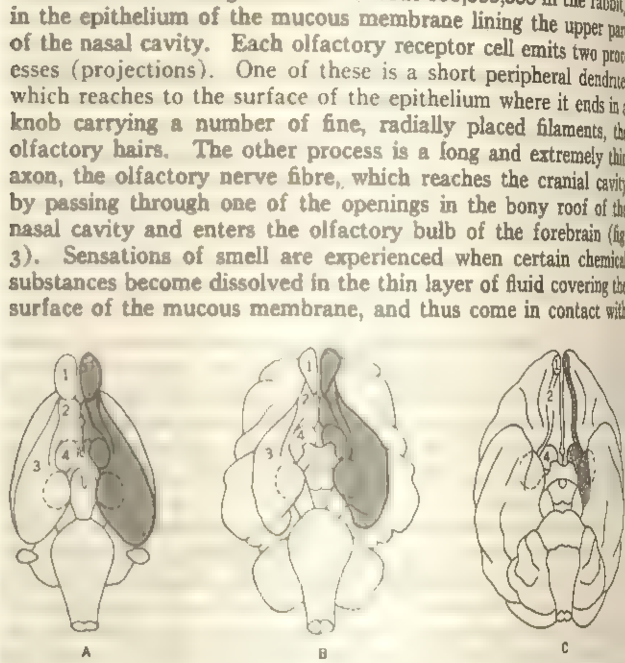
A. Side view of the head of human embryo about 27 days old, showing olfactory pit and visceral arches and clefts. B. Transverse section through head of an embryo, showing relation of olfactory pits to forebrain and to roof of stomodaeal space. C. Head of human embryo about 29 days old, showing division of lower part of mesial frontal process into two globular processes. D. Transverse section of embryo head, showing deepening of olfactory pits and their relation to hemisphere vesicles of forebrain

are present, and into the latter projects the true turbinal, though there is a pseudoturbinal in the upper or olfactory chamber. In mammals the olfactory chamber of the nose is variously developed; most of them are macrosmatic, and have a large area of olfactory mucous membrane; some, like the seals, whalebone whales, monkeys and man, are microsmatic, while the toothed whales have the olfactory region practically suppressed in the adult, and are said to be anosmatic. There are generally five turbinal bones in macrosmatic mammals, so that man has a reduced number. The lowest of the series, the maxilloturbinal, is the equivalent of the single true turbinal bone of birds and reptiles, and in most mammals is a double scroll, one leaf turning upward and the other down.

Jacobson's organ first appears in amphibians, where it is found as an anteroposterior gutter in the floor of the nasal cavity. In reptiles the roof of the gutter closes in on each side, and a tube is formed lying below and internal to the nasal cavity, opening anteriorly into the mouth and ending by a blind extremity, posteriorly to which branches of the olfactory and trigeminal nerves are distributed. In the higher reptiles (crocodiles and chelonians) the organ is suppressed in the adult, and the same applies to birds; but in the lower mammals, especially the monotremes it is very well developed, and is enclosed in a cartilaginous sheath from which a turbinal process projects into its interior. In other mammals, with the exception of the Primates and perhaps the Chiroptera, the organ is quite distinct, though even in man, as has been shown, its presence can be demonstrated in the embryo.

(F. G. P.; P. N.)

Nervous Pathways of Smell.—The pathway of olfactory conduction begins with the olfactory receptors—small, slender nerve cells embedded in large numbers (about 100,000,000 in the rabbit) in the epithelium of the mucous membrane lining the upper part of the nasal cavity. Each olfactory receptor cell emits two processes (projections). One of these is a short peripheral dendrite, which reaches to the surface of the epithelium where it ends in a knob carrying a number of fine, radially placed filaments, the olfactory hairs. The other process is a long and extremely thin axon, the olfactory nerve fibre, which reaches the cranial cavity by passing through one of the openings in the bony roof of the nasal cavity and enters the olfactory bulb of the forebrain (fig. 3). Sensations of smell are experienced when certain chemical substances become dissolved in the thin layer of fluid covering the surface of the mucous membrane, and thus come in contact with



BY COURTESY OF MEDICAL AUDIO VISUAL DEPT., WALTER REED ARMY INSTITUTE OF RESEARCH

FIG. 3.—BASAL ASPECT OF THE BRAIN OF THE (A) RAT, (B) CAT AND (C) MONKEY

Olfactory structures on the right side of each drawing are indicated by shading; on the left they are numbered as follows: (1) olfactory bulb; (2) olfactory tract; (3) cortex of the pyriform lobe; (4) olfactory tubercle. The broken circle indicates the position of the amygdaloid complex, which is covered by the cortex of the pyriform lobe. (The three brains have not been drawn on the same scale)

the olfactory hairs. In all probability it will be found that the receptor cells differ among themselves in their sensitivities to various odorous substances.

In the olfactory bulb, the olfactory nerve fibres end in contact with the antenna-shaped dendrites of the large mitral cells, which represent the second main link in the chain of olfactory conduction. Each mitral cell emits a long axon, many of which enter into the formation of the olfactory tract, a white fibre band extending back from the bulb over the basal surface of the forebrain (fig. 3). The olfactory tract distributes its fibres mainly to the cortex of the pyriform lobe, which constitutes the final cortical receiving area of the olfactory pathway. In man, this region corresponds to the uncus of the hippocampal gyrus. A smaller number of fibres of the olfactory tract end in two further olfactory structures; viz., the olfactory tubercle and the medial part of the amygdaloid complex (the latter lies deep to the olfactory cortex; fig. 3).

In mammals with a highly developed sense of smell (macrosmatic mammals), such as the rodents and carnivores, the olfactory brain structures are relatively large and occupy all or a large part of the basal surface of the forebrain (fig. 3A and B). A marked reduction of all olfactory structures is evident in the microsmatic primates (monkeys, apes and man; fig. 3C), which for their orientation rely more heavily upon the senses of vision and touch. (W. J. H. N.)

See also BRAIN; NERVE; SMELL AND TASTE.

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brates (1954); Herbert W. Rand, *The Chordates* (1950); C. L. Prosser (ed.), *Comparative Animal Physiology* (1950); C. P. McCord and W. N. Witheridge, *Odors: Physiology and Control* (1949); A. Brodal, "The Hippocampus and the Sense of Smell: a Review," *Brain*, 70:179–222 (1947); W. E. Le Gros Clark, "Inquiries Into the Anatomical Basis of Olfactory Discrimination," *Proc. Roy. Soc.*, B, 146:299–319 (1957). (F. G. P.; P. N.; W. J. H. N.)

OLGA, SAINT (d. A.D. 969), Kievan princess, regent of the grand principality of Kiev from 945 to 964. She was the widow of Prince Igor, who was killed in 945 by the rebellious Drevlyane tribe after an attempt to extort excessive tribute. As Igor's son Svyatoslav was still a minor, Olga became the actual ruler of Kievan Russia, governing the country with a strong and skilful hand. She severely punished the Drevlyane for their crime and took measures to regulate the collection of tribute and to safeguard the security of the state. Olga was the first of the Kievan princely house to adopt the "Greek faith," namely Orthodox Christianity, being baptized *c.* 955; and she subsequently visited Constantinople. The *Primary Russian Chronicle* eulogized her as the precursor of Russian Christianity, "as daybreak precedes the sun and as the dawn precedes the day; for she shone like the moon by night, and she was radiant among the infidels like a pearl in the mire." Olga's memory was greatly venerated in Russia, and she was later canonized as the first Russian saint of the Orthodox Church. (S. G. Pu.)

OLIER, JEAN JACQUES (1608–1657), founder of the Sulpicians and spiritual writer, one of the chief architects of the religious renewal of 17th-century France, was born at Paris on Sept. 20, 1608. Destined by his mother for an ecclesiastical career and at 18 already prior of two monasteries and abbot of a third, he gave himself to a life of pleasure when his theological training at the Sorbonne was over. He was converted in 1631 and went to Rome for further studies. He returned to Paris the following year after having been cured at Loreto of a serious eye ailment and devoted himself wholly to the care and instruction of the poor of the city and to preaching throughout the rural districts. Ordained priest in 1633, he came under the influence of St. Vincent de Paul and Charles de Condren and in 1641 established a seminary for the training of future priests at Vaugirard. The year following he was made pastor of the sprawling, disorganized parish of St. Sulpice in Paris. Thither he transported his seminary and made it and the parish models that would be imitated widely. His writings, in the tradition of Pierre de Bérulle (*q.v.*), are chiefly concerned with the spiritual implications of the Christian priesthood. He died April 2, 1657.

Olier's *Oeuvres complètes* were edited by J. P. Migne (1856).

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OLIGARCHY is the traditional term used to denote the rule of the few when that rule is looked upon with disfavour. Aristotle used it to designate the rule of the few when it was exercised not by the best, but by bad men unjustly. In this sense, it overlaps with the later concept of plutocracy.

It is a recurrent idea that all forms of government are in the final analysis reducible to the rule of a few. Oligarchs will secure effective control whether the formal authority is vested in the people, a monarch, the proletariat or a dictator. Thus, Karl Marx and Friedrich Engels insisted that throughout capitalism, the key capitalists had controlled the government; they coined the famous phrase, "the state is the executive committee of the exploiting class." The Italian political scientist Gaetano Mosca likewise insisted that a "ruling class" always constituted the effective oligarchical control. Vilfredo Pareto elaborated the idea in his doctrine of the "elite." The modern tendency to analyze social patterns in terms of an "elite," although greatly reinforced by Pareto's theory, goes further back than Marx and Engels, who employed the term "elite" to describe the class-conscious communists, the leading group within the proletariat. To say that all governments are in essence oligarchical may be an exaggeration. Yet a tendency persists in all organizations to evolve a limited group at the centre who, as insiders, "run the show." Political science and sociology are beginning to differentiate more carefully between various types of control and power. The type of power held by a democratic party boss, while overwhelming in relation to any single member of the party, is very different from that wielded by the boss of the single party in a totalitarian and authoritarian pattern. Likewise, the control group within an organization does not occupy the same position under democratic conditions (which provide for the group's being effectively challenged by outsiders at any time) as it does under an authoritarian plan. If effective control changes hands as rapidly as it does in a city of the U.S. or a British trade union, it is doubtful that those exercising it should be spoken of as a "class" or an "elite." The expression "the few" is too abstract to tell us much. Like the other purely numerical concepts of government inherited from Greek philosophy, oligarchy is an outmoded term, because it fails to direct attention to what we really wish to know about a government. (C. J. Fr.)

OLIGOCENE, in geology, is the third epoch of the Tertiary period. The name is derived from the Greek *oligos*, "few," and *kainos*, "recent," in reference to the relatively small percentage (about 10%) of living shellfish found as fossils. The Oligocene is the time interval between the older Eocene and the younger Miocene and the Oligocene series includes the rocks formed during this interval. In those classifications in which it includes the European stages Tongrian, Rupelian and Chattian, it is generally estimated to have a time duration of about 11,000,000 years. The interval was originally included by Sir Charles Lyell in his Older Miocene. The term Oligocene was proposed by H. E. Beyrich in 1854 and again in 1858, being based on rocks in north Germany and their contained fauna. The Oligocene is thus the youngest division of the older, and the middle division of the revised Tertiary (*q.v.*) as indicated on the accompanying geologic time chart.

Geologic Time Chart

System and Period	Series and Epoch	Distinctive Records of Life	Began (Millions of Years Ago)
		CENOZOIC ERA	
Quaternary	Recent (last 11,000 years)		
	Pleistocene	Early man	2+
Tertiary	Pliocene	Large carnivores	10
	Miocene	Whales, apes, grazing forms	27
	Oligocene	Large browsing mammals	38
	Eocene	Rise of flowering plants	55
	Paleocene	First placental mammals	65–70
		MESOZOIC ERA	
Cretaceous		Extinction of dinosaurs	130
Jurassic		Dinosaurs' zenith, primitive birds, first small mammals	180
Triassic		Appearance of dinosaurs	225
		PALEOZOIC ERA	
Permian		Reptiles developed, conifers abundant	260
Carboniferous			
Upper (Pennsylvanian)		First reptiles, coal forests	300
Lower (Mississippian)		Sharks abundant	340
Devonian		Amphibians appeared, fishes abundant	405
Silurian		Earliest land plants and animals	435
Ordovician		First primitive fishes	480
Cambrian		Marine invertebrates	550–570
		PRECAMBRIAN TIME	
		Few fossils	more than 3,490

LIFE OF THE EPOCH

The life of the epoch resembled that of the Eocene more than that of the succeeding Miocene.

Marine.—Foraminifera were abundant; nummulites were still numerous at first but of smaller size, becoming extinct by the close of the epoch. Corals, bryozoans and echinoids were abundant in clear waters of the middle and lower latitudes but were less widely distributed than previously. Shelled cephalopods were few but gastropods and pelecypods assumed more of their present importance.

Terrestrial.—On land the highly varied fauna was composed of a mixture of surviving archaic types and the beginnings of modern families. It is possible to recognize carnivores (Canidae and Felidae), insectivores, rodents, ruminants and camels. Fore-

runners of the modern rhinoceros, elephant and horse are recognizable. Giant herbivores such as the brontotheres (or titanotheres) were a spectacular element.

See also PALEONTOLOGY.

For the flora *see* PALEOBOTANY.

CONDITIONS DURING THE OLIGOCENE

Oligocene deposits are of freshwater, brackish, marine and terrestrial origins; they include sands, sandstones, grits, marls, shales, limestones, conglomerates, lignites and volcanic materials. The thickness varies from a few hundred feet, as in parts of France, to well over 10,000 ft. as in Oregon-Washington, northern South America and Burma. The deposits were mostly laid down in shallow water or on land, but in places, as in parts of Oregon-Washington, Colombia and Peru, the fossils indicate a deepwater marine environment of several hundreds to perhaps several thousands of feet in depth. Here and there, as in north Germany and the Lake Aral region in western Asia, the sea gained ground that had been unoccupied during the preceding Eocene, but in most areas the seas were less extensive than in the Eocene and the succeeding Miocene epoch. During the late Eocene and early Oligocene important diastrophic changes were in progress. In Europe the Pyrenees and parts of the Alps were uplifted at this time. In the early Oligocene the Bering sea land bridge was elevated, allowing a notable terrestrial faunal migration between the old and new worlds. Near the end of the epoch the ancient Tethys sea started to fragment and marine connections between the Mediterranean and the Indo-Pacific region were broken. In places, as in the Rocky mountains and parts of France, lacustrine or lake and terrestrial deposits were formed. There was extensive vulcanism in the high plains and Rocky mountain areas of the United States and in the northern Andes of South America.

OLIGOCENE STRATIGRAPHY

Neither the lower nor the upper limit of the Oligocene is well defined (*see* TERTIARY), but there is more general agreement on the placement of the boundary with the preceding Eocene than with the succeeding Miocene.

European Stages and Formations.—The epoch is more often considered to include (from oldest to youngest) the European stages identified as Tongrian (Lattorfian, Sannoisian), Rupelian (Stampian) and Chattian (Casselian), but there is little general agreement as to whether or not the Aquitanian stage is younger than, or in part equivalent to, the Chattian. Thus the Aquitanian may or may not be included in the Oligocene.

The Tongrian stage (from Tongres, Belg.) is represented by marine and freshwater clays and sands in Belgium, marine sandy glauconitic beds in northern Germany at Latdorf between Magdeburg and Leipzig and the famous series of supragypsiferous marls (Sannoisian) of the Paris basin. At the base of the Sannoisian are blue marls, deposited in salt lagoons, then white marls with freshwater horizons and finally widely distributed green marine marls. Contemporaneous marine sands and clays in northern Germany were called Lattorfian. In Britain, classic exposures of Lower Oligocene sediments occur on the Isle of Wight and have been described from base upward as Middle Headon beds (brackish and marine), Upper Headon beds (freshwater clays, marls and limestones) and Osborne and Bembridge beds (brackish and freshwater sands, clays and limestones).

The precise correlation of different members of the Tongrian stage in western Europe is still uncertain. Many geologists have considered the molluscan and echinoid faunas of these beds as closely allied to those of the uppermost Eocene of the Paris basin.

The Rupelian stage (from Rupel, a tributary of the Scheldt in Belgium) is the most widely distributed and easily recognized unit of the Oligocene in western Europe. It is represented in Belgium by a thick series of clays, the *argiles de Boom*, and in the Paris basin by the *sables de Fontainebleau* and the underlying Brie limestone (sometimes termed the Stampian). Marine sandstones of equivalent age, called the Septarienton, occur in the Mainz basin and in northern Germany, where they were deposited in a transgressing sea. The Hampstead beds in the Isle of Wight, which consist of marine to brackish clays and marls, were deposited during early Rupelian time.

The Chattian stage (from Chattes, an ancient tribe which lived near Kassel, Ger.) is represented in the Mainz basin and northern Germany by glauconitic marine sands and overlying brackish and freshwater marls and limestones. Equivalent beds are unknown in Britain and Belgium. After the deposition of the Fontainebleau sands the sea left the Paris basin, and its area was occupied by a huge lake within which accumulated the Étampes limestone of which the *meulière de Montmorency* is a lateral equivalent. Above these beds lie the freshwater Beauce limestones, which in part belong to the Aquitanian stage. Continental Oligocene beds are found in several basins of the central European continent.

Marine and continental Oligocene deposits occur in the Alpine geosyncline of southern and eastern Europe and the Aral-Caspian region. Deposits of the Tethyan seaway, characterized by tropical faunas with nummulites and *Lepidocyclina*, extend from the western Mediterranean to India and even the East Indian region.

Western Hemisphere Correlations and Formations.—Exact correlation of marine Oligocene deposits of the new world with those of western Europe is difficult because of provincial faunas. Marine sediments occur in the Gulf and Atlantic coastal plains of the United States, in eastern Mexico, Central America, the West Indies, the northern third of Venezuela and Colombia and in western Ecuador and northwestern Peru. Thick deposits occur in the Coast ranges of California, Oregon, Washington and in southern Alaska and northeastern Asia.

In the eastern United States lower Oligocene sediments occur only in Mississippi and Alabama and are represented by the thin deltaic Forest Hill sand and the Red Bluff clay. Superposed are light-coloured shaly marls and clays of the Vicksburg group. They were deposited during the Middle Oligocene in a widely transgressing sea which extended at times from South Carolina to the coastal plain of Mexico. A slight subsidence of the sea floor during Late Oligocene time was followed by deposition of nearly 100 ft. of the Flint River and Suwannee limestones from South Carolina to northern Florida and by the Chickasawhay marls and shales from Alabama to the Mississippi river. No sediments of Upper Chattian age are exposed unless the sandstones of the lower part of the Catahoula formation extend down into the Oligocene. This formation is thought to have been deposited during the Aquitanian, which is variously included in either the Oligocene or the Miocene (see *European Stages and Formations*, above). Marine limestones and shales of Oligocene age are widely distributed in the West Indies, Costa Rica and Panamá.

Marine Oligocene sediments of diverse character occur in northern Venezuela and Colombia. They are mainly blue, brown and gray shales, interbedded sandy shales and sandstones and thick massive sandstones which were deposited in a slowly subsiding trough. These deposits range from 5,000 to 10,000 ft. thick and have been named the Mugrosa, Colorado and Poso series in Colombia and the El Fausto, Icotea, Churuguara, San Luis, Agua Clara, Agua Salada and Carapita formations in Venezuela. The Agua Clara formation is the best known and consists of more than 2,500 ft. of lagoonal gypsiferous shales with marine intercalations. Near the end of the Oligocene the seaway briefly extended south along the eastern front of the Andes in Venezuela, Colombia and Ecuador. These marine deposits are intercalated in the midst of thick continental and lacustrine detrital sediments.

Several thousand feet of marine sandstones and shales occur in the coastal part of northwest Peru and extend through western Ecuador to Colombia. They accumulated in a trough which seemingly connected the Caribbean sea with the Pacific ocean.

During the Oligocene an area more than 100 mi. wide in western North America, extending from Vancouver Island to middle Oregon and in California from San Francisco bay to the Transverse ranges was largely occupied by marine embayments.

In Oregon and Washington over 10,000 ft. of marine shale, sandstone, and conglomerate have been classified from top downward as the Blakeley, Lincoln and Keasey formations. Faunal zones (*see* FOSSIL) based on mollusks and foraminifera have been recognized within these deposits but it is uncertain how much of

the Keasey formation extends down into the Eocene and how much of the Upper Blakeley formation ranges into the Miocene. In central California the Oligocene is represented by marine sandstones, sandy shales and deposits of volcanic tuff. In the San Joaquin valley there are deposits of massive and stratified light-gray shale and sand called the Tumey sand and Tumey shale. Other basins in southern California received thick accumulations of terrestrial and lacustrine conglomerate, sandstone and shale which were named the Sespe formation. Locally this formation ranges in age from Upper Eocene to Lower Miocene.

Land-laid deposits of Oligocene age occur throughout much of the Rocky mountains and adjacent areas of the United States. In the eastern Rocky mountains they are represented by the Wind River series, in Montana by the Pipestone Springs and Cook Ranch formations and in Oregon by the lower John Day formation.

Sandstones and shales containing marine fossils similar to those of the Blakeley formation occur in southern Alaska, Sakhalin Island, Kamchatka and in the northern island of Japan (Poronai formation).

New Zealand.—In New Zealand the marine deposits referred to the Oligocene are known as the Kaiatean, Whaingaroan (the two may be combined into the Ototaran), Duntroonian and Waitakian stages. The sediments of this age include mudstones, sandstones, limestones and marls, and attain a thickness of over 3,000 ft.

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OLIGOCHAETA, a class of annelid worms, comprising the earthworms and small mud-living or aquatic, rarely marine or parasitic, species, most of which have several pairs of small bristles on each body segment. *See* Annelida.

OLIGOCLASE: *see* Feldspar.

OLIMPO, the northernmost of the three departments which make up the Paraguayan Chaco, is a region of scrub forest and grassland on a sandy and often swampy plain sloping eastward to the Paraguay river. For 150 mi. it is adjacent to Bolivia, from which it is separated by an artificial boundary. The population numbered 3,362 in 1962, consisting principally of Indians, cattle herders and lumberers producing quebracho wood. Large areas are almost uninhabited, and most people live in or near the capital, Olimpo, a port on the Paraguay river. This city is a strategic outpost and the only trading centre serving the needs of the department. (G. J. B.)

OLINDA, a city of the northeastern state of Pernambuco, Braz., located on a low hill on the Atlantic coast, about 7 mi. N. of the port city of Recife. Pop. (1960) 100,545. Olinda is noted principally for its ornate churches and monasteries, which date from the 16th and 17th centuries, and other buildings of historical interest. It was founded as the colonial capital in 1537 by Duarte Coelho Pereira. By 1600 an economy based upon sugar and Negro slave labour had made it a feudal and ecclesiastical stronghold. In 1630 the Dutch captured Olinda and occupied and retained control of Pernambuco until 1654. By that time the city had entered an era of decadence and its place of leadership had passed to Recife which became the capital. The Olinda seminary, founded in 1800 by Bishop José Azeredo Coutinho, won recognition for the liberal thinkers it graduated before independence was achieved. (J. J. J.)

OLIPHANT, LAURENCE (1829–1888), British author, traveler and mystic, one of the most paradoxical figures in Victorian society, was born in Cape Town, South Africa, in 1829, his father being at that time attorney general in Cape Colony. His education was desultory; he was called to the bar but soon gave up the law. Before the age of 24 his travels had provided material for two books, *A Journey to Khatmandu* (1852) and *The Russian Shores of the Black Sea in the Autumn of 1852, and a Tour Through the Country of the Don Cossacks* (1853). Later experiences in various parts of the world, as secretary to Lord Elgin, war correspondent of the *Times*, unofficial British observer and (briefly) first secretary of the British legation in Japan, are recorded with verve in *Episodes in a Life of Adventure* (1887) and other books, one of which, the *Narrative of the Earl of Elgin's Mission to China and Japan* (1859), gives a fascinating account of 19th-century gunboat diplomacy. In 1865 appeared his satirical novel of London society, *Piccadilly: a Fragment of Contemporary Biography*, and in the same year he became Conservative member of parliament for the Stirling burghs.

In 1867 Oliphant went to the U.S. and joined the Brotherhood of the New Life, first at Amenia, and then at Brocton, N.Y., founded by the spiritualist "prophet" T. L. Harris, to whose rule he submitted until 1881. In 1878 he had proposed to Disraeli and Lord Salisbury a plan for the Jewish colonization of Palestine (not Jewish himself, he appears to have been largely politically motivated), and in 1882 he and his wife settled in Haifa, where they formed a small community and wrote together the esoteric *Sympneumata: Evolutionary Forces Now Active in Man* (1884)—apparently a plea for purified sex life. Oliphant also wrote *Altiora peto* (1883), which has been compared with the novels of Aldous Huxley. He died at Twickenham on Dec. 23, 1888.

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OLIPHANT, MARGARET OLIPHANT (1828–1897), prolific Scottish novelist, historical writer and biographer, best known for her portraits of small-town life, was born in Wallyford, Midlothian, on April 4, 1828. In 1852 she married her cousin, Francis Wilson Oliphant, and settled in London. Widowed in 1859, her life became a wearisome struggle to provide, by writing, for her children and later, for her brother's children. Between 1849 and her death she published more than 100 separate books, of which the best known are the *Chronicles of Carlingford*, published anonymously 1863–76. These four novels of contemporary life in a small town include *Miss Majoribanks* (1866), a young lady's attempts at social climbing, and *Salem Chapel* (1863), a young, intelligent nonconformist minister's trials with his narrow-minded congregation. The best of her Scottish novels are *Passages in the Life of Mrs. Margaret Maitland* (1849), *Merkland* (1851) and *Kirsteen* (1890). *A Beleaguered City* (1880) and *A Little Pilgrim in the Unseen* (1882) introduce the supernatural. She also published historical studies, children's books, biographies, and *Annals of a Publishing House: William Blackwood and His Sons* (1897), a work of importance to literary historians. She wrote with sympathy, insight and humour about domestic life, but although she was often compared with George Eliot, she lacked the latter's intellectual fibre. She died at Windsor on June 25, 1897.

See *Autobiography and Letters*, ed. by Mrs. H. Coghill (1899).
(W. L. G. Ja.)

OLIVARES, GASPAR DE GUZMÁN, Conde-Duque de (1587–1645), Spanish statesman who for nearly 22 years ruled the country as King Philip IV's favourite, was born on Jan. 6, 1587, in Rome, where his father, Enrique de Guzmán, 2nd conde de Olivares, was Philip II's ambassador to the Holy See till 1591. He succeeded to his father's title in 1607, during Philip III's reign, and, despite the jealousy of the duque de Lerma, won a dominant influence over the heir to the throne, who, on becoming king as Philip IV in March 1621, put him in charge of affairs. The rank of grandee having been attached to his countship in 1621, Olivares kept its name by styling himself conde-duque de Olivares after he was created duque de Sanlúcar (1625).

Energetic and accustomed to splendour, a patron of dramatists and the subject of brilliant portraits by Velázquez, Olivares was avid for power. Foreign policy, however, was in fact already predetermined from Philip II's time, and no minister could have dissuaded king, church and nation from pursuing the idea of Spanish hegemony in the Europe of the Counter-Reformation: so it was scarcely the fault of Olivares that Spain failed to renew the truce with the Dutch (1621; *see* Netherlands, The) and became involved in Italian conflicts and in that course of support for the Austrian Habsburgs in Germany which finally led to France's declaration of war in 1635 (*see* Thirty Years' War).

In domestic affairs he was more personally responsible for the catastrophes of the period: he overrode the rights of the autonomous regions of the monarchy and so provoked the revolts of the Catalans and of the Portuguese, which both began in 1640, as well as the abortive conspiracy of Francisco de Guzmán, marqués de Ayamonte, for a separate Andalusian kingdom (1641). Even so, his motive for authoritarian treatment of the regions was, partly at least, economic: he wanted them to provide supplies of money to offset the decline in imports of precious metals from America.

Under strong pressure from a court intrigue headed by the queen (Elizabeth of France), Philip IV dismissed his favourite in Jan. 1643. Olivares retired to Loeches and published an able counterblast to a memorandum by his enemies, but was soon ordered to proceed to distant Toro; and in Dec. 1644 the Inquisition began to investigate his conduct. He died at Toro on July 22, 1645.

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OLIVE, a subtropical, broad-leaved evergreen tree (*Olea europaea*), grown for the production of its fruit, which is utilized for the extraction of olive oil (*q.v.*) and also for table olives. It is a member of the family Oleaceae, which also includes the privet, lilac, ash, forsythia and jasmine. The genus *Olea* contains about 30 other species, none bearing edible fruit, which are native to such parts of the world as South Africa, New Zealand, India and Afghanistan.

The edible olive, probably first collected wild in the eastern Mediterranean or south-central Asia region, is undoubtedly one of the world's oldest cultivated crops. There is evidence that the olive was grown on the island of Crete about 3500 B.C., and the Semitic peoples apparently cultivated it as early as 3000 B.C. (According to Scripture it was an olive leaf that Noah's dove took back to the ark.) Olive oil was a highly prized luxury for anointing the body in Greece during the time of Homer, about 900 B.C., and it was an important crop of the Romans around 600 B.C. In subsequent times olive growing spread to all the countries bordering the Mediterranean.

Plant Characteristics.—*Growth Form.*—The olive plant is a relatively slow-growing but long-lived evergreen tree, 10 to 40 ft. or more high. Branches are numerous and the tree, young or old, is very bushy. Strong, old trunks are deeply furrowed with ridges running from the branches to the roots, presenting a wide buttress at the base of the tree. The leaves, leathery and lance-shaped, are dark green above and silvery on the underside and are paired opposite each other on the twig. The wood is resistant to decay, and if the top dies back a new trunk will often arise from the roots. The tree is attractive, its beauty having been extolled for thousands of years. In ancient times it was a common feature of the landscapes of Palestine and parts of western Asia, as indicated by Scripture and Greek and Roman writings.

The trees bloom in late spring. Small, inconspicuous whitish flowers are borne in loose clusters in the axils of the leaves. Flowers are of two types: (1) perfect, containing both male and female parts, which are capable of developing into the olive fruits; and (2) male, or staminate, which contain only the male, pollen-producing parts. The olive is wind-pollinated, the presence of bees or other insects being unnecessary for fruit production.

Fruit-setting in the olive is often erratic; in some areas, especially where irrigation and fertilization are not practised, alternate bearing is the rule. The trees may set a heavy crop one year and not even bloom the next.

FRUITING BRANCH OF THE OLIVE (OLEA EUROPAEA)

BY COURTESY OF SPANISH TOURIST OFFICE

ONE OF THE FAMOUS 1,000-YEAR-OLD OLIVE TREES OF MAJORCA

The Fruit and Its Composition.—The olive fruit is classed botanically as a drupe, similar to the peach or plum. It consists of the skin (exocarp), the flesh (mesocarp) and the pit or stone (endocarp). Within the stone is found the seed, usually one, but sometimes two. Olives tend to have maximum oil content (about 20%–30% of fresh weight) and greatest weight six to eight months after the blossoms appear. At this time they are black, and will continue to cling to the tree for several weeks. Fruits for oil extraction are allowed to mature, but for processing as food immature fruits are handpicked or shaken off the tree.

Varieties.—There are literally hundreds of named varieties of both types of olives, table and oil, grown round the world in the warmer climates. In California olives are grown almost exclusively for table use. The Mission variety, which still ranks high in acreage planted, was selected from the seedlings first grown by the Franciscans in San Diego. Other table varieties introduced later from Europe include Ascolano (white olive of Ascoli) from Italy; Manzanillo and Sevillano from Spain; and Karydolia, Konservolia and Amygdalolia from Greece. In Europe olives are grown primarily for oil; among the varieties cultivated are Picual, Nevadillo, Chemali, Morcal, Oliviere, Leccino, Corregiolo, Zorzalino and Cornicabra.

Cultivation.—The tree will tolerate drought periods of five or six months through the summer, provided winter rainfalls of at least 8 to 10 in. occur. Olive trees will not survive temperatures below about 10° F. (−12° C.), being injured at 15° F. (about −9° C.). To form flowers and fruit the olive seems to require an exposure of several months to winter-chilling conditions. The tree itself will grow satisfactorily in tropical regions of the world but fails to bear fruit, probably because of a lack of winter chilling. Commercial olive production is generally found to occur in two belts around the world, one between 30° and 45° N. latitude, the other between 30° and 45° S. latitude. In these areas the necessary climatic requirements for vegetative growth and fruitfulness can be found.

Olive varieties do not come true from seed. Seedlings generally produce inferior fruit and must be budded or grafted to one of the named varieties. Olives also can be propagated by cuttings, either by hardwood cuttings set in the nursery row in the spring or by small leafy cuttings rooted under mist sprays in a propagating frame. Either type responds markedly to treatments with a root-promoting hormone.

The nursery trees are planted 25 to 35 ft. apart in irrigated orchards, or 40 to 75 ft. apart in unirrigated groves. They start bearing in 4 to 8 years, but full production is not reached until 15 or 20 years, or when dry-farmed, until the trees are 40 to 50 years old.

In the Mediterranean countries most olive groves are unirrigated. Although remarkably drought resistant, the olive will use just as much water as other trees if it is available. A general misconception is that olives require planting on poor, rocky hillside land and should be unirrigated. Although the olive plant will endure adverse conditions that would kill most other tree fruits, it responds markedly to irrigation, good soil and nitrogen fertilizers.

In California, where many groves are planted on some of the best orchard soils and carefully irrigated through the dry summers, yields of five to ten times those in the unirrigated orchards of the Mediterranean countries are obtained. In Spain, however, the general belief is that irrigated olives do not pickle as well as those dry-farmed and often the trees are not irrigated even when water is available.

Harvesting.—Harvesting of the fruit for pickling is done in

the autumn before the fruit turns black. Harvesting usually continues for about two months, or until the fruit becomes damaged by frost. Temperatures of 27° or 28° F. (about 2° to 3° C.) for several hours are likely to injure the tissues so the fruit cannot be used for pickling; such frozen fruits can be allowed to remain on the tree, however, to be harvested later for oil extraction. Table olive harvest is done by handpicking.

Olives to be harvested for oil extraction are allowed to remain on the tree until late winter when they turn black and reach their maximum oil content—20% to 30% of the fresh weight of the fruit (*see* OLIVE OIL). A common harvest practice, although undesirable, is to beat the trees with long poles, knocking the olives on to sheets spread on the ground under the tree. In many orchards, however, the fruit is handpicked even for oil extraction.

PRODUCTION AND PROCESSING

Production.—In the 20th century Spain became, by far, the leader in commercial olive production, accounting for about 38% of the world's olive production, followed by Italy with about 20% and Greece with about 13%. Other important olive-producing countries are Portugal, Turkey, Tunisia, France, Morocco, Algeria, Syria, Yugoslavia, Jordan, United States, Cyprus, Israel and Argentina. Europe, with nearly 500,000,000 olive trees, has more than three-quarters of the world's cultivated olives, followed by Asia (about 13%), Africa (8%) and America (3%).

Commercial olive production did not begin in the United States —where it is limited to California—until the latter part of the 19th century. The olive was earlier brought into California, however, from Mexico in 1769 by the Franciscan fathers. In South America and Australia, development of a commercial olive industry is even more recent, starting in the early part of the 20th century.

Olives are grown mainly for the production of olive oil. This is well illustrated in Spain where more than 90% of the crop is crushed annually for oil extraction.

The two leading producers of table olives are Greece and Spain, the former producing 35,000 tons in a good year and the latter 25,000 tons. Next in order of production are the United States (average 17,000 tons), Algeria (15,000), Argentina (12,600) and Italy (10,000).

Processing.—Fresh, unprocessed olives are inedible, as they are extremely bitter. This bitterness, due to a glucoside, can be neutralized by treatments with a dilute alkali such as lye (sodium hydroxide). Salt applications also dispel some of the bitterness.

Pickled Green Olives.—In the Mediterranean basin, and to some extent in California, the table olive crop is utilized for pickled green olives. For this the fruits are harvested before they begin to soften or to show any colour change. They are placed in vats immediately after picking and are covered with 1¼% to 2% lye solution; this solution is allowed to penetrate about two-thirds the distance to the pit (as determined by sampling and applying dilute phenolphthalein solution, a chemical indicator, to the cut surface of an olive). Leaving some bitterness around the pit imparts a more pleasing flavour to the product.

The lye solution is removed and the olives are covered with water, which is changed several times a day for one to two days until the lye is nearly removed. During treatment and washing, undue exposure to the air is avoided, as this causes an undesirable darkening of the fruit.

The olives are next transferred to 180-gallon vats (in Spain) or to 50-gallon oak barrels (in California). These are filled with a salt solution to produce a 7%–8% salt brine. The olives are sealed in these containers for one to six months while lactic acid fermentation takes place. Sugar is often added after several weeks to maintain the fermentation process. Finally, the olives are packed in sealed glass jars filled with a 7½% salt brine.

Canned Ripe Olives.—In California most of the table olive crop is processed as canned black ripe olives. This method is used little or not at all in other olive-producing countries. Harvesting takes place when the fruits are straw-yellow to cherry-red in colour, depending upon the variety. A considerable proportion of the crop is stored in large vats, filled with a 5% to 12% brine, until the olives can be processed. The lactic acid fermentation that takes place in this brine storage prevents the development of spoilage bacteria.

When taken from brine storage, the olives are processed in shallow vats. They are first treated four to eight times with solutions of 1.2% to 2% lye. During this time the olives become darkened by oxidative reactions resulting from exposure to air between the lye treatments or from aeration due to compressed air being bubbled through the water containing the olives.

After the last lye treatment the olives are washed with water repeatedly, from five to seven days, to remove all traces of lye or bitterness. Finally, the olives are pasteurized by heating them in water to 175° F. (about 79° C.) for 30 minutes. This stops any undesirable fermentation.

The olives are then cured in a 2% brine for two days, sorted and graded to size and finally sealed in enamel-lined cans. In California canned olives are sterilized at 240° F. (about 116° C.) for 60 minutes under State Board of Health inspection.

A variation of the above procedure is used in preparing "green-ripe" canned olives. The olives are picked while still green and are processed as soon as harvested. Two lye applications (1.5% to 2%) are given, after which the lye is removed by soaking the olives for several days in water changed three or four times daily. The olives are then stored in a 2% brine for two to three days, then canned as described for the black-ripe process. In the green-ripe method the olives are not exposed to the air at any time during processing, hence they retain their green colour.

PESTS AND DISEASES

Pests.—The olive is not subject to many insect or disease pests. The most important, by far, is the olive fly (*Dacus oleae*), which occurs only in the Mediterranean countries, not being found in the olive-producing regions of the western hemisphere nor in Australia. So serious is this pest that in Spain, Italy and Greece it reduces the olive crop by half in some years. There are three to five generations during the growing season, the first starting in late spring. The larva burrows in the flesh of the fruit, forming cavities, making the fruit unfit for pickling and reducing the yield and quality of the oil. Trees grown under irrigation seem to be more susceptible to attack than those dry-farmed. No completely satisfactory control measures have been developed. Other less troublesome insect pests are black scale (*Saissetia oleae*), olive scale (*Parlatoria oleae*) and the olive kernel borer (*Prays oleae*).

Diseases.—Two diseases attack olives. One is a bacterial disease, called olive knot in California, that is caused by the organism *Bacterium savastanoi*. It causes gall-like growths to develop on the branches and twigs. There is no satisfactory control for this pest other than pruning out and destroying diseased areas as soon as they appear. The second important disease is sometimes termed peacock spot, because of the variegated spots appearing on the leaves in late winter and early spring. This is caused by the fungus *Cycloconium oleaginum*, which infects leaves during the rainy months of the year, causing them to turn yellow and drop in late spring. Sprays of lime sulfur or Bordeaux mixture applied just before the rainy season starts will generally give control.

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(H. T. Hn.; X.)

OLIVEIRA MARTINS, JOAQUIM PEDRO DE (1845–1894), Portuguese writer, biographer and one of the first Portuguese exponents of socialism. He was born in Lisbon on April 30, 1845. Lack of money made him interrupt his studies and go into a commercial firm. In 1870 he was appointed manager of the St. Eufémia mine in Spain. He returned to Portugal in 1874 and became administrator of the railway from Oporto to Póvoa. In 1884 he was appointed director of the industrial museum in

Oporto. He joined the Progressive party and in 1886 was elected deputy by Viana do Castelo, soon building up a parliamentary reputation. He had a short and ill-starred term of office as minister of finance in 1892 and died at Lisbon on Aug. 24, 1894.

During his early days in Lisbon Martins had been in contact with the most eminent Portuguese intellectuals and, influenced by the literary group of *O Cenáculo* in which Antero Tarquinia de Quental was prominent, he contributed to *O Pensamento*, a socialist paper. His years in Spain and his direct knowledge of the working class broadened his socialist views and gave him the material for two remarkable books—*Teoria do Socialismo* (1873) and *Portugal e o Socialismo* (1873). After his return to Portugal he published a short series of monographs intended to start a campaign of socialist indoctrination. Turning his attention to Portuguese economic history, he wrote a technical study, *A Reorganização do Banco de Portugal* (1877), to analyze the causes and consequences of the Portuguese financial crisis of 1876. At the same time he sent to the Academy of Sciences in Lisbon a careful analysis of the economic crises of 1846 and 1876—*Memória sobre a circulação fiduciária* (1878). In *As Eleições* (1878) he criticized the existing electoral system and demanded a more democratic representation.

Martins had been interested in history from early youth (he made his literary debut with a historical novel *Phebus Moniz*, 1867) and now, influenced by Proudhon's view that the "theory of socialism is evolution," he embarked on a new venture with *Biblioteca das Ciências Sociais*, in which he attempted to demonstrate the validity of this thesis throughout the great periods of history. His plan begins with a survey of the economic and social structure of primitive societies—*As Raças humanas e a civilização primitiva* (1881), *Quadro das instituições primitivas* (1883)—and closes with a lively picture of the Roman republic—*História da República Romana* (1885). However, in the course of tracing the development of forms of government, he abandoned Proudhon's rigid concept and adopted the views of the German school of anthropology. He thereby came to believe that as a society grows and develops a spiritual element takes shape under the force of historical circumstances. This element becomes in the end the guiding principle of the social group in the form of the unifying national spirit. Imbued with the idea of Hegelian evolution, Martins interpreted the history of the Hispanic peoples—*História da Civilização Ibérica* (1879)—as the result of a common will sustained by the same ideal, explaining Portuguese independence by mere accidental causes. This theory of the chance incident leaves the door ajar for the role of the "great man," the "hero" of Thomas Carlyle. He expounded these views in his biographies *Os filhos de D. João I* (1891), *A Vida de Nun' Álvares* (1893) and the unfinished *O Príncipe Perfeito* (1896). His psychological insight and human sympathy combined with the clarity of his style made him unsurpassed alike in his biographical portraits and in the grandiose frescoes of a battle or the fall of an empire.

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OLIVE OIL is the oil extracted from the fleshy part of the ripened fruit (pericarp) of the olive tree, *Olea europaea* (*see* OLIVE). Oil constitutes from 20% to 30% of the ripe fruit, depending on climatic conditions and care in cultivation. About 99% of the world supply of olive oil is produced in the countries of the Mediterranean basin, though it is also produced in California, South America and Australia.

Olive oils can be grouped according to production method: (1) oils obtained from the first mechanical pressing without further treatment; (2) oils from the second pressing, which is made with hot water; and (3) oils extracted with solvents. First-pressing oils are called virgin and their quality depends on the state of the fruit. Only oils from the very best fruit are fit for consumption without further treatment. Only rarely are they exported without being treated; more often they are used as the basis for export types or for local consumption. The crushing apparatus used in expressing the oil varies from the most primitive Roman presses, consisting of conical stones operated by mule or by hand, to the most modern types of hydraulic presses.

The international grades of olive oil are as follows: (1) virgin (first pressing that meets defined standards); (2) pure, or edible (mixture of refined with virgin oil); (3) refined, or commercial (made from refinement of *lampante*, see below); and (4) sulfide (made from extraction with solvents and repeatedly refined). To obtain the best-quality edible oil it is essential that the oil be removed from contact with the residual and putrescible pulp as soon as possible, for the consequent formation of free fatty acids may cause rancidity. In practice the residual pulp is pressed again with hot water and from this pressing is obtained an oil with higher acid content, which together with inferior virgin oils constitutes the oil called *lampante* because of its primitive use as a fuel for lamps. This is further refined to remove acid, colour and odour. It is sold as refined oil, which is used largely for mixing with first-extraction oils to produce edible varieties. Still another type, of inferior quality, is obtained from extraction with a volatile solvent, usually carbon disulfide. This oil's commercial name is sulfur oil and it is used both for food and for industry.

Edible olive oil should be practically devoid of free fatty acids. The *U.S. Pharmacopeia* requires that the fatty acid content of olive oil not exceed 1.41%; however, most export types do not exceed 1%. It varies in colour from clear yellow to golden yellow. Some varieties obtained from unripe fruit have a greenish tinge. Almost every producing country produces oils of varying characteristics and qualities; these variances depend on the districts in which the olive is grown and the degree of ripeness of the fruit.

The precise characteristics of each oil depend on the glycerides formed by saturated or unsaturated fatty acids (*see* OILS, FATS AND WAXES). In olive oil, fatty acids occur in roughly the following percentages: oleic acid 67%–83%, linoleic acid 7%–12%, palmitic acid 5%–15%, stearic acid 1%–4%, myristic acid 1% and others 1%.

Olive oil is sometimes mixed with other vegetable oils. Mixing, however, is not permitted in all countries; in some it is treated as fraud. Adulteration can be detected by chemical analysis.

Pure olive oil is used largely for culinary purposes and in the preservation of foods, particularly canned fish. It is also used in the textile industry (wool combing), in the manufacture of toilet preparations and cosmetics, in the pharmaceutical industry for medicinal purposes, in the manufacture of high-quality castile soap and as a lubricant.

Leading countries in the production of olive oil in the mid-1960s were Spain with an annual production of 387,000 tons, Italy 262,500 tons and Tunisia 115,000 tons. Other principal producing countries were Greece (90,000 tons), Portugal (85,000), Turkey (55,000), the middle east, Algeria and Morocco. All but 5% of the oil produced in the Mediterranean basin was consumed there. World production (excluding the U.S.S.R.), according to the UN Food and Agriculture organization, averaged well above 1,000,000 tons annually.

See also references under "Olive Oil" in the Index.

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OLIVER (OLIVIER), **ISAAC** (d. 1617), English miniature painter, whose work is in the first rank of British miniatures, was born at Rouen, France, of French Huguenot parents who took him to London about 1568. He studied under Nicholas Hilliard, and was in Venice in 1596. Apparently he married Sarah, daughter of Marcus Gheeraerts the Elder, the portrait painter, in 1602. Besides miniature portraits he painted small religious and classical pictures. His patrons included Queen Elizabeth I, Henry, prince of Wales, Sir Philip Sidney and Anne of Denmark. His earlier miniatures carry on the fine tradition of Hilliard; his later ones are influenced by the oil painters of that time.

Oliver died, between 50 and 60 years of age, in London, and was buried at St. Anne's, Blackfriars.

His son PETER OLIVER (c. 1594–1647) was his pupil and carried on his later style. Peter copied Italian pictures in miniature, and his signed and dated portraits range from 1619 to 1646. He is said to have painted landscapes in miniature. (C. H. C. B.)

OLIVES, MOUNT OF (also called OLIVET; Arabic JABAL AT TUR), a mile-long ridge of rounded limestone hills facing the Temple mount at Jerusalem and separated from it by the valley of the Kidron. The ridge (in Jordan) has several low peaks, and its northern end joins Mt. Scopus. The northern elevation is highest, about 2,723 ft. above sea level. The second (about 2,641 ft.), called the Ascension, is the traditional site of Jesus' ascension. There the emperor Constantine built a rotunda and a basilica, and a number of other sanctuaries were constructed later. This peak stands directly opposite to the east gate of Jerusalem, being 371 ft. above the bed of the Kidron and 208 ft. higher than the Temple plateau. The third summit is called the Prophets and the fourth the Mount of Offense, where Solomon built the idolatrous shrines for his heathen wives. The Mount of Olives is referred to only four times in the Old Testament: David fled over it barefoot from Absalom (II Sam. xv, 30); there was a shrine on its summit (II Sam. xv, 32); the glory of the Lord appeared there to Ezekiel (Ezek. xi, 23); and Zechariah pictured God standing there to go forth against Jerusalem's enemies (Zech. xiv, 4). Jesus often went to the Mount of Olives, and it is mentioned frequently in the New Testament. He was welcomed by the multitude as he descended its slope; from there he prophesied the destruction of the Temple; after the Last Supper he returned there to wait and pray; his ascension took place somewhere on its slopes. Bethphage was somewhere on the mount; Bethany was over its southern shoulder, and Gethsemane was at its foot. There are a number of Christian and Muslim enclosures and buildings on the slopes. (E. D. GR.)

OLIVETANS (ORDO S. BENEDICTI MONTIS OLIVETI), a monastic order following the Benedictine rule, founded by St. Bernard Tolomei, a Sienese nobleman. The Olivetans were independent till 1962, when they obtained the status of a Benedictine congregation. *See* BENEDICTINES: *Independent Orders;* ORDERS AND CONGREGATIONS, RELIGIOUS.

OLIVINE, an important rock-forming mineral composed mainly of magnesium and ferrous orthosilicate. The name alludes to those common varieties which have an olive-green colour and is often applied incorrectly to other green stones. The transparent varieties used in jewelry are known as precious olivine, chrysolite (not to be confused with chrysotile, a serpentine) and peridot (*see* also GEM). These are obtained chiefly from St. John's Island, Egy., in the Red sea; upper Burma; and Minas Gerais, Braz. The common variety, which is relatively infusible, withstanding temperatures of more than 1,500° C., is used as a refractory brick in special applications.

Olivine is a common constituent of many basic and ultrabasic igneous rocks such as basalt, gabbro, peridotite and dunite, which is an almost pure olivine rock. It also occurs as an accessory constituent of some metamorphosed rocks, particularly the dolomitic marbles and schists. In stony meteorites (*q.v.*) it is a principal constituent, and is occasionally imbedded in iron meteorites. Iron-rich olivine is often found in slag.

The mineral occurs usually as compact or granular masses or as grains and blebs in the rock of which it is a constituent. Faceted crystals are not common. The colour is variable, with shades of green, yellowish-brown, gray and black. Olivine alters readily to a serpentine, chlorite or an amphibole and anhydrous and hydrous iron oxides such as magnetite, hematite, goethite and lepidocrocite. By weathering processes the mineral is altered to carbonates or hydrous iron oxides and silica.

In addition to the magnesium and iron, common olivine contains small amounts of manganese, calcium and, rarely, zinc and lead. When some of these components are dominant the olivine is called forsterite, Mg_2SiO_4; fayalite, Fe_2SiO_4; tephroite, Mn_2SiO_4; and monticellite, $CaMgSiO_4$. These pure end members of the olivine group have been synthesized in the laboratory. Forsterite and fayalite are known to form a complete series of solid solutions or mix crystals.

The hardness of olivine is 6.5 to 7; the specific gravity, 3.22 to 4.32; and it is brittle, breaking with a conchoidal fracture or along two indistinct and inequal cleavages. The mineral is decomposed by hot hydrochloric acid, forming gelatinous silica. Under the microscope it is distinguished by its high index of refraction (1.64–1.88) and its double refraction (birefringence = 0.033–0.051).

All members of the olivine group crystallize in the orthorhombic system and have the same crystal structure as deduced by X-ray diffraction. The general formula is $XYSiO_4$, where X and Y may be magnesium, ferrous iron, manganese, calcium, zinc and lead. Fayalite inverts to a spinel (*q.v.*) structure (cubic) under extreme pressures.

See also references under "Olivine" in the Index. (H. S. Y.)

OLLIVIER, OLIVIER ÉMILE (1825–1913), French statesman and writer, chief minister in Napoleon III's "liberal empire" of 1870, was born at Marseilles on July 2, 1825, the son of the revolutionary Demosthène Ollivier. He studied law in Paris and was admitted to the bar in 1846. An adherent of the socialist and romantic movement, he was appointed commissary-general of the Bouches-du-Rhône *département* at the outbreak of the revolution of 1848; but his idealistic policy there alienated both radicals and conservatives, and in July he was demoted to the prefecture of Haute-Marne. When Louis Napoleon became president of the republic, Ollivier was dismissed from office (Jan. 1849). Compelled to abandon his socialist activities by the despotism of the Second Empire, he concentrated on his legal practice and rose to the first rank as a barrister.

Elected to parliament in 1857, Ollivier became one of the republican minority known as "the Five." He made vigorous attacks on Napoleon III's dictatorship but differed from most of his republican allies in believing that forms of government mattered little, that revolutions often produced evils worse than those which they remedied and that the opposition should therefore seek not to overthrow the empire by force but to persuade it to grant liberty to the country. So, when the emperor made the liberal concessions of Nov. 24, 1860, Ollivier welcomed them and offered his support to the empire if Napoleon would establish representative government. He soon broke with the republicans and, together with the duc de Morny, worked for a "liberal empire," a compromise between Napoleonic autocracy and parliamentary government. His ideas fitted well with Napoleon's, and on Jan. 2, 1870, he was appointed minister of justice at the head of a liberal government chosen from the leaders of the majority in parliament. He drew up a new constitution (approved in a plebiscite by nearly 70% of the votes) and set up numerous commissions to prepare the complete reform of such questions as the relationship of labour and capital, education and law. He seemed to have transformed the empire from despotism to constitutional monarchy without bloodshed or violence.

Ollivier's work was ruined by the outbreak of the Franco-German War (*q.v.*). He had no wish for war, but allowed the control of events to slip out of his hands, so that when Bismarck's "Ems telegram" was published he considered it an intolerable insult to France and declared war (July 19, 1870). The French military reverses soon obliged him to resign, which he did on Aug. 9. He withdrew to Italy.

Returning to France in 1873, Ollivier lived mainly at St. Tropez and took no further part in politics. His former republican colleagues, now ministers of the third republic, decried him as a traitor for having gone over to Napoleon III and for having undertaken "with a light heart" a war that had brought national disaster. Yet he might have achieved much had his experiment of the liberal empire not been cut short. Moreover, he had wide interests and varied talents: his writings include a study of Michelangelo, a novel and volumes on ecclesiastical affairs as well as political books. His great work, however, is *L'Empire libéral,* partly a history of the second empire and partly his memoirs: 16 volumes of it appeared between 1895 and 1912, the last volume and the index posthumously (1915, 1918). His first marriage (1857) was to Blandine Liszt, Franz Liszt's daughter by Mme d'Agoult. A member of the Académie Française from 1870, Ol-

livier died at St. Gervais-les-Bains (Haute-Savoie) on Aug. 20, 1913.

See P. Saint-Marc, *Émile Ollivier* (1950); T. Zeldin, *Émile Ollivier and the Liberal Empire* (1963). (T. Ze.)

OLMEDO, JOSÉ JOAQUÍN (1780–1847), Ecuadorian poet and statesman, whose patriotic verse reflects the revolutionary spirit of his time, was born in Guayaquil on March 20, 1780. He studied at the University of San Marcos in Lima, receiving his LL.D. degree in 1805. He was sent to Spain in 1811 to represent Guayaquil in the *Cortes de Cádiz*. After his return in 1816, he participated actively in politics and continued writing poetry. In 1825 he again went to Europe, this time to represent Peru in London and Paris. He returned to Guayaquil in 1828 and when Ecuador became a republic in 1830 he was elected its first vice-president but declined the honour. He died in Guayaquil on Feb. 19, 1847.

As a poet, Olmedo is a neoclassicist. He is best known for his odes *La victoria de Junín: Canto a Bolívar* (1825), the finest example of heroic poetry in the neoclassical style written in Spanish America, and *Al General Flores, vencedor en Miñarica* (1835), an eloquent composition lamenting the civil wars that were beginning to destroy the unity of South America, so soon after independence from Spain had been achieved.

For his collected poems *see* A. Espinosa-Pólit, *Poesías completas de José Joaquín de Olmedo*, with bibliography (1945; 1947).

See E. C. Hills, ed., *The Odes of Bello, Olmedo and Heredia* (1920). (L. Ll.)

OLMSTED, FREDERICK LAW (1822–1903), U.S. landscape architect, was born in Hartford, Conn., on April 27, 1822. He already had an adventurous career when he published his *Journeys and Explorations in the Cotton Kingdom* (1861), which gave a picture of the conditions surrounding American slavery that had great influence on British opinion, and was much quoted in the controversies at the time of the Civil War. During the war he was the untiring secretary of the U.S. sanitary commission.

When Central park, New York city, was projected, he, in conjunction with Vaux, proposed the plan which, in competition with more than 30 others, won first prize. Olmsted was made superintendent to carry out the plan. This was practically the first attempt in the United States to apply art to the improvement or embellishment of nature in a public park; it attracted great attention, and the work was so satisfactorily done that he was engaged thereafter in most of the important works of a similar nature in America—Prospect park, Brooklyn; Fairmount park, Philadelphia; South park, Chicago; Riverside and Morningside parks, New York; Mount Royal park, Montreal; the grounds surrounding the Capitol at Washington, and at Leland Stanford university at Palo Alto, Calif.; and many others.

He developed the bare stretch of lake front at Chicago into the world's fairgrounds, contributing much to the architectural beauty and the success of the exposition. He was greatly interested in the Niagara reservation, made the plans for the park there, and also did much to influence the state of New York to provide the Niagara park.

He was the first commissioner of the national park of the Yosemite and the Mariposa grove, directing the survey and taking charge of the property for the state of California. He also held directing appointments under the cities of New York, Boston, Philadelphia, Baltimore, Wilmington and San Francisco, the joint committee on buildings and grounds of congress, the Niagara Falls Reservation commission, the trustees of Harvard, Yale, Amherst and other colleges and public institutions. After 1886 he was largely occupied in laying out an extensive system of parks and parkways for the city of Boston and the town of Brookline, and on a scheme of landscape improvement of Boston harbour.

Olmsted died on Aug. 28, 1903.

OLMÜTZ: *see* Olomouc.

OLNEY, RICHARD (1835–1917), U.S. lawyer and secretary of state, was born at Oxford, Mass., on Sept. 15, 1835. After graduation from Brown university in 1856 and from Harvard law school two years later, he began the practice of law in Boston. A Democrat in politics, he served one term in the state legislature but failed of reelection and was not widely known in 1893 when Pres. Grover Cleveland appointed him a member of his cabinet as attorney general. In this position, during the strike of railway employees against the Pullman company in Chicago in 1894, he instructed the U.S. attorneys to obtain injunctions from the federal courts to restrain the strikers from acts of violence, and thus set a precedent for what came to be called "government by injunction." He also advised the president to use federal troops to quell the disturbances in the city, on the ground that the federal government must prevent interference with the mail and with interstate commerce.

In June 1895, Olney became secretary of state, succeeding Walter Q. Gresham, who died in office. Olney became involved almost immediately in a controversy with Great Britain concerning a boundary dispute over British Guiana between the British and Venezuelan governments. On July 20, 1895, in a note to the British government he announced the so-called "Olney corollary" to the Monroe Doctrine—that intervention by the United States was permissible and even desirable to force a settlement of any dispute involving the Monroe Doctrine. The secretary went so far as to declare that, "Today the United States is practically sovereign on this continent, and its fiat is law upon the subjects to which it confines its interposition." Fortunately the British did not want war, and eventually arbitrated the boundary line in 1899. Olney also was the author of an arbitration treaty with Great Britain, the Olney-Pauncefote treaty, which failed to win approval by the senate in May 1897. At the expiration of Cleveland's term in March 1897, Olney returned to the practice of law and refused all offers to return to public life. He died in Boston on April 8, 1917.

See S. F. Bemis (ed.), *The American Secretaries of State and Their Diplomacy*, vol. 8 (1928); Henry James, *Richard Olney and His Public Service* (1923).

OLNEY, a market town in the Newport Pagnell rural district of Buckinghamshire, Eng., on the Ouse 20 mi. N.E. of Buckingham by road. Pop. (1961) 2,384. William Cowper the poet lived there from 1767 to 1786. John Newton, curate of Olney, had Cowper's assistance in the production of the *Olney Hymns*. The town has agricultural associations, a tannery and a craftsman-made furniture industry. Olney has revived the ancient custom of a pancake race run on Shrove Tuesday at 12 noon, in which women competitors toss their pancakes three times while racing from the market place to the parish church, where a service follows. It is run in competition with Liberal, Kansas, where a similar race takes place. (R. W. Du.)

OLOMOUC (Ger. Olmütz), a town in the North Moravian *kraj* (region) of Czechoslovakia, 72 km. (45 mi.) N.E. of Brno by road. Pop. (1961) 72,348. It is one of the oldest towns of Moravia, lying close to an isolated craggy hill detached from the foothill country of northwestern Moravia, and on the west bank of the Morava at its confluence with the Bystrice. Southward stretches the Hana region comprising some of the most fertile land in Moravia, with rich soils formed on loess deposits.

Historical buildings in the city include the fine 14th-century Gothic cathedral, with a tower 328 ft. high and the 15th-century town hall, with an impressive tower adorned by Anton Pohl's astronomical clock. The great square, characteristic of many towns in Czechoslovakia, contains an 18th-century Trinity column.

Road and rail routes converge on Olomouc. Its industries are based on the specialized farming of the south: sugar refineries, malthouses, a brewery, cheese and edible fat factories. It has the largest refrigeration plant in Moravia and engineering and building industries are also prosperous.

Olomouc is thought to have its origin in a Roman fort (Mons Julii), and its name is possibly a garbled form of this classical term. The bishopric dates from 1063 and was raised to an archbishopric in 1777. At the peace of Olomouc (1478), Moravia was ceded to the king of Hungary. Olomouc was reckoned as the capital of Moravia until the Thirty Years' War. Its long occupation by the Swedes damaged its usefulness as a regional capital and from 1640 Brno was recognized as the first city in Moravia. Until

1886 the main importance of Olomouc was that of a strongpoint and its military significance was greatest in the mid-18th century during the struggle between Frederick the Great of Prussia and Maria Theresa of Austria over Silesia. The Emperor Ferdinand I of Austria abdicated there in 1848 in favour of the young Francis Joseph and the Olmütz convention of 1850 restored the German confederation. In the late 19th century the fortifications were demolished and its manufacturing and trading functions began to develop, stimulated by railway building. The university (founded 1576) was suppressed in 1858, and there survived only the theological seminary with a famous library; it was revived after World War II and named after the patriot-historian F. Palacky. In the middle ages and early modern history Olomouc was mainly a community of German merchants. As late as 1900, of a population of 21,000 two-thirds were reckoned as German. (H. G. S.)

OLONA (*Touchardia latifolia*), a shrub of the nettle family (Urticaceae), native to the Hawaiian Islands, where it has long been cultivated as a fibre plant. The bast fibre obtained from the young shoots possesses remarkable tensile strength, being three times as strong as that of the finest grades of abacá fibre (*q.v.*). Because of its great pliability, olona fibre is readily woven into cloth or made into cordage. Another valuable quality is its unusual durability in water, making it especially suitable for fish nets.

OLSZTYN (Ger. ALLENSTEIN) a town of northeastern Poland, headquarters of the *wojewodztwo* (province) of the same name, is situated on the Lyna river and three lakes, about 195 km. (121 mi.) N. of Warsaw by road. Pop. (1960) 68,000. Old buildings include a Gothic castle, a Gothic cathedral (14th–16th century) and parts of the walls. There is the Masurian Regional museum and a school of agriculture. The town is an important rail and road centre. It is the seat of the Warmia (Ermland) bishopric. The Teutonic knights founded a castle there in 1334 and the surrounding settlement acquired town rights in 1353. In 1466 the town with the historic region of Warmia became Polish and was annexed by Prussia (1772). Extensively damaged during World War II, it was returned to Poland in 1945 and was entirely resettled by Poles.

OLSZTYN *wojewodztwo* extends to the Russian frontier in the north. Pop. (1960) 876,700; area 8,117 sq.mi. The population density, 108 per square mile, is one of the lowest in Poland. The forests (23% of the total area) and the Masurian lakeland (including Sniardwy, the largest lake in Poland) make the province an important tourist region. There is little industry but timber and food production are important. Apart from Olsztyn the chief towns are Ostroda (17,700), Ketrzyn (16,100), Gizycko (14,900), Szczytno (12,900), Lidzbark Warminski (11,100), Ilawa (11,900), Bartoszyce (11,700) and Mragowo (10,800). (T. K. W.)

OLYBRIUS (d. 472), western Roman emperor from April to November 472, was not recognized in the east. Before his elevation he was a wealthy senator, married to Placidia, the daughter of Valentinian III. Gaiseric, king of the Vandals, hoped that Olybrius could be made western emperor, and this support made him suspect to the eastern emperor Leo I. Leo sent him from Constantinople, where he was then living, to Rome, hoping that he would be killed there. But in fact Ricimer elevated him to the throne soon after his arrival. The reigning emperor, Anthemius, was overthrown and put to death on July 11, 472; but Ricimer himself died soon afterward. Olybrius, however, survived him by only two months, dying on Nov. 2. Nothing is known of his character. (E. A. T.)

OLYMPIA, a place in Greece in the western Peloponnese, scene of the Olympic games (*see* also GAMES, CLASSICAL). Olympia lies on the northern bank of the Alpheus (Alfios) river about 10 mi. from its mouth. A tributary stream, the Cladeus (Kladios), joins the Alpheus just below Olympia, to the south. The country is rich and well watered, consisting of low wooded hills alternating with farmland.

HISTORY

Traces of Early Bronze Age habitation have been found in the environs of Olympia, but the earliest remains on the site of the classical sanctuary are some apsidal houses of the Middle Bronze Age (2000–1600 B.C.). These were abandoned, covered by a deep layer of silt and quite forgotten. There are no remains of the Late Bronze (Mycenaean) Age at Olympia itself, although again some have been found in the environs.

The origins of the classical sanctuary go back to the beginning of the Iron Age around or soon after 1000 B.C. Bronze statuettes and other votives dating from this period have been found. The sanctuary at this time was under the control of the neighbouring town of Pisa, but Elis also had some share in it. Elis soon allied itself with Sparta and increased its share of the control. Some time about 570 B.C. the allies defeated Pisa and from then on the Eleans were the religious supervisors of Olympia while the Spartans constituted themselves its political protectors. There were various traditions as to the origin of the games. According to one the first race was between Pelops and Oenomaus (*qq.v.*), who used to challenge the suitors of his daughter Hippodameia and then slay them when they lost. Another attributed the festival to Heracles. The list of Olympic victors begins in 776 B.C. with Coroebus of Elis, and this list is often cited by ancient authors for purposes of dating, the name of the winner of the footrace usually being given. In later antiquity the Olympiads were numbered for greater convenience of reference.

The festival occurred every four years and was held in high summer at the time of the full moon, that is, roughly our month of August. A sacred truce was declared so that even in time of war any who wished might have safe conduct to the games. Athletes who participated had trained for ten months before the games, the last month at the gymnasium in the town of Elis about 25 mi. N.W. of Olympia. The festival lasted for five days, and in the 5th century B.C. the events were distributed as follows: On the first day the final scrutiny of the athletes took place to determine their eligibility, and oaths were taken in the Bouleuterion or council house. On the second day came the chariot and horse races and the pentathlon. The third day, the day of the full moon, was reserved for the great sacrifice to Zeus; in the afternoon the events for boys took place. On the fourth day came the chief athletic events, footraces in the morning and wrestling, boxing and *pankration* (a combination of wrestling and boxing) in the afternoon. The last day was given over to feasting and celebration. The victor's prize was a crown of wild olive made from the tree called "the olive of the fair crown" which grew behind the temple of Zeus. The victor received a hero's welcome on his return home, and odes were often composed in his honour; 14 of Pindar's odes celebrate Olympic victors.

The sanctuary was seriously damaged in A.D. 267 as a result of the invasion of the Heruli. A fortification wall was built soon after, using fragments of ruined buildings, which enclosed the heart of the sanctuary, the temple of Zeus and the Bouleuterion. The games continued, however, for more than a century until they were abolished by the emperor Theodosius I probably in A.D. 393, the 293rd Olympiad. The last recorded Olympic victor is the Armenian prince Varazdates, who won the boxing match in A.D. 385.

Excavations.—The first excavations were conducted on the site of the temple of Zeus in 1829 by the French Expédition Scientifique de Morée (A. Blouet). The temple was sufficiently cleared to reveal its general plan, and fragments of three sculptured metopes were found; these are now in the Louvre museum, Paris. The great German excavations of 1875–81 cleared the whole of the sacred precinct and some buildings that lay outside it and fixed by exploratory trenches the position of the stadium. Thus the plan of a great Greek sanctuary was revealed for the first time. In the early years of the 20th century some small-scale exploratory digging was done in the deeper layers in the sanctuary. Large-scale work was resumed by the Germans in 1936, one of the chief aims being the excavation and restoration of the stadium. Interrupted by World War II in 1942, it was resumed in 1952. In 1960 the excavation of the stadium was completed, and its restoration in 1961. Other structures were explored in this period, the most important of which was the workshop of Phidias.

THE REMAINS

The sacred precinct was called the Altis or "sacred grove of

Zeus." It was an irregular quadrangular area over 200 yd. on a side, bounded on the north by the hill of Cronus and enclosed by a wall on the other three sides. In it were the temples of Zeus and Hera, the principal altars and votive offerings, the treasuries and administration buildings. Outside were the athletic installations and the hostels, baths and other accommodation for visitors.

Temple of Zeus.—This was the largest and most important building at Olympia and one of the largest Doric temples in Greece. It was built about 460 B.C. by the architect Libon of Elis. The material was a coarse local shell-conglomerate, the exposed surfaces of which were covered with a coat of fine white stucco. The temple had 6 columns across the front and 13 on the sides. There was a pronaos and an opisthodomos, and the cella was divided into three aisles by two rows of slender columns arranged in two stories. (*See* also GREEK ARCHITECTURE.) The roof tiles were of marble.

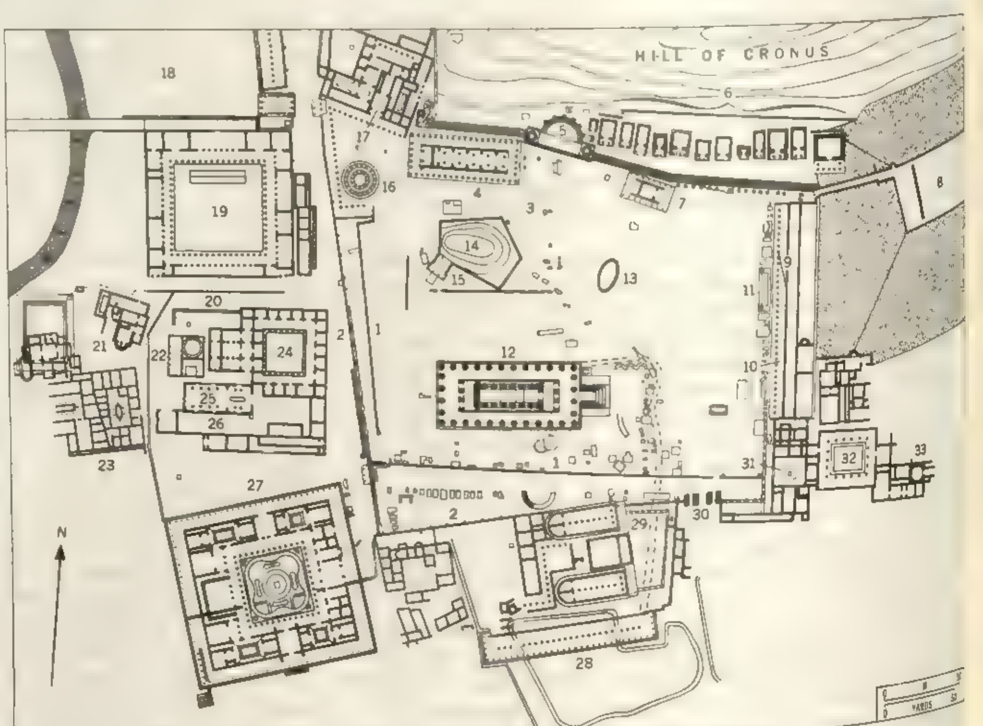
The temple was richly decorated with sculpture, much of which has survived and is to be seen in the Olympia museum. In the front gable the chariot race between Pelops and Oenomaus was represented and both parties were shown preparing for the race. In the back gable was the battle of the Lapiths and Centaurs at the wedding of Perithous. These sculptures are masterpieces of the early classical style, but the name of the artist is not known. Pausanias' attribution of them to Paeonius and Alcamenes is generally rejected as these sculptors are known to have worked in the later 5th century. The frieze that ran above the front and back porches had sculptured metopes with the 12 labours of Heracles, six at each end. At the peak of the gable was a gilded figure of Victory and at each corner a gilded caldron, but these have not survived.

Within the temple was the great gold and ivory statue of Zeus, the work of the Athenian sculptor Phidias (*q.v.*). This was the most famous of all ancient statues and was counted one of the seven wonders of the world. It made a profound impression on all who saw it, and people were generally agreed that Phidias had succeeded in creating the image of Homer's Zeus. The god was represented seated on an elaborately wrought throne. He held a Victory in his right hand and a sceptre in his left. (*See* also GREEK ART: *The Classical Period* [*c. 480–c. 330 B.C.*].)

Workshop of Phidias.—This statue was made piece by piece by Phidias and his collaborators in a building just outside the Altis to the west of the temple. This building, subsequently converted into a church, was still known in the time of Pausanias as the "workshop of Phidias." The excavations of 1954–58 brought dramatic confirmation of the identification. In the deeper layers in and around the building, particularly toward the south, a great mass of material that was evidently waste from an artist's atelier was found. This material was of various kinds: tools, slivers and worked fragments of ivory and bone, glass ornaments and molds. The molds are of clay of a very heavy fabric, like roof tiles, and the larger ones are sometimes reinforced with iron rods. They are of an unusual open form and were evidently used for hammering into shape the thin plates of gold that formed the statue's drapery. The pottery found with this debris indicates that the workshop was active in the years around 430 B.C., an important fact because it settles an old controversy as to whether Phidias made the Zeus before or after his other great chryselephantine statue, the Athena Parthenos, which was completed in 438 B.C. The new evidence is decisive in favour of the later date. One of the pieces of pottery, a ribbed mug, has inscribed on its bottom in neat clear letters the words "I am (the property) of Phidias."

Altar of Zeus.—The great altar of Olympian Zeus was not in front of the temple, as might have been expected, but to one side, and nearer the temple of Hera. It was elliptical in shape and consisted of an elevated base approached by steps. From the base rose a large mound made of the ashes of the thighs of victims sacrificed to Zeus. The whole height of the altar was 22 ft.

Temple of Hera.—This was the oldest temple at Olympia and one of the most venerable in all Greece. It was originally a joint temple of Hera and Zeus until a separate temple was built for the latter. It has sometimes been thought that the temple of Hera was built in the 10th or 11th century B.C., but this view is now rejected. The existing temple was probably built about 600 B.C., and an earlier phase, without peristyle, may go back to the 8th century. The temple is long and narrow, having 6 columns across the ends and 16 along the sides. The columns are Doric and show a great variety of styles. This is because they were originally of wood and were gradually replaced in stone. In the 2nd century A.D. there was still one wooden column in the back porch. The entablature was of wood and the upper parts of the walls were of mud brick. The cella had two interior rows of columns, alternate columns being attached by spurs to the cella walls and thus forming bays. Pausanias says that in the temple was an image of Hera seated on a throne with an image of Zeus standing beside her. An archaic limestone head thought to be that of the Hera has been found. Pausanias also reports a stone statue of Hermes carrying the young Dionysus, a work of Praxiteles; this statue was found in the cella of the temple in 1877 and is one of the most prized possessions of the Olympia museum.



FROM M. SANTANGELO "IL SANCTUARIO DEI GIUOCHI OLIMPICI," ROME, 1960

PLAN OF THE SANCTUARY AT OLYMPIA

(1) Greek walls of the Altis; (2) Roman walls of the Altis; (3) Helladic settlement; (4) Temple of Hera; (5) Exedra of Herodes Atticus; (6) Terrace of the treasuries; (7) Metroum; (8) Stadium; (9) early classical starting line; (10) Echo Colonnade; (11) Bases of columns supporting the statues of Arsinoe and Ptolemy II; (12) Temple of Zeus; (13) Altar of Zeus (?); (14) Sanctuary of Pelops; (15) Terrace retaining wall; (16) Philippeum; (17) Prytaneum; (18) Gymnasium; (19) Palaestra; (20) Theokoleon; (21) Greek bath; (22) Baths; (23) Hospitium; (24) Roman house; (25) Byzantine church; (26) Workshop of Phidias; (27) Leonidaeum; (28) Southern stoa; (29) Bouleuterion; (30) Neronian entrance; (31) Hellanodikeion; (32) House of Nero; (33) House of the Octagon

Treasuries.—A row of 12 treasuries overlooks the Altis from the lowest slopes of the hill of Cronus. These are small structures in the form of a Doric temple *in antis* and date from the 6th century B.C. All were erected by Dorian states ranging from Byzantium to Gela in Sicily and Cyrene in North Africa. In the case of only three, Sicyon, Megara and Gela, is enough material available to allow a reconstruction on paper. These treasuries were erected by the several states either as thank offerings for Olympic victories gained by its citizens or as a general mark of homage to Olympian Zeus and to contain the dedicated gifts in which the wealth of the sanctuary consisted.

Sanctuary of Pelops and the Metroum.—The Elean hero Pelops had a sanctuary in the Altis between the temples of Zeus and Hera. It was an open-air sanctuary surrounded by a wall, and trees grew in it and statues were set up.

The Metroum or temple of the Great Mother of the Gods was a small Doric temple of the 4th century B.C. just below the treasuries. The cult no longer existed in Roman times, and the temple contained statues of Roman emperors.

Philippeum, Prytaneum and Exedra of Herodes.—A round building of the Ionic order, with Corinthian half columns on the inside, was erected by Philip of Macedonia to commemorate his victory over the Greeks at Chaeronea in 338 B.C. It contained gold and ivory statues of Philip, Alexander and other members of their family.

The Prytaneum was a building in the northwest corner of the Altis which contained a hearth on which burned a perpetual fire, and a banquet room in which the Olympic victors were feasted. A large, lavishly decorated fountain, on an apsidal plan, was erected by Herodes Atticus in the name of his wife Regilla. On it were displayed some 20 statues of Herodes and his family and of members of the imperial family including Hadrian and Antoninus Pius.

Echo Colonnade.—This building was officially called the Stoa Poikile or "painted colonnade" from the paintings that used to be on its walls. The popular name was given it because the echo repeated a word seven times or more. The colonnade closed the east side of the Altis and was separated from the east Altis wall which supported the stadium embankment by a narrow passage. The colonnade was built soon after the middle of the 4th century B.C. Deep down beneath its floor the starting line of the early classical stadium has been found.

Zanes.—These were bronze statues of Zeus erected with money from fines imposed on those who wantonly violated the rules of the games. The bases of 16 of these have been found just outside the covered entrance to the stadium, the entrance by which the athletes entered.

Bouleuterion.—The Bouleuterion or council house lies just outside the Altis to the south. It comprised two Doric buildings of different date but identical oblong form with apsidal ends toward the west. In the space between was a rectangular court at the centre of which stood the statue of Zeus Horkios ("Zeus who presides over oaths"). Beside this statue the athletes took the oath not to indulge in foul play during the contests.

Outside the Altis to the southwest stood the Leonidaeum, a large hostel for the reception of distinguished visitors, built in the 4th century B.C. and remodeled in Roman times. To the northwest were the Palaestra, where wrestlers and boxers trained, and the gymnasium with an elaborate entrance gateway and a covered running track.

Stadium.—The stadium lay to the east of the Altis. In early classical times it was not cut off from the sanctuary, and one end of the track was in the area directly in front of the temple and the great ash altar of Zeus (beneath the later Echo Colonnade). About the middle of the 4th century B.C. the stadium was shifted about 90 yd. eastward and a little to the north. The track was surrounded by massive sloping embankments of earth for the accommodation of the spectators, except to the north where the natural slope of the hill sufficed. The western embankment, parallel to which the Echo Colonnade was built, effectively cut the stadium off from the Altis. Connection between the two was maintained by what was called the Krypte or "covered entrance" which pierced the embankment and, in Roman times, was covered with a stone vault. This entrance was used by the athletes and the umpires. There were no stone seats in the stadium except for a box on the south side about one-third of the way from the starting line nearest the Altis; here the *Hellanodikai* or chief judges of the games sat. Directly opposite this was the altar of Demeter Chamyne from which the priestess of that cult was privileged to watch the games (married women were excluded from the Olympic festival but unmarried girls were permitted). The track was about 230 yd. long and 35 yd. wide. It was separated from the sloping embankments by a low stone parapet beside which ran an open stone water channel with basins at intervals. The actual course was marked by stone starting lines at either end. These were about 210 yd. apart (192.27 m. = 600 Olympic feet). There was space for 20 runners at a time. The classic race was the *stade, i.e.*, one length of the course. There was also a *diaulos*, two lengths, and a *dolichos* or long-distance race, the length of which varied and might be as much as 24 stades or nearly three miles. Other athletic contests were also held in the stadium. This 4th-century stadium has been fully excavated and its track and embankments restored so that it may be seen as it was in late classical times.

When the stadium embankments were excavated many votive offerings were discovered. Some of these were works of art of various kinds, including bronze statuettes and reliefs and several terra-cotta statues of which the most noteworthy was a group of Zeus and Ganymede, about half life size and dating from around 470 B.C. Others were arms or armour that had been dedicated in the sanctuary, and the Olympia museum houses the largest collection of ancient Greek weapons in the world. Some of these pieces have identifying inscriptions on them and so are interesting historical documents. Mention may be made of a helmet of Corinthian type with the name of Miltiades, the victor of Marathon, and a Persian helmet with the inscription "The Athenians (dedicated the helmet) to Zeus, having taken it from the Medes."

The hippodrome where the horse races were held lay south of the stadium in the open valley of the Alpheus. No trace of this has been found. Pausanias gives a long description of the hippodrome and of the elaborate starting machinery.

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For an excellent, well-illustrated summary of the work since 1936 *see* E. Kunze's article in *Neue deutsche Ausgrabungen im Mittelmeergebiet und im vorderen Orient*, published by the German Archaeological Institute, pp. 263–310 (1959). *See* also the series of *Berichte* by E. Kunze and others, 7 vol. (1937–61) and the series *Olympische Forschungen*, E. Kunze and others, 4 vol. (1944–58). (E. V.)

OLYMPIA, the capital city of Washington, U.S., and the seat of Thurston county, at the extreme southern end of Puget sound, is located 60 mi. S.S.W. of Seattle. The city is surrounded on the landward sides by low green hills. On the south the Deschutes river flows through a rocky canyon into Deschutes basin, a fresh-water lake that is part of the capitol grounds, with an outlet to Puget sound. To the north are the snow-capped Olympics, and to the east rises Mt. Rainier in the Cascades. On a promontory jutting into the sound stand the white sandstone state government buildings, of classic design.

The trade of the port of Olympia, averaging about 500,000 tons per year, consists of logs, lumber, plywood, forest products of all types, ores, petroleum products, aluminum and steel products, beverages and military supplies and other products from local industries, including processed foods. It is a centre of oyster culture, producing both the large Pacific oysters and the small, Olympia oysters. Olympia is headquarters of the Olympic National Forest service. Three miles south of the city's centre is St. Martin's college (Roman Catholic, 1895) for men.

The first American settlement on Puget sound was made in 1845 at the falls of the Deschutes river, on the site of Tumwater, 1 mi. S. of Olympia, under the leadership of Michael T. Simmons from Kentucky. In 1849 Tumwater was practically deserted when the men left for the California gold fields, but in 1850 a town was laid out on the site of some homesteads where Olympia now stands. At

first called Smithfield, after one of the early settlers, the town was renamed shortly for the Olympic mountains. In 1851 congress authorized the establishment of a customhouse, making Olympia the first port of entry on Puget sound. In 1852 the first newspaper north of the Columbia river in Oregon territory was established there (the *Columbian*). In 1853 Olympia became the capital of the newly created Washington territory, upon the arrival of the first governor, Isaac I. Stevens. It was chartered as a city in 1859. A monument in Capitol park marks the terminus of the Old Oregon trail. For comparative population figures *see* table in WASHINGTON (STATE): *Population.* (R. E. BU.)

OLYMPIAS (*c.* 375–316 B.C.), wife of Philip II of Macedonia and mother of Alexander the Great, was the daughter of Neoptolemus, king of Epirus (her original name was apparently Myrtale; she may have been called Olympias after Philip's victory in the Olympic games of 356). Philip's polygamy did not threaten her position until in 337 he married a high-born Macedonian, Cleopatra. Olympias withdrew to Epirus, returning after Philip's assassination (336), when she killed Cleopatra and her infant daughter. On departing for his invasion of Asia (334), Alexander appointed Antipater (*q.v.*) regent of Macedonia. He and Olympias quarreled repeatedly; Olympias eventually retired *c.* 331 to Epirus, which she virtually ruled after the death of her brother Alexander I in Italy.

After Alexander the Great died (323) Antipater continued to control Macedonia until his death in 319. His successor Polyperchon invited Olympias to return and act as regent for her young grandson Alexander IV, but she did not do so until 317, when Antipater's son Cassander had established Philip II's half-witted son Philip III (Arrhidaeus) as king of Macedonia. The Macedonians went over to Olympias without a battle. She killed Philip and his wife Eurydice, Cassander's brother and a hundred of his partisans. Cassander re-entered Macedonia; Olympias was blockaded in Pydna, surrendering in spring 316. She was condemned to death, but the soldiers sent by Cassander refused to execute her; she was finally killed by relatives of those she had executed.

Ancient writers made much of Olympias' passionate and imperious character, her ruthlessness and her devotion to the orgiastic cult of Dionysus; many of the stories they record are, however, probably pure invention. *See* also MACEDONIA, KINGDOM OF.

OLYMPIC GAMES. While the origin of the Olympic games is not known exactly, traditionally the first celebration of the ancient games was in 776 B.C. Thereafter they were held at four-year intervals until *c.* A.D. 393, when they were abolished by the Roman emperor Theodosius I after Greece had lost its independence. Few enterprises created by man have lasted so long. At first the program was confined to one day and consisted only of a single event, a race the length of the stadium. Afterward additional races, the discus throw, the javelin throw, the broad jump, boxing, wrestling, the pentathlon, chariot racing and other events were added, and the duration, including the religious ceremonies, was extended to seven days. Participation in the games was at first restricted to Greeks, but competitors came from all of the Greek colonies. A sacred truce was declared and enforced to permit participants to travel unmolested to the games. Women were not allowed as competitors or, except for the priestesses of Demeter, as spectators. Before the contests opened all the competitors and their families, the trainers and the judges swore a solemn oath to keep the competition clean and fair and to give just decisions.

The games occupied such an important position in the life of Greece that time was measured by the four-year interval between them—an "Olympiad." The greatest honour then to be attained by any Greek was the winning of the simple branch of wild olive given to a victor in the games. Kings competed alongside commoners; even the Roman emperor Nero (A.D. 37–68) sought Olympic honours. Winners became national heroes, musicians sang their praise and sculptors preserved their strength and beauty in marble. Their feats of skill and courage were recorded by the poets and writers of the time. The gracefulness and sportsmanship of the contestant and the method of winning were esteemed equally with the victory itself. (*See* also GAMES, CLASSICAL: *Greece.*)

It was through the efforts of Baron Pierre de Coubertin (1863–1937) of France, a brilliant educator and scholar but not an athlete, that the Olympic games were revived. Having decided that at least one of the reasons for the glory of the Golden Age of Greece was the emphasis placed on physical culture and frequent athletic festivals, he concluded that nothing but good could result if the athletes of all countries of the world were brought together once every four years on the friendly fields of amateur sport, unmindful of national rivalries, jealousies and differences of all kinds and with all considerations of politics, race, religion, wealth and social status eliminated. He summoned an international conference at the Sorbonne, Paris, in 1894, which was attended by the representatives of nine different nations.

The games of the I Olympiad of the modern cycle were held under the royal patronage of the king of Greece in 1896 in a new marble stadium constructed in Athens for the purpose. Subsequent games were held in Paris (1900), St. Louis (1904), London (1908), Stockholm (1912), Antwerp (1920), Paris (1924), Amsterdam (1928), Los Angeles (1932), Berlin (1936), London (1948), Helsinki (1952), Melbourne (1956), Rome (1960) and Tokyo (1964). The XIX Olympiad was awarded to Mexico City for 1968. The games of the VI, XII and XIII Olympiads scheduled, respectively, for Berlin (1916), Tokyo then Helsinki (1940) and London (1944), were not held because of war. In 1906 a set of games was held in Athens, but these were not considered as part of the official series.

A separate cycle of winter games was initiated in 1924 at Chamonix, France; subsequent games were held at St. Moritz, Switz. (1928), Lake Placid, N.Y. (1932), Garmisch-Partenkirchen, Ger. (1936), St. Moritz (1948), Oslo (1952), Cortina d'Ampezzo, Italy (1956), Squaw Valley, Calif. (1960) and Innsbruck, Aus. (1964).

The direction of the Olympic movement and the regulation of the games is vested in the Comité International Olympique (International Olympic committee [I.O.C.]), with headquarters at Mon Repos, Lausanne, Switz. The committee elects its members for life after a thorough investigation. The I.O.C. is a unique organization in that its members do not represent their countries but are delegates from the committee to their countries. No country may have more than three members. Members must not accept from other organizations or from their governments any instructions that may bind them or interfere with the independence of their votes. Baron Pierre de Coubertin headed the committee until he retired in 1925. He was followed by Count Henry de Baillet Latour of Belgium, who served until his death in 1942. The next president was J. Sigfrid Edström of Sweden, who was succeeded in 1952 by Avery Brundage of the United States.

Contestants in the Olympic games must be amateurs. The Olympic definition is as follows:

> An amateur is one who participates and always has participated in sport as an avocation without material gain of any kind. He cannot avail himself of this qualification: (a) if he has not a basic occupation designed to insure his present and future livelihood; (b) if he receives or has received a remuneration for participation in sport; (c) if he does not comply with the rules of the International Federation concerned, and the official interpretations of this rule.

One of the features of the Olympic games introduced successfully for the first time at the Los Angeles games is the Olympic Village. This is special housing provided so that all the competitors from the different countries can live in the same compound.

At the Berlin games in 1936 the sacred Olympic flame, which burns in the stadium throughout the games, was ignited by a torch carried from Olympia, Greece, the site of the ancient games, through the intervening countries by relays of runners. This procedure was repeated at the following games.

The International Olympic committee awards the following various cups and diplomas annually:

The Olympic cup, instituted by Baron de Coubertin in 1906, is awarded to an institution or organization for outstanding service to amateur sport or to the Olympic movement.

The Olympic Diploma of Merit, created at the I.O.C. congress in Brussels in 1905, is awarded for the same reasons to an individual.

The Mohammed Taher trophy, founded by I.O.C. member Mohammed Taher in 1950, is awarded to an athlete who merits special recognition.

The Fearnley cup, founded by former I.O.C. member Sir Thomas Fearnley in 1950, is awarded to an amateur sport club or local association for merit.

The Count Bonacossa trophy, founded by the National Olympic Committee of Italy in honour of I.O.C. member Count Alberto Bonacossa, is awarded annually to a national Olympic committee for outstanding service furthering the Olympic movement.

The I.O.C. has granted its patronage to certain regional games which contribute to the development of amateur sports in the areas where they are organized. These are the Mediterranean games; Asian games; Juegos Deportivos Pan-Americanos; Juegos Deportivos Bolivarianos; and Juegos Deportivos Centroamericanos y del Caribe.

Participation in the Olympic games is organized by the national Olympic committees, of which more than 100 were recognized by the I.O.C. in the 1960s. National Olympic committees must include representatives of all the national governing bodies whose sports are included in the Olympic program. They must be independent and autonomous and must avoid any political, commercial or religious interference. Only national Olympic committees can enter competitors in the games, and they must certify to their amateur standing.

Each Olympic sport is governed by international federations composed of national federations in each participating country. Competitors must belong to these national federations. The international federations write the rules governing their sports, and the events in the Olympic games are under their direction subject only to the Olympic regulations.

Ceremonies.—The opening ceremony of the games, staged in the principal stadium, is impressive. The chief of state of the country where the games are held is received at the entrance of the stadium by the president of the International Olympic committee and the president of the organizing committee, who escort him to a box where he is greeted with the national anthem of his country. The parade of the competitors then takes place. Each national contingent, dressed in its official uniform, preceded by a shield bearing the name of its country and its national flag, enters the stadium in alphabetical order, except that Greece heads the parade and the organizing country appears last. Each contingent after completing its march around the stadium lines up on the centre of the grounds in a column, behind its shield and flag, facing the tribune of honour. The president of the organizing committee delivers a brief speech of welcome and asks the chief of state to proclaim the games open. Immediately a fanfare of trumpets is sounded and the Olympic flag is slowly hoisted; pigeons are released, followed by an artillery salute. At this moment the Olympic flame arrives in the stadium and the sacred fire is lit. A benediction is pronounced and the Olympic hymn is sung. Immediately afterward a contestant from the country where the games are taking place mounts the tribune and pronounces the following oath on behalf of all the assembled athletes:

> In the name of all competitors I swear that we will take part in these Olympic Games, respecting and abiding by the rules which govern them, in the true spirit of sportsmanship, for the glory of sport and for the honour of our teams.

The choir sings the national anthem and the competitors leave the stadium. The ceremony thus comes to an end and the competitions may begin. The closing ceremony, equally impressive, is concluded by the president of the International Olympic committee, who calls the youth of the world to assemble in four years to celebrate the games of the next Olympiad: "May they display cheerfulness and concord so that the Olympic torch may be carried on with ever greater eagerness, courage and honour for the good of humanity throughout the ages." The trumpet sounds, the Olympic fire is extinguished, the Olympic flag is lowered, there is a salute of five guns and the choir sings the final anthem.

Modern Olympiads.—After 1896, interest in each of the Olympic games centred in the sport of track and field, though at times the program ranged from archery through yachting.

In 1896, 13 nations were represented at Athens and this number dwindled to 11 at St. Louis in 1904. There was steady progress after that (*see* Table I). The modern Olympiads fall roughly into three eras: (1) 1896–1912; (2) 1920–32; (3) 1936 on. The first era attracted chiefly athletes from the United States, the British empire and the European continent. The second, after World War I, saw entries from the other continents increase rapidly. The third, which began with the great spectacle at Berlin in 1936, saw the games become a truly global affair.

There also has been continual progress in athletic proficiency, with each Olympiad seeing records broken in almost every sport (*see* Table II). No Olympiad was ever celebrated without the establishment of at least one new world's record in track and field.

The program for the Olympic games usually includes the compulsory events: athletics (track and field), gymnastics, boxing, fencing, shooting, wrestling, rowing, swimming, equestrian, modern pentathlon, cycling, weight lifting and yachting; as well as optional events such as soccer football, water polo, field hockey, basketball, canoeing and, at some Olympics, an exhibition of fine arts. The winter games normally include skiing, skating, ice hockey and bobsled. Women compete in track and field, fencing, gymnastics, canoeing, swimming, yachting and fine arts and, at the winter games, in skiing and skating.

In addition to the amateur code, major Olympic rules include: no minimum or maximum age limit; only nationals may represent a country; there may be no more than three entries from any country in each event (four in the winter games); no contestant may be disqualified on grounds of religion, colour or politics; the games must be completed within 16 days; no point score may be kept in the games, which are contests between individuals and teams and not between nations (groups not connected with the I.O.C., however, often keep an unofficial point score based on 10 points for a first place, 5 for second, 4 for third, 3 for fourth, 2 for fifth and 1 for sixth in each event); the games are entrusted to a city, not a country; the games must be held in the first year of the Olympiad.

TABLE I.—*Participation in the Olympic Games**

(Official, demonstration and optional sports included)

Location	Date	Sports	Events	Participants (women included)	Participating nations
Athens	1896	10	42	285 —	13
Paris	1900	17	60	1,066 (6 women)	20
St. Louis	1904	15	67	496 —	11
London	1908	26	104	2,059 (36 women)	22
Stockholm	1912	19	106	2,541 (57 women)	28
Antwerp	1920	24	154	2,606 (63 women)	29
Paris	1924	24	137	3,092 (136 women)	44
Amsterdam	1928	22	120	3,015 (290 women)	46
Los Angeles	1932	23	124	1,408 (127 women)	37
Berlin	1936	27	142	4,069 (328 women)	49
London	1948	25	138	4,468 (438 women)	59
Helsinki	1952	25	149	5,867 (573 women)	69
Melbourne†	1956	26	148	3,329 (384 women)	67
Rome	1960	24	150	5,396 (537 women)	84
Tokyo	1964	26	162	5,541 (719 women)	94

Winter games (Demonstration events included)

Location	Date	Sports	Events	Participants (women included)	Participating nations
Chamonix	1924	8	16	293 (13 women)	16
St. Moritz	1928	7	15	491 (27 women)	25
Lake Placid	1932	8	19	307 (30 women)	17
Garmisch-Partenkirchen	1936	10	21	756 (76 women)	28
St. Moritz	1948	11	24	878 (90 women)	28
Oslo	1952	7	23	960 (123 women)	30
Cortina d'Ampezzo	1956	7	24	923 (146 women)	32
Squaw Valley	1960	8	27	693 (159 women)	30
Innsbruck	1964	11	35	1,414 (225 women)	36

*Figures supplied by U.S. Olympic committee. †Equestrian events were held in Stockholm.

TABLE II.—*Olympic Track and Field Records—Men*

Event	Location	Year	Holder	Country	Winning effort
100-m. dash	Tokyo	1964	R. Hayes	United States	10 sec.
200 m. dash	Tokyo	1964	H Carr	United States	20 3 sec.
400-m. run	Rome	1960	O. Davis	United States	44 9 sec
800 m run	Tokyo	1964	P Snell	New Zealand	1 min 45 1 sec.
1,500-m. run	Rome	1960	H Elliott	Australia	3 min 35 6 sec.
5,000-m. run	Melbourne	1956	V. Kuts	U S S R	13 min. 39 6 sec.
10,000 m. run	Tokyo	1964	W Mills	United States	28 min 24 4 sec.
Marathon*	Tokyo	1964	Abebe Bikila	Ethiopia	2 hr. 12 min. 11.2 sec.
110 m hurdles	Melbourne	1956	L Calhoun	United States	13 5 sec
400 m hurdles	Rome	1960	G Davis	United States	49 3 sec
3,000-m steeplechase	Tokyo	1964	G. Roelants	Belgium	8 min 30 8 sec.
400-m. relay	Tokyo	1964	—	United States	39 sec
1,600-m. relay	Tokyo	1964	—	United States	3 min. 0.7 sec.
20-km. walk*	Tokyo	1964	K. Matthews	Great Britain	1 hr 29 min 34 sec.
50-km walk*	Tokyo	1964	A. Pamich	Italy	4 hr 11 min. 12.4 sec
High jump	Tokyo	1964	V. Brumel	U.S.S.R.	2.18 m.
Broad jump	Rome	1960	R Boston	United States	8 12 m.
Pole vault	Tokyo	1964	F Hansen	United States	5 10 m
Hop, step and jump	Tokyo	1964	J Schmidt	Poland	16 85 m.
Shot put	Tokyo	1964	D Long	United States	20 33 m.
Discus throw	Tokyo	1964	A. Oerter	United States	61.00 m.
Javelin throw	Melbourne	1956	E Danielsen	Norway	85 71 m.
Hammer throw	Tokyo	1964	R Klim	U S S R	69 74 m
Decathlon	Rome	1960	R Johnson	United States	8,392 pt †

*These records are unofficial because courses differ. †8,001 pt. by revised table used in 1964.

History of Track and Field.—*Athens, 1896.*—James Connolly of Boston became the first modern Olympic champion when he won the hop, step and jump. His U.S. teammates Thomas Burke, Ellery Clark and Robert Garrett scored two victories each, as did Edwin Flack of Australia. Fittingly enough, a Greek, Spyros Louis, won the marathon race.

Paris, 1900.—Held in conjunction with the Paris exposition, the II Olympiad was another triumph for the United States. Ray Ewry began his unequaled Olympic career with three wins in the standing jumps, Alvin Kraenzlein earned four gold medals and in all track and field events, 17 went to the U.S. A. E. Tysoe, C. Bennett and J. Rimmer scored for Great Britain.

St. Louis, 1904.—This was almost a private affair for the U.S., with few entries from other countries and only one other gold medalist, Étienne Desmarteau of Canada. Ewry again was a triple winner, as were Archie Hahn, James Lightbody and Harry Hillman.

London, 1908.—The most acrimonious of modern Olympiads, this was also the last monopolized by the U.S. and the British empire, who divided 22 of the 26 track and field gold medals. Ewry completed his career with a double victory to bring his gold medal total to eight. Mel Sheppard and Martin Sheridan of the U.S. were also double winners, as were George Larner of Great Britain and E. Lemming of Sweden, the first Scandinavian champion. John Hayes of the U.S. in the marathon and Wyndham Halswelle of Great Britain, in the 400-m. run, scored disputed victories.

Stockholm, 1912.—The name of the greatest athlete in the V Olympiad appears in no record books. He was Jim Thorpe, American Indian, who won the pentathlon and decathlon, but was later disqualified for professionalism. Even without Thorpe's victories, the U.S. was still dominant, with Ralph Craig taking the sprints, schoolboy James "Ted" Meredith setting a world's record in the 800-m. run and Ralph Rose, Patrick McDonald and Matthew McGrath monopolizing the weight events. Finland earned its first gold medals, six all told, with three of them going to Hannes Kolehmainen in the distance runs.

Antwerp, 1920.—After an eight-year hiatus, the Olympics resumed in war-torn Belgium with the largest program to that date. These games saw the debut of Finland's Paavo Nurmi, destined to be second only to Ewry in Olympic track and field victories. Nurmi won the 10,000-m. run and cross-country races; Kolehmainen took the marathon; five other Finnish victories in field events enabled the small Nordic nation to tie the U.S. in track and field events with nine gold medals apiece. Sprinters Charles Paddock and Allen Woodring led the U.S. team, which had no double winner. Twin triumphs were scored by A. G. Hill of Great Britain in the middle distances and Ugo Frigerio of Italy in the walks.

Paris, 1924.—For the first time, a modern Olympiad was completely dominated by one man—Nurmi. In one afternoon, within two hours, Nurmi won and set Olympic records in the 1,500-m. and 5,000-m. runs. Later he added the 10,000-m. cross-country title and also won an unofficial 3,000-m. team race. With Ville Ritola winning the other distance races, Finland surpassed its 1920 record with 10 gold medals. The U.S., however, had 12 this time, with Harold Osborn winning the high jump and decathlon and Clarence Houser taking the shot-put and discus. Harold Abrahams in the 100-m. dash, Eric Liddell in the 400-m. run and Douglas Lowe in the 800-m. run gave Great Britain three individual victories on the track, while the United States had only one such winner, Jackson Scholz in the 200-m. dash.

Amsterdam, 1928.—P. Nurmi bowed out of Olympic history with his sixth gold medal in the 10,000-m. run, but the continuance of Finnish domination of the distance races was assured when Harri Larva won the 1,500-m. run. Ritola took the 5,000-m. run and Toivo Loukola captured the 3,000-m. steeplechase. A 19-year-old Canadian schoolboy, Percy Williams, was the surprise winner in the sprints. Veteran British stars Douglas Lowe and Lord Burghley (David Cecil) took the 800-m. run and 400-m. hurdles, respectively. The U.S. was saved from a shutout on the track when Ray Barbutt won the 400-m. run, but did score heavily in the relays and field events. Asia appeared in the gold medal list for the first time when Mikio Oda of Japan won the hop, step and jump. Women participated for the first time in track and field events.

Los Angeles, 1932.—The great distances involved in travel and a world-wide depression cut the entries in half, but the introduction of the Olympic Village marked the X Olympiad as another advance toward Baron de Coubertin's dream. After its embarrassments of the 1920s, the U.S. made a strong comeback on native soil as records were set in almost every event. Eddie Tolan won and set new marks in both sprints. William Carr set a world's record in the 400-m. run after a duel with another U.S. runner, Ben Eastman. George Saling in the hurdles, William Miller in the pole vault, Edward Gordon in the broad jump, Lee Sexton in the shot-put, John Anderson in the discus and James Bausch in the decathlon were other U.S. champions. British schoolmaster Thomas Hampson set a world's record in the 800-m. run and his teammate Thomas Green won the 50-km. walk. Both relays, 400-m. and 1,600-m., went to the U.S. in world's record times. Lauri Lehtinen and Volmari Iso-Hollo gave Finland two distance victories, but Luigi Beccali of Italy and Janusz Kusocinski of Poland prevented any sweep like those recorded in the 1920s by the Finns, as they won the 1,500-m. and 10,000-m. runs, respectively.

Berlin, 1936.—The role which Nurmi played at Paris in 1924 fell to Jesse Owens, an American Negro, in the XI Olympiad under quite dramatic conditions. Adolf Hitler attempted to turn the Berlin spectacle into a glorification of his Nazi state and the result was that a strong movement developed in the United States against participation in the games. The movement failed of its purpose, however, and Owens was one of five U.S. Negro stars to win gold medals in track and field. Owens won four gold medals, set two Olympic records, tied a third and was part of a 400-m. relay team which set a world's record. Other Negro stars were Archie Williams, who won the 400-m. run; John Woodruff, who took the 800-m. run; Cornelius Johnson, who won the high jump; and Ralph Metcalfe, who ran with Owens on the relay team. Other U.S. champions were Earle Meadows in the pole vault, Kenneth Carpenter in the discus and Glenn Morris with a world's record in the decathlon. Harold Whitlock was Great Britain's only individual winner in the 50-km. walk, but John Lovelock of New Zealand set a world's record as he won the 1,500-m. run and the British team of Frederick Wolff, A. G. K.

TABLE III.—*Olympic Champions, 1896–1912*

Event	1896	1900	1904	1908	1912
TRACK AND FIELD—MEN					
60-m. dash	—	A. Kraenzlein; U.S. (7.0 sec.)	A. Hahn; U.S. (7 sec.)	—	—
100-m. dash	T. Burke; U.S. (12.0 sec.)	F. Jarvis; U.S. (10.8 sec.)	A. Hahn; U.S. (11 sec.)	R. Walker; S.Af. (10.8 sec.)	R. Craig; U.S. (10.8 sec.)
200-m. dash	—	J. Tewksbury; U.S. (22.2 sec.)	A. Hahn; U.S. (21.6 sec.)	R. Kerr, Can. (22.6 sec.)	R. Craig; U.S. (21.7 sec.)
400-m. run	T. Burke; U.S. (54.2 sec.)	M. Long, U.S. (49.4 sec.)	H. Hillman; U.S. (49.2 sec.)	W. Halswelle; Gt Brit. (50 sec., walkover)	C. Reidpath; U.S. (48.2 sec.)
800-m. run	E. Flack; Austr. (2 min. 11 sec.)	A. Tysoe, Gt.Brit. (2 min. 1.4 sec.)	J. Lightbody; U.S. (1 min. 56 sec.)	M. Sheppard; U.S. (1 min. 52.8 sec.)	J. Meredith; U.S. (1 min. 51.9 sec.)
1,500-m. run	E. Flack; Austr. (4 min. 33.2 sec.)	C. Bennett; Gt.Brit. (4 min. 6 sec.)	J. Lightbody; U.S. (4 min. 5.4 sec.)	M. Sheppard, U.S. (4 min. 3.4 sec.)	A. Jackson; Gt.Brit. (3 min. 56.8 sec.)
5,000-m. run	—	—	—	—	H. Kolehmainen; Fin. (14 min. 36.6 sec.)
10,000-m. run	—	—	—	E. Voigt; Gt.Brit. (25 min. 11.2 sec.)*	H. Kolehmainen; Fin. (31 min. 20.8 sec.)
Marathon	S. Louis; Gr. (2 hr. 58 min. 50 sec.)	M. Theato, Fr. (2 hr. 59 min. 45 sec.)	T. Hicks; U.S. (3 hr. 28 min. 53 sec.)	J. Hayes; U.S. (2 hr. 55 min. 18.4 sec.)	K. McArthur; S.Af. (2 hr. 36 min. 54.8 sec.)
110-m. hurdles	T. Curtis; U.S. (17.6 sec.)	A. Kraenzlein; U.S. (15.4 sec.)	F. Schule; U.S. (16 sec.)	F. Smithson; U.S. (15 sec.)	F. Kelly, U.S. (15.1 sec.)
200-m. hurdles	—	A. Kraenzlein; U.S. (25.4 sec.)	H. Hillman; U.S. (24.6 sec.)	—	—
400-m. hurdles	—	J. Tewksbury; U.S. (57.6 sec.)	H. Hillman; U.S. (53 sec.)	C. Bacon; U.S. (55 sec.)	—
2,500-m. steeplechase	—	G. Orton, U.S. (7 min. 34 sec.)	J. Lightbody; U.S. (7 min. 39.6 sec.)	A. Russell, Gt.Brit. (10 min. 47.8 sec.)†	—
4,000-m. steeplechase	—	J. Rimmer; Gt.Brit. (12 min. 58.4 sec.)	—		—
10-km. walk	—	—	—	G. Larner; Gt.Brit. (1 hr 15 min 57.4 sec.)‡	G. Goulding; Can. (46 min. 28.4 sec.)
3,500-m. walk	—	—	—	G. Larner, Gt Brit. (14 min. 55 sec.)	—
400-m. relay	—	—	—	—	Great Britain (42.4 sec.)
1,600-m. relay	—	—	—	United States (3 min. 29.4 sec.)	United States (3 min. 16.6 sec.)
Team races	—	Gt.Brit. (5,000 m.)	United States (4 mi.)	Great Britain (3 mi.)	United States (3,000 m.)
8,000-m. cross country (team)	—	—	—	—	Sweden
8,000-m. cross country (indiv.)	—	—	—	—	H. Kolehmainen; Fin. (45 min. 11.6 sec.)
Standing high jump	—	R. Ewry; U.S. (5 ft. 4 13/16 in.)	R. Ewry; U.S. (4 ft. 10 15/16 in.)	R. Ewry, U.S. (5 ft. 1 13/16 in.)	P. Adams; U.S. (5 ft. 4 3/16 in.)
Running high jump	E. Clark; U.S. (5 ft. 11 1/4 in.)	I. Baxter; U.S. (6 ft. 2 3/4 in.)	S. Jones; U.S. (5 ft. 10 15/16 in.)	H. Porter, U.S. (6 ft. 2 13/16 in.)	A. Richards; U.S. (6 ft. 3 15/16 in.)
Standing broad jump	—	R. Ewry, U.S. (10 ft. 6 1/8 in.)	R. Ewry; U.S. (11 ft. 4 7/8 in.)	R. Ewry; U.S. (10 ft. 11 1/16 in.)	C. Tsiklitiras; Gr. (11 ft. 11/16 in.)
Running broad jump	E. Clark; U.S. (20 ft. 10 in.)	A. Kraenzlein; U.S. (23 ft. 6 7/8 in.)	M. Prinstein; U.S. (24 ft. 1 1/8 in.)	F. Irons, U.S. (24 ft. 6 1/2 in.)	A. Gutterson; U.S. (24 ft. 11 3/16 in.)
Pole vault	W. Hoyt, U.S. (10 ft. 9 7/8 in.)	I. Baxter; U.S. (10 ft. 9 7/8 in.)	C. Dvorak; U.S. (11 ft. 6 in.)	E. Cooke, U.S. A. Gilbert; U.S. (tied) (12 ft. 2 1/16 in.)	H. Babcock; U.S. (12 ft. 11 1/2 in.)
Standing hop, step and jump	—	R. Ewry; U.S. (34 ft. 8 1/2 in.)	R. Ewry; U.S. (34 ft. 7 3/16 in.)	—	—
Running hop, step and jump	J. Connolly; U.S. (44 ft. 11 3/4 in.)	M. Prinstein; U.S. (47 ft. 4 1/2 in.)	M. Prinstein; U.S. (47 ft.)	T. Ahearne; Gt.Brit. (48 ft. 11 1/8 in.)	G. Lindblom; Swed. (48 ft. 5 1/16 in.)
16-lb. shot-put	R. Garrett; U.S. (36 ft. 9 3/4 in.)	R. Sheldon; U.S. (46 ft. 3 1/8 in.)	R. Rose; U.S. (48 ft. 7 in.)	R. Rose; U.S. (46 ft. 7 7/16 in.)	P. McDonald, U.S. (50 ft. 3 15/16 in.)
Special shot-put	—	—	E. Desmarteau; Can. (34 ft. 3 15/16 in.)§	—	R. Rose; U.S. (90 ft. 10 9/16 in.)‖
Discus throw (free style)	R. Garrett; U.S. (95 ft. 7 5/8 in.)	R. Bauer; Hung. (118 ft. 2 7/8 in.)	M. Sheridan; U.S. (128 ft. 10 1/2 in.)	M. Sheridan; U.S. (134 ft. 1 15/16 in.)	A. Taipale; Fin. (145 ft. 9/16 in.)
Discus throw (special styles)	—	—	—	M. Sheridan; U.S. (124 ft. 7 11/16 in.)¶	A. Taipale; Fin. (271 ft. 10 3/16 in.)‖
Javelin throw (free style)	—	—	—	E. Lemming, Swed. (178 ft. 7 1/4 in.)	E. Lemming; Swed. (198 ft. 11 1/8 in.)
Javelin throw (special styles)	—	—	—	E. Lemming; Swed. (179 ft. 10 5/8 in.)¶	J. Saaristo; Fin. (358 ft. 11 7/8 in.)‖
16-lb. hammer throw	—	J. Flanagan; U.S. (167 ft. 3 7/8 in.)	J. Flanagan, U.S. (168 ft. 15/16 in.)	J. Flanagan; U.S. (170 ft. 4 1/16 in.)	M. McGrath; U.S. (179 ft. 7 1/8 in.)
All around championship	—	—	T. Kiely; Gt Brit.	—	H. Wieslander; Swed. ♀
Pentathlon	—	—	—	—	F. Bie; Nor.
Tug of war	—	Sweden Denmark	United States	Great Britain	Sweden
SWIMMING—MEN					
50-yd. free style	—	—	Z. Halmay; Hung. (28 sec.)	—	—
100-m. free style	A. Hajós (Guttmann); Hung. (1 min. 22.2 sec.)	—	Z. Halmay; Hung. (1 min. 2.8 sec.) δ	C. Daniels; U.S. (1 min. 5.6 sec.)	D. Kahanamoku; U.S. (1 min. 3.4 sec.)
100-m. free style (sailors)	J. Malokinis; Gr. (2 min. 20.4 sec.)	—	—	—	—
200-m. free style	—	F. Lane; Austr. (2 min. 25.2 sec.)	C. Daniels; U.S. (2 min. 44.2 sec.)□	—	—
400-m. free style	P. Neumann; Aus. (8 min. 12.6 sec.)°	—	C. Daniels, U.S. (6 min. 16.2 sec.)▲	H. Taylor; Gt.Brit. (5 min. 36.8 sec.)	G. Hodgson; Can. (5 min. 24.4 sec.)
1,000-m. free style	A. Hajós (Guttmann); Hung. (18 min. 22.2 sec.)+	J. Jarvis; Gt.Brit. (13 min. 40.2 sec.)	E. Rausch; Ger. (13 min. 11.4 sec.)●	—	—
1,500-m. free style	—	—	E. Rausch; Ger. (27 min. 18.2 sec.)**	H. Taylor; Gt.Brit. (22 min. 48.4 sec.)	G. Hodgson; Can. (22 min.)
4,000-m. free style	—	J. Jarvis; Gt.Brit. (58 min. 24 sec.)	—	—	—
100-m. backstroke	—	E. Hoppenberg; Ger. (2 min. 47 sec.)††	W. Brack; Ger. (1 min. 16.8 sec.) δ	A. Bieberstein; Ger. (1 min. 24.6 sec.)	H. Hebner; U.S. (1 min. 21.2 sec.)
200-m. breast stroke	—	—	—	F. Holman; Gt.Brit. (3 min. 9.2 sec.)	W. Bathe; Ger. (3 min. 1.8 sec.)
400-m. breast stroke	—	—	G. Zacharias; Ger. (7 min. 23.6 sec.)▲	—	W. Bathe; Ger. (6 min. 29.6 sec.)
200-m. obstacle swim	—	F. Lane; Austr. (2 min. 38.4 sec.)	—	—	—
60-m. underwater swim	—	W. de Vaudeville; Fr. (1 min. 53.4 sec.)	—	—	—
200-yd. relay	—	Germany (time not given)††	United States (2 min. 4.6 sec.)	—	—
800-m. relay	—	—	—	Great Britain (10 min. 55.6 sec.)	Australia-New Zealand (10 min. 11.2 sec.)
Plunge for distance	—	—	W. Dickey; U.S. (62 ft. 6 in.)	—	—
High diving	—	—	G. Sheldon; U.S.	H. Johansson; Swed.	E. Adlerz; Swed. (two events)
Springboard diving	—	—	—	A. Zürner; Ger.	P. Günther; Ger.

*5 mi. †3,200 m. ‡10 mi. §56-lb. weight. ‖Both hands. ¶Greek style. ♀Decathlon. δ100 yd. □220 yd. °500 m. ▲440 yd. +1,200 m. ●880 yd. **1 mi. ††200 m.

TABLE III.—*Olympic Champions, 1896–1912 (Continued)*

Event	1896	1900	1904	1908	1912
SWIMMING—WOMEN					
100-m. free style	—	—	—	—	F. Durack; Austr N.Z. (1 min. 22.2 sec.)
400-m. relay	—	—	—	—	Great Britain (5 min. 52.8 sec.)
High diving	—	—	—	—	G. Johansson; Swed.
BOXING					
Flyweight	—	—	G. Finnegan; U.S.	—	—
Bantamweight	—	—	O. Kirk; U.S.	H. Thomas; Gt.Brit.	—
Featherweight	—	—	O. Kirk; U.S.	R. Gunn; Gt.Brit.	—
Lightweight	—	—	H. Spanger; U.S.	F. Grace; Gt.Brit.	—
Welterweight	—	—	A. Young; U.S.	—	—
Middleweight	—	—	C. Mayer; U.S.	J. Douglas; Gt.Brit.	—
Heavyweight	—	—	S. Berger; U.S.	A. Oldman; Gt.Brit.	—
WRESTLING (CATCH-AS-CATCH-CAN)					
Flyweight	—	—	R. Curry; U.S.	—	—
Bantamweight	—	—	G. Mehnert; U.S.	G. Mehnert; U.S.	—
Featherweight	—	—	I. Niflot; U.S.	G. Dole; U.S.	—
Lightweight	—	—	B. Bradshaw; U.S.	G. Relwyskow; Gt Brit.	—
Welterweight	—	—	O. Roem; U.S.	—	—
Middleweight	—	—	C. Erickson; U.S.	S. Bacon; Gt Brit.	—
Heavyweight	—	—	B. Hansen; U.S.	G. O'Kelly; Gt Brit.	—
WRESTLING (GRECO-ROMAN)					
Featherweight	K. Schuhmann; Ger.‡‡	—	—	—	K. Koskelo; Fin.
Lightweight	—	—	—	E. Porro; It.	E. Väre; Fin.
Middleweight	—	—	—	F. Martenson; Swed.	C. Johansson; Swed.
Light heavyweight	—	—	—	V. Weckman; Fin.	—
Heavyweight	—	—	—	R. Weisz; Hung.	Y. Saarela; Fin.
WEIGHT LIFTING					
One hand	L. Elliot; Gt. Brit.	—	O. Osthoff; U.S.	—	—
Two hands	V. Jensen; Den.	—	P. Kakousis; Gr.	—	—
CYCLING					
Road race (indiv.)	A. Konstantinidis; Gr.	—	—	V. Johnson; Gt Brit.	R. Lewis; S.Af
Road race (team)	—	—	—	—	Sweden
1,000-m scratch	P. Masson; Fr §§	G. Taillandier; Fr.	M. Hurley; U.S. ‖‖	(race declared void)	—
2,000-m tandem race	—	—	—	M. Schilles; Fr A. Auffray; Fr.	—
Team pursuit	—	United States (1,500 m.)	—	Great Britain (1¾ mi.)	—
Time trials	P. Masson; Fr. (333.3 m.)	W. Johnson; Gt.Brit. (⅓ mi.)	—	—	—
440-yd. race	—	—	M. Hurley; U.S.	—	—
⅓-mi. race	—	—	M. Hurley; U.S.	—	—
1-mi. race	—	—	M. Hurley; U.S.	—	—
5,000-m. race	—	—	B. Downing; U.S.¶¶	B. Jones; Gt.Brit.	—
10-km race	P. Masson, Fr.	—	C. Schlee, U.S. 99	C. Kingsbury, Gt Brit 66	—
100-km. race	L. Flameng; Fr.	—	—	C. Bartlett; Gt.Brit.	—
25-mi. race	—	—	B. Downing; U.S.	—	—
12-hr. race	F. Schmal; Aus.	—	—	—	—
EQUESTRIAN EVENTS					
Prize jumping (indiv.)	—	Haegeman; Belg.	—	—	J. Cariou; Fr.
Prize jumping (team)	—	—	—	—	Sweden
High jump	—	Gardère; Fr. G. Trissino; It. (tied)	—	—	—
Long jump	—	Van Langendonck; Belg.	—	—	—
3-day military event (indiv.)	—	—	—	—	A. Nordlander; Swed.
3-day military event (team)	—	—	—	—	Sweden
Dressage (indiv.)	—	—	—	—	C. Bonde; Swed.
FENCING					
Indiv. foil (amateur)	E. Gravelotte, Fr.	C. Coste, Fr.	R. Fonst, Cuba	—	N. Nadi; It
Indiv. foil (professional)	L. Pyrgos; Gr.	L. Merignac; Fr.	—	—	—
Indiv. foil (junior)	—	—	A. Fox; U.S.	—	—
Team foil		—	Cuba	—	—
Indiv. sabre (amateur)	J. Georgiadis; Gr.	G. de la Falaise; Fr.	M. Diaz; Cuba	J. Fuchs; Hung.	J. Fuchs; Hung.
Indiv. sabre (professional)	—	A. Conte, It	—	—	—
Team sabre	—		—	Hungary	Hungary
Indiv. épée (amateur)	—	R. Fonst; Cuba	R. Fonst; Cuba	G. Alibert; Fr.	P. Anspach; Belg.
Indiv. épée (professional)	—	A. Ayat; Fr.	—	—	—
Indiv. épée (open)	—	A. Ayat; Fr.	—	—	—
Team épée	—	—	—	France	Belgium
Singlestick	—	—	A. Van Zo Post; Cuba	—	—
GYMNASTICS					
All-around indiv.	—	S. Sandras; Fr.	J. Lenhardt; U.S.	A. Braglia; It.	A. Braglia; It.
Parallel bars (indiv.)	A. Flatow; Ger.	—	G. Eyser; U.S.	—	—
Parallel bars (team)	Germany	—	—	—	—
Horizontal bar (indiv.)	H. Weingärtner; Ger.	—	A. Heida; U.S. E. Hennig; U.S. (tied)	—	—
Horizontal bar (team)	Germany	—	—	—	—
Side horse	L. Zutter; Switz.	—	A. Heida; U.S.	—	—
Flying rings	J. Mitropoulos; Gr.	—	H. Glass, U.S.	—	—
Long horse (vaults)	K. Schuhmann, Ger.	—	A. Heida, U.S. G. Eyser; U.S. (tied)	—	—
Rope climb	N. Andriakopoulos; Gr.	—	G. Eyser; U.S.	—	—
Indian clubs	—	—	E. Hennig; U.S.	—	—
3-event competition (indiv.)	—	—	A. Spinnler; Ger.	—	—
Triathlon	—	—	M. Emmerich; U.S.	—	—
7-event competition (indiv.)	—	—	A. Heida; U.S.	—	—
Team (Swedish system)	—	—	—	—	Sweden
Team (optional exercises)	—	—	—	—	Norway
Team (prescribed apparatus)	—	—	United States	Sweden	Italy
ROWING					
Single sculls (senior)	—	H. Barrelet; Fr.	F. Greer; U.S.	H. Blackstaffe; Gt.Brit.	W. Kinnear; Gt.Brit. (skiff)
Single sculls (assn. senior)	—	—			—
Single sculls (intermediate)	—	—	D. Duffield; U.S.	—	—
Double sculls	—	—	F. Shepherd; U.S.	—	—
Pairs (without coxswain)	—		United States (2 events)	—	—
Pairs (with coxswain)	—	Belgium	United States (2 events)	Great Britain	—
Fours (without coxswain)	—	Netherlands	—	—	Germany (outrigger)
Fours (with coxswain)	—	France (2 events)	United States (3 events)	Great Britain	Denmark
Eights	—	Germany United States	United States	Great Britain	Great Britain

‡‡All competitors wrestled in one group regardless of weight. §§2,000 m. ‖‖880 yd. ¶¶2 mi. 99 5 mi. 66 20 km.

TABLE III.—*Olympic Champions, 1896–1912* (*Continued*)

Event	1896	1900	1904	1908	1912
YACHTING					
Over 10-m. class	—	"Esterel"; Fr.	—	"Hera"; Gt.Brit.□□	"Magda IX"; Nor.□□
10-m. class	—	"Aschenbrodel"; Ger.	—	—	"Kitty"; Swed.
8-m. class	—	"Olle"; Gt.Brit.°°	—	"Cobweb"; Gt.Brit.	"Taifun"; Nor.
7-m. class	—	—	—	"Heroine"; Gt.Brit.	—
6-m class	—	"Lerina"; Switz.▲▲	—	"Dormy"; Gt.Brit.	"Mac Miche"; Fr.
MOTOR BOATING					
A class	—	—	—	E. Thubron; Fr.	—
B class (under 60 ft.)	—	—	—	T. Thornycroft; Gt.Brit.	—
C class (6.5—8-m.)	—	—	—	T. Thornycroft; Gt.Brit.	—
SHOOTING					
Army gun (indiv., 200 m)	P. Karasevdas; Gr.	—	—	—	—
Army gun (indiv., 300 m.)	G. Orphanidis; Gr.	A. Helgerad; U.S.	—	—	S. Prokopp; Hung.
Army gun (indiv., 600 m.)	—	—	—	—	P. Colas; Fr.
Army gun (indiv., 1,000 yd.)	—	—	—	J. Millner; Gt.Brit.	—
Army gun (indiv., all-around)	—	J. Millner; U.S.	—	—	—
Army gun (team, 300 m.)	—	Norway	—	—	—
Army gun (team, all-around)	—	United States	—	United States	United States
Full-bore rifle (300 m., standing)	—	L. Madsen; Den.	—	—	—
Full bore rifle (300 m., kneeling)	—	K. Staeheli; Switz.	—	—	—
Full bore rifle (300 m., prone)	—	A. Paroche; Fr.	—	—	—
Free rifle (indiv., 300 m.)	—	E. Kellenberger; Switz.++	—	A. Helgerud; Nor.	P. Colas; Fr.
Free rifle (team, 300 m.)	—	Switzerland++	—	Norway	Sweden
6 mm. small gun (open rear sight)	—	C. Grosett; Fr.	—	—	—
Small-bore rifle	—	A. Carnell; Gt.Brit.	—	A. Carnell; Gt.Brit.	F. Hird; U.S.
Small-bore rifle (team)	—	Great Britain	—	Great Britain	Great Britain
Small-bore rifle (vanishing target)	—	W. Styles; Gt.Brit.	—	W. Styles; Gt.Brit.	V. Carlberg; Swed.
Small-bore (team, vanishing target)	—	—	—	—	Sweden
Small-bore rifle (moving target)	—	A. Fleming; Gt.Brit.	—	A. Fleming; Gt.Brit.	—
Pistol (25-m.)	J. Phrangudis; Gr.	—	—	—	—
Pistol (30-m.)	S. Paine; U.S.	—	—	—	—
Service revolver	J. Paine; U.S.	M. Larrouy; Fr.	—	—	—
Revolver (team)	—	Switzerland	—	—	—
Free revolver	—	K. Röderer; Switz.	—	—	—
Revolver and pistol	—	P. Van Asbrock; Belg.	—	P. Van Asbrock; Belg.	A. Lane; U.S.
Revolver and pistol (team)	—	United States	—	United States	United States
Dueling pistol	—	—	—	—	A. Lane; U.S.
Dueling pistol (team)	—	—	—	—	Sweden
Running deer (single shot)	—	O. Swahn; Swed.	—	O. Swahn; Swed.	A. Swahn; Swed.
Running deer (double shot)	—	W. Winans; U.S.	—	W. Winans; U.S.	A. Lundeberg; Swed.
Running deer (team)	—	Sweden	—	Sweden	Sweden
Wild boar target (moving)	—	L. Debray; Fr.	—	—	—
Live pigeon	—	L. Bon de Lunden; Belg.	—	—	—
Live pigeon (hunting gun)	—	R. de Barbarin; Fr.	—	—	—
Clay pigeon	—	W. Ewing; Can.	—	W. Ewing; Can.	J. Graham; U.S.
Clay pigeon (team)	—	Great Britain	—	Great Britain	United States
ARCHERY					
Game shooting	—	Mackintosh; Austr.	—	—	—
Cordon doré (50 m.)	—	Herouin; Fr.	—	—	—
Chapelet	—	Mougin; Fr.	—	—	—
Cordon doré perche (33 m.)	—	H. Van Innis; Belg.	—	—	—
À la perche	—	Foulon; Fr.	—	—	—
Au chapelet (33 m.)	—	H. Van Innis; Belg.	—	—	—
American round (men)	—	—	H. Taylor; U.S.	—	—
York round (men)	—	—	P. Bryant; U.S.	W. Dod; Gt.Brit.	—
Team competition (men)	—	—	United States	—	—
Continental style (men)	—	—	—	E. Grizot; Fr.	—
Columbia round (women)	—	—	M. Howell; U.S.	—	—
National round (women)	—	—	M. Howell, U.S.	Q. Newall; Gt.Brit.	—
Team competition (women)	—	—	United States	—	—
TENNIS AND LAWN TENNIS					
Lawn tennis (men's singles)	J. Boland; Gt.Brit.	L. Doherty; Gt.Brit.	B. Wright; U.S.	M. Ritchie; Gt.Brit.	C. Winslow; S.Af.
Lawn tennis (men's doubles)	J. Boland; Gt.Brit. F. Thraun; Ger.	R. Doherty; Gt.Brit. L. Doherty; Gt.Brit.	E. Leonard; U.S. B. Wright; U.S.	G. Hillyard; Gt.Brit. R. Doherty; Gt.Brit.	H. Kitson; S.Af. C. Winslow; S.Af.
Lawn tennis (women's singles)	—	C. Cooper; Gt.Brit.	—	D. Chambers-Lambert, Gt Brit.	M. Broquedis; Fr.
Lawn tennis (mixed doubles)	—	C. Cooper; Gt.Brit. R. Doherty; Gt.Brit.	—	—	D. Köring; Ger. H. Schomburgk; Ger.
Tennis (men's singles)	—	—	—	A. Gore; Gt.Brit.	A. Gobert; Fr.
Tennis (men's doubles)	—	—	—	H. Roper-Barrett and A. Gore; Gt.Brit.	M. Germot; Fr. A. Gobert; Fr.
Tennis (women's singles)	—	—	—	G. Eastlake-Smith; Gt.Brit.	E. Hannam; Gt.Brit.
Tennis (mixed doubles)	—	—	—	—	E. Hannam; Gt.Brit. C. Dixon; Gt.Brit.
Tennis, English rules (*jeu de paume*)	—	—	—	J. Gould; U.S.	—
TEAM SPORTS					
Polo	—	—	—	Great Britain	—
Water polo	—	Great Britain	United States	Great Britain	Great Britain
Association football (soccer)	—	Great Britain	Canada	Great Britain	Great Britain
Rugby football	—	France	—	Australia-New Zealand	—
Basketball	—	—	United States	—	—
Field hockey	—	—	—	England	—
Baseball	—	—	—	—	United States
Lacrosse	—	—	Canada	Canada	—
MISCELLANEOUS SPORTS					
Figure skating (men)	—	—	—	U. Salchow; Swed.	—
Figure skating (women)	—	—	—	M. Syers; Gt.Brit.	—
Figure skating (pairs)	—	—	—	A. Hübler; Ger. H. Burger; Ger.	—
Special figures	—	—	—	N. Kolomenkin; Russ.	—
Golf (men)	—	C. Sands; U.S.	G. Lyon; Can.	—	—
Golf (women)	—	M. Abbot; U.S.	—	—	—
Roque	—	—	C. Jacobus; U.S.	—	—
Racquets (singles)	—	—	—	E. Noel; Gt.Brit.	—
Racquets (doubles)	—	—	—	V. Pennel; Gt.Brit. J. Astor; Gt.Brit.	—
Glima (Icelandic) wrestling	—	—	—	—	Iceland
Modern pentathlon	—	—	—	—	G. Lilliehöök; Swed.
ART CONTESTS					
Architecture	—	—	—	—	H. Monod; Switz. A. Laverrière; Switz.
Literature	—	—	—	—	P. de Coubertin; Fr.●●
Music	—	—	—	—	R. Barthelemy; It.
Painting	—	—	—	—	G. Pellegrini; It.
Sculpture	—	—	—	—	W. Winans; U.S.

□□12-m. boat. °°Also classed as a 3-ton boat. ▲▲Also classed as a 2-ton boat. ++Full-bore rifle. ●●Father of the modern Olympics.

TABLE IV.—*Olympic Champions, 1920–36*

Event	1920	1924	1928	1932	1936
TRACK AND FIELD—MEN					
100-m. dash	C. Paddock; U.S. (10.8 sec.)	H. Abrahams; Gt.Brit. (10.6 sec.)	P. Williams; Can. (10.8 sec.)	E. Tolan; U.S. (10.3 sec.)	J. Owens, U.S. (10.3 sec.)
200-m. dash	A. Woodring; U.S. (22 sec.)	J. Scholz; U.S. (21.6 sec.)	P. Williams; Can. (21.8 sec.)	E. Tolan; U.S. (21.2 sec.)	J. Owens; U.S. (20.7 sec.)
400-m. run	B. Rudd; S.Af. (49.6 sec.)	E. Liddell; Gt.Brit. (47.6 sec.)	R. Barbutti; U.S. (47.8 sec.)	W. Carr; U.S. (46.2 sec.)	A. Williams; U.S. (46.5 sec.)
800-m. run	A. Hill; Gt.Brit. (1 min. 53.4 sec.)	D. Lowe; Gt.Brit. (1 min. 52.4 sec.)	D. Lowe; Gt.Brit. (1 min. 51.8 sec.)	T. Hampson; Gt.Brit. (1 min. 49.8 sec.)	J. Woodruff, U.S. (1 min. 52.9 sec.)
1,500-m. run	A. Hill; Gt.Brit. (4 min. 1.8 sec.)	P. Nurmi; Fin. (3 min. 53.6 sec.)	H. Larva; Fin. (3 min. 53.2 sec.)	L. Beccali; It. (3 min. 51.2 sec.)	J. Lovelock; N.Z. (3 min. 47.8 sec.)
5,000-m. run	J. Guillemot; Fr. (14 min. 55.6 sec.)	P. Nurmi; Fin. (14 min. 31.2 sec.)	V. Ritola; Fin. (14 min. 38 sec.)	L. Lehtinen; Fin. (14 min. 30 sec.)	G. Höckert; Fin. (14 min. 22.2 sec.)
10,000-m. run	P. Nurmi; Fin. (31 min. 45.8 sec.)	V. Ritola; Fin. (30 min. 23.2 sec.)	P. Nurmi; Fin. (30 min. 18.8 sec.)	J. Kusocinski; Pol. (30 min. 11.4 sec.)	I. Salminen; Fin. (30 min. 15.4 sec.)
Marathon	H. Kolehmainen; Fin. (2 hr. 32 min. 35.8 sec.)	A. Stenroos; Fin. (2 hr. 41 min. 22.6 sec.)	A. El Ouafi; Fr. (2 hr. 32 min. 57 sec.)	J. Zabala; Arg. (2 hr. 31 min. 36 sec.)	K. Son; Jap. (2 hr. 29 min. 19.2 sec.)
110-m. hurdles	E. Thompson; Can. (14.8 sec.)	D. Kinsey; U.S. (15 sec.)	S. Atkinson; S.Af. (14.8 sec.)	G. Saling; U.S. (14.6 sec.)	F. Towns; U.S. (14.2 sec.)
400-m. hurdles	F. Loomis; U.S. (54 sec.)	M. Taylor; U.S. (52.6 sec.)	Lord Burghley; Gt.Brit. (53.4 sec.)	R. Tisdall, Eire (51.8 sec.)	G. Hardin; U.S. (52.4 sec.)
3,000-m. steeplechase	P. Hodges; Gt.Brit. (10 min. 0.4 sec.)	V. Ritola; Fin. (9 min. 33.6 sec.)	T. Loukola; Fin. (9 min. 21.8 sec.)	V. Iso-Hollo; Fin. (10 min. 33.4 sec.)*	V. Iso-Hollo; Fin. (9 min. 3.8 sec.)
3,000-m. team race	United States	Finland	—	—	—
10,000-m. cross country	P. Nurmi; Fin. (27 min. 15 sec.)†	P. Nurmi; Fin. (32 min. 54.8 sec.)	—	—	—
10,000-m. cross country (team)	Finland	Finland	—	—	—
400-m. relay	United States (42.2 sec.)	United States (41 sec.)	United States (41 sec.)	United States (40 sec.)	United States (39.8 sec.)
1,600-m. relay	Great Britain (3 min. 22.2 sec.)	United States (3 min. 16 sec.)	United States (3 min. 14.2 sec.)	United States (3 min. 8.2 sec.)	Great Britain (3 min. 9 sec.)
3,000-m. walk	U. Frigerio; It. (13 min. 14.2 sec.)	—	—	—	—
10-km. walk	U. Frigerio; It. (48 min. 6.2 sec.)	U. Frigerio; It. (47 min. 49 sec.)	—	—	—
50-km. walk	—	—	—	T. Green; Gt.Brit. (4 hr. 50 min. 10 sec.)	H. Whitlock; Gt.Brit. (4 hr. 30 min. 41.4 sec.)
High jump	R. Landon, U.S. (6 ft. 4 3/16 in.)	H. Osborn; U.S. (6 ft. 5 15/16 in.)	R. King, U.S. (6 ft. 4 [illegible] in.)	D. McNaughton; Can. (6 ft. 5 5/8 in.)	C. Johnson; U.S. (6 ft. 8 in.)
Broad jump	W. Pettersson; Swed. (23 ft. 5 1/2 in.)	H. De Hubbard; U.S. (24 ft. 5 1/8 in.)	E. Hamm, U.S. (25 ft. 4 5/16 in.)	E. Gordon; U.S. (25 ft. 3/4 in.)	J. Owens; U.S. (26 ft. 5 5/16 in.)
Pole vault	F. Foss, U.S. (12 ft. 5 9/16 in.)	L. Barnes; U.S. (12 ft. 11 1/2 in.)	S. Carr, U.S. (13 ft. 9 [illegible] in.)	W. Miller; U.S. (14 ft. 1 7/8 in.)	E. Meadows, U.S. (14 ft. 3 1/4 in.)
Hop, step and jump	V. Tuulos, Fin. (47 ft. 7 1/16 in.)	A. Winter; Austr. (50 ft. 11 1/4 in.)	M. Oda; Jap. (49 ft. 10 13/16 in.)	C. Nambu; Jap. (51 ft. 6 7/8 in.)	N. Tajima, Jap. (52 ft. 5 15/16 in.)
16-lb. shot-put	V. Porhola, Fin. (48 ft. 7 1/16 in.)	C. Houser; U.S. (49 ft. 2 1/4 in.)	J. Kuck; U.S. (52 ft. 13/16 in.)	L. Sexton; U.S. (52 ft. 5 15/16 in.)	H. Woellke; Ger. (53 ft. 1 3/4 in.)
56-lb. weight throw	P. MacDonald; U.S. (36 ft. 11 1/2 in.)	—			—
Discus throw	E. Niklander; Fin. (146 ft. 7 1/16 in.)	C. Houser; U.S. (151 ft. 5 1/16 in.)	C. Houser; U.S. (155 ft. 3 in.)	J. Anderson, U.S. ([illegible] ft. [illegible] in.)	K. Carpenter; U.S. (165 ft. 7 1/8 in.)
Javelin throw	J. Myrrä; Fin. (215 ft. 9 3/4 in.)	J. Myrrä; Fin. (206 ft. 6 3/4 in.)	E. Lundquist; Swed. (218 ft. 6 1/16 in.)	M. Järvinen; Fin. ([illegible] ft. [illegible] in.)	G. Stock; Ger. (235 ft. 8 5/16 in.)
Hammer throw	P. Ryan; U.S. (173 ft. 5 11/16 in.)	F. Tootell; U.S. (174 ft. 10 1/4 in.)	P. O'Callaghan; Eire (168 ft. 7 1/4 in.)	P. O'Callaghan, Eire (176 ft. [illegible] in.)	K. Hein; Ger. (185 ft. 4 in.)
Tug-of-war	Great Britain	—	—		—
Pentathlon	E. Lehtonen; Fin.	E. Lehtonen; Fin.	—	—	—
Decathlon	H. Lovland; Nor.	H. Osborn, U.S.	P. Yrjola, Fin.	J. Bausch, U.S.	G. Morris; U.S.
TRACK AND FIELD—WOMEN					
100-m. dash	—	—	E. Robinson; U.S. (12.2 sec.)	S. Walasiewicz; Pol. (11.9 sec.)	H. Stephens; U.S. (11.5 sec.)
800-m. run	—	—	L. Radke-Batschauer; Ger. (2 min. 16.8 sec.)	—	—
80-m. hurdles	—	—	—	M. Didrikson; U.S. (11.7 sec.)	T. Valla; It. (11.7 sec.)
400-m. relay	—	—	Canada (48.4 sec.)	United States (47 sec.)	United States (46.9 sec.)
High jump	—	—	E. Catherwood; Can. (5 ft. 2 9/16 in.)	J. Shiley; U.S. (5 ft. 4 13/16 in.)	I. Csák, Hung. (5 ft. 2 15/16 in.)
Discus throw	—	—	H. Konopacka; Pol. (129 ft. 11 15/16 in.)	L. Copeland; U.S. (133 ft. 1 5/8 in.)	G. Mauermayer; Ger. (156 ft. 3 3/16 in.)
Javelin throw	—	—	—	M. Didrikson; U.S. (143 ft. 3 11/16 in.)	T. Fleischer; Ger. (148 ft. 2 3/4 in.)
SWIMMING—MEN					
100-m. free style	D. Kahanamoku; U.S. (1 min. 0.4 sec.)	J. Weissmuller; U.S. (59 sec.)	J. Weissmüller; U.S. (58.6 sec.)	Y. Miyazaki; Jap. (58.2 sec.)	F. Csik; Hung. (57.6 sec.)
400-m. free style	N. Ross; U.S. (5 min. 26.8 sec.)	J. Weissmuller, U.S. (5 min. 4.2 sec.)	A. Zorilla, Arg. (5 min. 1.6 sec.)	C. Crabbe; U.S. (4 min. 48.4 sec.)	J. Medica, U.S. (4 min. 44.5 sec.)
1,500-m. free style	N. Ross, U.S. (22 min. 23.2 sec.)	A. Charlton, Austr. (20 min. 6.6 sec.)	A. Borg, Swed. (19 min. 51.8 sec.)	K. Kitamura; Jap. (19 min. 12.4 sec.)	N. Terada; Jap. (19 min. 13.7 sec.)
100-m. backstroke	W. Kealoha; U.S. (1 min. 15.2 sec.)	W. Kealoha; U.S. (1 min. 13.2 sec.)	G. Kojac; U.S. (1 min. 8.2 sec.)	M. Kiyokawa; Jap. (1 min. 8.6 sec.)	A. Kiefer; U.S. (1 min. 5.9 sec.)
200-m. breast stroke	H. Malmroth; Swed. (3 min. 4.4 sec.)	R. Skelton, U.S. (2 min. 56.6 sec.)	Y. Tsuruta; Jap. (2 min. 48.8 sec.)	Y. Tsuruta; Jap. (2 min. 45.4 sec.)	T. Hamuro; Jap. (2 min. 42.5 sec.)
400-m. breast stroke	H. Malmroth; Swed. (6 min. 31.8 sec.)	—	—	—	—
800-m. relay	United States (10 min. 4.4 sec.)	United States (9 min. 53.4 sec.)	United States (9 min. 36.2 sec.)	Japan (8 min. 58.4 sec.)	Japan (8 min. 51.5 sec.)
High diving	A. Wallman; Swed.	R. Eve, Austr.	P. Desjardins; U.S.	H. Smith; U.S.	M. Wayne; U.S.
Artistic diving	C. Pinkston; U.S.	A. White, U.S.	—	—	—
Springboard diving	L. Kuehn; U.S.	A. White, U.S.	P. Desjardins; U.S.	M. Galitzen; U.S.	R. Degener; U.S.
SWIMMING—WOMEN					
100-m. free style	E. Bleibtrey; U.S. (1 min. 13.6 sec.)	E. Lackie; U.S. (1 min. 12.4 sec.)	A. Osipowich; U.S. (1 min. 11 sec.)	H. Madison; U.S. (1 min. 6.8 sec.)	H. Mastenbroek; Neth. (1 min. 5.9 sec.)
400-m. free style	E. Bleibtrey; U.S. (4 min. 34 sec.)‡	M. Norelius; U.S. (6 min. 2.2 sec.)	M. Norelius; U.S. (5 min. 42.8 sec.)	H. Madison; U.S. (5 min. 28.5 sec.)	H. Mastenbroek; Neth. (5 min. 26.4 sec.)
100-m. backstroke	—	S. Bauer; U.S. (1 min. 23.2 sec.)	M. Braun; Neth. (1 min. 22 sec.)	E. Holm; U.S. (1 min. 19.4 sec.)	D. Senff; Neth. (1 min. 18.9 sec.)
200-m. breast stroke	—	L. Morton; Gt.Brit. (3 min. 33.2 sec.)	H. Schrader, Ger. (3 min. 12.6 sec.)	C. Dennis; Austr. (3 min. 6.3 sec.)	H. Maehata; Jap. (3 min. 3.6 sec.)
400-m. relay	United States (5 min. 11.6 sec.)	United States (4 min. 58.8 sec.)	United States (4 min. 47.6 sec.)	United States (4 min. 38 sec.)	Netherlands (4 min. 36 sec.)
Springboard diving	A. Riggin; U.S.	E. Becker; U.S.	H. Meany; U.S.	G. Coleman; U.S.	M. Gestring; U.S.
High diving	S. Fryland Clausen; Den.	C. Smith; U.S.	E. Becker Pinkston; U.S.	D. Poynton; U.S.	D. Poynton-Hill; U.S.

*Ran extra lap by mistake. †Error in distance. ‡300 m.

TABLE IV.—*Olympic Champions, 1920–36 (Continued)*

Event	1920	1924	1928	1932	1936
BOXING					
Flyweight	F. De Genero; U.S.	F. La Barba; U.S.	A. Kocsis; Hung.	I. Énekes; Hung.	W. Kaiser; Ger.
Bantamweight	C. Walker; S.Af.	W. Smith; S.Af.	V. Tamagnini; It.	H. Gwynne; Can.	U. Sergo; It.
Featherweight	P. Fritsch; Fr.	J. Fields; U.S.	L. van Klaveren; Neth.	C. Robledo; Arg.	O. Casanovas; Arg.
Lightweight	S. Mosberg; U.S.	H. Nielsen; Den.	C. Orlandi; It.	L. Stevens; S.Af.	I. Harangi; Hung.
Welterweight	T. Schneider; Can.	J. Delarge; Belg.	E. Morgan; N.Z.	E. Flynn; U.S.	S. Suvio; Fin.
Middleweight	H. Mallin; Gt Brit.	H. Mallin; Gt Brit.	P. Toscani; It.	C. Barth; U.S.	J. Despeaux; Fr.
Light heavyweight	E. Eagan; U.S.	H. Mitchell; Gt Brit.	V. Avendano; Arg.	D. Carstens; S.Af.	R. Michelot; Fr.
Heavyweight	R. Rawson; U.S.	O. von Porat; Nor.	R. Jurado; Arg.	S. Lovell; Arg.	H. Runge; Ger.
WRESTLING (CATCH-AS-CATCH CAN)					
Bantamweight	—	K. Pihlajamäki; Fin.	K. Mäkinen; Fin.	R. Pearce; U.S.	O. Zombori; Hung.
Featherweight	C. Ackerly; U.S.	R. Reed; U.S.	A. Morrison; U.S.	H. Pihlajamäki; Fin.	K. Pihlajamäki; Fin.
Lightweight	K. Anttila; Fin.	R. Vis; U.S.	O. Kapp; Est.	C. Pacome; Fr.	K. Kárpáti; Hung.
Welterweight		H. Gehri; Switz.	A. Haavisto; Fin.	J. Van Bebber; U.S.	F. Lewis; U.S.
Middleweight	E. Leino; Fin.	F. Haggmann; Switz.	E. Kyburz; Switz.	I. Johansson; Swed.	E. Poilvé; Fr.
Light heavyweight	A. Larsson; Swed.	J. Spellman; U.S.	T. Sjostedt; Swed.	P. Mehringer; U.S.	K. Fridell; Swed.
Heavyweight	R. Roth; Switz.	H. Steele; U.S.	J. Richthoff; Swed.	J. Richthoff; Swed.	K. Palusalu; Est.
WRESTLING (GRECO-ROMAN)					
Bantamweight	—	E. Putsep; Est.	C. Leucht; Ger.	J. Brendel; Ger.	M. Lorincz; Hung.
Featherweight	O. Friman; Fin.	K. Anttila; Fin.	V. Väli; Est.	G. Gozzi; It.	Y. Erkan; Turk.
Lightweight	E. Väre; Fin.	O. Friman; Fin.	L. Keresztes; Hung.	E. Malmberg; Swed.	L. Koskela; Fin.
Welterweight	-	E. Vesterlund; Fin.	V. Kokkinen; Fin.	I. Johansson; Swed.	R. Svedberg; Swed.
Middleweight	C. Westergren; Swed.	—	I. Moustafa; Egy.	V. Kokkinen; Fin.	I. Johansson; Swed.
Light heavyweight	C. Johansson; Swed.	C. Westergren; Swed.	—	R. Svensson; Swed.	A. Cadier; Swed.
Heavyweight	A. Lindfors; Fin.	J. Deglane; Fr.	R. Svensson; Swed.	C. Westergren; Swed.	K. Palusalu; Est.
WEIGHT LIFTING					
Featherweight	F. de Haes; Belg.	P. Gabetti; It.	F. Andrysek; Aus.	R. Suvigny; Fr.	A. Terlazzo; U.S.
Lightweight	A. Neyland; Est.	E. Décottignies; Fr.	K. Helbig; Ger.	R. Duverger; Fr.	M. Mesbah; Egy.
Middleweight	B. Gance; Fr.	C. Galimberti; It.	F. Roger; Fr.	R. Ismayr; Ger.	K. El Thouni; Egy.
Light heavyweight	E. Cadine; Fr.	C. Rigoulot; Fr.	S. Nosseir; Egy.	L. Hostin; Fr.	L. Hostin; Fr.
Heavyweight	F. Bottino; It.	G. Tonani; It.	J. Strassberger; Ger.	J. Skobla; Czech.	J. Manger; Ger.
CYCLING					
1,000-m. time trial	—	—	W. Falck-Hansen; Den.	E. Gray; Austr.	A. van Vliet; Neth.
1,000-m. sprint	M. Peeters; Neth.	L. Michard; Fr.	R. Beaufrand; Fr.	J. Van Egmond; Neth.	T. Merkens; Ger.
2,000-m. tandem race	H. Ryan; Gt Brit. T. Lance; Gt.Brit.	J. Cugnot; Fr. L. Choury; Fr.	B. Leene; Neth. D. van Dijk; Neth.	M. Perrin; Fr. L. Chaillot; Fr.	E. Ihbe; Ger. C. Lorenz; Ger.
4,000-m. team pursuit	Italy	Italy	Italy	Italy	France
50-km. race	H. George; Belg.	J. Willems; Neth.	—	—	—
Road race (indiv.)	H. Stenqvist; Swed.	A. Blanchonnet; Fr.	H. Hansen; Den.	A. Pavesi; It.	R. Charpentier; Fr.
Road race (team)	France	France	Denmark	Italy	France
EQUESTRIAN EVENTS					
50 km. long-distance test	E. Johansen; Nor.	—	—	—	—
20 km. long-distance test	J. Misonna; Belg.	—	—	—	—
3-day event (indiv.)	H. Morner; Swed.	A. van der Voort van Zijp; Neth.	F. Pahud de Mortanges; Neth.	F. Pahud de Mortanges; Neth.	L. Stubbendorf; Ger.
3-day event (team)	Sweden	Netherlands	Netherlands	United States	Germany
Dressage (indiv.)	J. Lundblad; Swed.	E. Linder; Swed.	C. von Langen; Ger.	F. Lesage; Fr.	H. Pollay; Ger.
Dressage (team)	Belgium§	—	Germany	France	Germany
Figure riding	T. Bonckaert; Belg.		—	—	—
Prize jumping (indiv.)	T. Lequio; It.‖	A. Gemuseus; Switz.	F. Ventura; Czech.	T. Nishi; Jap.	K. Hasse; Ger.
Prize jumping (team)	Sweden	Sweden	Spain	(all teams disqualified)	Germany
FENCING					
Foil (indiv., men)	N. Nadi; It.	R. Ducret; Fr.	L. Gaudin; Fr.	G. Marzi; It.	G. Gaudini; It.
Foil (indiv., women)	—	E. Osiier; Den.	H. Mayer; Ger.	E. Preis; Aus.	I. Schacherer-Elek; Hung.
Foil (team)	Italy	France	Italy	France	Italy
Épée (indiv.)	A. Massard; Fr.	C. Delporte; Belg.	L. Gaudin; Fr.	C. Cornaggia-Medici; It.	F. Riccardi; It.
Épée (team)	Italy	France	Italy	France	Italy
Sabre (indiv.)	N. Nadi; It.	S. Posta; Hung.	O. Tersztyánszky; Hung.	G. Piller; Hung.	E. Kabos; Hung.
Sabre (team)	Italy	Italy	Hungary	Hungary	Hungary
GYMNASTICS					
All around indiv.	G. Zampori; It.	L. Stukelj; Yugos.	G. Miez; Switz.	R. Neri; It.	A. Schwarzmann; Ger.
Team (men)	Italy	Italy	Switzerland	Italy	Germany
Team (women)	—	—	Netherlands	—	Germany
Team (Swedish system)	Sweden	—	—		—
Team (optional exercises)	Denmark	—	—	United States¶	
Parallel bars	—	A. Guttinger; Switz.	L. Vácha; Czech.	R. Neri; It.	K. Frey; Ger.
Horizontal bar	—	L. Stukelj; Yugos.	G. Miez; Switz.	D. Bixler; U.S.	A. Saarvala; Fin.
Flying rings	—	F. Martino; It.	L. Stukelj; Yugos.	G. Gulack; U.S.	A. Hudec; Czech.
Long horse (vaults)	—	F. Kriz; U.S.	E. Mack; Switz.	S. Guglielmetti; It.	K. Schwarzmann; Ger.
Side horse	—	J. Wilhelm; Switz.	H. Hanggi; Switz.	—	K. Frey; Ger.
Side horse (vaults)	—	A. Séguin; Fr.	—	I. Pelle; Hung.	—
Rope climb	—	B. Supcik; Czech.	—	R. Bass; U.S.	—
Free-standing exercises	—	—	—	I. Pelle; Hung.¶	G. Miez; Switz.
Tumbling	—	—	—	R. Wolfe; U.S.	—
Indian clubs	—	—	—	G. Roth; U.S.	—
ROWING					
Single sculls	J. Kelly; U.S.	J. Beresford; Gt.Brit.	H. Pearce; Austr.	H. Pearce; Austr.	G. Schafer; Ger.
Double sculls	United States	United States	United States	United States	Great Britain
Pairs (with coxswain)	—	Switzerland	Switzerland	United States	Germany
Pairs (without coxswain)	Italy	Netherlands	Germany	Great Britain	Germany
Fours (with coxswain)	Switzerland	Switzerland	Italy	Germany	Germany
Fours (without coxswain)	-	Great Britain	Great Britain	Great Britain	Germany
Eights	United States	United States	United States	United States	United States
YACHTING					
40-m. class	"Sif"; Swed.	—	—	—	—
30-m. class	"Kullan"; Swed.	—	—	—	—
12-m. class (old)	"Atalanta"; Nor.	—	—	—	—
12-m. class (new)	"Heira II"; Nor.	—	—	—	—
10-m. class (old)	"Eleda"; Nor.	—	—	—	—
10-m. class (new)	"Mosk II"; Nor.	—	—	—	—
8-m. class (old)	"Irene"; Nor.	—	—	—	—
8-m. class (new)	"Sildra"; Nor.	"Bera"; Nor.	"L'Aile VI"; Fr.	"Angelita"; U.S.	"Italia"; It.
7-m. class	"Ancora"; Gt.Brit.	—	—	—	—
6.5-m. class (new)	"Oranje"; Neth.	—	—	—	—
6-m. class (old)	"Edelweiss II"; Belg.	—	—	—	—
6-m. class (new)	"Io"; Nor.	"Elisabeth V"; Nor.	"Norna"; Nor.	"Bissbi"; Swed.	"Lalage"; Gt.Brit.
12 ft. centreboard boat	"Beatriss III"; Neth.	L. Huybrechts; Belg.		—	—
12-ft. dinghy		—	S. Thorell; Swed.	—	—
18-ft. centreboard boat	"Brat"; Gt Brit.	—		—	—
Monotype class	—	—		J. Lebrun; Fr.	"Nürnberg"; Neth.
Star class	—	—	—	"Jupiter"; U.S.	"Wannsee"; Ger.

§Figure riding. ‖Hunting competition. ¶Calisthenics.

TABLE IV.—*Olympic Champions, 1920–36 (Continued)*

Event	1920	1924	1928	1932	1936
CANOEING					
Single kayak (1,000 m.)	—	—	—	—	G. Hradetzky; Aus.
Single kayak (10,000 m.)	—	—	—	—	E. Krebs; Ger.
Canadian single (1,000 m.)	—	—	—	—	F. Amyot; Can.
Single collapsible (10,000 m.)	—	—	—	—	G. Hradetzky; Aus.
Double kayak (1,000 m.)	—	—	—	—	Austria
Double kayak (10,000 m.)	—	—	—	—	Germany
Canadian double (1,000 m.)	—	—	—	—	Czechoslovakia
Canadian double (10,000 m.)	—	—	—	—	Czechoslovakia
Double collapsible (10,000 m.)	—	—	—	—	Sweden
SHOOTING					
Rifle (300 m., 2 position)	M. Fisher; U.S.	—	—	—	—
Rifle (300 m., standing)	C. Osburn; U.S.	—	—	—	—
Rifle (300 m., prone)	O. Olsen; Nor.	—	—	—	—
Rifle (600 m., prone)	H. Johansson; Swed.	—	—	—	—
Rifle (all-around)	—	M. Fisher; U.S.	—	—	—
Rifle (team, 300 m., 2 position)	United States	—	—	—	—
Rifle (team, 300 m., standing)	Denmark	—	—	—	—
Rifle (team, 300 m., prone)	United States	—	—	—	—
Rifle (team, 600 m., prone)	United States	—	—	—	—
Rifle (team, all-around)	United States	United States	—	—	—
Small-bore rifle (indiv.)	L. Nuesslein; U.S.	C. Coquelin de Lisle; Fr.	—	B. Rönnmark; Swed.	W. Rögeberg; Nor.
Small-bore rifle (team)	United States	France	—	—	—
Pistol (indiv.)	C. Frederick; U.S.	H. Bailey; U.S.	—	—	C. van Oyen; Ger.
Pistol (team)	United States	United States	—	—	—
Pistol or revolver (indiv.)	G. Paraense; Braz.♀	—	—	R. Morigi; It.	T. Ullmann; Swed.δ
Pistol and revolver (team)	United States	—	—	—	—
Running deer (single shot)	O. Olsen; Nor.	J. Boles; U.S.	—	—	—
Running deer (double shot)	O. Lilloe-Olsen; Nor.	O. Lilloe-Olsen; Nor.	—	—	—
Running deer (team, single shot)	Norway	Norway	—	—	—
Running deer (team, double shot)	Norway	Great Britain	—	—	—
Clay pigeon	M. Arie; U.S.	G. Halasy; Hung.	—	—	—
Clay pigeon (team)	United States	United States	—	—	—
ARCHERY					
Fixed target (team, 2 events)	Belgium	—	—	—	—
Fixed target (indiv., small)	E. van Meer; Belg.	—	—	—	—
Fixed target (indiv., large)	E. Clostens; Belg.	—	—	—	—
Moving target (team, 28 m.)	Netherlands	—	—	—	—
Moving target (team, 33 m.)	Belgium	—	—	—	—
Moving target (team, 50 m.)	Belgium	—	—	—	—
Moving target (indiv., 28 m.)	H. van Innis; Belg.	—	—	—	—
Moving target (indiv., 33 m.)	H. van Innis; Belg.	—	—	—	—
Moving target (indiv. 50 m.)	L. Brulé; Fr.	—	—	—	—
Individual competition (women)	O. Newal; Gt.Brit.	—	—	—	—
LAWN TENNIS					
Men's singles	L. Raymond; S.Af.	V. Richards; U.S.	—	—	—
Men's doubles	O. Turnbull; Gt.Brit. M. Woosnam; Gt.Brit.	F. Hunter; U.S. V. Richards; U.S.	—	—	—
Women's singles	S. Lenglen; Fr.	H. Wills; U.S.	—	—	—
Women's doubles	H. McNair; Gt.Brit. K. McKane; Gt.Brit.	H. Wightman; U.S. H. Wills; U.S.	—	—	—
Mixed doubles	S. Lenglen; Fr. M. Décugis; Fr.	H. Wightman; U.S. R. Williams; U.S.	—	—	—
TEAM SPORTS					
Polo	Great Britain	Argentina	—	—	Argentina
Water polo	Great Britain	France	Germany	Hungary	Hungary
Association football (soccer)	Belgium	Uruguay	Uruguay	—	Italy
Rugby football	United States	United States	—	—	—
Field hockey	Great Britain	—	India	India	India
Basketball	—	—	—	—	United States
Handball	—	—	—	—	Germany
Baseball	—	—	—	—	United States
MISCELLANEOUS SPORTS					
Modern pentathlon	G. Dyrssen; Swed.	B. Lindman; Swed.	S. Thofelt; Swed.	J. Oxenstierna; Swed.	G. Handrick; Ger.
Mountaineering	—	—	—	F. Schmidt; Ger. T. Schmidt; Ger.	—
Gliding	—	—	—	—	H. Schreiber; Ger.
ART CONTESTS					
Architecture	—	—	J. Wils; Neth. A. Hensel; Ger.	J. Hughes; Gt.Brit. G. Saake; Fr. P. Bailey; Fr. P. Montenot; Fr.	W. March; Ger. H. Kutschera; Aus.
Literature	R. Nicolai; It.	G. Charles; Fr.	K. Wierzynski; Pol. F. Mező; Hung.	P. Bauer; Ger.	F. Dhünen; Ger. U. Karhumäki; Fin.
Music	G. Monier; Belg.	—	—	—	P. Höffer; Ger. W. Egk; Ger.
Painting	—	J. Jacoby; Luxem.	I. Israëls; Neth. J. Jacoby; Luxem. W. Nicholson; Gt.Brit.	D. Wallin; Swed. L. Blair; U.S. J. Webster-Golinken; U.S.	A. Diggelmann; Switz.
Sculpture	A. Collin; Belg.	C. Dimitriadis; Gr.	P. Landowski; Fr. E. Grienauer; Aus.	M. Young; U.S. J. Klukowski; Pol.	F. Vignoli; It. E. Sutor; Ger.
WINTER SPORTS					
Figure skating (men)	G. Grafström; Swed.	G. Grafström; Swed.	G. Grafström; Swed.	K. Schafer; Aus.	K. Schäfer; Aus.
Figure skating (women)	M. Mauroy; Swed.	H. Planck Szabó; Aus.	S. Henie; Nor.	S. Henie; Nor.	S. Henie; Nor.
Figure skating (pairs)	L. Jacobsson; Fin. W. Jacobsson; Fin.	H. Engelmann; Aus. A. Berger; Aus.	A. Joly; Fr. P. Brunet; Fr.	A. Brunet; Fr. P. Brunet; Fr.	M. Herber; Ger. E. Baier; Ger.
500-m. speed skating (men)	—	C. Jewtraw; U.S. (44 sec.)	C. Thunberg; Fin. B. Evensen; Nor. (43.4 sec., dead heat)	J. Shea; U.S. (43.4 sec.)	I. Ballangrud; Nor. (43.4 sec.)
500-m. speed skating (women)	—	—	—	J. Wilson; Can. (58 sec.)	—
1,000-m. speed skating (women)	—	—	—	E. Dubois; U.S. (2 min. 4 sec.)	—
1,500-m. speed skating (men)	—	C. Thunberg; Fin. (2 min. 20.8 sec.)	C. Thunberg; Fin. (2 min. 21.1 sec.)	J. Shea; U.S. (2 min. 57.5 sec.)	C. Mathisen; Nor. (2 min. 19.2 sec.)
1,500-m. speed skating (women)	—	—	—	K. Klein; U.S. (3 min. 4 sec.)	—
5,000-m. speed skating (men)	—	C. Thunberg; Fin. (8 min. 39 sec.)	I. Ballangrud; Nor. (8 min. 50.5 sec.)	I. Jaffee; U.S. (9 min. 40.8 sec.)	I. Ballangrud; Nor. (8 min. 19.6 sec.)
10,000-m. speed skating (men)	—	J. Skutnabb; Fin. (18 min. 4.8 sec.)	—	I. Jaffee; U.S. (19 min. 13.6 sec.)	I. Ballangrud; Nor. (17 min. 24.3 sec.)
Combined speed skating (men)	—	C. Thunberg; Fin.	—	—	—
Ice hockey	Canada	Canada	Canada	Canada	Great Britain
Cross-country skiing (18 km.)	—	T. Haug; Nor.	J. Gröttumsbraaten; Nor.	S. Utterström; Swed.	E.-A. Larsson; Swed.
Cross-country skiing (50 km.)	—	T. Haug; Nor.	P. Hedlund; Swed.	V. Saarinen; Fin.	E. Viklund; Swed.

♀Revolver. δSport pistol.

Table IV.—*Olympic Champions, 1920–36 (Continued)*

Event	1920	1924	1928	1932	1936
Winter Sports (*Continued*)					
Nordic combined	—	T. Haug; Nor.	J. Gröttumsbraaten; Nor.	J. Gröttumsbraaten; Nor.	O. Hagen; Nor.
Ski jumping	—	J. Tullin-Thams; Nor.	A. Andersen; Nor.	B. Ruud; Nor.	B. Ruud; Nor.
40-km. skiing relay	—	—	—	—	Finland
Alpine combined (men)	—	—	—	—	F. Pfnür; Ger.
Alpine combined (women)	—	—	—	—	C. Cranz; Ger.
Military ski patrol	—	Switzerland	Norway	—	Italy
Two-man bobsled	—	—	J. Heaton; U.S.[o]	United States	United States
Four-man bobsled	—	Switzerland	United States[°]	United States	Switzerland
Ice shooting (team)	—	—	—	—	Austria
Distance shooting	—	—	—	—	G. Edenhauser; Aus.
Target shooting	—	—	—	—	I. Reiterer; Aus.
Sled-dog race	—	—	—	E. Goddard; Can.	—
Curling	—	Great Britain	—	Canada	—

[o]One-man sled. [°]Five-man sled.

Table V.—*Olympic Champions, 1948–64*

Event	1948	1952	1956	1960	1964
Track and Field—Men					
100-m. dash	H. Dillard; U.S. (10.3 sec.)	L. Remigino; U.S. (10.4 sec.)	R. Morrow, U.S. (10.5 sec.)	A. Hary; Ger. (10.2 sec.)	R. Hayes; U.S. (10 sec.)
200-m. dash	M. Patton; U.S. (21.1 sec.)	A. Stanfield; U.S. (20.7 sec.)	R. Morrow; U.S. (20.6 sec.)	L. Berruti; It. (20.5 sec.)	H. Carr; U.S. (20.3 sec.)
400-m. run	A. Wint; Jam. (46.2 sec.)	G. Rhoden; Jam. (45.9 sec.)	C. Jenkins; U.S. (46.7 sec.)	O. Davis; U.S. (44.9 sec.)	M. Larrabee; U.S. (45.1 sec.)
800-m. run	M. Whitfield; U.S. (1 min. 49.2 sec.)	M. Whitfield; U.S. (1 min. 49.2 sec.)	T. Courtney; U.S. (1 min. 47.7 sec.)	P. Snell; N.Z. (1 min. 46.3 sec.)	P. Snell; N.Z. (1 min. 45.1 sec.)
1,500-m. run	H. Eriksson; Swed. (3 min. 49.8 sec.)	J. Barthel; Luxem. (3 min. 45.2 sec.)	R. Delany; Eire (3 min. 41.2 sec.)	H. Elliott; Austr. (3 min. 35.6 sec.)	P. Snell, N.Z. (3 min. 38.1 sec.)
5,000-m. run	G. Reiff; Belg. (14 min. 17.6 sec.)	E. Zatopek; Czech. (14 min. 6.6 sec.)	V. Kuts; U.S.S.R. (13 min. 39.6 sec.)	M. Halberg; N.Z. (13 min. 43.4 sec.)	R. Schul; U.S. (13 min. 48.8 sec.)
10,000-m. run	E. Zatopek; Czech. (29 min. 59.6 sec.)	E. Zatopek; Czech. (29 min. 17 sec.)	V. Kuts; U.S.S.R. (28 min. 45.6 sec.)	P. Bolotnikov; U.S.S.R. (28 min. 32.2 sec.)	W. Mills, U.S. (28 min. 24.4 sec.)
Marathon	D. Cabrera; Arg. (2 hr. 34 min. 51.6 sec.)	E. Zatopek; Czech. (2 hr. 23 min. 3.2 sec.)	A. Mimoun; Fr. (2 hr. 25 min.)	Abebe Bikila; Eth. (2 hr. 15 min. 16.2 sec.)	Abebe Bikila; Eth. (2 hr. 12 min. 11.2 sec.)
110-m. hurdles	W. Porter; U.S. (13.9 sec.)	H. Dillard; U.S. (13.7 sec.)	L. Calhoun; U.S. (13.5 sec.)	L. Calhoun; U.S. (13.8 sec.)	H. Jones; U.S. (13.6 sec.)
400-m. hurdles	R. Cochran; U.S. (51.1 sec.)	C. Moore; U.S. (50.8 sec.)	G. Davis; U.S. (50.1 sec.)	G. Davis; U.S. (49.3 sec.)	W. Cawley; U.S. (49.6 sec.)
3,000-m. steeplechase	T. Sjostrand; Swed. (9 min. 4.6 sec.)	H. Ashenfelter; U.S. (8 min. 45.4 sec.)	C. Brasher; Gt Brit. (8 min. 41.2 sec.)	Z. Krzyszkowiak; Pol. (8 min. 34.2 sec.)	G. Roelants; Belg. (8 min. 30.8 sec.)
400-m. relay	United States (40.6 sec.)	United States (40.1 sec.)	United States (39.5 sec.)	Germany (39.5 sec.)	United States (39 sec.)
1,600-m. relay	United States (3 min. 10.4 sec.)	Jamaica (3 min. 3.9 sec.)	United States (3 min. 4.8 sec.)	United States (3 min. 2.2 sec.)	United States (3 min. 0.7 sec.)
20-km. walk	J. Mikaelsson; Swed. (45 min. 13.2 sec.)*	J. Mikaelsson; Swed. (45 min. 2.8 sec.)*	L. Spirine; U.S.S.R. (1 hr. 31 min. 27 sec.)	V. Golubnichy; U.S.S.R. (1 hr. 34 min. 7.2 sec.)	K. Matthews; Gt.Brit. (1 hr. 29 min. 34 sec.)
50-km. walk	J. Ljunggren; Swed. (4 hr. 41 min. 52 sec.)	G. Dordoni; It. (4 hr. 28 min. 7.8 sec.)	N. Read, N.Z. (4 hr. 30 min. 42.8 sec.)	D. Thompson; Gt.Brit. (4 hr. 25 min. 30 sec.)	A. Pamich; It. (4 hr. 11 min. 12.4 sec.)
High jump	J. Winter; Austr. (6 ft. 5 15/16 in.)	W. Davis; U.S. (6 ft. 8 5/16 in.)	C. Dumas; U.S. (6 ft. 11 1/2 in.)	R. Shavlakadze; U.S.S.R. (7 ft. 1 1/16 in.)	V. Brumel; U.S.S.R. (7 ft. 1 13/16 in.)
Broad jump	W. Steele; U.S. (25 ft. 8 1/8 in.)	J. Biffle; U.S. (24 ft. 10 in.)	G. Bell, U.S. (25 ft. 8 1/4 in.)	R. Boston; U.S. (26 ft. 7 11/16 in.)	L. Davies; Gt.Brit. (26 ft. 5 11/16 in.)
Pole vault	O. Smith; U.S. (14 ft. 1 5/16 in.)	R. Richards; U.S. (14 ft. 11 1/8 in.)	R. Richards; U.S. (14 ft. 11 1/2 in.)	D. Bragg; U.S. (15 ft. 5 1/8 in.)	F. Hansen; U.S. (16 ft. 8 13/16 in.)
Hop, step and jump	A. Ahman; Swed. (50 ft. 6 5/16 in.)	A. Ferreira da Silva; Braz. (53 ft. 2 9/16 in.)	A. Ferreira da Silva; Braz. (53 ft. 7 11/16 in.)	J. Schmidt; Pol. (55 ft. 1 3/4 in.)	J. Schmidt; Pol. (55 ft. 3 1/4 in.)
16-lb. shot-put	W. Thompson; U.S. (56 ft. 2 in.)	P. O'Brien; U.S. (57 ft. 1 7/16 in.)	P. O'Brien; U.S. (60 ft. 11 1/8 in.)	W. Nieder; U.S. (64 ft. 6 3/4 in.)	D. Long; U.S. (66 ft. 8 3/8 in.)
Discus throw	A. Consolini; It. (173 ft. 1 15/16 in.)	S. Iness; U.S. (180 ft. 6 1/2 in.)	A. Oerter; U.S. (184 ft. 10 7/8 in.)	A. Oerter; U.S. (194 ft. 1 7/8 in.)	A. Oerter; U.S. (200 ft. 1 9/16 in.)
Javelin throw	T. Rautavaara; Fin. (228 ft. 10 7/8 in.)	C. Young; U.S. (242 ft. 3/4 in.)	E. Danielsen; Nor. (281 ft. 2 3/8 in.)	V. Tsibulenko; U.S.S.R. (277 ft. 8 1/4 in.)	P. Nevala, Fin. (271 ft. 2 5/16 in.)
Hammer throw	I. Németh; Hung. (183 ft. 11 1/2 in.)	J. Csermák; Hung. (197 ft. 11 9/16 in.)	H. Connolly, U.S. (207 ft. 3 3/4 in.)	V. Rudenkov, U.S.S.R. (220 ft. 1 11/16 in.)	R. Klim; U.S.S.R. (228 ft. 9 11/16 in.)
Decathlon	R. Mathias; U.S.	R. Mathias; U.S.	M. Campbell, U.S.	R. Johnson; U.S.	W. Holdorf; Ger.
Track and Field—Women					
100-m. dash	F. Blankers-Koen; Neth. (11.9 sec.)	M. Jackson; Austr. (11.5 sec.)	B. Cuthbert; Austr. (11.5 sec.)	W. Rudolph; U.S. (11 sec.)	W. Tyus; U.S. (11.4 sec.)
200-m. dash	F. Blankers-Koen; Neth. (24.4 sec.)	M. Jackson; Austr. (23.7 sec.)	B. Cuthbert; Austr. (23.4 sec.)	W. Rudolph; U.S. (24 sec.)	E. McGuire; U.S. (23 sec.)
400-m. run	—	—	—	—	B. Cuthbert; Austr. (52 sec.)
800-m. run	—	—	—	L. Shevcova; U.S.S.R. (2 min. 4.3 sec.)	A. Packer; Gt Brit. (2 min. 1.1 sec.)
80-m. hurdles	F. Blankers-Koen; Neth. (11.2 sec.)	S. Strickland de la Hunty; Austr. (10.9 sec.)	S. Strickland de la Hunty; Austr. (10.7 sec.)	I. Press, U.S.S.R. (10.8 sec.)	K. Balzer; Ger. (10.5 sec.)
400-m. relay	Netherlands (47.5 sec.)	United States (45.9 sec.)	Australia (44.5 sec.)	United States (44.5 sec.)	Poland (43.6 sec.)
High jump	A. Coachman; U.S. (5 ft. 6 1/8 in.)	E. Brand; S.Af. (5 ft. 5 3/4 in.)	M. McDaniel; U.S. (5 ft. 9 5/16 in.)	Y. Balas; Rum. (6 ft. 13/16 in.)	Y. Balas-Söter; Rum. (6 ft. 2 13/16 in.)
Broad jump	O. Gyarmati; Hung. (18 ft. 8 1/4 in.)	Y. Williams; N.Z. (20 ft. 5 11/16 in.)	E. Krzesinska; Pol. (20 ft. 10 in.)	V. Krepkina; U.S.S.R. (20 ft. 10 3/4 in.)	M. Rand; Gt Brit. (22 ft. 2 1/8 in.)
Shot-put	M. Ostermeyer; Fr. (45 ft. 1 1/2 in.)	G. Zybina; U.S.S.R. (50 ft. 1 9/16 in.)	T. Tychkevich; U.S.S.R. (54 ft. 5 1/8 in.)	T. Press; U.S.S.R. (56 ft. 9 7/8 in.)	T. Press; U.S.S.R. (59 ft. 6 3/16 in.)
Discus throw	M. Ostermeyer; Fr. (137 ft. 6 3/8 in.)	N. Romaschkova; U.S.S.R. (168 ft. 8 7/16 in.)	O. Fikotova; Czech. (176 ft. 1 3/4 in.)	N. Ponomareva; U.S.S.R. (180 ft. 9 1/4 in.)	T. Press; U.S.S.R. (187 ft. 10 3/4 in.)
Javelin throw	H. Bauma; Aus. (149 ft. 6 in.)	D. Zátopková; Czech. (165 ft. 7 in.)	I. Iaounzem; U.S.S.R. (176 ft. 8 1/2 in.)	E. Ozolina; U.S.S.R. (183 ft. 7 7/8 in.)	M. Penes; Rum. (198 ft. 7 7/16 in.)
Pentathlon	—	—	—	—	I. Press; U.S.S.R.
Swimming—Men					
100-m. free style	W. Ris; U.S. (57.3 sec.)	C. Scholes; U.S. (57.4 sec.)	J. Henricks; Austr. (55.4 sec.)	J. Devitt; Austr. (55.2 sec.)	D. Schollander; U.S. (53.4 sec.)
200-m. butterfly	—	—	W. Yorzyk; U.S. (2 min. 19.3 sec.)	M. Troy; U.S. (2 min. 12.8 sec.)	K. Berry; Austr. (2 min. 6.6 sec.)
400-m. free style	W. Smith; U.S. (4 min. 41 sec.)	J. Boiteux; Fr. (4 min. 30.7 sec.)	M. Rose; Austr. (4 min. 27.3 sec.)	M. Rose; Austr. (4 min. 18.3 sec.)	D. Schollander; U.S. (4 min. 12.2 sec.)
1,500-m. free style	J. McLane; U.S. (19 min. 18.5 sec.)	F. Konno; U.S. (18 min. 30.3 sec.)	M. Rose; Austr. (17 min. 58.9 sec.)	J. Konrads; Austr. (17 min. 19.6 sec.)	R. Windle; Austr. (17 min. 1.7 sec.)
100-m. backstroke	A. Stack; U.S. (1 min. 6.4 sec.)	Y. Oyakawa; U.S. (1 min. 5.4 sec.)	D. Theile; Austr. (1 min. 2.2 sec.)	D. Theile; Austr. (1 min. 1.9 sec.)	J. Graef; U.S. (2 min. 10.3 sec.)†
200-m. breast stroke	J. Verdeur; U.S. (2 min. 39.3 sec.)	J. Davies; Austr. (2 min. 34.4 sec.)	M. Furukawa; Jap. (2 min. 34.7 sec.)	W. Mulliken; U.S. (2 min. 37.4 sec.)	I. O'Brien; Austr. (2 min. 27.8 sec.)
400-m. medley	—	—	—	—	R. Roth; U.S. (4 min. 45.4 sec.)
400-m. relay	—	—	—	—	United States (3 min. 33.2 sec.)

*10 km. †200 m.

TABLE V.—*Olympic Champions, 1948–64* (*Continued*)

Event	1948	1952	1956	1960	1964
SWIMMING—MEN (Continued)					
400-m. medley relay	—	—	—	United States (4 min. 5.4 sec.)	United States (3 min. 58.4 sec.)
800-m. relay	United States (8 min 46 sec.)	United States (8 min 31.1 sec.)	Australia (8 min 21 6 sec.)	United States (8 min 10 2 sec)	United States (7 min 52 1 sec.)
Springboard dive	B Harlan; U.S.	D. Browning; U.S.	R. Clotworthy; U.S.	G. Tobian; U.S.	K Sitzberger; U.S.
High dive	S. Lee, U.S.	S Lee; U.S.	J. Capilla Perez, Mex.	R. Webster; U S	R Webster; U.S.
SWIMMING—WOMEN					
100-m. free style	G Andersen; Den. (1 min 6.3 sec.)	K Szöke; Hung. (1 min. 6.8 sec.)	D Fraser; Austr. (1 min 2 sec.)	D Fraser, Austr (1 min 1 2 sec)	D Fraser, Austr. (59 5 sec.)
100-m. butterfly	—	—	S. Mann; U.S. (1 min 11 sec)	C. Schuler; U.S. (1 min 9 5 sec)	S. Stouder; U S. (1 min 4.7 sec)
400-m. free style	A. Curtis; U.S. (5 min 17.8 sec)	V. Gyenge; Hung. (5 min 12 1 sec)	L. Crapp; Austr. (4 min 54 6 sec.)	C. von Saltza; U.S. (4 min 50 6 sec.)	V. Duenkel; U.S. (4 min 43.3 sec.)
100-m. backstroke	K. Harup; Den. (1 min 14 4 sec.)	J. Harrison; S Af. (1 min 14 3 sec.)	J. Grinham, Gt Brit. (1 min 12 9 sec)	L Burke, U S (1 min 9 3 sec)	C Ferguson; U.S. (1 min 7.7 sec)
200-m. breast stroke	N. van Vliet, Neth. (2 min. 57 sec.)	E. Székely; Hung (2 min 51.7 sec.)	U Happe, Ger (2 min 53 1 sec.)	A Lonsbrough, Gt Brit (2 min 49 5 sec)	G Prozumenschikova; U S S R (2 min 46.4 sec.)
400-m. medley	—	—	—	—	D. De Varona; U.S. (5 min. 18.7 sec.)
400-m. relay	United States (4 min 29.2 sec.)	Hungary (4 min. 24 4 sec.)	Australia (4 min. 17 1 sec.)	United States (4 min 8 9 sec)	United States (4 min 3.8 sec.)
400-m. medley relay	—	—	—	United States (4 min 41 1 sec)	United States (4 min. 33.9 sec)
Springboard dive	V. Draves; U.S.	P. McCormick; U.S.	P. McCormick; U.S.	I. Kramer; Ger.	I. Engel-Kramer; Ger.
High dive	V. Draves, U S.	P. McCormick, U S.	P McCormick, U S.	I Kramer; Ger	L Bush; U.S.
BOXING					
Flyweight	P Perez, Arg	N Brooks, U S	T Spinks, Gt Brit	G Torok, Hung	F Atzori; It.
Bantamweight	T. Csik, Hung	P. Hamalainen, Fin.	W Behrendt, Ger	O Grigoriev, U S S R	T Sakurai; Jap.
Featherweight	E Formenti, It	J Zachara, Czech.	V Safronov, U S S R	F. Musso It	S Stepashkin, U.S.S.R.
Lightweight	G Dreyer, S.Af.	A Bolognesi, It.	R Mc Taggart, Gt Brit.	K Pazdzior, Pol	J Grudzien, Pol.
Light welterweight	—	C Adkins, U S	V. Enguibarian, U.S.S.R.	B Nemecek Czech	J Kulej Pol.
Welterweight	J. Torma; Czech.	Z Chychla, Pol.	N. Linca; Rum.	G. Benvenuti; It.	M. Kasprzyk; Pol.
Light middleweight	—	L Papp, Hung	L. Papp; Hung.	W. McClure; U.S.	B. Lagutin; U.S.S.R.
Middleweight	L Papp; Hung.	F Patterson, U.S.	G. Chatkov, U.S.S.R.	E. Crook, U.S.	V. Popenchenko; U S S.R
Light heavyweight	G Hunter, S Af.	N. Lee; U.S.	J. Boyd; U.S.	C. Clay; U.S.	C. Pinto; It.
Heavyweight	R. Iglesias; Arg	E. Sanders; U.S.	P. Rademacher; U.S.	F. de Piccoli; It.	J. Frazier; U.S.
WRESTLING (CATCH-AS-CATCH-CAN)					
Flyweight	L Viitala; Fin.	H Gemici, Turk	M Tsalkalamanidze; U.S.S.R.	A Bilek, Turk	Y. Yoshida; Jap.
Bantamweight	N Akar, Turk.	S Ishii, Jap	M Dagistanli; Turk.	T McCann U S	Y. Uetake, Jap.
Featherweight	G Bilge, Turk.	B Sit Turk	S. Sasahara; Jap.	M Dagistanli Turk.	O Watanabe, Jap.
Lightweight	C. Atik; Turk.	O Anderberg; Swed.	E Habibi; Iran	S Wilson U S	E Dimov; Bulg.
Welterweight	J Dogu; Turk.	W Smith, U S	M. Ikeda Jap	D Blubaugh, U S	I Ogan, Turk.
Middleweight	G Brand, U S	D Cimakuridze, U S S.R.	N Nikolov, Bulg.	H Gungor, Turk	P Gardjev, Bulg.
Light heavyweight	H Wittenberg, U S.	W Palm, Swed	G Takhti Iran	I Atli Turk	A. Medved; U.S.S.R.
Heavyweight	G. Bóbis, Hung	A Mekokishvili, U S S R	H Kaplan; Turk	W Dietrich, Ger	A. Ivanitsky; U.S.S.R.
WRESTLING (GRECO-ROMAN)					
Flyweight	P. Lombardi; It.	B Gurevich, U S S R.	N Soloviev; U.S.S R	D Pirvulescu, Rum	T. Hanahara; Jap.
Bantamweight	K. Pettersen; Swed.	I Hódos, Hung	K Vyropaev; U.S.S.R.	O Karavaev U S S R	M. Ichiguchi; Jap.
Featherweight	M. Oktav; Turk.	Y Punkin, U S S.R.	R. Mäkinen; Fin.	M Sille Turk	I. Polyak; Hung.
Lightweight	G. Freij; Swed.	C Safin; U S S R.	K. Lehtonen; Fin.	A Koridze, U S S R	K. Ayvaz; Turk.
Welterweight	G. Andersson; Swed.	M Szilvási, Hung	M. Bayrak, Turk	M Bayrak, Turk	A. Kolesov; U.S.S.R.
Middleweight	A. Grönberg; Swed.	A. Gronberg; Swed.	G Kartozia, U S S R	D Dobrev, Bulg	B. Simic; Yugos.
Light heavyweight	K. Nilsson; Swed.	K Gröndahl; Fin	V Nikolaev, U S S R.	T Kis, Turk	B. Alexandrov; Bulg.
Heavyweight	A. Kirecci; Turk.	J. Kotkas; U S S R.	A Parfenov, U S S R.	I Bogdan, U S S R	I. Kozma; Hung
JUDO					
Lightweight	—	—	—	—	T Nakatani; Jap.
Middleweight	—	—	—	—	I. Okano; Jap
Heavyweight	—	—	—	—	I Inokuma; Jap.
Nonweight	—	—	—	—	A Geesink; Neth.
WEIGHT LIFTING					
Bantamweight	J. De Pietro; U.S.	I. Udodov; U S S R.	C Vinci; U S	C Vinci, U S	A Vakhonin; U S S.R.
Featherweight	M Fayad; Egy.	R Chimishkyan; U S.S.R.	I Berger, U S	Y Minaev, U S S R	Y. Miyake, Jap.
Lightweight	I. Shams; Egy.	T. Kono, U.S.	I Rybak, U S S R	V Bushuev, U S S R	W Baszanowski; Pol.
Middleweight	F. Spellman; U.S.	P. George; U S.	F. Bogdanovski; U S.S.R.	A Kurynov, U S S R.	H Zdrazila; Czech
Light heavyweight	S. Stanczyk; U.S.	T. Lomakin; U.S.S.R.	T. Kono; U.S.	I Palinski, Pol	R Plyukfeider; U S.S.R.
Middle heavyweight	—	N. Schemansky; U.S.	A. Vorobiev; U.S.S.R.	A Vorobiev, U S S R.	V Golovanov; U S.S.R
Heavyweight	J. Davis; U.S.	J. Davis; U.S	P. Anderson; U.S.	Y Vlasov, U.S S R.	L Zhabotinsky; U S.S.R.
CYCLING					
1,000-m. time trial	J Dupont, Fr.	R. Mockridge; Austr.	L. Faggin; It.	S. Gaiardoni; It.	P. Sercu; Belg.
1,000-m. sprint	M. Ghella, It.	E. Sacchi; It	M Rousseau; Fr.	S Gaiardoni, It.	G Pettenella; It.
2,000-m. tandem	P. Perona; It. F. Teruzzi; It.	R Mockridge; Austr. L Cox; Austr.	J Browne, Austr A. Marchant; Austr.	G Beghetto, It S Bianchetto, It.	A Damiano; It. S Bianchetto; It.
4,000-m. pursuit (indiv.)	—	—	—	—	J. Daller; Czech.
4,000-m pursuit (team)	France	Italy	Italy	Italy	Germany
Road race (indiv.)	J. Beyaert; Fr.	A. Noyelle; Belg.	E Baldini; It.	V Kapitonov; U.S S.R.	M Zanin; It.
Road race (team)	Belgium	Belgium	France	Italy	Netherlands
EQUESTRIAN EVENTS					
Dressage (indiv.)	H Moser; Switz.	H St Cyr; Swed.	H St Cyr; Swed.	S. Filatov; U S S.R.	H Chammartin; Switz.
Dressage (team)	France	Sweden	Sweden	—	Germany
3-day event (indiv.)	B Chevallier; Fr.	H von Blixen-Finecke; Swed.	P Kastenman; Swed.	L. Morgan, Austr.	M. Checcoli; It.
3 day event (team)	United States	Sweden	Great Britain	Australia	Italy
Prize jumping (indiv.)	H. Mariles Cortes; Mex.	P Jonquères d'Oriola; Fr.	H. Winkler, Ger.	R. d'Inzeo, It.	P Jonquieres d'Oriola; Fr.
Prize jumping (team)	Mexico	Great Britain	Germany	Germany	Germany
FENCING					
Foil (indiv.)	J. Buhan; Fr.	C. d'Oriola; Fr.	C d'Oriola; Fr	V Zdanovich, U S S R	E. Franke; Pol.
Foil (indiv , women)	I. Elek; Hung.	I Camber; It.	G. Sheen; Gt.Brit.	A Schmid; Ger.	I. Ujlaki Rejto; Hung.
Foil (team)	France	France	Italy	U.S S R	U S S R.
Foil (team, women)	—	—	—	U S S R.	Hungary
Épée (indiv.)	L. Cantone; It.	E Mangiarotti; It.	C Pavesi; It.	G Delfino; It.	G Kriss; U.S.S.R.
Épée (team)	France	Italy	Italy	Italy	Hungary
Sabre (indiv.)	A Gerevich; Hung.	P. Kovács; Hung.	R. Kárpáti; Hung.	R. Kárpáti; Hung.	T Pezsa; Hung.
Sabre (team)	Hungary	Hungary	Hungary	Hungary	U.S.S.R.
GYMNASTICS—MEN					
All-around indiv.	V. Huhtanen; Fin.	V. Chukarin; U.S.S.R.	V Chukarin; U.S S.R.	B Chakhlin; U.S S.R.	Y Endo; Jap.
Team	Finland	U.S.S.R.	U.S.S.R.	Japan	Japan
Parallel bars	M. Reusch; Switz.	H Eugster; Switz.	V Chukarin; U.S S R.	B. Chakhlin; U S S R.	Y Endo; Jap.
Horizontal bar	J Stalder, Switz.	J. Gunthard; Switz.	T. Ono; Jap.	T. Ono; Jap.	B. Chakhlin; U.S.S.R.
Side horse	P. Aaltonen; Fin. V Huhtanen, Fin H Savolainen; Fin. (tied)	V. Chukarin; U.S.S.R.	B. Chakhlin; U.S.S.R.	B. Chakhlin; U.S.S.R. E. Ekman, Fin (tied)	M. Cerar; Yugos.
Long horse (vaults)	P. Aaltonen; Fin.	V. Chukarin; U.S.S R.	V. Muratov; U S S R. H. Bantz, Ger. (tied)	B. Chakhlin; U S S R T. Ono, Jap (tied)	H. Yamashita; Jap.
Flying rings	K. Frei; Switz.	G. Chaguinian; U.S.S.R.	A. Azarian, U S S R	A. Azarian, U S.S.R.	T Hayata; Jap.
Free exercises	F. Pataki; Hung.	K Thoresson; Swed.	V. Muratov; U S.S.R.	N. Aihara, Jap.	F. Menichelli; It.
Mass exercises	—	Finland	—	—	—

Table V.—*Olympic Champions, 1948–64* (*Continued*)

Event	1948	1952	1956	1960	1964
Gymnastics—Women					
All around indiv.	—	M Gorokhovskaya; U.S.S.R.	L. Latynina; U.S.S.R.	L. Latynina; U.S.S.R.	V. Caslavska; Czech.
Team	Czechoslovakia	U.S.S.R.	U.S.S.R.	U.S.S.R.	U.S.S.R.
Hand apparatus team	—	Sweden	—	—	—
Parallel bars	—	M Korondi; Hung.	A. Keleti; Hung.	P Astakhova; U S S R	P. Astakhova; U S S.R.
Horse vaults	—	E. Kalinchuk, U S S.R.	L Latynina; U S S.R.	M Nikolaeva; U S S R	V Caslavska; Czech.
Beam exercises	—	N Bocharova; U.S.S.R.	A. Keleti, Hung	E Bosakova; Czech	V Caslavska, Czech.
Free exercises	—	A. Keleti; Hung.	L. Latynina, U S S.R. A. Keleti; Hung. (tied)	L. Latynina, U.S.S.R.	L. Latynina; U S S.R.
Team drill	—	—	Hungary	—	—
Rowing					
Single sculls	M. Wood; Austr.	Y. Chukalov; U.S.S.R.	V. Ivanov; U.S.S.R.	V Ivanov; U.S.S.R.	V Ivanov; U.S.S.R.
Double sculls	Great Britain	Argentina	U S S R	Czechoslovakia	U.S S R.
Pairs (without coxswain)	Great Britain	United States	United States	U S S R.	Canada
Pairs (with coxswain)	Denmark	France	United States	Germany	United States
Fours (without coxswain)	Italy	Yugoslavia	Canada	United States	Denmark
Fours (with coxswain)	United States	Czechoslovakia	Italy	Germany	Germany
Eights	United States	United States	United States	Germany	United States
Canoeing					
Single kayak (women, 500 m)	K Hoff; Den	S. Saimo; Fin.	E. Dementieva, U S.S.R.	A Seredina; U.S S.R.	L Khvedosiuk; U.S.S.R.
Single kayak (1,000 m)	G Fredriksson, Swed.	G Fredriksson; Swed.	G. Fredriksson; Swed.	E. Hansen; Den.	R. Peterson; Swed.
Single kayak (10 000 m)	G Fredriksson, Swed.	T. Strömberg, Fin.	G Fredriksson, Swed.	—	—
Canadian single (1,000 m.)	J. Holecek; Czech.	J. Holecek; Czech.	L. Rottman; Rum.	G. Parti; Hung.	J. Eschert; Ger.
Canadian single (10,000 m.)	F. Capek; Czech.	F. Havens; U.S.	L. Rottman; Rum.	—	—
Double kayak (women, 500 m.)	—	—	—	U.S S.R.	Germany
Double kayak (1,000 m.)	Sweden	Finland	Germany	Sweden	Sweden
Double kayak (10,000 m.)	Sweden	Finland	Hungary	—	—
Canadian double (1,000 m.)	Czechoslovakia	Denmark	Rumania	U.S.S.R.	U.S.S.R.
Canadian double (10,000 m)	United States	France	U.S.S.R.	—	—
Single kayak relay	—	—	—	Germany	—
Kayak fours	—	—	—	—	U S S.R.
Yachting					
6-m. class	"Llanoria"; U.S.	"Llanoria"; U.S.	—	—	—
5.5-m. class	—	"Complex II"; U.S.	"Rush V"; Swed.	"Minotaur"; U.S.	"Barrenjoey"; Austr.
Dragon class	"Pan", Nor	"Pan"; Nor.	"Slaghoken II", Swed.	"Nirefs', Gr.	"White Lady"; Den.
Star class	"Hilarius"; U.S.	"Merope"; It.	"Kathleen"; U.S.	"Tornado"; U.S.S.R.	"Gem"; Bahamas
Flying Dutchman class	—	—	—	"Sirene"; Nor.	"Pandora"; N.Z.
Swallow class	"Swift"; Gt.Brit.	—	—	—	—
Firefly class	P. Elvström; Den.	—	—	—	—
Sharpie class	—	—	"Jest"; N.Z.	—	—
Monotype class	—	P Elvström; Den.	P Elvström; Den.	P. Elvström; Den.	W. Kuhweide; Ger.
Shooting					
Rifle	E Grunig, Switz.	A Bogdanov, U.S.S.R.	V Borissov; U S S.R.	H Hammerer, Aus	G. Anderson; U S
Small-bore rifle (prone)	A. Cook; U.S.	I. Sarbu; Rum.	G. Oulette; Can.	P. Kohnke; Ger.	L Hammerl; Hung.
Small-bore rifle (all-around)	—	E Kongsnaug, Nor.	A. Bogdanov; U.S S R.	V.Shamburkin;U.S.S.R.	L Wigger, U S.
Pistol	K. Takács; Hung.	K Takács, Hung.	S Petrescu, Rum ‡	W. McMillan; U.S.	P Linnosvuop, Fin
Sport pistol.	E. Vásquez Cam; Peru	H Benner, U.S	P. Linnosvuo; Fin.	A. Gustchin; U.S.S.R.	V. Markkanen; Fin.
Clay pigeon	—	G. Généreux; Can.	G. Rossini; It.	I. Dumitrescu; Rum.	E. Mattarelli; It.
Running deer	—	J Larsen; Nor	V Romanenko; U S S R	—	—
Team Sports					
Water polo	Italy	Hungary	Hungary	Italy	Hungary
Association football (soccer	Sweden	Hungary	U S S R.	Yugoslavia	Hungary
Field hockey	India	India	India	Pakistan	India
Basketball	United States	United States	United States	United States	United States
Volleyball (men)	—	—	—	—	U.S.S.R.
Volleyball (women)	—	—	—	—	Japan
Lacrosse	U.S. v. Gt.Brit. (tie)	—	—	—	—
Field handball	—	Sweden	—	—	—
Finnish baseball	—	Finland	—	—	—
Miscellaneous Sports					
Modern pentathlon (indiv.)	W. Grut; Swed.	L. Hall; Swed.	L. Hall, Swed.	F Nemeth, Hung.	F Torok; Hung.
Modern pentathlon (team)	—	Hungary	U.S.S.R.	Hungary	U.S.S.R.
Art Contests					
Architecture	Y. Lindegren, Fin. A. Hoch; Aus.	—	—	—	—
Literature	A. Tynni; Fin. G. Stuparich; It.	—	—	—	—
Music	Z. Turski; Pol.	—	—	—	—
Painting and drawing	A. Thomson; Gt.Brit.	—	—	—	—
Sculpture	A. Decaris; Fr. G. Nordahl; Swed.	—	—	—	—
Winter Sports					
Figure skating (men)	R Button; U.S.	R Button; U S	H Jenkins; U S.	D. Jenkins, U S	M Schnelldorfer; Ger.
Figure skating (women)	B Scott, Can	J Altwegg; Gt Brit.	T Albright, U S.	C Heiss, U.S.	S Dijkstra, Neth
Figure skating (pairs)	M Lannoy, Belg P Baugniet; Belg.	R Falk, Ger. P, Falk; Ger.	E Schwarz, Aus. K, Oppelt; Aus.	R. Paul, Can B. Wagner; Can.	O. Protopopov, U.S S R. L. Belousova; U S S.R.
500-m speed skating (men)	F Helgesen; Nor. (43.1 sec)	K Henry, U S. (43.2 sec.)	Y. Grishin; U.S.S.R. (40.2 sec.)	Y. Grishin; U.S.S R. (40 2 sec)	R McDermott; U S. (40.1 sec.)
500 m. speed skating (women)	—	—	—	H. Haase; Ger. (45.9 sec.)	L. Skoblikova; U.S.S.R. (45 sec.)
1,000-m. speed skating (women)	—	—	—	K. Guseva; U.S.S.R. (1 min 34 1 sec)	L. Skoblikova; U.S.S.R. (1 min 33 2 sec.)
1,500-m speed skating (men)	S. Farstad; Nor. (2 min. 17.6 sec.)	H. Andersen; Nor. (2 min. 20.4 sec.)	Y. Mikhailov; U.S.S.R. Y. Grishin; U.S.S.R. (tied) (2 min. 8.6 sec.)	Y. Grishin; U.S.S.R. R. Aas; Nor. (tied) (2 min. 10.4 sec.)	A. Antson; U.S.S.R. (2 min. 10.3 sec.)
1,500-m. speed skating (women)	—	—	—	L. Skoblikova; U.S.S.R. (2 min. 25.2 sec.)	L. Skoblikova; U.S.S.R. (2 min. 22.6 sec.)
3,000-m. speed skating (women)	—	—	—	L. Skoblikova; U.S.S.R. (5 min. 14.3 sec.)	L. Skoblikova; U.S.S.R. (5 min. 14.9 sec.)
5,000-m. speed skating (men)	R. Liaklev; Nor. (8 min 29 4 sec.)	H. Andersen; Nor. (8 min 10 6 sec.)	B. Shilkov; U.S.S.R. (7 min. 48 7 sec)	V. Kosichkin; U.S.S.R. (7 min 51 3 sec)	K. Johannesen; Nor. (7 min 38.4 sec.)
10,000-m speed skating (men)	A. Seyffarth; Swed. (17 min. 26.3 sec.)	H. Andersen; Nor. (16 min 45.8 sec.)	S. Ericsson; Swed. (16 min. 35.9 sec)	K. Johannesen; Nor. (15 min 46 6 sec)	J. Nilsson; Swed. (15 min 50.1 sec.)
Ice hockey	Canada	Canada	U.S.S.R.	United States	U.S.S.R.
Bandy (ice football)	—	Sweden	—	—	—
Silhouette pistol.					

TABLE V.—*Olympic Champions, 1948–64 (Continued)*

Event	1948	1952	1956	1960	1964
			WINTER SPORTS (*Continued*,		
5-km. cross-country ski (women)	—	—	—	—	C. Boyarskikh; U.S.S.R.
10-km. cross-country ski (women)	—	L. Wideman; Fin.	L. Kozyreva; U.S.S.R.	M. Gusakova; U.S.S.R.	C. Boyarskikh; U.S.S.R.
15-km. cross-country ski (men)	M. Lundström; Swed §	H. Brenden; Nor.§	H. Brenden; Nor.	H. Brusveen; Nor.	E. Mäntyranta; Fin.
30-km. cross-country ski (men)	—	—	V. Hakulinen; Fin.	S. Jernberg; Swed.	E. Mäntyranta; Fin.
50-km. cross-country ski (men)	N. Karlsson; Swed.	V. Hakulinen; Fin.	S. Jernberg; Swed.	K. Hamalainen; Fin.	S. Jernberg; Swed.
15-km. ski relay (women)	—	—	Finland	Sweden	U.S.S.R.
40-km. ski relay (men)	Sweden	Finland	U S S.R	Finland	Sweden
Nordic combined (men)	H. Hasu; Fin.	S. Slättvik; Nor.	S. Stenersen; Nor.	G. Thoma; Ger.	T. Knutsen; Nor
Ski jumping (men)	P. Hugsted; Nor.	A. Bergmann; Nor.	A. Hyvärinen; Fin.	H. Recknagel; Ger.	T. Engan; Nor.‖ V. Kankkonen, Fin.¶
Biathlon (men)	—	—	—	K. Lestander; Swed.	V. Melanin; U S S.R.
Slalom (men)	E. Reinalter; Switz.	O. Schneider; Aus.	A. Sailer; Aus.	E. Hinterseer, Aus	J. Stiegler; Aus.
Slalom (women)	G. Frazer; U.S.	A. Lawrence; U.S.	R. Colliard; Switz.	A. Heggtveit, Can.	C. Goitschel; Fr.
Giant slalom (men)	—	S. Eriksen; Nor.	A. Sailer; Aus.	R. Staub, Switz	F. Bonlieu, Fr.
Giant slalom (women)	—	A. Lawrence; U.S.	O. Reichert; Ger.	Y. Ruegg; Switz.	M. Goitschel; Fr.
Downhill ski race (men)	H. Oreiller; Fr.	Z. Colo; It.	A. Sailer; Aus	J. Vuarnet; Fr.	E. Zimmermann; Aus.
Downhill ski race (women)	H. Schlunegger; Switz.	T. Jochum-Beiser; Aus.	M. Berthod; Switz.	H. Beibl; Ger.	C. Haas; Aus.
Alpine combined (men)	H. Oreiller; Fr.	—	—	—	—
Alpinecombined (women)	T. Beiser; Aus.	—	—	—	—
Skeleton bobsled	N. Bibbia; It.	—	—	—	—
Two-man bobsled	Switzerland	Germany	Italy	—	Great Britain
Four-man bobsled	United States	Germany	Switzerland	—	Canada
Luge (indiv., men)	—	—	—	—	T. Köhler; Ger.
Luge (indiv., women)	—	—	—	—	O. Enderlein; Ger
Luge (pairs, men)	—	—	—	—	Austria
Military ski patrol	Switzerland	—	—	—	—
Winter pentathlon	G. Lindh; Swed.	—	—	—	—
Austrian curling	—	—	—	—	Austria

§18 km. ‖big jump. ¶small jump.

Brown, Godfrey Rampling and William Roberts defeated the U.S. in the 1,600-m. relay. Finland swept the distance races with Gunnar Höckert, Ilmari Salminen and Iso-Hollo, while Germany was limited to weight victories by Hans Woellke, Karl Hein and Gerhard Stöck.

London, 1948.—To Wembley stadium for the XIV Olympiad came the victorious nations of World War II (except the U.S.S.R.) and the neutrals. Germany and Japan, growing athletic powers of the 1930s, were absent, but were to be present in 1952 at Helsinki. It was predicted that only neutral Sweden would be able to challenge U.S. athletes in track and field and so it proved, with no other nation having more than one gold medalist. The U.S. champions of 1936 were gone, but new names replaced them. Hurdler Harrison Dillard failed to qualify in his own event, but went on to qualify for and win the 100-m. dash. Melvin Patton won the 200-m. dash, Mal Whitfield the 800-m. run and William Porter and Roy Cochran the hurdles. In the field events, Owen Guinn Smith, Willie Steele and Wilbur Thompson scored easy victories. A 17-year-old California schoolboy, Robert Mathias, won the grueling decathlon test and the two U.S. relay teams scored handily. Great Britain was completely shut out, but Arthur Wint of Jamaica in the 400-m. run and John Winter of Australia in the high jump scored for the British Commonwealth. Swedish gold medals were earned by Henry Eriksson, Thore Sjöstrand, John Mikaelsson, John Ljunggren and Arne Ahman. The 10,000-m. run was won by Czechoslovakian Emil Zátopek, in record time.

Helsinki, 1952.—Paavo Nurmi himself lit the flame to open the XV Olympiad, but the host nation failed to win a gold medal for the first time since 1908. The king of distance runners at Helsinki was the Czech, Zátopek, whose iron legs carried him to a feat Nurmi never even attempted—a sweep of the 5,000-m. and 10,000-m. runs and the marathon, with Olympic records for all three. To add an extra touch, Zátopek's wife, Dana Zátopková, won the women's javelin throw. The 14 U.S. gold medals for men's track and field did not match the 22 of 1904, but the competition was much keener. There was no double winner for the U.S., but Whitfield and Mathias repeated their 1948 victories, while Dillard switched back to the hurdles and defeated his teammate Jack Davis by inches. Horace Ashenfelter scored a most unexpected triumph for the U.S. in the 3,000-m. steeplechase and Joseph Barthel claimed Luxembourg's first Olympic gold medal in the 1,500-m. run. World records came in seven events: steeplechase; 50-km. walk; 1,600-m. relay; hop, step and jump; hammer throw; decathlon; and marathon.

Melbourne, 1956.—The years between the XV and XVI Olympiads saw three of man's great goals in track and field achieved. Roger Bannister of Great Britain broke the 4-min. barrier in the mile, Parry O'Brien of the United States surpassed 60 ft. in the shot-put and Charles Dumas of the U.S. qualified for the games by clearing 7 ft. in the high jump. Bannister had retired by 1956, but O'Brien and Dumas were among the 15 U.S. champions in men's track and field at Melbourne. As in the case of the Olympiad at Los Angeles, traveling distances cut down the number of individual entries and six nations also withdrew for various reasons on the eve of the games. However, none of the absentees were track and field powers and the competition was as brilliant as ever. The U.S.S.R. scored its first victories as Vladimir Kuts won the 5,000-m. and 10,000-m. runs and Leonid Spirine took the 20-km. walk. Egil Danielsen of Norway set a world's record in the javelin throw and A. Ferreira da Silva of Brazil repeated his Helsinki triumph and improved his Olympic record in the hop step and jump. Alain Mimoun of France, Zátopek's shadow at London and Helsinki, upset his foe in the marathon and Great Britain's Chris Brasher survived a foul call to win the steeplechase. Otherwise, it was a U.S. show. Even the 1,500-m. winner and record setter, Ronald Delany of Ireland, was a college student in the United States. The U.S. stars set records in almost every case: Robert Morrow in the 200-m. dash, after a nonrecord triumph in the 100-m. dash; Thomas Courtney in the 800-m. run; Lee Calhoun in the high hurdles; Glenn Davis in the 400-m. hurdles; Robert Richards in the pole vault, Dumas and O'Brien in their specialties; Alan Oerter in the discus; Harold Connolly in the hammer throw; Milton Campbell in the decathlon; and Morrow, Leamon King, Ira Murchison and Walter Thane Baker in the 400-m. relay. In women's track and field events, Mildred McDaniel set a new record for the high jump.

Rome, 1960.—No one person dominated track and field as had Nurmi, Owens, Zátopek or Kuts in the past, when the city of Rome whence had come the Roman decree abolishing the ancient games more than 1,500 years before, played host to the contests of the XVII Olympiad. Despite this, however, records were broken in 18 of the 24 athletic events, tied in one, and unofficially broken in the marathon, for which no official records are kept. The supremacy of the U.S. in men's track and field events slipped in Rome, the U.S. taking only 9 gold medals against 15 at Melbourne in 1956. Rafer Johnson, silver-medal winner at Melbourne behind Milton Campbell, set a new record in the decathlon. Lee Calhoun, Glenn Davis and Al Oerter repeated their Melbourne victories in the 110-m. hurdles, the 400-m. hurdles and the discus throw, respectively, Davis and Oerter breaking their own 1956 records. The oldest unequalled record in the Olympics, Jesse Owens' 1936 broad-jump mark, finally fell after nearly a quarter century to

Ralph Boston of the U.S. Other records set by U.S. athletes included those by Don Bragg in the pole vault, Bill Nieder in the shot-put and Otis Davis in the 400-m. run. Both Glenn and Otis Davis became double gold-medal winners by running with the record-breaking U.S. 1,600-m. relay team. The only other double winner in men's track and field was Armin Hary of Germany, whose record victory in the 100-m. dash and participation with the record-tying 400-m. relay team gave Germany its first gold track medals in the modern Olympics. Italy, too, was jubilant over its first gold track medal since 1932, won by Livio Berruti who set a record in the 200-m. dash. The U.S.S.R. increased its harvest of track and field gold medals from 3 in Melbourne to 5 in Rome. Records were set by Pyotr Bolotnikov in the 10,000-m. run, by Robert Shavlakadze in the high jump and by Vasily Rudenkov in the hammer throw. Other winners were Viktor Tsibulenko in the javelin throw and Vladimir Golubnichy in the 20-km. walk. Records were also broken in the 800-m. run by Peter Snell of New Zealand, in the 1,500-m. run by Herb Elliott of Australia and by Donald Thompson of Great Britain in the 50-km. walk. Poland took two gold medals, both records, when Zdzislaw Krzyszkowiak took the 3,000-m. steeplechase and Joszef Schmidt won the hop, step and jump. One of the most dramatic victories of the games, reminiscent of Spyros Louis' feat in 1896, came in the marathon, when Abebe Bikila, running barefooted, covered the grueling distance faster than any other modern athlete and thus brought Ethiopia its first Olympic gold medal in history. In women's track and field the 800-m. run, discontinued after the 1928 Olympics because it was too hard on the participants, was revived and won in record time by Ludmila Shevcova of the Soviet Union. Records were also set by Vera Krepkina in the broad jump, by Tamara Press in the shot-put, by Nina Ponomareva in the discus throw and by Elvira Ozolina in the javelin throw as the Soviets took 6 of the 10 events. Yolanda Balas of Rumania set a new record in the high jump. The most outstanding woman athlete and the only triple winner of either sex in track and field was Wilma Rudolph of the U.S. who won the 100- and 200-m. dashes and anchored the victorious 400-m. relay team.

Tokyo, 1964.—In this first Olympics held in Asia, U.S. athletes won half of the 24 gold medals given in men's athletics (track and field), setting eight Olympic and two world records in the process. Bob Hayes tied the world record in winning the 100-m. dash and anchored the record-breaking U.S. 400-m. relay team, and Henry Carr and Mike Larrabee took gold medals in the 200-m. and 400-m. runs, respectively, and were members of the world record, 1,600-m. relay team. Peter Snell of New Zealand, the only individual double winner, repeated his 1960 triumph with a new Olympic record in the 800-m. run and then finished first in the 1,500-m. event. Although the U.S. had never won at the longer distances, Billy Mills set a new Olympic record in the 10,000-m. run and Bob Schul took the gold medal at 5,000 m. Both hurdling events were won by U.S. men—Hayes Jones in the 110-m. hurdles and Rex Cawley at 400-m.—while Abebe Bikila of Ethiopia became the first man ever to win two marathons in the modern Olympics. Olympic records were also set in the 3,000-m. steeplechase by Gaston Roelants of Belgium and in the 20-km. walk by Ken Matthews of Great Britain, while Abdon Pamich of Italy set a world record in the 50-km. walk.

In field events Olympic records fell to Al Oerter of the U.S. (his third) in the discus throw, Josef Schmidt of Poland in the triple jump (his second), Valery Brumel of the U.S.S.R. in the high jump, Fred Hansen of the U.S. in the pole vault, Dallas Long of the U.S. in the shot-put and Romuald Klim of the U.S.S.R. in the hammer throw. Major upsets included the victories of Lynn Davies of Great Britain in the broad jump and Willi Holdorf of Germany in the decathlon.

In women's track and field the only double winner was Tamara Press of the U.S.S.R. who won the shot-put, as she did in 1960, and the discus throw. Her sister Irena, winner of the 80-m. hurdles at Rome, won the new women's pentathlon. Betty Cuthbert of Australia, winner of three gold medals in 1956, added a fourth with a victory in the 400-m. run. Wyomia Tyus and Edith McGuire of the U.S. won the 100-m. and 200-m. dashes, respectively. Great Britain came through with victories by Ann Packer in the 800-m. run and Mary Rand in the broad jump. Rumania's winners were high jumper Yolanda Balas-Söter (who also won in 1960) and Mihaela Penes who won the women's javelin throw.

See also references under "Olympic Games" in the Index.

BIBLIOGRAPHY.—An official report is published by the organizing committee for each set of games. National Olympic committees also issue reports. *See* also J. Kieran and A. Daley, *The Story of the Olympic Games, 776 B.C.–1956 A.D.* (1957); F. A. M. Webster, *Olympic Cavalcade* (1948); E. A. Bland (ed.), *Olympic Story* (1948); B. Henry, *Approved History of the Olympic Games* (1948); F. Mezö, *The Modern Olympic Games* (1956). (Av. Br.; D. Sr.; X.)

OLYMPIC NATIONAL PARK, in the state of Washington, was established in 1938 to protect the Olympic mountains and their incomparable forests and wildlife, as well as a 50-mi. stretch of unspoiled Pacific shore line. It includes 896,599 ac. There are active glaciers on Mt. Olympus, 7,954 ft., and probably more than 100 glaciers, presenting some of the finest examples of glaciation in the United States, exist in the park. Frequent warm rain clouds from the Japanese current provide an average annual precipitation of 142 in. on the western slope, producing rain-forest conditions in which native conifers grow to their largest size. Records include western red cedar, 20 ft. in breast-high diameter; Douglas fir, 17 ft. 8 in.; Sitka spruce, 16 ft. 3 in.; and western hemlock, 9 ft. This rain forest extends 12 mi. along the river valleys. In its depths trunks and fallen logs are densely covered with carpeting mosses which impart a golden luminescence, and fungi grow to immense dimensions.

On the eastern slopes, which are less moist, are many forested canyons with quiet lakes and meadows. Six thousand Roosevelt elk range in the park, as do Columbian black-tailed deer, black bear and cougar; 140 species of birds have been recorded. The ocean strip safeguards a wilderness shore of rocky points, sandy beaches, islets and tidal pools, where myriad invertebrate animals live. Three Indian reservations lie in the ocean strip and another adjoins it to the south. The park offers excellent mountain climbing, camping and pack trips, and 500 mi. of trails lead into the wilderness regions. Convenient access is afforded by road, ferry, bus and airline. Lodges, motels and ranches provide accommodation. (F. M. Pd.)

OLYMPIODORUS, the name of several ancient Greek writers. The following are noteworthy:

1. Olympiodorus of Thebes (5th century A.D.), a historical writer, came from Thebes in Egypt. He was sent on a mission to Attila by the Western Roman emperor Honorius in 412 and later went to live at the court of the Eastern emperor Theodosius II. His history dealt with events in the west from 407 to 425, in 22 books. An abstract of it is preserved in the *Bibliotheca* of Photius.

For the text *see* C. Muller (ed.), *Fragmenta historicorum graecorum*, iv (1851); L. Dindorf (ed.), *Historici graeci minores*, i (1870).

2. The elder Olympiodorus of Alexandria (5th century A.D.), a Peripatetic, lectured on Aristotle in Alexandria and is chiefly remembered as one of the teachers of Proclus.

3. The younger Olympiodorus of Alexandria (6th century A.D.), a Neoplatonist, appears to have maintained the Platonic tradition in Alexandria after the emperor Justinian had suppressed the Athenian school in 529 (*see* ACADEMY, GREEK; and NEOPLATONISM). This seems to be the sense of his remark that the Platonic succession had not been interrupted despite the confiscations that it had endured. His philosophy is in close conformity with that of his Athenian contemporary Damascius (*q.v.*). His works include lucid and valuable commentaries on Plato's *Phaedo* (ed. by W. Norwin [1913]), *Gorgias* (ed. by W. Norwin, [1936]), *Philebus* and *Alcibiades I*; a life of Plato; an introduction to Aristotle's philosophy; and commentaries on Aristotle's *Categories* and *Meteora*.

See F. Überweg and K. Praechter, *Die Philosophie des Altertums*, 12th ed. (1926).

4(?). Olympiodorus the alchemist, author of a work *On the Sacred Art of the Philosopher's Stone* (ed. by M. Berthelot, *Collection des alchimistes grecs* [1887–88]), is variously identified by scholars: sometimes with Olympiodorus of Thebes, sometimes with Olympiodorus the Neoplatonist.

OLYMPUS (etymology very doubtful, probably not Greek), the name of several mountains and ridges in Greece and Asia Minor, also of sundry mythical persons, some perhaps originally mountain spirits or gods, and of a city in Lycia (Deliktas near modern Cirali on the west coast of the Gulf of Antalya, Turkey).

The ancient Mts. Olympus included in Asia Minor the modern Ulu Dag near Brusa (the ancient Mysian Olympus) and probably Musa Dagi (above the Lycian city Olympus); in Cyprus the highest point of the Troödos massif; and in Lesbos modern Mt. Ayios Ilias. The modern place name Olimbos indicates several mountains, hills and villages in Greece anciently called Olympus, but the most important is the great mountain (9,570 ft.) on the borders of Macedonia and Thessaly, across the Vale of Tempe from Mt. Ossa. Of imposing appearance, it was thought from an unknown but early date to be the abode of the celestial gods. As they were also thought to live in the sky, supposed to be a solid vault of bronze, stone or some other hard material, confusion between the mountain top and the heavens was natural and occurs as early as Homer. Thus, in *Iliad*, i, Athena comes down "from heaven" to speak to Achilles, and then returns "to Olympus, to the house of aegis-wearing Zeus." But in *Odyssey*, xi, the sky is some way above the summit of Olympus, for the Aloadae plan to pile Ossa and Pelion on it "that the sky might be climbed." Evidently there was no fixed or consistent doctrine, and attempts to assign the differing accounts in the poems to different dates or strata of belief are quite groundless. But it was generally agreed that Olympus extended very high indeed; in *Odyssey*, vi, it never has any stormy weather, and cloudless *aither*, pure upper air, surrounds it, "and there the blessed gods take their pleasure every day." Later writers repeat and elaborate this description, which no doubt was due ultimately to the sight of the mountain peak emerging from a belt of comparatively low clouds. It is no great wonder that in time "heaven" and "Olympus" come to be used quite indifferently in poetry. The ancients were not mountaineers and knew little of the actual weather conditions at high altitudes. Any god of any importance, save those definitely infernal, is commonly said to live on Olympus, regardless of the whereabouts of his place of cult; *e.g.*, the Muses in Homer, although the chief seat of their worship was Helicon, are said to "possess Olympian dwellings."

(H. J. R.; X.)

OLYNTHUS (modern Greek Olinthos), an ancient city about 1½ mi. inland from the head of the Gulf of Torone, in Chalcidice, near modern Miriofiton. A Thracian tribe, the Bottiaeans, held the town until winter 480–479 B.C., when the Persian general Artabazus, on his return from escorting Xerxes to the Hellespont, suspecting that a revolt was meditated, killed the inhabitants and handed the town over to Greeks from Chalcidice.

Olynthus thus became a Greek city, but it remained insignificant in the lists of the Delian league (*q.v.*) until 432, when King Perdiccas II of Macedonia added to its population the inhabitants of Chalcidian towns in the neighbourhood. Henceforward the chief Greek city west of the Strymon river, it revolted from Athens, formed a base for Brasidas' expedition (424) and was never again reduced. In the 4th century it was the head of the Chalcidic league, which may be traced back to the peace of Nicias (421) or even to 432; the members called themselves Chalcidians, though Greek writers usually call them Olynthians. The league concluded an important treaty, about 390, with Amyntas III, king of Macedonia, and by 382 it had absorbed most of the Greek cities west of the Strymon, and even held Pella, the chief city in Macedonia. But in this year Sparta was induced by an embassy from Acanthus and Apollonia, not yet included in the league, to attack; and the Olynthians, after three years of indecisive warfare, formally dissolved the confederacy (379). Twenty years later, however, in the reign of Philip II, the power of Olynthus is asserted by Demosthenes to have been much greater than before the Spartan expedition, and the league included 32 cities. When war broke out between Philip and Athens (357), Olynthus was at first in alliance with Philip. Subsequently it concluded an alliance with Athens; but in spite of all the efforts of the Athenians (urged on by the orator Demosthenes in his three *Olynthiac* speeches) Philip razed it in 348.

Between 1928 and 1938 Olynthus was excavated under the auspices of the American School of Classical Studies at Athens. The desertion of the site after 348 B.C. enabled the excavators to discover the grid plan of the ancient town, built on two hills, and to gain further insight into the relation between classical and Hellenistic Greek art.

See D. M. Robinson (ed.), *Excavations at Olynthus*, 14 vol. (1929–52); M. Gude, *A History of Olynthus* (1933).

OM, in Hinduism, the sacred syllable that symbolizes the Absolute. *See* Mantra.

OMAGH, an urban district and market town and the county town of County Tyrone, N. Ire., lies on the river Strule, 73 mi. W. of Belfast by road. Pop. (1961) 8,109. Situated in the ancient O'Neill territory of Tir-Eoghain (Tir-Owen, Tyrone) Omagh was the scene of past conflict but has few ancient monuments. It is now a prosperous town serving as market, shopping and transport centre for a wide countryside and is connected with Belfast by rail. It is the centre for Tyrone county administration and has long had an important army barracks and regimental headquarters of the Royal Inniskilling Fusiliers. Local industries include the processing of dairy products and the manufacture of shirts. There is trout fishing on the Strule from which mussel-pearls are also sometimes obtained. Ten miles north lies the picturesque village of Gortin, approached through the scenic pass and shooting moors of Gortin gap, between Mullaghcarn (1,778 ft.), Curraghchosaly (1,372 ft.) and lower hills.

(Hu. S.)

OMAHA, a Siouan-speaking American Indian tribe of the Dhegiha group that included the Osage (*q.v.*), Ponca, Kansa and Quapaw. According to tradition, the group once lived in the lower Ohio River valley as a single nation from which the tribes split as they moved west. Since their first recorded meeting with Europeans in the early 18th century, the Omaha have been settled in northeastern Nebraska, where their reservation was established in 1854. Land allotments were made in 1882 with the help of the anthropologist A. C. Fletcher (*q.v.*) to prevent the removal of the tribe to Oklahoma; somewhat later they gained U.S. citizenship.

Like other prairie tribes the Omaha combined agriculture with hunting (*see* Plains Indians). In spring and autumn they lived in permanent villages of dome-shaped earth lodges, moving into tepees for the hunting seasons. Omaha social organization was elaborate, with the tribe divided by a class system into chiefs, priests, physicians and commoners. Rank was inherited in the male line, although higher status could be acquired by distributing horses and blankets or providing feasts. The kinship system, called the Omaha type because it was first studied among this tribe, was classificatory, nongenerational and based on patrilineal descent (*see* Kinship Terminology). However, residence in the villages was matrilocal. The lineages were combined into ten exogamous patrilineal clans, each with its own religious ceremonies, personal names, hair style and tabus. The clans were grouped into moieties representing earth and sky, respectively symbolizing female and male, south and north, and left and right. Clans of the earth moiety had charge of ceremonies concerning war and food supply, while the ceremonies of the sky moiety were designed to secure supernatural aid. When the entire tribe camped during the summer bison hunt or on migrations, tepees were arranged in a large circle symbolizing the clan and moiety systems. Tribal government was controlled by a council of seven chiefs, joined by the five highest-ranking priests. Omaha population in 1780 is estimated to have been 2,800. In the 1960s about 1,100 were reported from the reservation in Nebraska.

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(Ch. C.)

OMAHA, largest city in Nebraska, U.S., a port of entry and the seat of Douglas county, is located in the extreme eastern part of the state on the west bank of the Missouri river opposite Council Bluffs, Ia. The population in 1950 was 251,117; in 1960 it was 301,598 by federal census. The population of the Omaha standard metropolitan statistical area (Douglas and Sarpy counties, Neb. and Pottawattamie county, Ia.) was 457,873 in 1960. (For com-

parative population figures *see* table in NEBRASKA: *Population.*)

While Omaha had its beginnings shortly after the passage of the Kansas-Nebraska act in 1854, the area had already been visited. Meriwether Lewis and William Clark passed the site in 1804 on their journey of exploration to the Pacific coast and Manuel Lisa (*q.v.*) established a fur-trading post in the vicinity during the War of 1812. The vanguard of the Utah-bound Mormons spent the winter of 1846–47 there at an encampment which they named Winter Quarters, later called Florence and subsequently annexed by Omaha. This remained for several years an important way station for Mormon immigrants on their way to Salt Lake City.

Omaha, named for a dispossessed Indian tribe, was founded in 1854 by Council Bluffs promoters who were anxious to have the capital of the newly created Nebraska Territory located directly across the river from them. Already there was talk of building a railroad to the Pacific and the location of a territorial capital might influence the builders to lay their tracks through or near it. The plan worked and Omaha was made the capital despite the fact that there were older and larger communities in the territory. A few years later Pres. Abraham Lincoln designated Council Bluffs as the eastern terminus of the first transcontinental railroad, and by the second half of the 20th century Omaha was one of the largest railroad centres in the U.S.

As the actual starting point for the railroad, Omaha soon became a focal point for trade and industry and grew rapidly during the early years, although the capital was moved to Lincoln soon after Nebraska became a state in 1867, the year Omaha was incorporated as a city. A succession of drought years following the great blizzard of 1888 did much to discredit the entire region. This, added to the panic of 1893, brought population growth to a standstill.

In 1892 Omaha was the site of the Populist party's national convention which nominated James B. Weaver for the presidency. Six years later the Trans-Mississippi and International exposition was held there. The Knights of Ak-Sar-Ben (Nebraska spelled backward), the city's leading civic organization, was formed in 1895. By the time of World War I the city had started to grow again. A number of suburban communities, including South Omaha, site of the Union stockyards, were annexed. In 1946 Ft. Crook, an army post located 8 mi. S. of the city, was transferred to the U.S. air force, renamed Offutt air force base and made the headquarters of the strategic air command.

Most of the citizens of Omaha gain a livelihood from some activity connected with agriculture. Long important for meat packing, Omaha by the second half of the 20th century had become one of the nation's largest livestock markets, meat-packing centres and primary grain markets. In addition to being important as a distribution and food-processing centre, it is called "the Hartford of the midwest" because of the large number of insurance companies located there. Other industries include oil refining, smelting and the manufacture of feed, farm machinery, paints and varnishes, garden tools, ball bearings, telephone equipment and paper boxes.

The needs of higher education are met by the Municipal University of Omaha (1908), Creighton university (Roman Catholic; 1878) and the University of Nebraska college of medicine (1883–87; re-established in 1902). There are also two Roman Catholic women's colleges, Duchesne College of the Sacred Heart (1881) and the College of St. Mary (1923). The city has a symphony orchestra and a community playhouse. The Joslyn Art museum attracts large numbers of visitors while a $7,000,000 municipal auditorium offers excellent facilities for conventions and entertainments. In addition to a number of scenic parks within the city, Fontenelle forest, the largest unbroken native forest in the state, is located 1 mi. S. of Omaha. Located 11 mi. W. of the city is Boys Town, site of the internationally famous boys' home established (1917) in Omaha by the Rev. Edward J. Flanagan and later moved to its present location. Incorporated as a village in 1936, the community is run by the boys, who elect their own executives and officials. (F. W. A.)

OMAN, SIR CHARLES WILLIAM CHADWICK (1860–1946), English historian, whose most enduring work was in military history, was born at Mozufferpore, India, on Jan. 12, 1860. He was educated at Winchester and at New college, Oxford, became a fellow of All Souls in 1883 and Chichele professor of modern history at Oxford in 1905. From 1919 to 1935 he was member of parliament for Oxford university. He was knighted in 1920. Oman believed that the duty of a historian was to write—he used to point to Lord Acton (*q.v.*) as an example of wasted learning. His many books include a *History of Greece* (1888), *England Before the Norman Conquest* (1910), *The Art of War in the Middle Ages* (1898, rev. ed. 1924) and, his finest work, *A History of the Peninsular War, 1807–14,* seven volumes (1902–30). Oman had no interest in ideas but his work was factual, solid and useful. He died at Oxford on June 23, 1946. (M. KL.)

OMAN, JOHN WOOD (1860–1939), British Presbyterian theologian who united in a singular degree profound learning with originality and independence of judgment, was born on July 23, 1860, in Orkney, Scot. The influence of his boyhood's environment of hill and sea is discernible in his writings. After graduating at Edinburgh university and at the theological college of the United Presbyterian Church, he studied in Germany and subsequently entered the ministry of the Presbyterian Church of England. In 1907 he was appointed professor of systematic theology at its theological college in Cambridge (Westminster college), of which he was later principal (1922–35). He died in Cambridge on May 17, 1939.

Oman, like Friedrich Schleiermacher, whose *Reden über die Religion* he translated into English, taught the uniqueness and independence of the religious consciousness. The sense of "the sacred" establishes man as a personal being in the midst of natural process and is the source of his mastery over it. In his main work *The Natural and the Supernatural* (1931), Oman developed this in a massive treatment of knowledge and perception, of necessity and freedom, of the history and classification of religions. Doctrinally Oman's theology was built on the essentially personal nature of the divine-human relationship and on the concepts of reverence, sincerity and freedom. Man is called of God to revere and seek after the absolute values of truth and goodness, to walk freely and steadfastly by his own insight, to accept in faith all the risks of so doing. In *Grace and Personality* (1917) these basic themes were wrought out in relation to grace and reconciliation; in *Vision and Authority* (1902), in relation to authority; in *The Church and the Divine Order* (1911), in relation to the church.

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OMAN: *see* MUSCAT AND OMAN; TRUCIAL OMAN.

OMAR I ('UMAR IBN AL-KHATTAB) (*c.* A.D. 586–644), the second of the Muslim caliphs, reigned from 634 to 644. Born at Mecca and belonging to the clan of 'Adi of the Meccan tribe of Quraish (Koreish), Omar at first opposed Mohammed, but about 615 became a Muslim. By 622, when he went to Medina with Mohammed and the other Meccan Muslims, he had become one of Mohammed's chief advisers, closely associated with Abu Bakr. His position in the state was marked by Mohammed's marriage to his daughter Hafsa in 625. On Mohammed's death in 632 Omar was largely responsible for reconciling the Medinan Muslims to the acceptance of a Meccan, Abu Bakr, as head of state (caliph). Abu Bakr (632–634) relied greatly on Omar and nominated him to succeed him. As caliph Omar was the first to call himself "commander of the faithful" (*amir-al-mu'minin*). His reign saw the transformation of the Islamic state from an Arabian principality to a world power, with the conquest of Syria, Palestine, Egypt, Mesopotamia and Iran (for details, *see* CALIPHATE). Throughout this remarkable expansion Omar closely controlled general policy and laid down the principles for administering the conquered lands. The structure of the later Islamic empire, including legal practice, is largely due to him. Assassinated by a Persian slave for personal reasons, he died at Medina on Nov. 3, 644. A strong ruler, stern toward offenders, and himself ascetic to the point of harshness, his justice and authority were universally respected. (W. M. WT.)

OMAR II ('UMAR IBN 'ABD-AL-'AZIZ) (*c.* 682–720), Omayyad caliph, reigned from 717 to 720 (*see* CALIPHATE). Born at Medina, he was unexpectedly raised to the caliphate by the will of his

predecessor, Suleiman, after a youth spent in religious studies and pious practices. The disastrous campaign against Constantinople in 717 and the discontent of the non-Arab Muslims confronted him with serious problems. His attitude of piety led him to policies more in accordance with religious principles, but also politically justified. Conversion to Islam was encouraged, and the converts were freed from poll tax and other disabilities. Rules for Christians and Jews were more strictly enforced. Such policies led to financial difficulties, but his concern for non-Arab Muslims (*mawali*) showed awareness that power was shifting from the Syrian army to the *mawali*. Because of his piety and his friendship with the "pious opposition" in Medina, he alone of the Omayyads was respected in Abbasid times. He died near Aleppo in Feb. 720. (W. M. Wt.)

OMAR EL-HADJ (Omar Saidou Tal) (*c.* 1797–1864), Tukulor marabout, who in the mid-19th century established himself as the ruler of a large area of the western Sudan (in the modern republic of Mali) in northwest Africa. He was born *c.* 1797 at Aloar near Podor on the lower reaches of the Senegal river. In 1820 he traveled to Mecca (whence his title of el-Hadj) and there received from the chief of the Tidjaniya brotherhood the title of caliph for the Sudan. Returning to Senegal he won a great success through his personality and the democratic character of his brotherhood, but this made the Tukulor tribal chiefs jealous.

In 1848 Omar settled at Dinguiraye in northeast Guinea. There he built up an army and preached a holy war against the pagan Mandingo. Then he attacked the Bambara and seized Nioro (north of Bamako), thus founding an empire. Next he turned against the French colony of Senegal and in 1857 attacked the post of Medine (south of Kayes). This was defended by the Senegalese half-caste Paul Holle, who was saved *in extremis* by a flotilla commanded by Comdt. L. C. C. Faidherbe, governor of Senegal. Omar then directed his attention to the Sudan and seized Hamdallahi, the capital of the Fulani. Most of the Fulani chiefs, who belonged to the Qadriya brotherhood, were put to death, but one of them, Ba Lobbo, escaped, rallied his followers and recaptured Hamdallahi. Omar fled and took refuge in a cave, but he was killed when his enemies blew it up with gunpowder (1864). (Hu. De.)

OMAR KHAYYAM (Ghiyathuddin Abulfath 'Omar ibn Ibrahim al-Khayyami) (d. 1123 or 1132), Persian mathematician, astronomer and poet, whose *Rubaiyat* was introduced to western readers by Edward FitzGerald (*q.v.*), was born at or near Nishapur. Probably he derived the name Khayyam ("tentmaker") from his father's trade. He is said to have received an annual salary of 10,000 dinars from his friend Nizam al-Mulk, the vizier of the Seljuk sultan Alp Arslan, for the pursuit of his mathematical studies, in which he made a name for himself by his standard work or algebra, written in Arabic. In 1074 he was invited by Arslan's successor Malik Shah, who favoured him with his patronage, to undertake the astronomical observations necessary for his reform of the calendar. Philosophy, jurisprudence and history are among the subjects on which Omar is said to have been an authority, but only a few brief tracts in Arabic on metaphysics remain to attest his varied erudition, beside some notes on Euclid. An engaging miscellany in Persian, entitled *Nauruznama*, has been published (1933) but its ascription to Omar has been contested. He died in Nishapur in 1123 or 1132.

Omar's fame in the west and now in the east also, rests upon the collection of *ruba'is* or quatrains attributed to him. These had attracted comparatively little attention until they inspired Edward FitzGerald to write his universally celebrated *Rubaiyat of Omar Khayyam* (1st ed., 1859). The belated acclaim accorded to this poem stimulated extensive research into the original quatrains of Omar around which a very large learned literature has grown up. It seems reasonable to conclude that Omar wrote in all some 1,000 *ruba'is*. Each quatrain was composed on a particular occasion and forms a complete poem in itself; it was FitzGerald who conceived the idea of combining a series of these *ruba'is* into a continuous elegy or "tesselated Eclogue" as he liked to call it, in which "many Quatrains are mashed together." Edward Heron-Allen estimated in 1899 that 49 of FitzGerald's quatrains are faithful and beautiful paraphrases of single quatrains by Omar, 44 are traceable to more than one quatrain and four others have less relevance to the original poems. The following example, preceded by A. J. Arberry's literal translation, shows how closely FitzGerald kept to his original when he found this manageable:

> If I had hold of heaven, like God, I would remove this heaven from the midst, and I would make anew another heaven in such wise that the noble man should easily attain his heart's desire.
> (*Omar Khayyám*, p. 162; 1952.)

> Ah Love! could thou and I with Fate conspire
> To grasp this sorry Scheme of Things entire,
> Would we not shatter it to bits—and then
> Re-mould it nearer to the Heart's Desire?

Omar's philosophy of life as revealed in his *ruba'is* appears to be that of an agnostic rather than a freethinker, and is an expression of a typical Persian attitude. It is well summed up in his reported last words: "O God! Truly I have striven to know thee according to the range of my powers. Therefore forgive me, for indeed such knowledge of thee as I possess is my only means of approach to thee."

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OMAYYADS (Umayyads), first of the two great dynasties of the Muslim empire (*see* Caliphate), ruling from 660 to 750. The name is derived from the family of Umayya, the main part of the clan of 'Abd-Shams of the Meccan tribe of Quraish (Koreish). To this family belonged several rich merchants. One, Abu Sufyan, leader of resistance to Mohammed from 624 to 627, later [illegible] the hopelessness of the Meccan cause and advocated surrender to Mohammed and acceptance of Islam. Mohammed and his immediate successors consequently made more use of the administrative skill of the family of Umayya than of that of comparable families. Omar's appointment of Abu Sufyan's son Mu'awiya (*q.v.*) to [illegible] governor of Syria placed him in a strong position, so that in [illegible] he emerged victor from the struggle for the caliphate which [illegible] on the death of Othman (a member of the family of [illegible] though not reckoned as belonging to the dynasty).

The dynasty is divided into two groups. The first, sometimes called Sufyanids (from Abu Sufyan), consisted of Mu'awiya and his son and grandson. Civil war followed Mu'awiya's death [illegible] the rule of the dynasty was re-established by the other [illegible] Marwanid, notably by Marwan I (684–685) and Abd-al-Malik (*q.v.*; 685–705). The political ideas underlying the Omayyad caliphate were essentially Arab. The caliph's power was [illegible] on as an extended form of that of the nomadic chief, and his relations to his subordinates were expected to be similar. The basis of Omayyad rule was the Syrian army, and the capital was Damascus. Arab tribesmen from the desert, and non-Arab Muslims, were chiefly responsible for the continued expansion in east and [illegible] Because of this the Omayyad caliphate is sometimes called the Arab kingdom. Its Arab character also produced the weakness which caused its downfall. The recrudescence of feuds between Arab tribes seriously reduced Omayyad military power. The conversion of non-Arabs and the remission of the poll tax on [illegible] to a financial crisis; at the same time these new Muslims [illegible] were dissatisfied with their inferior status. These [illegible] led to the overthrow of the Omayyads in 750 by the Abbasids (*q.v.*).

A member of the family (Abd-al-Rahman), who escaped from the Abbasids, established himself as a Muslim ruler in Spain in 756. He founded the dynasty of the Omayyads of Cordova, which reached its zenith under Abd-al-Rahman III (912–961

[illegible] declined and disappeared in 1031. *See* CORDOBA, CALIPHATE OF; ABD-AL-RAHMAN. *See* also references under "Omayyads" in the Index. (W. M. WT.)

OMBRE, a game of cards, the most fashionable in Europe for [illegible] years but now practically obsolete. It has been traced as [illegible] back as the 14th century. As late as 1884 Friedrich Anton [illegible] standard manual stated, "Of all games, undoubtedly the most interesting, diversified, and widely known is Ombre." Originally [illegible] with the Spanish packs of 40 or 48 cards, it was adapted to the French pack of 52. In the course of time it accreted terms from Spanish, French, Italian and English, as well as a great complexity of rules. Played for the most part by three players, it [illegible] a variant for four, so-called quadrille, which gained great [illegible]rity and was one of the five games treated by Edmond Hoyle [illegible]43). A simplification of quadrille, usually called solo, is still [illegible]. A 32-card pack (ace down through 7) is used with the club queen (*spadille* or *spadilla*) ranking as the highest trump, the spade queen (*basto* or *basta*) as the third highest trump, and the 7 of the trump suit (*manille* or *manilla*) as the second highest trump. (G. MH.; X.)

OMBUDSMAN is a legislative commissioner for the investigation of citizens' complaints of bureaucratic abuse. The office originated in Sweden early in the 19th century and is still largely confined to Scandinavia (and New Zealand), though interest in it became widespread after the mid-20th century. The legislature appoints the ombudsman, but it may not interfere with his handling of particular cases. He is an independent and impartial arbiter between government and the individual. His scope of authority covers all agencies, boards, and commissions, but sometimes excludes municipal government (New Zealand and Norway), cabinet decisions (New Zealand, Norway, and Sweden), or judges (Denmark, New Zealand, and Norway). Counterbalancing his vast [illegible]diction is the fact that his power is solely recommendatory. [illegible] suggest changes in government action but may not com[illegible] them.

Precursors of the ombudsman may be seen in the Chinese *Yuan* [illegible] of inspectors for control of the bureaucracy), the Roman [illegible] (*q.v.*), the *justicia mayor* of Aragon (*see* CORTES), and the colonial American Councils of Censors (*see* CENSOR).

History of the Office.—The ombudsman originated in Sweden, [illegible] included a "parliamentary agent for justice," *riksdagens [illegible] ombudsman* (called by his initials, "JO"; *ombudsman*, [illegible]), in the Basic Law of 1809; the first JO was appointed in [illegible]. Except for the creation of a separate military ombudsman, *riksdagens militieombudsman* (MO), in 1915, the Swedish om[illegible] office has remained basically unchanged in more than [illegible] years of operation.

Finland adopted the office of JO in 1919, together with other [illegible]ures of Swedish government. For more than a decade, the [illegible] ombudsman office was eclipsed by that of the chancellor [illegible] but it was revived in the 1930s by lengthening the term [illegible]e and by arranging a division of labour with the chancellor. [illegible]ark made provision for a parliamentary commissioner, [illegible] ombudsmand, in the 1953 constitution, and the office [illegible] into operation in 1955. The first Norwegian parliamentary [illegible]man for administration, *stortingets ombudsmann for for[illegible]*, took office in 1963. He is also known as the ombuds[illegible] civil affairs, *sivilombudsmann*, to distinguish him from the [illegible] military ombudsman, *ombudsmannen for forsvaret*. [illegible] of military ombudsman was created in 1952, superim[illegible] upon an existing structure of enlisted spokesmen chosen by [illegible] of the Norwegian armed forces. West Germany also [illegible] a military ombudsman office, established in 1956. In 1962 [illegible]land appointed its first parliamentary commissioner of [illegible]igations, with the official alternate designation of "ombuds[illegible]."

Functions of the Ombudsman.—The ombudsman serves [illegible] related purposes: (1) redressing individual grievances; (2) [illegible]ing the quality of administration; and (3) helping the legis[illegible] to supervise the bureaucracy.

Redress of Grievances.—On the average, each civil ombudsman [illegible] more than 1,000 written complaints a year, in addition to the handful which he takes up of his own volition. The majority of these are rejected without investigation. In a number of cases, the citizen fails to state a complaint; the ombudsman sometimes solicits clarification and helps the aggrieved person to explain his grievance intelligibly. In other cases, the person or body complained of is outside the jurisdiction of the ombudsman, who may then instruct the citizen as to where to lodge his complaint. Other applications are rejected because the party has not exhausted available administrative or legal remedies; again, the ombudsman describes these alternative avenues of appeal. In giving advice, the ombudsman provides legal aid in the administrative sphere—an area of the law in which such assistance has otherwise been lacking.

The balance of the complaints are transmitted by the ombudsman to the agency in question for elucidation. His office could not function without the cooperation of the administration. This cooperation is almost always forthcoming, and the ombudsman does not have to exercise his formal power to compel evidence and testimony. Because the bulk of investigative work is done by the agencies themselves, the ombudsman does not need a large staff.

When the fact-finding process is complete, the ombudsman forms an opinion as to the correctness of the government's action. He does not merely impose his judgment in place of the administrator's but asks whether the administrator acted reasonably under the law. In the majority of cases investigated, the ombudsman finds that the agency acted properly and within the scope of its discretion. In replying to the complainant, he explains why the agency action was unobjectionable.

In the remaining cases, the ombudsman comes to the conclusion that the agency acted improperly. He may express to the bureau and to the complainant his opinion that there was rudeness or unnecessary delay. If he feels that the decision of the agency was erroneous, he may state what a correct decision would have been and, whenever possible, suggest a solution. He conveys his opinion and recommendation to the complainant, usually after giving the authorities an opportunity to remedy the matter.

The ombudsman may not change the decision of an administrator but may only recommend a different decision. He relies upon his prestige and upon the reasonableness of his views to persuade the agency to alter its position. Vestigially, the Swedish and Finnish ombudsmen may prosecute erring officials, but even these offices rely primarily upon censure.

Improving Administration.—The very existence of an ombudsman improves the general climate of public opinion toward government. Citizens who secure redress are, of course, gratified. Others may become reconciled by the ombudsman's explanation of the basis for agency action. Moreover, the ombudsman encourages the administration to explain to the citizen why it acts as it does and to include in any adverse decision clear information as to possible rights of appeal. More generally, the populace gains a sense of security in knowing that there is someone to whom to turn.

The existence of an ombudsman also improves the general quality of government service by making officials more circumspect. The device is not, however, a substitute for a sound and efficient administrative system; it can remedy only marginal defects.

Ombudsmanic inquiry opens lines of communication among and within agencies. Many revisions of agency action occur at the beginning of the ombudsman's investigation, indicating that superiors were not aware of the actions of their subordinates. By serving as a clearinghouse for complaints, the ombudsman helps to identify trouble spots such as incompetent, careless, or impolite employees and harsh or unworkable procedures.

The ombudsman also improves morale in public service. Civil servants themselves are among his clientele, bringing complaints about conditions of employment. When the occasional incompetent or chronically intemperate employee is located and removed, the vast majority of courteous and efficient workers are spared the stigma of group condemnation. Further, as is more often the case, the air is cleared of unfounded complaints. If agency slowness or error is caused by personnel shortage, the ombudsman may call that to the attention of the legislature.

Assistance to Legislative Supervision.—In Western industrialized societies, effective legislative oversight of administration is hampered by the vastness and complexity of bureaucracy. Complaints received by individual legislators from their constituents are treated sporadically and in isolation. The ombudsman's special and annual reports provide modest assistance to the legislature in carrying out its supervisory function. Article 19 of the New Zealand Ombudsman Act, for example, directs the ombudsman to call attention to laws producing "unreasonable, unjust, oppressive, or improperly discriminatory results."

At the same time, the ombudsman frees the legislator for other tasks by shouldering some of the burden of constituent casework. Many lawmakers welcome casework, however, and the citizen is of course free to continue to bring his grievances to his elected representative. Many grievances received by legislators do not fall within the ombudsman's jurisdiction.

Related Institutions.—The functions of the chancellors of justice in Sweden and Finland overlap those of their respective ombudsmen. Neither official will take a case which is under consideration by the other. The technical distinction between chancellor and ombudsman is that the former is appointed by the government rather than by Parliament. The comptroller-general of Israel, as an adjunct to audit, acts as ombudsman. In the state of California the Commission on Judicial Qualifications serves as an ombudsman in investigating complaints of judicial misbehaviour; without attempting to review disputed questions of law, the commission, through its executive secretary, inquires into allegations of rudeness, delay, or incompetence on the bench.

Functions similar to those of an ombudsman are undertaken by procurators-general in Eastern Europe and by the Administrative Management Agency in Japan. Great Britain has a parliamentary commissioner who is authorized to investigate complaints referred to him by members of parliament. Civilian police review boards in a few U.S. cities act as ombudsmen within their limited range of authority.

Ombudsman proposals have been considered in a number of Western European and Commonwealth nations and in many Canadian and U.S. provinces, states, and cities. Continued interest in the ombudsman idea arises from the conviction that complex government only mirrors complex society. Mediating between man and Leviathan is a perennial problem of modern, depersonalized industrial civilization.

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OMDURMAN, the largest of the "Three Towns" (Khartoum, Khartoum North and Omdurman) at the union of the Blue and White Niles, and the largest town of the Republic of the Sudan, is situated on the left bank of the main Nile just below the confluence. Pop. (1965 est.) 185,380. It was a village of fishermen and boatmen until the victory of the mahdi, Mohammed Ahmed ibn Seyyid 'Abdullah (*q.v.*), in 1885 and the sack of Khartoum. The mahdi and his successor, the Khalifa 'Abdullahi, established their capital there, and their followers rapidly built an unplanned African town of mud houses, courtyards, and narrow, winding alleys. Nearly all of this disappeared after the final defeat of the khalifa by Maj. Gen. Sir Herbert (later Lord) Kitchener's forces at the Battle of Omdurman, which took place a few miles to the north, on Sept. 2, 1898. The khalifa's house, however, is now a museum and the mahdi's tomb has been restored and embellished. Associated with the principal mosque is a school for training young men in Muslim law and theology. There are two large private schools and many government schools.

Modern buildings include the telephone exchange, broadcasting station and National theatre. Omdurman is a commercial centre with a large bazaar, the chief articles of commerce being hides and gum arabic for export, and imported cotton piece goods. The river trade has much diminished, but merchants' trucks are driven as far west as Darfur, north to Dongola, east to Kassala and south to Malakal. Craftsmen work in metal, wood, leather, cloth and ivory, and there are furniture factories, potteries and a tannery. The market in camels, cattle and sheep is important. (J. H. G. L.)

OMEN: *see* Augur; Divination; Oracle.

OMRI (in the Douai version of the Bible, Omrai), an Israelite general, chosen by the army as ruler (I Kings xvi, 16) when, during a campaign against the Philistines, reports came that Zimri, a captain of the chariots, had murdered the king, Elah, in the royal city of Tirzah and proclaimed himself king. Omri promptly marched against Zimri and captured Tirzah; Zimri, recognizing the hopelessness of his position, set fire to the palace and perished in the flames. A rival party set up Tibni, with whom the Greek versions associate his brother Joram, as king, but Omri defeated this faction and became undisputed king of Israel *c.* 884 B.C. The one deed of his reign recorded in I Kings xvi, 24, is his purchase of the hill of Samaria, upon which he founded a new royal city. But Mesha of Moab mentions him as "having afflicted Moab many days." In spite of the fact that he suffered some reverses at the hand of Syria (I Kings xx, 34), he must have been an accomplished statesman who consolidated his kingdom and made it respected, because for generations after his death Israel is known to the cuneiform writers as "House (or Land) of Omri," and the Israelite Jehu as a "son of Omri." He reigned 12 years and was succeeded by his son Ahab (*q.v.*).

OMSK, an *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., was formed in 1934. Its area, considerably reduced in 1944 to form Tyumen *oblast*, is now 53,861 sq.mi. Pop. (1959) 1,645,017. It lies in the south of the West Siberian plain in the basin of the middle Irtysh, which bisects the *oblast*. The Irtysh is joined by its tributaries, the Om, Tara, Ui, Tui and Shish on the right and Ishim, Osha and Ayev on the left. The whole surface is an extremely flat plain with innumerable small lakes, especially in the south, and extensive marshes and peat bogs in the north. The largest lake is Tenis in the west. The climate is sharply continental with a temperature range at Omsk of 38° C. (69° F.) from a January average of −19° C. (−2° F.) to a July average of 19° C. (67° F.). Rainfall is low, 12½ in. a year, with a marked summer maximum. The *oblast* extends over three natural zones: in the north is taiga forest of pine, fir, spruce, stone pine and birch on podzol soils; in the centre is the transitional forest-steppe zone with alternating open grass steppe and groves of birch; and in the south is true steppe. Both the last two zones have rich chernozem soils and are to a large degree under the plow. In the steppe zone there are no rivers other than the Irtysh and Om and the lakes are almost all saline.

Of the 1959 population 43% (710,319) were urban and of these the bulk lived in the administrative centre of Omsk. The other 5 towns and 9 urban districts were all small and unimportant except as local agricultural centres. Industry is almost entirely concentrated in Omsk. Agriculture is highly developed, especially in the south and centre of the *oblast*. Considerable areas were plowed up under the Virgin and Idle Lands project of the 1950s, and the arable land totaled about 10,000,000 ac., with a further 6,000,000 ac. of meadow and pasture. Nearly two-thirds of the arable land lies in the steppe zone and most of the remainder in the forest-steppe. Grains are the most important crops, led by spring wheat; maize (corn) and oats are also significant and rye is common in the north. The chief industrial crops are crown (or common) flax, false flax (*Camelina microcarpa*), sunflowers and mustard in the south, and fibre flax in the north. Around Omsk, market gardening is developed. The extensive pasture and hay land have led to large-scale livestock husbandry, with about 1,000,-000 head of cattle and more than 1,000,000 sheep and goats. The greatest emphasis is on dairy products and the *oblast* is one of the most important producers in the U.S.S.R. of butter and condensed

and dried milk. Sheep are kept chiefly in the south, where pig rearing is also important. In the forested north there is some timber cutting, the logs being towed in rafts up the Irtysh to Omsk for sawmilling. (R. A. F.)

OMSK, a town and *oblast* administrative centre of the Russian Soviet Federated Socialist Republic, U.S.S.R., stands on the right bank of the Irtysh river, where it is joined by the Om and crossed by the Trans-Siberian railway, 380 mi. W. of Novosibirsk. Pop. (1959) 581,108, making it the second city of Siberia. Although the region around Omsk was first reached by Russians in the late 16th century, the town itself was founded only in 1716. Originally a strongpoint at the eastern end of the Ishim fortified line between the Tobol and Irtysh, Omsk developed as a centre for the increasingly important agriculture of the area and became a town in 1804. Its military function as the administrative headquarters of the Siberian Cossacks persisted until the late 19th century. It was the seat (1918–19) of the Anti-Bolshevik government of Aleksandr Vasilievich Kolchak (*q.v.*).

The building of the Trans-Siberian in the 1890s and Omsk's position as transshipment point on the Irtysh led to rapid commercial growth. Great impetus to industrial development was given during World War II since when its population has more than doubled. Engineering, especially the production of agricultural machinery, dominates a wide range of industry. Four pipelines from the Second Baku (*q.v.*) oil field, two of which were built in the early 1960s, supply the large refinery and petrochemicals industry of Omsk. Other industries include the manufacture of cotton and woolen textiles, cord, footwear, leather goods, and the processing of flour and meat products. Timber working is also carried on. The links provided by the Trans-Siberian railroad east to Novosibirsk and west to Sverdlovsk and Chelyabinsk were improved in the early 1960s by the construction of a branch railway southeastward to Barnaul and the new Central Siberian railway. Among the cultural and educational facilities of Omsk are the S. M. Kirov Agricultural institute, engineering, medical and veterinary institutes and a number of other research and higher educational establishments. (R. A. F.)

ŌMUTA, Japanese city of southern Fukuoka prefecture (northern Kyushu), located on the east coast of Ariake bay. Pop. (1965) 193,875. Ōmuta is a coal-mining centre where some of Japan's finest bituminous coal is extracted from the Miike coal field. Its artificial harbour has modern coal-handling facilities. Ōmuta has been an important industrial city since 1917, especially in the manufacture of chemicals. Industries include coke ovens, a zinc refinery, ferroalloy steel mill, fireproof brick works, a cotton mill and a synthetic petroleum plant. (J. D. Ee.)

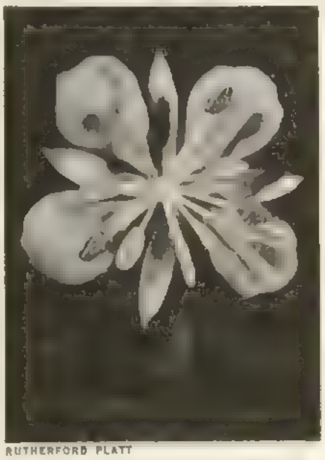
ON: *see* Heliopolis.

ONA, in the 1960s an almost extinct people of Tierra del Fuego (*q.v.*), and their Andean Equatorial language. They knew no agriculture, continually migrating in small hunting and gathering bands, until by the 19th century they were all but destroyed through European depredations. Aside from rodents, their main food was the guanaco, small herds of which were stalked by bowmen; berries and shellfish were collected by women and children. The guanaco also provided fur for robes (the most prominent articles of clothing), leather for moccasins, bones and sinews for tools, weapons and decorations, and hide for windbreak dwellings. Manufactures were few, simple and portable, including coiled baskets, bark containers, bows, spears, stone axes and hide scrapers. Archaeological data in the form of stone and bone tools suggest that the Ona subsistence organization endured for millenniums. Ona society comprised 39 exogamous patrilineal bands, feuding in reprisal against murder and violation of territory; tradition held that the culture hero K'aux had assigned hunting grounds to distinct patrilineal groups. There were no chiefs; bands recognized limited authority of a kinship elder contingent on religious morality and patrilineal organization. The moral system was symbolized in periodic boys' initiation rites (*klóketen*) held by each band. This important ceremony served to dramatize the leadership of band elders and relationships to ancestors and supernatural beings. The rich Ona mythology indicates the integrative force of supernatural sanctions in their social structure.

By the mid-1960s less than 50 Ona were known to survive, and it was expected that either they would be absorbed by their neighbours, or they would face total extinction.

See J. M. Cooper, "The Ona," in J. H. Steward (ed.), *Handbook of South American Indians,* vol. 1 (1946); J. H. Steward and L. C. Faron, *Native Peoples of South America* (1959). (L. C. Fa.)

ONAGRACEAE, the evening primrose family of dicotyledonous plants, belonging to the myrtle order (Myrtales), contains about 20 genera and more than 500 species concentrated in the temperate region of the new world. The family is characterized by flowers with parts mostly on the plan of four (4 sepals, 4 petals, 4 or 8 stamens), but there are some exceptions. The ovary is inferior; *i.e.,* below the flower proper. In the temperate zone the Onagraceae is best known by genera like *Epilobium,* including the great willow herb or fireweed (so-called since it becomes readily established on newly burned areas), occurring in cooler parts of the world and disseminated by means of a tuft of hairs at the tip of each seed. Another well-known genus is *Oenothera,* with about 150 species, some of which are grown in gardens. Most of its members are yellow- or white-flowered; some species are evening bloomers, hence the name evening primrose, others are day bloomers with names like suncup. The genus has been of great importance in studies in genetics and evolution (mutation theory of Hugo De Vries).



RUTHERFORD PLATT

WILLOW HERB (EPILOBIUM): ARRANGEMENT OF FLORAL PARTS TYPICAL OF THE FAMILY ONAGRACEAE

Fuchsia, with about 100 species, is largely tropical and subtropical, but some species are widely used in gardens and as potted plants indoors. Fuchsias differ from the other members of the family by having fleshy fruit. *Clarkia,* native of western North America and Chile, with about 35 species, is well known in gardens. The flowers range from purplish-red to pink and lavender and are often blotched or flecked. *Lopezia,* with 18 species ranging from Mexico to Panama, has a small highly specialized flower with only two stamens, a sterile, petaloid stamen enfolding a fertile one. *Lopezia* species can be grown as garden annuals or in the greenhouse. The genus *Zauschneria,* or California fuchsia, is a relative of *Epilobium,* but with more elongate and larger flowers; it is perennial and bears a profusion of brilliant scarlet flowers in the autumn or late summer.

In wet places, especially in warmer parts of both the old and new worlds, is another large day-blooming genus, *Ludwigia,* ranging from annual herbs to large shrubs; the flowers are yellow, the petals falling away easily. Some other genera of the family are *Boisduvalia; Circaea,* enchanter's nightshade, with hooked bristles on the fruits; *Gaura,* with small nutlike, indehiscent fruits; *Gayophytum,* thread-stemmed annuals with minute flowers; and *Hauya* of Mexico and Central America, shrubby or arborescent, with large white to pinkish flowers. (P. A. M.)

ONATAS, a Greek sculptor of the time of the Persian wars, a member of the flourishing school of Aegina. Many of his works are mentioned by Pausanias; they included a Hermes carrying the ram, and a strange image of the Black Demeter made for the people of Phigalia; also some groups in bronze at Olympia and Delphi, including a bronze chariot for Hieron I of Syracuse. From Pausanias' descriptions we may assume that the figures on the pediments of Aegina represent his style. They are manly, vigorous, athletic, showing great knowledge of the human form, but somewhat stiff and automatonlike.

OÑATE, JUAN DE (*c.* 1550–*c.* 1630), first Spanish governor of New Mexico, was born in New Spain. Appointed governor in 1595, he was charged with exploring and colonizing New Mexico at his own expense. Crossing the Rio Grande in 1598, he established headquarters at that river's confluence with the Chama.

Firmness with the Indians kept the peace, but poverty and deprivation caused many colonists to flee southward in 1601 while Oñate was absent. His lack of success in establishing a stable government led him to resign in 1607, and in 1609 Oñate and his heirs were removed from New Mexico. Found guilty of cruelty, immorality and false reporting, he was exiled from the colony, heavily fined and deprived of his titles. By 1624 his continued appeals brought a reversal of his sentence, but not his restoration to office.

See G. P. Hammond's *Don Juan de Oñate and the Founding of New Mexico* (1927), a biography; G. Hammond and A. Rey (eds. and trs.), *Don Juan de Oñate, Colonizer of New Mexico, 1595–1628*, 2 vol. (1953). (K. M. S.)

ONEGA, a river of Archangel *oblast* of the U.S.S.R., is 255 mi. long and drains a basin of about 22,228 sq.mi. It originates in Lake Lacha and flows in a general northerly direction to the Onega gulf (Onezhskaya Guba) of the White sea. The basin is mostly a rolling plain of boulder clays with low morainic hills and deposits of fluvio-glacial sands. The whole area is densely forested and swamps are widespread. Timber is exploited in the basin and although the Onega is navigable only to Yarnema, it is much used for rafting. The average annual discharge is 20,306 cu.ft. per sec., but the recorded maximum is 97,116 cu.ft. and the minimum 2,543 cu.ft. per sec. Nearly half the flow comes in spring after snow melt. Ice first appears in early October and, although stretches with rapids may not freeze, the river as a whole is frozen until late April—early May. Ice breakup is usually accompanied by ice jams and serious flooding. (R. A. F.)

ONEGA, LAKE (ONEZHSKOYE OZERO), the fourth largest lake of the U.S.S.R. (the sixth if the Caspian and Aral seas are included), covers an area of 3,819 sq.mi. It lies in the northwest of European Russia. Its shores are mostly in the Karelian A.S.S.R., but Leningrad and Vologda *oblasts* adjoin its southern end. Onega is orientated with its greatest length, 154 mi., north-northwest to south-southeast. The maximum width is 56 mi. The lake surface is at 108 ft. above sea level and the greatest depth is 361 ft. There are more than 40 rivers draining into Onega, but many are small, the most notable being the Suna and Shuya on the west and Vodla and Vytegra on the east. The outlet is the Svir, flowing from the southwest corner of Onega into Lake Ladoga. The shoreline, relatively smooth at the southern end, is greatly indented on the north, where there is a succession of long, narrow gulfs of the lake, separated by parallel peninsulas and islands, formed by glacial deposition.

The lake margins freeze in the second half of November, but the centre does not freeze until the end of December and in some years may remain open. The thaw begins in the shallow south in late April and is complete by the end of May. Summer surface water temperatures range from 19° C. (66° F.) in the centre to 25° C. (77° F.) along the shores. At depth, the temperature remains fairly constant at 4°–6° C. (39°–42° F.).

The lake has valuable fisheries. It is also very important for navigation, forming a link in the White sea-Baltic waterway (*q.v.*). The Svir is canalized, while a canal section runs from Povenets at the northern end of Onega to Lake Vyg (Vygozero) and the White sea. The Vytegra is canalized and leads by the Volga-Baltic waterway (*q.v.*) to the Volga. A lateral canal runs parallel to the lake shore between the Vytegra and Svir. This was completed in 1852 to give protection from the frequent storms on the lake, but is now used only by smaller craft. (R. A. F.)

ONEIDA, the only city of Madison county in central New York, is located 6 mi. S.E. of Oneida lake, about midway between Utica and Syracuse. Founded by Sands Higinbotham in 1829, its future was determined by an agreement he made with the Utica and Syracuse railroad (later part of the New York Central system) to stop all trains there for refreshments in return for a free right of way and land for a depot. Oneida was incorporated as a village in 1848 and as a city in 1901. On the southern edge of the city is the village of Oneida Castle, site of a former gathering place of the Oneida Indians, marked by a granite boulder which they held sacred. Nearby is the site of the Oneida community (*see* UTOPIA), an experiment in communal living founded in 1848. In 1880 it was reorganized as a business corporation which in the second half of the 20th century produced a leading line of silverware. Other manufactures include caskets and burial vaults, furniture, paper and plywood boxes, milking machines and cigars. For comparative population figures *see* table in NEW YORK: *Population*. (V. C. C.)

ONEIDA, a tribe of North American Indians of Iroquoian stock, one of the original five nations of the Iroquois confederacy in central New York state. The name derives from *O-nē-yot-de á:ga'* (upright stone people) as they were called by their Onondaga (*q.v.*) neighbours in allusion to their veneration of the Oneida stone, a granite boulder near their former village. Oneida descendants were estimated to number 3,000 in the 1960s, with major concentrations near London, Can. (1,070), in Wisconsin (661) and in central New York state (369). They were called sons and daughters by their eastern neighbours, the Mohawk (*q.v.*), who spoke a related dialect and had an identical social system of three clans and nine chiefs. The least populous of the confederates, the Oneida had but one town during the 17th century of 60 to 100 longhouses, with perhaps 700 people; it was palisaded and situated in New York state on hilltop sites first in Madison county and afterward Oneida county southeast of Oneida lake, where they had extensive fisheries. Whether theirs was the fortress that Samuel de Champlain besieged in 1615 at Nichols pond is uncertain, but Dutch traders visited them in 1634 and the French Jesuit Jacques Bruyas established St. François Xavier mission among the Oneida in 1667, ten years before the first English visitor. By 1677 they were reported to have 100 houses and an estimated 200 warriors, but it was noted that the newly built town on Oneida creek had little cleared ground, and that they were borrowing corn from the Onondaga. A French-Canadian military expedition destroyed both town and corn in 1696. Thereafter the community divided into Oneida (Upper Castle) and Canowaroghere (skull on a pole). A village of North Carolina Tuscarora joined them, becoming in 1722 the sixth nation of the Iroquois league, and erstwhile Oneida enemies in the Carolinas became targets of war parties for a generation. A strong French faction that frustrated the league's policy of friendship to the English, combined with the New England missionary influence of Rev. Samuel Kirkland, inclined the Oneida to the colonist cause in the American Revolution. They consequently felt the depredations of the loyalist Iroquois under Joseph Brant and retired within the American lines, acting as scouts for Gen. John Sullivan's expedition of reprisal. Returning to their homes they took in remnants of the Mahikan and were compensated by the U.S. for their losses. In the following years the Oneida divided into factions resulting from disagreements over Quaker missions, their traditional faith and the sale of lands. By 1833, those who had not settled at Oneida-town on the Thames river, Ont., emigrated to Green Bay, Wis., a few families remaining at Oneida and Onondaga, N.Y. In the 1960s most Oneida were nominally Christian and sharing in the opportunities of their U.S. and Canadian neighbours of European origin. *See* also IROQUOIS.

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ONEIDA COMMUNITY: *see* UTOPIA.

O'NEILL. The intimate association of this Irish name with the province of Ulster tends to obscure the fact that there are several other small but distinct septs of O'Neill elsewhere. The O'Neills of Thomond were chiefs of the present barony of Bunratty in County Clare; the O'Neills of County Carlow (barony of Rathvilly) and the O'Neills of the Decies (Waterford) are others: representatives of all these are still to be found in those areas.

These are quite overshadowed by the much more numerous O'Neills of the northern province, from whose coat of arms the Red Hand of Ulster was taken. Their leading families were, at least until the destruction of the Gaelic order at the beginning of the 17th century, the most prominent in the history of Ireland. They trace their descent from Niall of the Nine Hostages who died in A.D. 405 and is the first king of Ireland whose existence is an undisputed historical fact. From his time till 1002, when Brian

Boru became *Árd Rí*, Niall's descendants were, with few interruptions, successive kings of Ireland. The Uí Néill, as they were called, formed two main branches: the northern Uí Néill of north Ulster and the southern Uí Néill who established themselves in Meath and the adjoining part of south Ulster. In the 14th century a branch of the former migrated to Antrim where they became known as Clannaboy or Clandeboy, *i.e.* Clann Aodha Buidhe, from Aodh Buidhe or Hugh Boy O'Neill.

The surname O'Neill does not however derive from Niall of the Nine Hostages: the eponymous ancestor was Niall Glúndub (d. 919), king of Ireland, the first to bear it being his grandson Domhnall (or Donell) O'Neill, who succeeded to the subkingship of Ailech in 943. O'Neill is thus one of the very earliest hereditary surnames in Ireland or indeed in Europe. Both Donell O'Neill's predecessors were killed in battles against the Northmen, who had long been infesting the northern coastal areas of the country. A century earlier Niall Glúndub's grandfather, another Niall (791–845) successfully repelled them from the coast of Donegal.

The exploits of the early O'Neills are recounted in the *Book of Leinster*, the *Annals of the Four Masters*, etc. Prior to the mid-16th century Norman and English influence was little felt in the Ulster of the O'Néills, even though nominal allegiance was paid to Richard II and to Edward IV: the latter, indeed, in 1463 acknowledged Henry O'Neill as "chief of the Irish kings." During this period the O'Neills were dominant in the greater part of Ulster though constantly at war with the other great Ulster sept of O'Donnell (*q.v.*). The first of the O'Neills to emerge as leader of the Irish against the English in the 16th century was Conn O'Neill (*c.* 1484–1559), known as Conn Bacach (the Lame), grandson of Henry O'Neill. He was inaugurated chief of the Tyrone O'Neills in 1519 and after an invasion of his territory in 1541 by Sir Anthony St. Leger, the lord deputy, he went to England and made his submission in person to Henry VIII who created him earl of Tyrone for life. His son Shane and the majority of his clan greatly resented this and the resulting feud was aggravated by the nomination of Conn's illegitimate son Matthew as his heir, with the title of baron of Dungannon. Matthew's parentage was actually in doubt, and in addition this nomination by the king was contrary to the Irish law or custom of tanistry. Matthew was murdered by Shane's men in 1558. Eventually after a period of fighting and negotiation Shane O'Neill went to London in 1562 and his claim to the chieftainship was reluctantly recognized by Elizabeth I, who thus repudiated Matthew's son Brian, though she made a reservation of the rights of Hugh, who had succeeded Brian as baron of Dungannon.

There were at this time three powerful contemporary members of the O'Neill family in Ireland: Shane, Turlough and Hugh, 2nd earl of Tyrone. Turlough had been elected tanist (successor) when his cousin Shane (*c.* 1530–67) was inaugurated the O'Neill, *i.e.*, chief of the clan, and he schemed to supplant him during Shane's absence in London. The feud did not long survive Shane's return to Ireland, where he re-established his authority. Elizabeth finally authorized the earl of Sussex to take the field against Shane but two expeditions failed. Shane then laid the whole blame for his lawless conduct on the lord deputy's alleged repeated attempts on his life. Elizabeth consented to negotiate, and practically all O'Neill's demands were conceded. O'Neill then turned his hand against the MacDonnells, claiming that he was serving the queen by harrying the Scots. In 1565 he routed the MacDonnells and took Sorley Boy prisoner near Ballycastle. This victory strengthened Shane's position and preparations were made for his subjugation. Later, after a signal defeat by the O'Donnells at Farsetmore (1567), he took refuge with the MacDonnells at Cushendun, who slew him in revenge for his treatment of their leader Sorley Boy MacDonnell (*q.v.*).

Shane's successor in the chieftainship, Turlough Luineach O'Neill (*c.* 1530–95), who had murdered his cousin Brian O'Neill, baron of Dungannon, after 18 years spent alternately fighting and temporizing with the English, eventually handed over the chieftainship to Brian's son Hugh.

Hugh O'Neill (*c.* 1540–1616), 2nd earl of Tyrone, known as "the great earl," was brought up in London; but in 1567, after the death of Shane, he returned to Ireland under the protection of Sir Henry Sidney. He attended parliament as earl of Tyrone, though Conn's title had been for life only, and had not been assumed by Brian. Hugh's constant disputes with Turlough were fomented by the English, but after Hugh's inauguration as the O'Neill on Turlough's resignation in 1593, he was supreme in the north. Having roused the ire of Sir Henry Bagenal by eloping with his sister in 1591, he afterward assisted him in defeating Hugh Maguire at Belleek in 1593; and then again went into opposition and sought aid from Spain and Scotland. Sir John Norris was ordered to Ireland to subdue him in 1595, but Tyrone took the Blackwater fort and Sligo castle before Norris was prepared; he was thereupon proclaimed a traitor.

In spite of the traditional enmity between the O'Neills and the O'Donnells, Tyrone allied himself with Hugh Roe O'Donnell, nephew of Shane's former enemy Calvagh O'Donnell, and the two chieftains opened communications with Philip II of Spain, their letters to whom were intercepted by the viceroy, Sir William Russell. They presented themselves as champions of the Catholic religion, claiming religious and political liberty for the Irish. In April 1596 Tyrone received promises of help from Spain. He temporized successfully for more than two years, making professions of loyalty which deceived Sir John Norris and the earl of Ormonde. In 1598 a formal pardon was granted to Tyrone by Elizabeth. Within two months he was again in the field, and on Aug. 14 he destroyed an English force under Bagenal at the Yellow ford on the Blackwater.

If the earl had known how to profit by this victory, he might then have successfully withstood the English power in Ireland; for in every part of Ireland—and especially in the south, where James Fitzthomas Fitzgerald, with O'Neill's support, was asserting his claim to the earldom of Desmond at the head of the Geraldine clansmen—discontent broke into flame. But Tyrone procrastinated. Eight months after the battle of the Yellow ford, the earl of Essex landed in Ireland. He met Tyrone at a ford on the Lagan on Sept. 7, 1599, when a truce was arranged; but Elizabeth objected to the conditions allowed to the O'Neill and to Essex's treatment of him as an equal. Tyrone then issued a manifesto to the Catholics of Ireland summoning them to join his standard. After an inconclusive campaign in Munster in Jan. 1600, he returned to Donegal where he received supplies from Spain and a token of encouragement from Pope Clement VIII. In May of the same year armies under Sir Henry Docwra and Lord Mountjoy compelled O'Neill to retire to Armagh. He marched to Munster in Nov. 1601 with a view to joining forces with O'Donnell at Kinsale and with the Spaniards under Juan del Aquila who had landed there. Had Tyrone's advice, counseling caution rather than an immediate attack, been acted on the defeat at Kinsale, which had such far-reaching and disastrous results for Ireland, might not have occurred. Following this, while Hugh O'Donnell went to Spain, O'Neill returned to the north. Though he submitted on honourable terms and was confirmed in his title of earl of Tyrone by James I, by Sept. 1607 he found his position untenable and the celebrated episode known as the flight of the earls took place. He and Rory O'Donnell, earl of Tyrconnell embarked at midnight at Rathmullen on Lough Swilly, with their wives and families and retainers, intending to go to Spain, but adverse winds drove them to the Netherlands; thence they went to Rome where they were well received by Pope Paul V. Tyrone died there in 1616, three years after he had been outlawed and attainted.

Sir Phelim O'Neill (*c.* 1604–53), a kinsman of the earl of Tyrone, took a prominent part in the rebellion of 1641. In that year he was elected member of the Irish parliament and joined the earl of Antrim and other lords in supporting Charles I. He surprised and captured Charlemont castle on Oct. 22, 1641, and having been chosen commander in chief of the Irish in the north he issued a pretended commission from Charles I authorizing his proceedings. Phelim and his followers ravaged Ulster on the pretext of reducing the Scots, but in Leinster failed to take Drogheda and were compelled by the earl of Ormonde to raise the siege in April 1642. Soon after that he was superseded by his kinsman Owen Roe O'Neill.

Owen Roe O'Neill (*c.* 1590–1649), the subject of the well-known ballad "The Lament for Owen Roe," was the son of Art O'Neill, a younger brother of Hugh, 2nd earl of Tyrone. Having served with distinction for 30 years in the Spanish army, he was immediately recognized on his return to Ireland as the leading representative of the O'Neills. Phelim resigned the northern command in his favour. Differences soon arose between Owen Roe and the supreme council of the Catholic confederation which met at Kilkenny in 1642. Owen Roe's real aim was the complete independence of Ireland, while the majority of the council, which largely consisted of Hiberno-Norman Catholics, desired to secure religious liberty and an Irish constitution under the English crown. In 1646 a cessation of hostilities was arranged between Ormonde and the Catholics; and O'Neill, furnished with supplies by the papal nuncio Giovanni Battista Rinuccini, turned against the parliamentarian army under Gen. Hector Monro. On June 5, 1646, O'Neill routed Monro at Benburb; but, being summoned to the south by Rinuccini, he had to leave Monro unmolested at Carrickfergus. For the next two years confusion reigned, O'Neill supporting the party led by Rinuccini, though continuing to profess loyalty to Ormonde as the king's representative. Isolated by the departure of the papal nuncio in 1649 he prepared to co-operate more earnestly with Ormonde and the Catholic confederates when Oliver Cromwell's arrival in Ireland in Aug. 1649 brought the Catholic party face to face with serious danger. Before anything was accomplished by this combination, however, Owen Roe died on Nov. 6, 1649.

The alliance between Owen Roe and Ormonde had been opposed by Sir Phelim O'Neill, who after his kinsman's death expected to be restored to his former command. In this he was disappointed but he continued to fight against the parliamentarians until 1652. The next year, having been betrayed by a kinsman, he was tried for high treason and executed.

Daniel O'Neill (*c.* 1612–64), a member of the Clandeboy branch of the family, spent much of his early life at the court of Charles I and became a Protestant. He commanded a troop of horse in Scotland in 1639; was involved in army plots in 1641, for which he was committed to the Tower of London but escaped; and on the outbreak of the Civil War returned to England and served under Prince Rupert. He then went to Ireland to negotiate between Ormonde and his uncle, Owen Roe O'Neill. He was made a major general in 1649. He joined Charles II at The Hague, and took part in the expedition to Scotland and the Scottish invasion of England in 1652.

Hugh O'Neill (d. 1660), known as Hugh Mac Art, had served with distinction in Spain before he accompanied his uncle, Owen Roe, to Ireland in 1642. After the death of Owen he defended Clonmel in 1650 against Cromwell, on whom he inflicted the latter's most severe defeat in Ireland. He so stubbornly resisted Henry Ireton's attack on Limerick in 1647 that he was excepted from the benefit of the capitulation, and, after being condemned to death and reprieved, was sent as a prisoner to the Tower of London. He was released in 1652, and died some time after 1660, probably in Spain.

In the next generation, which saw the final defeat of the Stuart and Irish cause in 1691, O'Neills, if less influential, were still very prominent as soldiers. In James II's Irish army there were four important O'Neill regiments and in the outlawries which followed the Jacobite defeat there were included more than 40 O'Neills. Many O'Neills fought with distinction later in the Irish brigade in the service of France. Though their importance as a leading family came to an end with the failure of the Stuart cause, the O'Neills did not sink into obscurity in the 18th century as did so many Gaelic Catholic families. As a protestant, John O'Neill (1740–98) was a member of the Irish parliament: though he was an active supporter of Catholic emancipation he died of wounds received in an action against the United Irishmen in 1798. In 1793 he had been created Baron O'Neill of Shane's Castle. His son was advanced to an earldom but this title died with him and, when his brother died in 1855, the viscountcy also became extinct. A relative on the female side, William Chichester, obtained the estates as heir general, assumed the surname of O'Neill and was created Baron O'Neill in 1868. Raymond Arthur Clanaboy O'Neill (1933–) succeeded to the title in 1944.

Other notable Ulstermen of the name were Arthur O'Neill (1737–1816), the blind harper, who preceded Edward Bunting in the collection of traditional Irish music, and John O'Neill (1834–78), leader of the Fenian invasion in Canada in 1867. Another John O'Neill (*c.* 1777–1860) was a successful poet and dramatist in London. Famous in the field of American drama were James O'Neill (1849–1920), Irish emigrant from Kilkenny, and his son Eugene O'Neill (1888–1953) the playwright (*see* O'NEILL, EUGENE GLADSTONE). Also worthy of mention is Peggy O'Neill (1796–1879), daughter of an Irish innkeeper in Washington; her love affairs and financial vicissitudes made sensational news and even affected the course of American politics. (*See* EATON, MARGARET O'NEALE.) The present chief of the name is H. E. Dom Hugh O'Neill of Lisbon, Portugal.

See E. MacLysaght, *Irish Families* (1957), and *More Irish Families* (1960), which include bibliographies; Micheline Walsh, *The O'Neills of Spain* (1960). (E. A. MacL.)

O'NEILL, EUGENE GLADSTONE (1888–1953), U.S. dramatist, born in New York city on Oct. 16, 1888, was by common consent America's greatest playwright and an artist of international renown. His career divided U.S. theatrical history in two. Before O'Neill, U.S. stages were awash with genteel, sentimentally spurious plays; he pioneered the drama of serious realism and uncompromising honesty.

When Eugene O'Neill took his place on the U.S. literary scene in the 1920s, it was to join a band of iconoclasts. H. L. Mencken was tilting with the "booboisie." Sinclair Lewis was baiting Babbitt. Sherwood Anderson was gingerly lifting the lid off sex. O'Neill ranged over the same themes but he sprayed them with a melancholy that clung like poison gas. Cries a leading character in *The Great God Brown:* "Why am I afraid to dance, I who love music and rhythm and grace and laughter? Why am I afraid to live, I who love life and the beauty of the flesh and the living colors of earth and sky and sea? Why am I afraid of love, I who love love? . . . Why was I born without a skin, O God . . . Or rather Old Greybeard, why the devil was I ever born at all?" (*The Plays of Eugene O'Neill*, 3 vol., New York, Random House, 1946.) O'Neill took this language of failure and flavoured it with the accent of tragedy. It was a convincing performance, in part because failure is often regarded as tragic in America, and in part because O'Neill had a rare mastery of his craft.

He came by a mastery of his craft early. His father, James O'Neill, was a matinee idol of the 1880s, playing for 16 years the count in *The Count of Monte Cristo*. Barnstorming with his father, young O'Neill soaked up theatrical know-how. In the fall of 1906 he entered Princeton university and flunked out the following spring. In the next few years he married and divorced, prospected for gold, went to sea and sailed the Atlantic from Southampton to South Africa. For O'Neill, the sea was a mystic experience, and some of the best of his 47 plays (e.g., *The Moon of the Caribbees, The Long Voyage Home*) are salty with the tang of the sea and the tongue of lonely, hard-bitten sailormen.

It was not until a mild case of tuberculosis bedded him in a sanitarium in 1913 that Eugene O'Neill thought of becoming a playwright. When the Provincetown (Mass.) Players produced his one-act *Bound East for Cardiff* in 1916, modern American drama unofficially began. By 1920 O'Neill fashioned a Broadway success and won a Pulitzer prize with his first full-length play, *Beyond the Horizon*, a bitter domestic tragedy. O'Neill was already felt to be a man of morose views who could be counted on to find the worm in the apple of life. Actually his plays were cardiograms of the outraged heart, poignantly charting the cancelled dream, the twisted love, the thwarted hope. O'Neill won two more Pulitzer prizes: *Anna Christie* (1922) and *Strange Interlude* (1928), and in 1936 became the second American (after Sinclair Lewis) to win the Nobel prize for literature. A restless technician, he thrilled theatregoers with tom-toms (*Emperor Jones*), masks (*The Great God Brown*), old-fashioned asides (*Strange Interlude*) and choral chants (*Lazarus Laughed*). A troubled thinker, he tried to pour modern experience into tragic molds.

It has been said that tragedy is the story of man's fate. Greek tragedy is the tragedy of destiny. Man's fate is in his stars. Shakespearean tragedy is the tragedy of character. Man's fate is in his will. Through suffering and death, Greek and Shakespearean tragic heroes appeased the gods and found redemption. O'Neill had to cope with an audience that was almost as suspicious of God, will and destiny as of a flat earth. Bowing to his time, O'Neill wrote the tragedy of personal psychology. Man's fate is in his genes and hormones. But if man is his own fate, there can be no release, only an endless cycle of sin and guilt. Says Lavinia Mannon at the end of *Mourning Becomes Electra:* "There's no one left to punish me . . . I've got to punish myself!" (*The Plays of Eugene O'Neill, ibid.*) O'Neill blended the determinism of John Calvin and Sigmund Freud to produce the only kind of tragic hero the 20th century could understand—the victim of circumstance.

The "sickness of today," O'Neill once said, was that the "old God was dead" and a new one was not in sight. To "belong" to the machine age, as O'Neill saw it, man had to be subhuman, an automaton. The instinct to love had been debased by possessiveness. The instinct to believe had atrophied. The best O'Neill could offer was chilly, stoic resignation. As the old barge captain puts it in *Anna Christie:* "You can't see where you vas going, no. Only dat ole devil, sea—she knows." (*The Plays of Eugene O'Neill, ibid.*)

O'Neill sometimes handled these themes crudely. He wrote a kind of waterlogged English that never floated memorably across the mind. What he intended for encounters with the inexpressible were simply collisions with the badly expressed. When the juice of life ran low in his characters, he pumped them full of grease paint. His mind was an open manhole; ideas (Strindberg's, Freud's, Jung's) tumbled in but were never really absorbed. Yet there is something granitic in O'Neill that refuses to be chipped away—the sweep of his passion and compassion, the hypnotic moods he projects over the footlights and, above all, his probity. He never cheated with his evidence, and his evidence came from the heart. He never consciously wrote a shoddy line.

The coming of World War II sapped O'Neill's will to write; then a muscular disorder made it physically impossible. When he died he left at least three plays in manuscript, including the autobiographical *Long Day's Journey Into Night,* which was produced in Stockholm in Feb. 1956 and in New York city later that year.

On the world's stages, only G. B. Shaw and Sean O'Casey clearly outrank him among 20th-century dramatists. Yet O'Neill never achieves the Aristotelian catharsis of pity and terror, or climbs to tragedy's classic realm where man's suffering and death stand bare, awesome and ennobling; his heroes wander instead, like eternally lost children through a haunted wood of pathos, futility, self-pity and frustration. But in his dedication to the best in his art form, Eugene O'Neill was a cultural hero, and as such, he left the U.S. theatre the memory of something finer than his best plays.

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ONION (*Allium cepa*), a hardy, bulbous, biennial plant of the lily family (Liliaceae). Native to middle Asia, with secondary centres of development in western Asia and the Mediterranean area, it is unknown in the wild state, having been cultivated since prehistoric times. The onion is now grown the world over, chiefly in the temperate zones.

The edible part of the onion is the thickened leaf bases arising from the extremely shortened stem, called the stem plate, at the base of the bulb. The upper part of the leaf is cylindrical and hollow. Fibrous, shallow roots emerge in a tuft from the stem plate. In the second season of growth a smooth seedstalk rises two to five feet, topped by a large globose umbel of small whitish flowers. The seeds are small, usually black, irregular and somewhat angular. Two types of onion produce no seeds: those propagated by bulblets formed instead of seeds in the umbel; and those propagated only by division of a vegetative cluster of plants. Most varieties of onions are sensitive to length of day and night. Bulbing varieties adapted to summer culture in high latitudes will not form bulbs during the short days of winter in low latitudes. Certain varieties that form large bulbs during the short days of low latitudes will form only small bulbs during the long days of high latitudes. The Welsh onion (*A. fistulosum*), native to China, forms no enlarged bulb.

BY COURTESY OF U.S. DEPARTMENT OF AGRICULTURE

ONION FLOWER HEAD (ALLIUM CEPA)

Varieties grown in the northern U.S. require a mild, cool climate. Varieties of Spanish and Egyptian type tolerate hot days of spring but not the midsummer heat of low latitudes. The latter types are sown in autumn in regions having little or no winter freezing. Northern bulbing varieties typically are firm fleshed, long keeping and very pungent. The Bermuda type, grown in the south for spring harvest, is less firm fleshed, is mild and can be stored several weeks but not several months.

Discovery of cytoplasmically inherited male sterility in the onion in 1925 led to a commercially feasible method of producing F_1 hybrid seed of onion (1944) and later of certain other plants. Substantial quantities of seed for growing superior F_1 hybrid varieties became commercially available in the U.S. after 1950.

Most onions are grown by sowing seed directly in the field, but large acreages of Bermuda and Spanish onions are grown from transplants. Some onions of the northern type are propagated by planting tiny mature bulbs called sets, which were grown from thickly sown seed the preceding year.

Nonbulbing onions for use in the fresh green state can be harvested at any time after they are large enough. Bulbing kinds sometimes are harvested similarly, before bulbs form, for immediate use. "Green onions" are marketed with the fresh green tops (leaves) attached. Bulb onions are mature enough to harvest soon after the necks weaken and the tops fall to the ground. The bulbs are pulled from the soil and dried in the field until the necks are thoroughly dry. The tops are then removed and the bulbs are bagged for shipment or crated for storage.

Onions keep best in dry, well-ventilated storage at about 32° to 34° F. *See* also VEGETABLE. (V. R. B.)

ONION MAGGOT, the larval stage of the small fly *Hylemya antiqua* of the family Muscidae (Anthomyiidae) order Diptera (*see* FLY), which attacks the roots of onions (rarely garlic and related plants) in damp, cool areas of Europe and North America. The eggs are laid on the soil close to the plants; the young larvae,

which grow to about one-third of an inch, feed on the roots or attack the bulbs and bases of the leaves. Many other insects are attracted to and feed upon the damaged plants, and bacterial rot often sets in. Species commonly found associated with *H. antiqua* are the lesser bulb fly (*Citabaena tuberculatus*) and species of *Fannia*.

Treatment consists in spraying the foliage with various insecticides when the flies appear. Certain seed treatments combined with a spraying schedule are effective. *See* ENTOMOLOGY: *Applied Entomology*. (C. H. CN.; X.)

ONITSHA, a commercial town of Eastern Nigeria, Federal Republic of Nigeria, which stands prominently on the eastern bank of the Niger river at its junction with the Anambra river. Pop. (1963) 163,032, predominantly Ibo. The town is virtually divided into two residential areas by the Oguta road, to the east of which lives chiefly the indigenous population, the west side being occupied by people of various tribes. Other main streets in a wide network are the Old Market and New Market roads; Venn, Sokoto and Awka roads; Modebe avenue; and Bright and Nottidge streets. There are no ancient buildings but the Roman Catholic Holy Trinity cathedral (1935) and the Anglican All Saints cathedral (1952) are notable modern buildings. Among many colleges and schools the oldest is the Dennis Memorial grammar school (1925) and others are St. Charles' teachers' training college (1929) and Christ the King college (1933). Onitsha market, built by the town council, is the largest in Nigeria.

Onitsha is served by road and river transport. The inhabitants are engaged largely in farming and trade. The chief export is palm produce, and textiles are the main import. (I. P. N. O.)

ONN BIN JA'AFAR, DATO' (1895–1962), Malayan statesman who played an important part in establishing the Federation of Malaya, was born at Johore Bahru in Johore state. The son of Dato' Ja'afar, prime minister of Johore, he was educated in England and after his return served for a time as a government officer in Johore. He turned to journalism, however, and edited two Malay newspapers, first the *Warta Melayu* and then the *Lembaga Melayu*. In 1936 he was appointed a member of the Johore State council. In 1947, as founder and leader of the United Malay National organization (U.M.N.O.) he forced the British government to withdraw its humiliating Malayan Union scheme of 1946. For this achievement the sultan of Johore appointed him prime minister of his state, but Dato' Onn soon resigned to devote all his time to Malayan politics. When, in Feb. 1948, the federation was inaugurated (*see* MALAYSIA: *History*) he became federal minister for home affairs. In 1951 the rejection of his proposal that U.M.N.O. should admit other races caused him to resign its leadership and in 1953 growing conservatism led him to found a new party (Partai Negara), which advocated a gradual approach to self-government. The party failed at the 1955 general election and Dato' Onn returned to journalism. Dato' Onn was knighted in 1953. He died at Johore Bahru on Jan. 19, 1962. (R. O. WT.)

ONONDAGA, meaning "on the mountain," is the name applied to North American Indians of Iroquoian speech; the central fire of the Longhouse of the Five Nations (afterward Six) of the Iroquois league; the aboriginal proprietors of New York state. Flanked by Oneida and Cayuga tribal lands, Onondaga territory extended from the Thousand Islands, their Laurentian homeland, south to the Susquehanna river. First stockaded on the mountain, the capital of Iroquoia later occupied open valley sites along the creek, toward the lake, within the county of that name, moving periodically to plant new gardens, to seek firewood, and to be nearer fish and game. Onondaga castle, now Onondaga reservation, lies just south of Syracuse. A 17th-century visitor counted 140 houses in the main town and 24 in another; he estimated 350 warriors (some 1,700 people); on the intervening two-mile clearing grew an abundance of maize for sale to Oneida. In the League of the Iroquois, the Onondagas claimed a total of 14 seats in council; they were "uncles, name bearers, fire keepers"; they furnished the chairman and archivist, who kept the records of transactions in wampum belts. British colonial representatives attended such congresses in the 18th century, when a sizable faction favouring the French had migrated to Catholic mission settlements on the St. Lawrence. The conservative faction remained loyal to British interest, and with the breakup of their league, after the American Revolution, a small party followed the other Six Nations to the Grand river, Ont., and the majority returned to their ancestral valley. The resident population of Onondaga reservation in New York in the 1960s was 744 according to the U.S. department of the interior.

See also IROQUOIS.

See G. P. Kurath, "Onondaga Ritual Parodies," *Journal of American Folklore*, vol. 67 (1954); L. H. Morgan, *League of the Iroquois* (1962). (W. N. F.)

ONTAKE-SAN, Japanese mountain, elevation 10,049 ft., located on the boundary of Gifu and Nagano prefectures (central Honshu). A compound volcano which has a heavy snow mantle in winter, it is second only to Fujiyama in elevation and popular esteem. Crowds of white-robed pilgrims climb to the ancient Shinto shrine on its summit during the height of the summer season. (J. D. EE.)

ONTARIO, a province of Canada, bounded on the east by the province of Quebec and on the west by the province of Manitoba, on the south by the U.S. states of New York, Ohio, Michigan and Minnesota, and on the north by Hudson bay and James bay. It is the second largest Canadian province, with a total area of 412,582 sq.mi., 68,490 sq.mi. (17%) of which is fresh water. It is the most populous of Canada's ten provinces with a total population (1961) of 6,236,092, and also the most productive, its varied economic activities accounting for about 40% of Canada's new wealth each year. The provincial capital is Toronto.

PHYSICAL GEOGRAPHY

Ontario lies in the east central part of North America, stretching from 42° to 57° N., and from 79° 30′ to 95° W. From its southernmost point in Lake Erie to its northernmost point on Hudson bay is a distance of 1,050 mi., while its greatest east to west distance from Quebec to Manitoba is also more than 1,000 mi.

Tradition and its shape divide Ontario into two very unequal parts, the line of division following the French and Mattawa river systems from Georgian bay on Lake Huron east-northeast through Lake Nipissing to Mattawa. To the south of this line is southern Ontario, containing less than one-eighth of the total area but having more than seven-eighths of the population and economic activity. To the north of the line, northern Ontario is a vast land of rock and forest, much of which is still relatively untouched.

Land Forms.—Ontario has a great length of shoreline. On James bay and Hudson bay it borders saltwater for 680 mi. while to the south on the Great Lakes and St. Lawrence, it has a freshwater shoreline of 2,362 mi. Ontario is a land of relatively low relief. Large areas near Hudson bay and James bay are not far above sea level, the lowlands along Lake Ontario and the St. Lawrence river are between 150 and 500 ft. above sea level, while most of the southwestern peninsula lies between 500 and 1,000 ft. above sea level. Higher areas, from 1,000 to 1,700 ft., are found in the flat-topped uplands south of Georgian bay, and in the more rugged southern portion of the Canadian shield stretching from the Ottawa river to the Manitoba boundary. The highest points in Ontario, near the northern and eastern shores of Lake Superior, are Tip Top hill and Mt. Batchawana, both of which reach over 2,100 ft. above sea level.

The most striking feature in southern Ontario is the Niagara escarpment. From the Niagara river it extends west to Hamilton as a flat-topped ridge about 350 ft. above the level of Lake Ontario. From Hamilton at the western end of the lake, it runs in a northwesterly direction to the Bruce peninsula, reaching its best development in the Blue mountain which stands more than 1,000 ft. above the waters of Georgian bay. Other hilly areas are found in the Oak ridges between Lake Ontario and Lake Simcoe.

Geology.—On the basis of bedrock geology, Ontario may be divided into four distinct zones as indicated on fig. 1 (A), (B) (C) and (D):

The Hudson bay lowland is underlain by Paleozoic rocks (A). Ranging in age from Ordovician to Devonian, these rocks consist

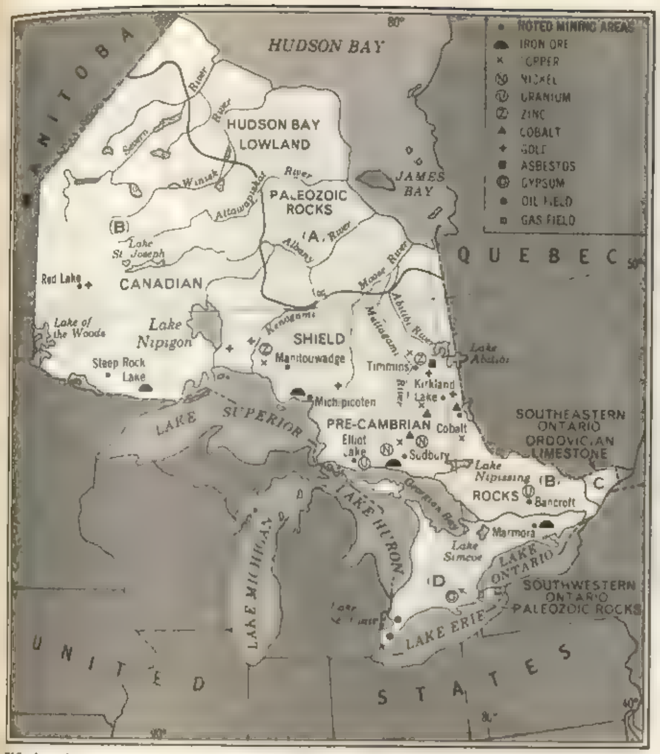


FIG. 1.—GEOLOGIC FORMATIONS, PHYSICAL FEATURES AND PRINCIPAL MINERAL DEPOSITS OF ONTARIO (*see* TEXT)

of horizontally bedded limestones, shales and sandstones.

The rocks of the Canadian shield (B) are Precambrian in age and among the oldest rocks in the world. They consist of gneisses, granites, graywackes, quartzites, crystalline limestone and many other metamorphosed sedimentary and igneous rocks. (*See* PRECAMBRIAN TIME: *The Precambrian Record.*) Many areas are strongly mineralized, yielding ores of iron, nickel, copper, gold, silver, cobalt and uranium.

A small area in southeastern Ontario is underlain by Ordovician limestone (C).

Southwestern Ontario is underlain by Paleozoic rocks (D) ranging in age from Ordovician to Devonian. Petroleum and natural gas, gypsum and salt are found in the rocks of southwestern Ontario. The hard Silurian dolomite which forms the cap rock of the Niagara escarpment is quarried extensively for use as crushed stone, while the red shale beneath it is used for brickmaking.

Ontario was glaciated in the Pleistocene epoch. The surface, nearly everywhere, is composed of unconsolidated rock debris laid down either by the ice itself or by the melt water which issued from the ice front. The minor surface land forms, therefore, are composed of till or boulder clay, and water-worked gravel, sand, silt and clay.

Lakes and Rivers.—Numerous lakes and rivers are found in Ontario. The southern part of the province is nearly all tributary to the St. Lawrence while, to the north, a number of river systems, including the Moose, Albany, Attawapiskat, Winisk and Severn drain to Hudson bay. The western margin of the province drains to the Nelson river system of Manitoba.

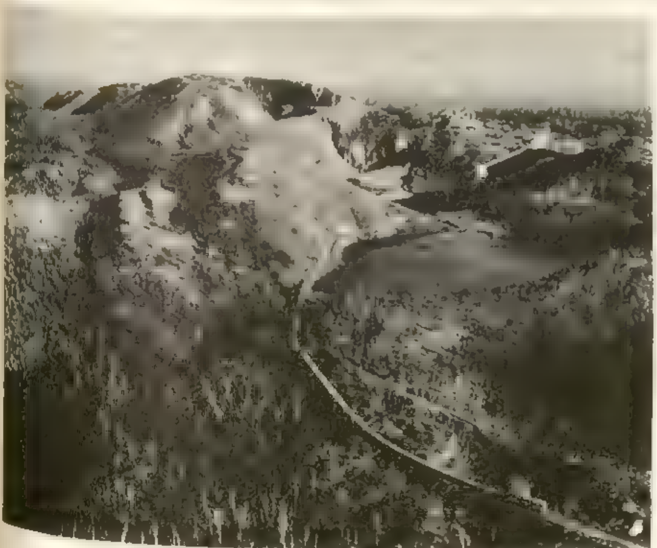
The surface waters of Ontario include the Canadian portion of four Great Lakes: Superior (11,110 sq.mi.), Huron (13,675 sq.mi.), Erie (4,940 sq.mi.) and Ontario (3,970 sq.mi.). Other notable lakes, wholly or partly in Ontario, are Lake of the Woods, Rainy lake, Lac Seul, Lake Nipigon, Lake Nipissing, Lake Abitibi, Lake Simcoe and Lake St. Clair. In addition, the surface of the Canadian shield is dotted with thousands of smaller lakes.

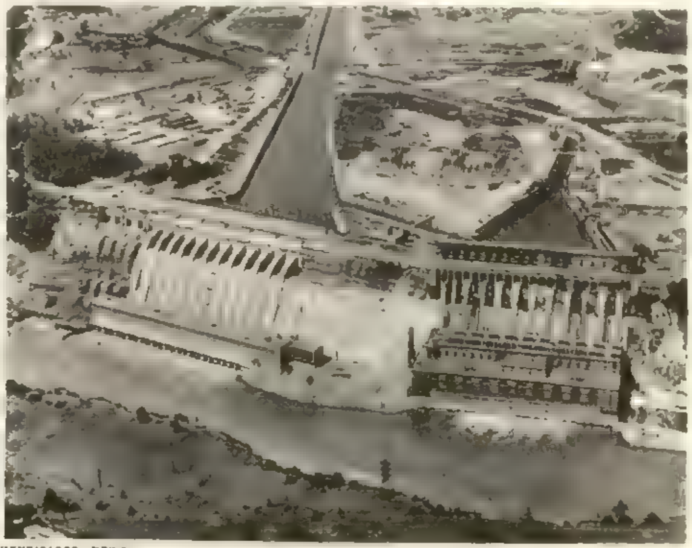
The rivers of Ontario which flow from the uplands of the Canadian shield are steep and rapid, furnishing numerous power sites. The great volume of the St. Lawrence system makes it an important source of power, while with the help of the St. Lawrence, Welland and Sault Ste. Marie canals, the St. Lawrence-Great Lakes system has become a very important inland waterway.

Niagara falls, 158 ft. in height, on the Niagara river between Lakes Erie and Ontario, is one of the scenic wonders of the world and a great tourist attraction (*see* NIAGARA RIVER AND FALLS). The smaller rivers in the north also have many scenic falls and rapids while the island-dotted waters of Georgian bay, the Muskoka lakes, Lake Timagami, Lake Nipissing, Lake of the Woods and many others provide wonderful vacation areas.

Climate.—Because of its large area, Ontario has a considerable range of climate, its temperature range being especially great. Average midwinter temperatures, everywhere, are well below freezing, but they range from less than −15° F. (about −26° C.) along the shore of Hudson bay to 25° F. (about −4° C.) along the shore of Lake Erie. Winters in the south are comparatively short, but in the north they are long and cold and the temperature may remain below zero (F.) for days at a time. The summer frost-free season in the north is less than 60 days, whereas it averages 175 days at the southernmost tip of the province. Average July temperature in the north is about 54° F. on the shore of Hudson bay, while it is 74° F. on Pelee Island in Lake Erie. The waters of the Great Lakes ensure that there is less difference between night and day temperatures along their shores than at inland points.

Mean annual precipitation varies from more than 40 in. to less than 15 in. Greatest precipitation is found along the slopes of the high land east of Lake Superior and on the uplands east and





BY COURTESY OF (RIGHT) "ONTARIO HYDRO"; PHOTOGRAPH, (LEFT) AUTHENTICATED NEWS

(LEFT) TRAIN CARRYING IRON ORE FROM A MINE NORTH OF SAULT STE. MARIE; (RIGHT) POWER GENERATING STATION NEAR QUEENSTON ON THE NIAGARA RIVER

south of Georgian bay. The areas with least precipitation are found in the far north. In general, precipitation is fairly evenly distributed in all months in southern Ontario, but in the north there is more precipitation in summer than in winter. Snowfall is abundant in the areas south and east of Georgian bay, getting about 120 in. per winter. On the other hand, the most southerly areas get less than 40 in., while the snow cover is often quite discontinuous. In northern Ontario, snowfall varies from more than 100 in. to less than 60 in., while the ground is snow-covered for at least five months of the year.

In general, about half of northern Ontario may be said to have a subarctic climate quite unsuitable to agriculture; the area west of Lake Superior has a mid-continental climate like that of northern Minnesota or southeast Manitoba; a small area of southern Ontario has almost a corn belt climate suitable for corn, sugar beets, tobacco and even grapes and peaches; the southeastern portions are generally suitable for dairy and general farming.

BY COURTESY OF CANADIAN CONSULATE GENERAL

(LEFT) UNIVERSITY COLLEGE, ONE OF THE OLDEST BUILDINGS OF THE UNIVERSITY OF TORONTO, THE PROVINCIAL UNIVERSITY OF ONTARIO; (RIGHT) EXHIBITION PARK, TORONTO, PERMANENT SITE OF THE ANNUAL CANADIAN NATIONAL EXHIBITION

Natural Vegetation.—Most of Ontario is naturally a forested region. Only along the shore of Hudson bay is the climate too harsh for tree growth, and there a strip of boggy tundra extends inward a few miles from the coast. Most of northern Ontario is covered with a boreal forest or taiga, composed of white and black spruce, tamarack and jack pine, often intermixed with aspen and birch. This region is noted for its pulpwood resources. The Great Lakes mixed forest stretches from Lake Superior to the Ottawa river. Formerly this area had great stands of white and red pine, and other stands of mixed maple, birch, spruce and hemlock. Most of southern Ontario was occupied by deciduous hardwood forests of sugar maple, beech, yellow birch, white and red oaks, elm, white and black ash, basswood, hickory and, in the extreme south, scarlet oak, chestnut, sassafras and Kentucky coffee tree. There are many poorly drained areas throughout Ontario which are either open bogs or swampy forests.

Animal Life.—Among the larger game animals of Ontario may be mentioned the moose, with a range almost coextensive with the forest, the woodland caribou, now rather rare, and the white-tailed deer, which is abundant in the mixed forest belt and may even be found in the hardwood forests of the south. There are many rodents, including the porcupine, the red squirrel and the eastern chipmunk. Two larger rodents, much at home in the water, are the beaver and the muskrat. The snowshoe rabbit is found throughout the boreal forest while the cottontail and the imported European hare are common in the south. Common in the south, also, are the black squirrel and the woodchuck. Among the carnivores more common in northern Ontario are the black bear, the timber wolf, the coyote, or brush wolf, and the red fox. Skunks, minks, bobcats and weasels are also found. Raccoons are plentiful in some parts of southern Ontario, and even the opossum may be found.

With so many lakes, Ontario is a natural home for water birds, including gulls, ducks, geese and herons. Among the uplands game birds are the ruffed grouse and the bobwhite and, in southern Ontario, the imported pheasant. Among the other birds may be mentioned various hawks and owls, ravens, crows and blackbirds, songbirds such as the robin, the cardinal, whippoorwill, bobolink, catbird, meadow lark, swallow and various song sparrows. Two introduced nuisances are the English sparrow and the starling.

There are many species of fish in Ontario waters. Most noted perhaps are the pike, pickerel, lake trout, whitefish, muskellunge, sturgeon, black bass and brook trout.

The lakes and rivers of Ontario are dotted with cabin resorts which cater to the sport fisherman in spring and summer, and they often remain open to accommodate the fall hunter as well.

Soils.—Developed under a forest cover, the soils of Ontario are well leached. In the area west of Lake Superior, the soils resemble those of the forested parts of the Prairie provinces and are usually classed as gray-wooded soils. In much of northern Ontario, true podzols with a markedly leached, gray horizon are to be found on well-drained materials. In southern Ontario the soils are normally gray brown podzolics, similar to those of Michigan and New York.

While the soils in well-drained locations exhibit these normal characteristics, there are many old lake plains and other flat areas which have imperfectly drained, immature soils. There are also many areas of bog soils in all parts of the province. Soil drainage has, therefore, been an important problem in the agricultural development of Ontario.

HISTORY

The first recorded European to visit Ontario was Étienne Brulé who explored the Ottawa river in 1613. (For general background and chronology of this period as well as later periods *see* CANADA: *History*.) In 1615, Brulé and Samuel de Champlain ascended the Ottawa and visited the Indian settlements near Georgian bay. Later, a mission to the Hurons was established at Fort Ste. Marie near the present town of Midland. Martyr's shrine, overlooking the restored site, is a memorial to the Jesuit fathers who lost their lives at the hands of the hostile Iroquois war parties who destroyed the settlement in 1649.

The French had fur-trading posts at Fort Frontenac (Kingston), Ft. Rouillé (Toronto), Sault Ste. Marie, Nipigon and Kaministikwia (Fort William). A small agricultural colony was begun on the banks of the Detroit river. The Hudson's Bay company founded Moose Factory in 1671, and the English were, thereafter rivals of the French in the fur trade of northern Ontario.

By the peace of Paris in 1763 at the close of the Seven Years' War, Canada was ceded to Great Britain. The Quebec act of 1774 made Ontario part of an extended colony ruled from Quebec. The first settlers were the United Empire Loyalists who came to Canada after the American Revolution, taking up land in the Niagara peninsula, around the Bay of Quinté, and along the north bank of the St. Lawrence river. In 1791, the Constitutional act divided

Canada into two provinces. The colonists of Upper Canada (the future Ontario) were guaranteed a development of English law and culture.

Upper Canada and Canada West.—The first legislature of Upper Canada met at Newark (now Niagara-on-the-Lake) in 1792 at the summons of the first lieutenant governor, Lt. Col. John Graves Simcoe. In 1793, Simcoe founded the town of York on the shore of Toronto bay and, in 1797, the legislature was moved to the new capital. During the war of 1812, invaders from the United States captured and burned York. The monument to Sir Isaac Brock at Queenston and the rebuilt Ft. York in Toronto are historic sites commemorating the war.

The treaty of Ghent in 1814 ended the war. The Rush-Bagot agreement of 1817 between Great Britain and the United States (and affirmed by the U.S. senate in 1818) limited the number and size of armed vessels on the Great Lakes and ensured a peaceful future for the frontier. In the next few years many immigrants arrived from the British Isles. The fur trade vanished, to be replaced by the square timber trade, and later the trade in sawn lumber. Wheat was also produced for export. By 1837 there were 350,000 people in Upper Canada. Demands for responsible government culminated in an abortive revolt led by William Lyon Mackenzie. The earl of Durham was appointed a special commissioner to make an investigation. His report, in 1839, recommended that responsible government should be granted to the provinces, and that Upper and Lower Canada should be united.

In 1841 the act of union was put into effect. Upper Canada then became known as Canada West. The capital, first established at Kingston, migrated from city to city until it was eventually settled at Ottawa by Queen Victoria in 1858. The principle of responsible government was finally established in 1849.

The Province.—In the 1840s and 1850s the economic life of Canada began to quicken. The Welland canal, built in 1829, was enlarged and deepened, and canals were built on the St. Lawrence. Reciprocal trade with the United States was established in 1854, and the Grand Trunk railway from Toronto to Montreal was opened in 1856. There were still many problems, some of which were intensified by the American Civil War. In 1867, the British North America act established the dominion of Canada, with its capital at Ottawa, and Canada West became the province of Ontario, with its capital at Toronto.

In the 1880s farm population reached its greatest expansion in most parts of Ontario. The opening of the Northwest Territories to settlement gave opportunity to many young, vigorous Ontarians, while their demands for goods encouraged the development of manufacturing and the growth of towns and cities in Ontario. Further support was given the "National Policy" of the dominion's first premier, John A. MacDonald, which protected Canadian industry from undue outside competition. Railway building also led to the development of mining and forest industry in the north.

After 1900, the economic history of Ontario has been one of expansion and diversification of manufactures, a process greatly accentuated during both World Wars I and II. Agriculture has become more specialized, depending less on export markets and more upon the needs of the expanding cities of the province.

In the federal political field Ontario has fairly consistently supported the Conservative party of Sir John A. MacDonald and the "National Policy." During most of the 20th century also, the Conservatives have been in power in Ontario under the successive leadership of Sir James Whitney, Sir William Hearst, G. Howard Ferguson, G. S. Henry, George Drew, T. L. Kennedy, Leslie Frost and J. P. Robarts. From 1919 to 1923 there was a Farmers' government under E. C. Drury, while from 1933 to 1943 the Liberals under M. F. Hepburn and Gordon Conant formed the government. Regardless of political labels, the policies of Ontario governments have been to promote the use of natural resources, the public development of water power, the expansion of the highway system, an enduring concern over educational matters, and a continued effort to obtain for the province a fair share of federal subsidies.

POPULATION

The census of 1961 recorded a population of 6,236,092 in Ontario. This was almost three times the population at the turn of the century and more than three and one-half times its number in 1867, the year of confederation (*see* Table I).

The great growth of population in Ontario has been largely urban. Farm population has actually declined; there has been a considerable increase in the number of persons residing in rural areas, but not on farms. The population is very unequally distributed between southern and northern Ontario (*see* Table II).

The rapid growth after 1941 has been attributed to a high birth rate (about 27 per 1,000), low death rate (9 per 1,000), and about 60,000 newcomers each year after World War II.

About two-thirds of the people of Ontario are of British origin and about one-tenth are of French descent. Most of the latter, however, are able to speak both French and English. Most new Canadians settling in Ontario learn to speak English.

The religious denominations in Ontario are, roughly, United Church of Canada, 29%; Roman Catholic, 25%; Anglican, 20%; Presbyterian, 9%; Baptist, 4%; Lutheran, 3%; Jewish, 2%; others, 8%. Roman Catholics are most numerous in northeastern and southeastern Ontario, and in the city of Windsor; Anglicans are most strongly represented in metropolitan Toronto, Hamilton, London and the Niagara peninsula. People of Jewish faith are most numerous in Toronto, while Lutherans are concentrated in Kitchener-Waterloo.

GOVERNMENT

Executive authority in Ontario is vested in the crown, represented by the lieutenant governor who is appointed by the government of Canada for a term of five years. His advisers are the cabinet, or executive council, headed by the premier, who remain in power as long as they have the confidence of the legislature. The legislature of 98 members is elected by popular vote for a period not exceeding five years. Government revenues are derived from corporation taxes, sales taxes, licences, royalties on natural resources, profits on the sale of liquor and subsidies from the government of Canada. The largest items of government expense include health and social welfare, highways, education, law enforcement, research and administration of natural resources, general administration and debt charges.

Politically, Ontario is divided into 43 counties, 11 districts and one metropolitan area (Toronto). The counties and the metropolitan area, each of which is further organized into local munici-

TABLE I.—*Population*

Census date	Total population	Rural population						Urban population	
		Total	%	Farm	%	Nonfarm	%	Total	%
1851	952,004	818,541	86.0					133,463	14.0
1871	1,620,851	1,264,854	78.0					355,997	22.0
1901	2,182,947	1,246,969	57.2	979,450	44.9	267,519	12.3	935,978	42.8
1931	3,431,683	1,335,691	38.8	800,960	23.3	534,731	15.5	2,095,992	61.2
1941	3,787,655	1,196,119	31.6	704,420	18.6	491,699	13.0	2,591,536	68.4
1951	4,597,542	1,346,443	29.3	678,043	14.7	668,400	14.6	3,251,099	70.7
1956	5,404,933	1,302,014	24.1	632,153	11.7	669,861	12.4	4,102,919	75.9
1961	6,236,092	1,412,563	22.7	505,699	35.8	906,864	64.2	4,823,529	77.3

Urban and rural data for 1956 based on 1956 definition; for 1951 based on 1951 definition; for years preceding 1951 the definition in effect.

TABLE II.—*1961 Population Distribution*

	Land area sq.mi.	Total population	Density per sq.mi.	Rural population	Density per sq.mi.	Urban population	% urban
Southern Ontario	39,735	5,457,581	137.3	1,146,721	28.9	4,310,860	79.0
Northern Ontario	323,547	778,511	24.1	265,842	0.8	512,669	65.9
Province of Ontario	363,282	6,236,092	17.2	1,412,563	3.9	4,823,529	77.3

Table III.—*Incorporated Places of 5,000 or More Population**

Place	Population 1961	1956	1951	1941	1921
Total province	**6,236,092**	**5,404,933**	**4,597,542**	**3,787,655**	**2,933,662**
Ajax	7,755	5,683	—	—	—
Arnprior	5,474	5,137	4,381	3,895	4,077
Aurora	8,791	3,957	3,358	2,726	2,307
Barrie	21,169	16,851	12,514	9,725	6,936
Belleville	30,655	20,605	19,519	15,710	12,206
Bowmanville	7,397	6,544	5,430	4,113	3,233
Brampton	18,467	12,587	8,389	6,020	4,527
Brantford	55,201	51,869	36,727	31,948	29,440
Brockville	17,744	13,885	12,301	11,342	10,043
Burlington	47,008	9,127	6,017	3,815	2,709
Chatham	29,826	22,262	21,218	17,369	13,256
Cobourg	10,646	9,399	7,470	5,973	5,327
Collingwood	8,385	7,978	7,413	6,270	5,882
Cornwall	43,639	18,518	16,899	14,117	7,419
Deep River	5,377	3,669	—	—	—
Dryden	5,728	4,428	2,627	1,641	1,019
Dundas	12,912	9,507	6,846	5,276	4,978
Dunnville	5,181	4,776	4,478	4,028	3,224
Eastview	24,555	19,283	13,799	7,966	5,324
Espanola	5,353	—	—	—	—
Forest Hill	20,489	19,480	15,305	11,757	—
Fort Erie	9,027	8,632	7,572	6,595	3,947
Fort Francis	9,481	9,005	8,038	5,897	5,109
Fort William	45,214	39,464	34,947	30,585	20,541
Galt	27,830	23,738	19,207	15,346	13,216
Gananoque	5,096	4,981	4,572	4,044	3,604
Georgetown	10,298	5,942	3,452	2,562	2,061
Goderich	6,411	5,886	4,934	4,557	4,107
Grimsby	5,148	3,805	2,773	2,331	2,004
Guelph	39,838	33,860	27,386	23,273	18,128
Hamilton	273,991	239,625	208,321	166,337	14,151
Hawkesbury	8,661	7,929	7,194	6,263	5,544
Ingersoll	6,874	6,811	6,524	5,782	5,150
Kapuskasing	6,870	5,463	4,687	3,431	926
Kenora	10,904	10,278	8,695	7,745	5,407
Kingston	53,526	48,618	33,459	30,126	21,753
Kitchener	74,485	59,562	44,867	35,657	21,763
Leamington	9,030	7,856	6,950	5,858	3,675
Leaside	18,579	16,538	16,233	6,183	325
Lindsay	11,399	10,110	9,603	8,403	7,620
London	169,569	101,693	95,343	78,134	60,959
Long Branch	11,039	10,249	8,727	5,172	—
Midland	8,656	8,250	7,206	6,800	7,016
Milton	5,629	4,294	2,451	1,964	1,873
Mimico	18,212	13,687	11,342	8,070	3,751
Newmarket	8,932	7,368	5,356	4,026	3,626
New Toronto	13,384	11,560	11,194	9,504	2,669
Niagara Falls	22,351	23,563	22,874	20,589	14,764
North Bay	23,781	21,020	17,944	15,599	10,692
Oakville	10,366	9,983	6,910	4,115	3,298
Orillia	15,345	13,857	12,110	9,798	7,631
Oshawa	62,415	50,412	41,545	26,813	11,940
Ottawa	268,206	222,129	202,045	154,951	107,843
Owen Sound	17,421	16,976	16,423	14,002	12,190
Paris	5,820	5,504	5,249	4,637	4,638
Parry Sound	6,004	5,378	5,183	5,765	3,546
Pembroke	16,791	15,434	12,704	11,159	7,875
Penetanguishene	5,340	5,420	4,949	4,521	4,037
Perth	5,360	5,145	5,034	4,458	3,790
Peterborough	47,185	42,698	38,272	25,350	20,994
Port Arthur	45,276	38,136	31,161	24,426	14,886
Port Colborne	14,886	14,028	8,275	6,993	3,415
Port Credit	7,203	6,350	3,643	2,160	1,123
Port Hope	8,091	7,522	6,548	5,055	4,456
Prescott	5,366	4,920	3,518	3,223	2,636
Preston	11,577	9,387	7,619	6,704	5,423
Renfrew	8,935	8,634	7,360	5,511	4,906
Richmond Hill	16,446	6,677	2,164	1,345	1,055
Riverside	18,089	13,335	9,214	4,878	1,155
St. Catharines	84,472	39,708	37,984	30,275	19,881
St. Thomas	22,469	19,129	18,173	17,132	16,026
Sarnia	50,976	43,447	34,697	18,734	14,877
Sault Ste. Marie	43,088	37,329	32,452	25,794	21,092
Simcoe	8,754	8,078	7,269	6,037	3,953
Smiths Falls	9,603	8,967	8,441	7,159	6,790
Stoney Creek	6,043	4,506	1,922	1,007	—
Stratford	20,467	19,972	18,785	17,038	16,094
Strathroy	5,150	4,240	3,708	3,016	2,691
Streetsville	5,056	2,648	1,139	709	615
Sturgeon Falls	6,288	5,874	4,962	4,576	4,125
Sudbury	80,120	46,482	42,410	32,203	8,621
Swansea	9,628	8,595	8,072	6,988	—
Thorold	8,633	8,053	6,397	5,305	4,825
Tillsonburg	6,600	6,216	5,330	4,002	2,974
Timmins	29,270	27,551	27,743	28,790	3,843
Toronto	672,407	667,706	675,754	667,457	521,893
Trenton	13,183	11,492	10,085	8,323	5,902
Wallaceburg	7,881	7,892	7,688	4,986	4,006
Waterloo	21,366	16,373	11,991	9,025	5,883
Welland	36,079	16,405	15,382	12,500	8,654
Weston	9,715	9,543	8,677	5,740	3,166
Whitby	14,685	9,995	7,267	5,904	3,957
Windsor	114,367	121,980	120,049	105,311	38,591
Woodstock	20,486	18,347	15,544	12,461	9,935

*Populations are reported as constituted at date of each census. Note: Dash indicates place did not exist during reported census, or data were not available.

palities, are all in the southern part of the province. Local government under the supervision of the Ontario department of municipal affairs is based upon the Municipal act of 1849, as amended. Municipal funds are expended largely on police and fire protection services, schools and public works.

EDUCATION

Under the British North America act, education was placed under provincial control. It is administered by the Ontario department of education and supported by local taxes and provincial grants. About 21% of the population is in school, at all levels from kindergarten to university postgraduate work.

Attendance at school is compulsory between 6 and 16 years of age. There are 13 grades, 8 in the elementary school and 5 years of high school. Satisfactory graduation from grade 13 is accepted for university entrance.

Institutions of higher learning include the University of Toronto, Queen's university at Kingston, University of Ottawa and Carleton university in Ottawa, McMaster university at Hamilton, University of Western Ontario at London, University of Windsor, University of Waterloo and University of Sudbury. The Ontario Agricultural college and Ontario Veterinary college are located at Guelph, but the students receive their degrees from the University of Toronto. Ryerson Institute of Technology in Toronto provides technical training in many lines. There are a number of teachers' colleges scattered throughout the province.

The public schools of the province are nondenominational but wherever Roman Catholic ratepayers are sufficiently numerous they may set up separate schools for their own pupils. The Roman Catholic Church supports Ottawa and Sudbury universities, as well as St. Michael's, which is affiliated with the University of Toronto.

PRODUCTION

Ontario is the most productive province in Canada, normally accounting for 40% of the national income. In the 19th century the economic welfare of the province depended very largely upon the exploitation of natural resources in forestry and agriculture. Since then, despite the growth of mining, the primary industries have been eclipsed by the secondary industries devoted to processing and manufacture.

Agriculture.—Farming is still the foremost of the primary industries of Ontario, and, despite great development of other industries, Ontario remains one of the most important agricultural provinces in Canada. There are about 120,000 farms in the province, occupying about 18,600,000 ac. and providing jobs for about 172,000 workers. Normally, Ontario accounts for more than one-quarter of the agricultural wealth of Canada.

Almost nine-tenths of Ontario's agricultural land is found in the southern part of the province, where climate, land forms and soils are generally favourable, and city markets lie close at hand. There, over large areas, agricultural settlement is practically continuous, while in northern Ontario farms are grouped in small tracts separated by vast areas of almost unbroken forest.

Agricultural production is highly diversified. The leading items contributing to the cash income are cattle, hogs, milk, poultry and eggs, field crops, vegetables, fruits and other special crops. On most Ontario farms such field crops as hay, oats, mixed grains and corn are grown as feed for livestock, and only to a slight extent appear on the market. Wheat, barley, sugar beets, soybeans, tobacco, flax and various canning crops, on the other hand, are usually sold for cash. Most Ontario farms are run as commercial enterprises, but there are a few farms, remotely situated, often in northern Ontario, where a pioneer self-sufficing agriculture is carried on. There is also a great deal of part-time farming; many operators of commercial farms have other employment as well.

Within southern Ontario it is possible to distinguish a number of special agricultural areas (*see* fig. 2). A small district which comprises about ten townships on the south shore of Lake Ontario is known as the Niagara fruit belt. It produces most of the grapes, peaches and other soft fruits of the province. Apple orchards are located along the north shore of Lake Ontario, and on the south shore of Georgian bay. Southwestern Ontario, between Lake Erie and Lake Huron, is the Ontario corn belt, vying with any area in the U.S. middle west both in quality of grain and in yield per acre. This area also produces winter wheat, soybeans, sugar beets, early vegetables and canning crops. Midway along the north shore of Lake Erie, centred in Norfolk county, is the chief tobacco

BY COURTESY OF (TOP LEFT) IMPERIAL OIL LTD., (TOP RIGHT) CANADIAN CONSULATE GENERAL, (BOTTOM) NATIONAL FILM BOARD OF CANADA

(TOP LEFT) TOBACCO AND CURING BARNS IN SOUTHERN ONTARIO; (TOP RIGHT) FREIGHTERS LOADING GRAIN AT PORT ARTHUR ON LAKE SUPERIOR; (BOTTOM) ONION HARVESTING NEAR BRADFORD, NORTH OF TORONTO

producing area of Canada. The counties which border Lake Huron market a large number of high-grade beef cattle. Near such large cities as Toronto, Hamilton and London, there are intensive dairy areas, while in eastern Ontario milk is produced for cheese factories and other processing plants. Southern Ontario has a thriving agriculture, its progress marked by a decreasing farm population and an increasing size of farm, electrification and mechanization, which enables one man to produce more than ever before.

Forest Industry.—A forest inventory showed that about 167,000 000 ac. or 72% of the land area was under forest in the second half of the 20th century. About 105,000,000 ac. or 63% was classed as productive forest. Of the productive forest about 53,000,000 ac. (50%) carries merchantable timber while the remainder is young growth. A small percentage of the wood, mostly in the south, is composed of hardwood species such as sugar maple, yellow birch, elm, white and red oak. In the north are found such softwoods as spruce, balsam fir and jack pine which are useful for pulpwood, and white and red pine which formerly furnished great quantities of logs for the lumber trade. It is estimated that Ontario has about 84,000,000,000 cu.ft. of accessible timber, including 159,000,000,000 bd.ft. of saw timber and 610,000,000 cords of smaller material. Ontario contains slightly less than 20% of the accessible productive forest area of Canada and about 23% of the corresponding economic forest resources.

Most of Ontario's forest stands on crown land and is administered by the Ontario department of lands and forests. It maintains a forest protection and fire ranger service, involving fire towers, a radio communication network and airplane patrols. Most of the cutting operations are carried on by licensees and leaseholders under conditions laid down by the government which collects stumpage and other fees. While it is certain that past history involved a great deal of careless and wasteful forest exploitation, the timber management program of the Ontario government is one of sustained-yield forestry. To this end, a forest inventory was made and the province was divided into 120 management units, of which 40 are formed by large timber companies who prepare their own operating plans, while the remainder are planned by the department. The department also has divisions of reforestation, of research and of game and fisheries. The parks division administers a number of forest parks, of which the two largest and most noted are Algonquin park, in the highlands southeast of North bay, and Quetico, along the boundary between Ontario and the state of Wisconsin.

Fish and Furs.—The fresh-water fisheries of Ontario are exploited mainly in the Great Lakes and in the lakes of northwestern Ontario. The average annual catch is about 45,000,000 lb. and is worth about $7,000,000. Lake Erie is the most important fishing ground; Georgian bay ranks second, with northern inland waters standing third. The most important species are yellow pickerel, whitefish, blue pickerel, perch, lake trout, sturgeon, lake herring and tullibee. Commercial fisheries employ about 3,500 persons, largely on a part-time basis.

The fur trade, once almost the sole source of wealth in Upper Canada, is now the least important of its resources. About 40% of the annual yield is wild fur, the product of the trap line. About 60% is derived from ranch grown pelts. Beaver, muskrat and mink make up nine-tenths of the trapped fur while various types of mink account for nearly all the production of the fur farms.

Mining.—From before 1900 Ontario has been the chief mineral-producing province in Canada. In the second half of the 20th century, the value of its minerals averaged more than $600,000,000 per year, or 30% of the national production. Although best known for many years for its gold mines, Ontario produces a long list of other minerals as well. The important metals include nickel, copper, gold, iron ore, cobalt, uranium and silver. Among the nonmetallic minerals are salt, asbestos, nephelite-syenite (used in the manufacture of glass and ceramic products), sulfur and quartz. Natural gas and petroleum are of some importance while structural materials such as sand and gravel, cement, brick, crushed stone and lime are produced in large quantities. Most of the metals and many of the important nonmetallics are won from the Pre-Cambrian rocks of northern Ontario. The Paleozoic rocks of southern Ontario yield salt, gypsum, oil and natural gas; the structural materials are produced mainly in southern Ontario also. The copper-nickel ores near Sudbury support the oldest and most populous mining community, producing most of the world's supply of nickel. Sudbury also produces platinum metals, gold, silver and iron.

The most important gold mines are in northeastern Ontario near Timmins and Kirkland Lake and in the Red Lake area, while Cobalt, one of the earliest mining camps, still produces silver and cobalt. Iron ore is mined at Steep Rock Lake in the country west of Lake Superior, at Michipicoten Harbour near the northeast corner of Lake Superior, and at Marmora in southeastern Ontario. Uranium is mined at Blind River and Elliot Lake, north of Lake Huron, and near Bancroft in the southeast. Manitouwadge produces zinc, copper and silver, and a major copper-zinc-silver find north of Timmins was reported in 1964.

Great quantities of stone are quarried from the brow of the Niagara escarpment near Hamilton; brick is made from the underlying shale. Much of the natural gas of southwestern Ontario is obtained from wells drilled in the floor of Lake Erie.

Electrical Power.—Most of the electrical power used in Ontario is derived from water power. Although second to Quebec in water-power installations, Ontario ranks well ahead in the proportion of available power under development. Without the St. Lawrence International power development (in which Ontario has a 1,100,000 h.p. share), the province has about 8,000,000 installed

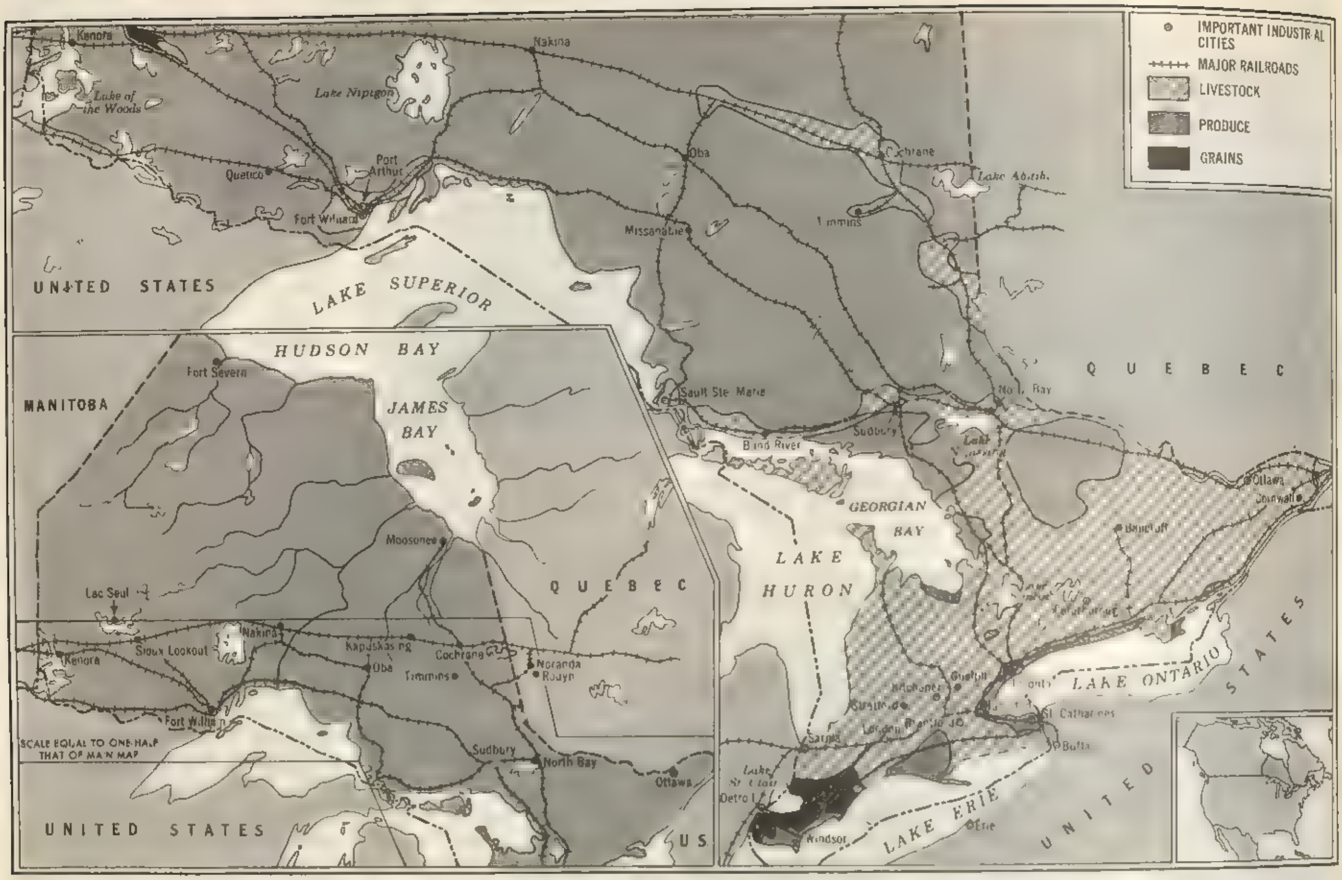


FIG. 2.—AGRICULTURAL LAND USE AND MAJOR INDUSTRIAL CENTRES OF ONTARIO

h.p. In addition, there are thermoelectric (steam generator) stations with a capacity of 1,000,000 h.p., while the electrical equivalent of another 1,000,000 h.p. is purchased from Quebec. Almost 90% of the primary electrical power is provided by the Ontario Hydro-Electric Power commission. In terms of kilowatts, the 1960 use of power in Ontario was estimated to be 5,425,000 kw., hydroelectric plants supplying 4,488,000 kw. (82.5%) and steam plants supplying 844,000 kw. (15.5%); the remainder was purchased power.

Public Ownership.—Ontario was a pioneer in public ownership of hydroelectric power. The Ontario Hydro-Electric Power commission was constituted in 1906. At first it merely bought power for distribution from private companies at Niagara. Later, under the guiding genius of Sir Adam Beck as chairman, the commission bought a number of generating stations and built others. In 1922, the first great station at Queenston, now known as the Sir Adam Beck-Niagara generating station no. 1, was built. Since that time a number of large stations have been built on the Ottawa river. The largest projects have been the Sir Adam Beck no. 2 at Queenston, and the Robert H. Saunders-St. Lawrence generating station near Cornwall. A nuclear-power demonstration station has also been built near Des Joachims generating station on the Ottawa. Large thermoelectric stations have been located at Windsor, Toronto and Lakeview. In northern Ontario there are large plants on the Abitibi, Mattagami, Mississagi, Nipigon, Aquasabon, English and Winnipeg rivers. Altogether, the Ontario Hydro-Electric commission serves 1,350 municipalities and, through them, more than 1,700,000 ultimate customers. Reasonably priced electrical energy is the key to Ontario's industrial expansion.

Manufactures.—Ontario has always been the leading manufacturing province in Canada, although, because of the development of industry in other provinces, its share is proportionally less than it once was. Nevertheless, Ontario produces half the manufactured goods of Canada and is one of the leading industrial areas in the world. Most of this industry, in which more than 645,000 persons are employed, is found in southern Ontario, largely in cities situated on or near the shores of the Great Lakes.

Many factors combine to encourage manufacturing. Raw materials from agriculture, forestry and mining are plentiful, abundant power is cheaply and efficiently distributed, the Great Lakes-St. Lawrence waterway provides convenient transportation for bulky raw materials, and there is a large and skilful labour force. Ontario is its own best market; its primary industries are relatively prosperous and this promotes prosperity in other lines. A significant factor is its nearness to the great manufacturing centres of the northeastern United States which have provided much of the capital invested in Ontario industries.

Metropolitan Toronto is by far the largest and most diversified of Ontario's industrial centres. There, slaughtering and meat packing, brewing, distilling, prepared foods, iron and steel products, machinery, aircraft, electrical goods, petroleum products, clothing, and printing and publishing are among the more important lines.

Hamilton is the most important primary iron and steel centre in Canada. Electrical machinery, chemicals and sheet metal products are also made. Windsor has long been noted for motor vehicles and parts. Pharmaceuticals, various steel products and chemicals are also important. Kitchener is noted for meat packing, beverages, leather products, furniture and miscellaneous iron and steel products. London has many of the same industries and is also the site of a diesel-electric locomotive plant.

Ottawa is noted for wood products, pulp and paper, printing and publishing, and food products. St. Catharines and adjoining towns manufacture wines, paper products, iron and steel products, automobile parts and fruit products. There are important shipyards nearby. Sarnia is the largest centre for petroleum refining, petrochemicals and allied products. Brantford is noted for agricultural machinery and miscellaneous iron and steel products. Peterborough manufactures electrical machinery, boats, outboard motors, watches, clocks and cereal products.

A few very special cases may be mentioned; among them are nickel refining at Port Colborne, the refining of radioactive minerals at Port Hope, and the work of the atomic energy corporation at Chalk River.

The extent to which certain industries are centred in Ontario is seen in the fact that Ontario makes 98% of all motor vehicles, 96% of the motor vehicle parts, 93% of the heavy electrical machinery and 92% of all the agricultural machinery made in Canada.

Construction.—The construction industry stands next to manufacturing, averaging 15% of the annual value of production, and employing over 200,000 workers. New housing is most important, not only in the five largest cities, but in many smaller ones as well. The Ontario Highways and Ontario Hydro-Electric commissions each spend more than $200,000,000 per annum in construction. The mining industry has not only undertaken many large projects but has initiated the building of new towns such as Manitouwadge and Elliot Lake. Wherever one goes in Ontario, the building of new industrial and commercial structures serves as a barometer of economic progress.

COMMUNICATIONS

Rivers and lakes provided the transportation for the settlement of Upper Canada, and Ontario still depends upon the water routes. The St. Lawrence and the Great Lakes form a navigable route for 1,200 mi. which, with the opening of the new 27 ft. seaway canals in 1959, is open to large ocean ships. Ontario ports handle more than 30,000,000 tons of shipping per year—more than any other province except British Columbia. The chief ports are Toronto, Hamilton, Sarnia, Fort William and Port Arthur.

Ontario has more than 10,500 mi. of railway, most of which is operated by the Canadian National and Canadian Pacific systems. Branch lines of United States railways also operate in southern Ontario. The Ontario Northland, from North Bay to Moosonee, was built by the Ontario government to open up the mining and forest areas of northeastern Ontario.

By the second half of the 20th century, Ontario had more than 83,000 mi. of road, of which 16,000 mi. were paved and 57,000 mi. surfaced with gravel or crushed stone. Ontario also had more than 1,700,000 motor vehicles, 40% of the Canadian total, one for each 3.2 persons.

Trans-Canada airlines provide several flights daily connecting Montreal, Ottawa, Toronto, London, Windsor, Sault Ste. Marie, the lakehead (Fort William–Port Arthur) and western Canada. Northeastern Ontario is also served. There are many flights to U.S. points. Malton, near Toronto, is the busiest airport.

Ontario is well served with communications facilities; it has over 2,000,000 telephones, nearly half the Canadian total, and Ontario people make more phone calls per capita than any other people in the world. Radio and television are well established, with more than 30 broadcasting stations and 16 television stations in the province.

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ONTARIO, a city of San Bernardino county in southern California, U.S., is located about 36 mi. E. of Los Angeles. The site was settled in 1882 by George and William B. Chaffey who established an agricultural colony and named it for their home province in Canada. A well-designed irrigation system brought water from the nearby San Gabriel mountains. Incorporated in 1891, Ontario became the trading centre for a prosperous agricultural district producing citrus fruits, grapes and olives. Chaffey Agricultural college, established and endowed by George Chaffey, later became a public high school and junior college. About 1940 Ontario began to experience economic diversification with the establishment of industries. Manufactures include aircraft and aircraft parts, wine, tile, steel, plastics and electrical equipment. In 1944 Ontario adopted a council-manager form of government. Pop. (1960) 46,617; a part of the San Bernardino-Riverside-Ontario standard metropolitan statistical area (*see* SAN BERNARDINO). For comparative population figures *see* table in CALIFORNIA: *Population*. (J. H. K.)

ONTARIO, LAKE, the smallest and most easterly of the Great Lakes of North America, is bounded on the north by the province of Ontario and on the south by the state of New York.

Lake Ontario, named from an Iroquois Indian term, is roughly elliptical, its major axis, 193 mi. long, lies nearly east and west, and its greatest breadth is 53 mi. The area of its water surface is 7,520 sq.mi. and the total area of its drainage basin, exclusive of lake surface, is 34,800 sq.mi. Its mean surface elevation above mean sea level is 245 ft., which is 325 ft. below the level of Lake Erie. Its greatest depth is 802 ft.; its average depth, much in excess of that of Lake Erie. As a result there are seldom any great fluctuations of level due to wind disturbance, but the lake follows the general rule of the Great Lakes of seasonal and annual variation. There is a general surface current down the lake toward the east, of about 8 mi. a day, which is strongest along the south shore. (For comparison with the other Great Lakes, a discussion of their origins, connections, utilization, etc., *see* GREAT LAKES, THE.)

History.—Lake Ontario was discovered by Etienne Brûlé, a scout, and viewed by his leader, Samuel de Champlain, in 1615, in the course of their return eastward from Lake Huron. During the next several decades French trading and missionary work developed extensively on the upper Great Lakes, with the route of travel between the Great Lakes and Montreal along the Ottawa river, far to the north of Lake Ontario. The Ontario region was held by the Iroquois Indians, allies of the British. A temporary peace with the Iroquois allowed some French activity along Lake Ontario, and in 1673 Fort Frontenac was built at present day Kingston, Ont. During the next several years Robert Cavelier de la Salle placed a few small sailing vessels on Lake Ontario and he erected a blockhouse at the mouth of the Niagara river in 1679. The French established Fort des Sables at Irondequoit Bay (near the present city of Rochester) about 1720. The first important British settlement on Lake Ontario was at Oswego, in 1722. Fort Niagara (which is still standing) was built by the French in 1725–27.

During the French and Indian War the British captured all posts on the lake and in 1763 France ceded the entire Great Lakes territory to the British. During the Revolutionary War military activities in the Lake Ontario region consisted mainly of raids on the American colonists by Indian allies of the British and punitive action by Americans against British Loyalists. The most important action was a battle at Oriskany where General Nicholas Herkimer and his American militia defeated an expeditionary force of British and Indians. The country around Lake Ontario was only lightly settled until after the Revolutionary War. That war probably hastened the development of Ontario by at least a generation, in providing it with Loyalist settlers, garrison trade and improved shipping on the lake. In the War of 1812, as fought on and around Lake Ontario, neither side appeared to make a very determined thrust and the leaders seldom gained their objectives. Both Great Britain and the United States built and maneuvered naval forces on the lake, but they never closed in decisive combat.

Physiography.—On the north side of the lake the land rises gradually from the shore and spreads out into broad plains which are thickly settled by farmers. A marked feature of the topography of the south shore is what is known as the Lake ridge, or Niagara escarpment. This ridge extends, with breaks, from Sodus, about 30 mi. E. of Rochester, west to the Niagara river, and is 3 to 8 mi. distant from the lake. The low ground between it and the shore is a celebrated fruit growing district, covered with vineyards, peach, apple and pear orchards and fruit farms. The Niagara river is the main feeder of the lake; the other largest rivers emptying into the lake are the Genesee, Oswego and Black from the south side, and the Trent, which discharges into the upper end of the bay of Quinte, a picturesque inlet 70 mi. long, on the north shore, between the peninsula of Prince Edward, near the eastern extremity of the lake, and the mainland. The east end of the lake, where it is 30 mi. wide, is crossed by a chain of five islands, and the lake has its outlet near Kingston, where it discharges into the head of

the St. Lawrence river between a group of islands. Elsewhere the lake is practically free from islands. The lake never freezes over except near land, but the harbours are closed by ice from about mid-December to mid-April.

Harbours and Commerce.—The principal Canadian ports are Kingston, at the head of the St. Lawrence river; Toronto, where the harbour is formed by an island with improved entrance channels constructed both east and west of it; and Hamilton, at the head of the lake, situated on a landlocked lagoon, connected with the main lake by Burlington channel, an artificial cut. The principal U.S. port is Oswego, N.Y., where a breakwater has been built, making an outer harbour.

The commerce of Lake Ontario is limited in comparison with that of the lakes above Niagara falls, and is in general confined to vessels which can pass the Welland canal and the St. Lawrence canals. (*See* WELLAND SHIP CANAL; SAINT LAWRENCE RIVER; SAINT LAWRENCE SEAWAY.) The commerce on the lake is generally confined to coal shipped from Rochester, Sodus bay, Little Sodus bay and Oswego to Canadian ports on the lake and U.S. and Canadian ports on the St. Lawrence river; to coal from Oswego to upper lake ports; to grain and other products shipped from upper lake ports through the Welland canal to the St. Lawrence; and to lumber from Canadian ports.

Lake Ontario is connected with the New York State Barge canal at Oswego, N.Y., and it is connected with Georgian bay (*q.v.*) of Lake Huron by the Trent Valley canal and waterway which accommodates small craft.

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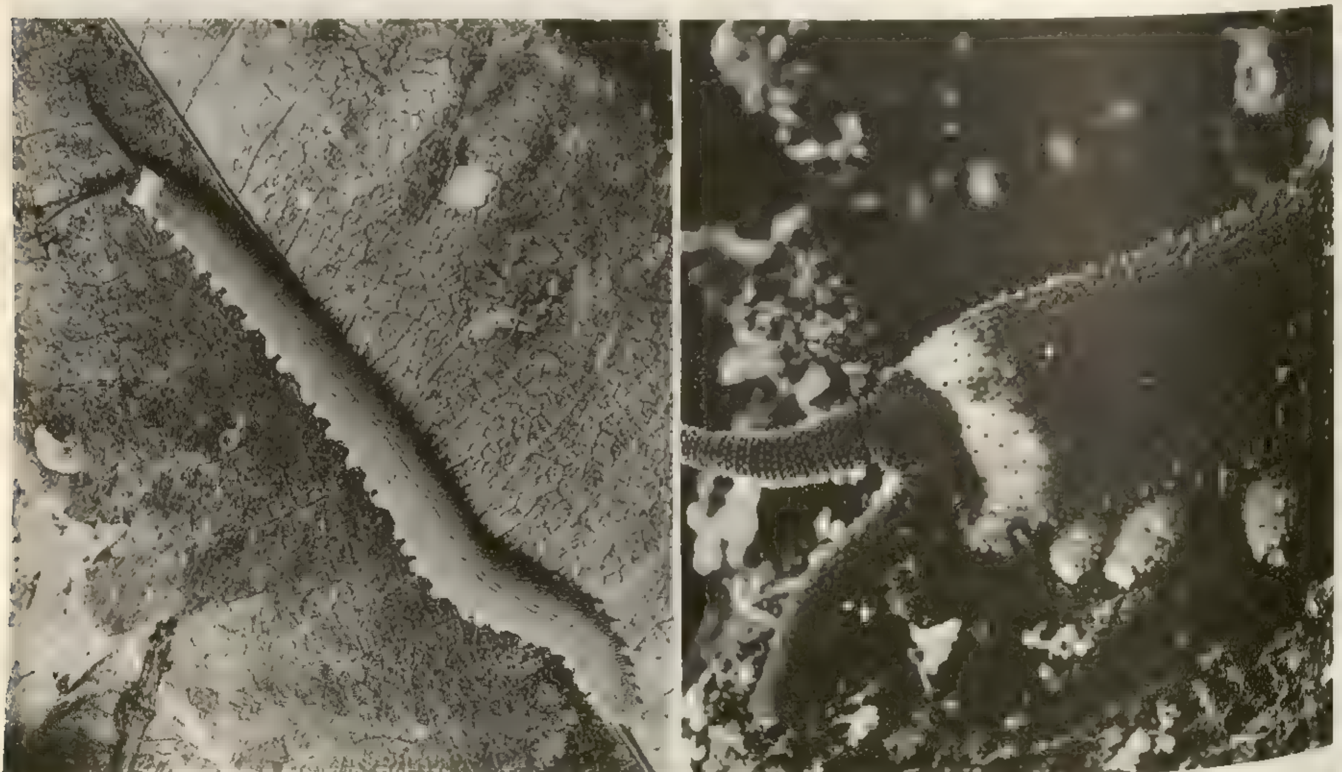
ONTOLOGY. The term "ontology" was introduced by the German philosopher Christian Wolff in the 18th century. It was intended to denote a particular branch of philosophy; namely, that branch which deals with the theory of being, for example the theory of what really exists in contrast with what only seems to exist, of what permanently exists in contrast with what only temporarily exists, and of what exists independently and unconditionally in contrast with what exists dependently and conditionally. Ontology therefore coincides with metaphysics (*q.v.*) in one sense; and on the whole little use has been made of Wolff's label.

The adjective "ontological," however, is employed to refer to a particular argument. The ontological argument for the existence of God was used by Descartes and, more disputably, by Anselm (*q.v.*; and *see* THEISM). Whereas other arguments for God's existence rested on factual premisses, the ontological argument rests on the purely conceptual or a priori premisses that "perfection" is part of the meaning of "God" and that "exists" is part of the meaning of "perfect." So there is a logical contradiction in the assertion that God does not exist. This argument was rejected as fallacious by Thomas Aquinas and by Kant; the latter showed that the second premiss pretends that "exists" is a predicate (*i.e.*, stands for an attribute or property) and so can be a part of the definition of a concept, as "quadrilateral" is a part of the definition of "square." But an assertion or denial of the existence of something of a certain description is not the mere unpacking of that description. It asserts or denies that the description applies to something. It says something true or false about the world. Its truth, if it is true, is not a logically necessary, conceptual or analytic truth, but a factual or synthetic truth. (G. R.)

ONYCHOPHORA, a small group of arthropodan animals, at one time thought to be intermediate between the annelid worms and the arthropods. The Onychophora (meaning "claw bearers") are a class of their own, equivalent in rank to the classes Crustacea, Diplopoda, Chilopoda; they comprise few genera and only 100–200 species. There is little range of form within the Onychophora. They exhibit some primitive arthropodan features in the composition of the head, simple eyes, limbs and alimentary canal and in the long series of segmental organs, as well as some highly specialized features in the mode of excretion (uric acid crystals), the form of the connective tissue "skeleton," the methods of reproduction and all structures concerned with eating live prey.

The Onychophora occur over all the southern continents, with a few species spreading into the Malay archipelago and India, which suggests survival of a once more widespread group of animals.

Habits and Correlated Structure.—Onychophora live in



RALPH BUCHSBAUM

FIG. 1.—(LEFT) ADULT PERIPATUS (MACROPERIPATUS GEAGI) ON A DECAYING LEAF. ACTUAL SIZE IS APPROXIMATELY 5 IN. (RIGHT) HEAD END OF PERIPATUS GREATLY ENLARGED TO SHOW THE MINUTE PAPILLAE WHICH GIVE ITS SKIN A VELVETY TEXTURE. A CLAWED FOOT IS SEEN ON LEG AT RIGHT

damp places, sheltering in decaying logs, clefts in the ground and under stones in treeless country; they cannot exist in sodden environments. They cannot control water loss from their innumerable spiracles and have no need to do so in their normal surroundings. Onychophora are active at night, seeking their small prey, mates and fresh shelter. They can withstand three months' fast. Dozens of individuals may reside in crevices deep in a decaying log. Dry country is an impassable barrier; therefore, localized species occur in isolated damp places. Vital in the whole evolution of the Onychophora is their extreme distortability, which enables them to squeeze through openings as small as ⅛ of their resting cross-section. They can thus creep into places whose narrow access bars carnivorous scute-bearing arthropods large enough to harm them, such as centipedes, insects and scorpions. *Peripatopsis* usually comes to rest after squeezing through one or more narrow crevices to reach more commodious spaces. This habit is of great protective value to an animal that lacks acute vision and has as its only means of defense the squirting of slime. This extreme deformability of body far exceeds that of other arthropods and is made possible by: the furrowed flexible cuticle, providing ample slack in all directions; the connective tissue "skeleton," which changes shape without stretching; the unstriated muscles; and compact jaws, which slide backward instead of sideways and lack a median tendon between the transverse muscles, an arrangement characteristic of many Arthropoda. All these features, at one time supposed to be annelidan, are specializations of the Onychophora that are essential for survival.

Onychophora are slow in walking. Their limb movements display a simpler range of gaits than any other arthropod. Secondarily soft-bodied arthropods, such as many insect larvae, have no such simple unspecialized gaits.

Structure.—*Peripatus* (fig. 1) is a typical onychophoran genus; the term is also commonly used to signify any onychophoran species. In size the Onychophora range from one to several inches in length. They are elongated, with a dry velvety skin. The 14–44 trunk segments (depending on the species) each bear a pair of short legs. The head has one pair of preoral antennae, the sensory spines of which tap the ground in walking, and a pair of jaws, each rather like a short, wide leg with a much enlarged terminal paired claw, surrounded by a round lip (fig. 2).

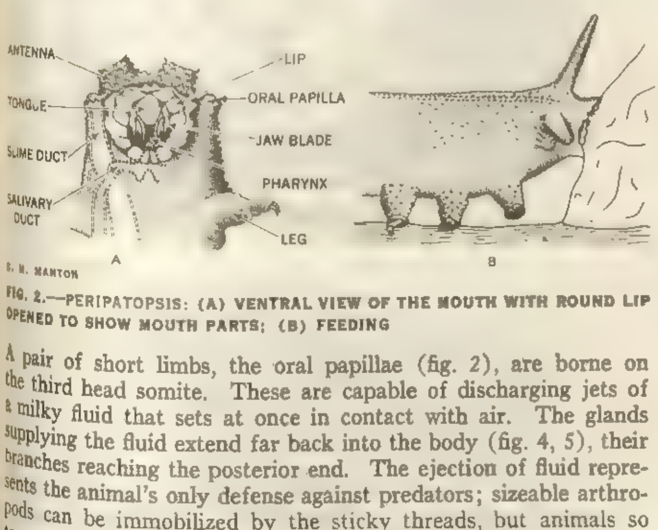


FIG. 2.—PERIPATOPSIS: (A) VENTRAL VIEW OF THE MOUTH WITH ROUND LIP OPENED TO SHOW MOUTH PARTS; (B) FEEDING

A pair of short limbs, the oral papillae (fig. 2), are borne on the third head somite. These are capable of discharging jets of a milky fluid that sets at once in contact with air. The glands supplying the fluid extend far back into the body (fig. 4, 5), their branches reaching the posterior end. The ejection of fluid represents the animal's only defense against predators; sizeable arthropods can be immobilized by the sticky threads, but animals so trapped do not appear to be used as food. Onychophora are carnivorous, eating other small arthropods, which are held by suction from the round mouth (fig. 2) and cut up by the jaws. Digestive fluids may be extruded into the wound and fluids sucked back from the prey, which need not be swallowed if it is large or hard.

No external demarcation of segmental boundaries is seen because the cuticle is very thin, although hardened externally as in other arthropods. Bending can occur anywhere so that no localized joints are needed, unlike the case in the majority of arthropods, which bear rigid plates or scutes. The cuticle is furrowed and raised into innumerable papillae, each terminating in an elaborate sensory spine (fig. 2, 3).

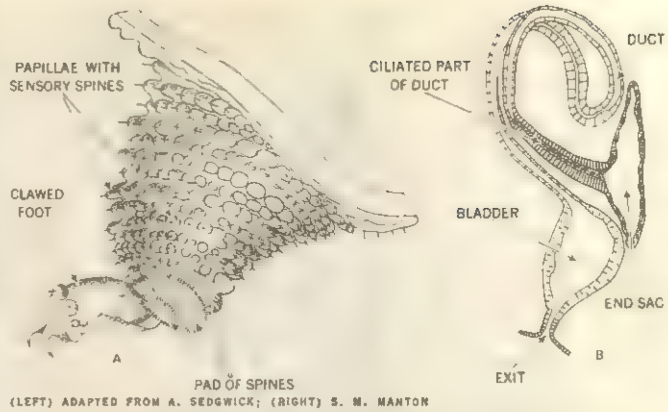


FIG. 3.—(A) LEG OF PERIPATUS SHOWING SPINE PAD ON WHICH IT WALKS (THE CLAWED FOOT IS RAISED UNLESS THE GROUND IS SLIPPERY); (B) COILED SEGMENTAL ORGAN OF PERIPATOPSIS

Under the outside cuticle and ectoderm the body wall consists of a thick layer of connective tissue fibres (crossing each other in many directions) on which are anchored the muscle fibres: circular, oblique, longitudinal and deep dorso-ventral, all of them unstriated or smooth.

A typical arthropodan hemocoelic body cavity houses the organs, which are bathed in blood circulated by a dorsal heart (fig. 4).

Arthropodan segmental organs are present in most segments; they consist of an end sac, representing the remains of the large segmental embryonic coelom (like that of a coelomate worm), and a duct passing to the exterior at the base of each leg (fig. 3–5). In a few species cilia occur in the duct near the end sac (fig. 2). The segmental organs eliminate water and other substances, but are not the major site of nitrogenous excretion. The segmental organs of the jaw segment enlarge to form the salivary glands (fig. 2, 4, 5). In other arthropods such organs are much restricted in number, being present on some segments only, where they form salivary or excretory glands (*e.g.*, antennal and maxillary glands of Crustacea, gnathochilarial gland of Diplopoda, maxillary gland of Chilopoda), or atrophied in the adult and replaced by excretory Malpighian tubules, as in insects.

Aerial respiratory organs are present in the form of unbranching tracheae, fine tubes carrying air from a number of spiracular depressions in the ectoderm of every segment to the various organs; 30 to 70 spiracles may occur in rows on one segment. Inasmuch as the spiracles have no closing device, such as insects have, and the unwettable body wall is perforated, the body may quickly dry out. The lipoid-impregnated outer cuticle prevents

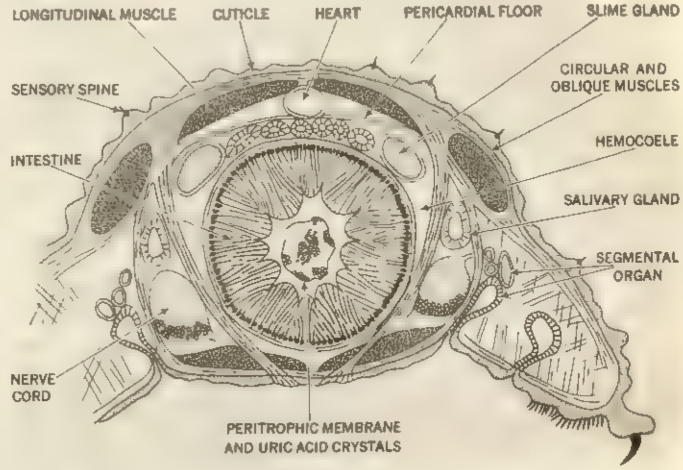


FIG. 4.—TRANSVERSE SECTION THROUGH THE BODY OF PERIPATOPSIS SHOWING THE MAIN ORGANS

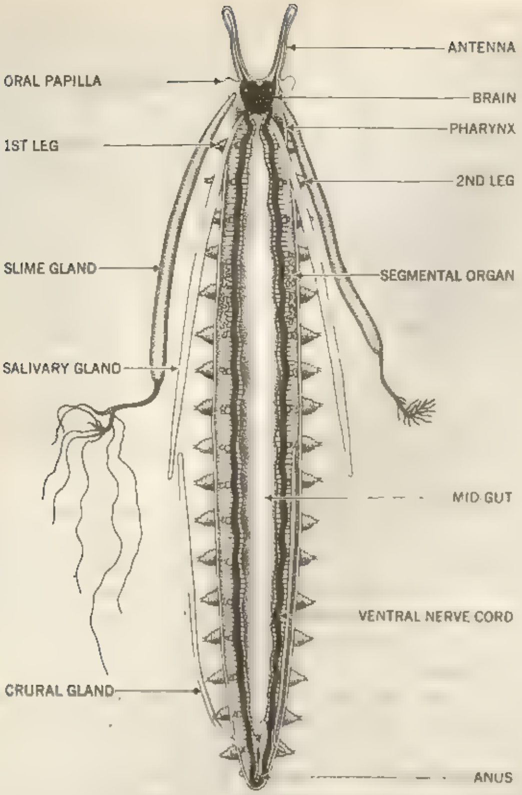


FIG. 5.—DORSAL DISSECTION OF PERIPATUS SHOWING MAIN ORGANS

the absorption of water under wet conditions, the risk of death by swelling being greater than death by desiccation. In structure the tracheal system differs from that of other arthropods, but tracheae have undoubtedly been evolved several times in adaptation to the land habit.

The alimentary canal is simple, with short fore- and hind-gut lined with cuticle and a long, ample, mid-gut, which serves for digestion, absorption and the daily excretion of uric acid crystals (fig. 4, 5). A peritrophic membrane, for elimination of wastes, occurs as in some other arthropods, but its manner of formation and removal is unique. Once a day uric acid crystallizes at the inner face of the peritrophic membrane, the latter then separates from the gut as a tube which shrinks around the crystals and any indigestible waste matter; the whole is passed to the exterior as a neat packet.

The nervous system consists of paired ventral nerve cords enlarged in every segment to form a pair of ganglia from which segmental nerves pass out to the organs (fig. 4, 5). The ganglia of each pair are united by several transverse strands of nerve fibres. At the head end, a dorsal brain innervates the antennae and eyes, and circumesophageal commissures continue to the ventral cord. The paired eyes, near the base of the antennae (fig. 2), possess a lens and a simple retina; they respond to changes in light intensity but seem not to record an acute image. Highly sensory taste spines lie on the lips and lining of the preoral cavity. The spines on the surface papillae (fig. 3, 4), each with its own nerve and sense capsule, are responsive to air movements, vibrations and tactile stimuli.

Reproduction and Development.—The sexes are separate and the sexual organs paired, opening by a median pore near the posterior end of the body. Copulation occurs in the Australian species, spermatophores being deposited in the female genital tract. In the African species of *Peripatopsis*, spermatophores are deposited anywhere on the surface of the body and sperms pass through the ectoderm and tissues to reach the ovary (fig. 6). Fertilization is internal. (The penetration of sperms through the body wall and tissues to reach the unfertilized eggs occurs elsewhere only in a few leeches and some insects.) The process is simple, but not primitive. A few species lay heavily yolked, shelled eggs; some retain a yolked egg in the oviduct until the hatching of a miniature adult; others retain a yolkless egg in which a transitory empty yolk sac may be present, and fluid nourishment is absorbed from the parental oviduct, pregnancy lasting 13 months. Minute yolkless eggs occur in new world species, nourishment being transmitted to the embryo in part by a uterine placentalike modification. Giving birth to miniature adults instead of laying shelled eggs is an adaptation toward life on land, which has also been acquired by a few amphibia, reptiles, snails and insects. The occurrence of an advanced characteristic such as viviparity is surprising in Onychophora, which show so many primitive arthropodan features. Growth is slow, four years or more being needed to reach full size in the African species, and increase in size is intermittent, as in all arthropods, occurring just after the molt.

Relationships.—The embryonic development of the Onychophora has many specialized features correlated with its primitive type of egg, but the basic pattern of development is that of an arthropod. The head is more primitive than in any other arthropod: only one pair of somites (antennal) shifts forward in front of the mouth during development, and even these bear transitory segmental ducts; and only one pair of limbs behind the mouth is used for feeding (other myriapod and insect groups have two or three pairs modified for feeding), but the head is clearly arthropodan and unlike that of annelids in structure and development.

There are many embryonic and other resemblances between Onychophora and Pauropoda, Diplopoda, Chilopoda and Symphyla, which suggest that the Onychophora, together with these classes and the insects, represents a monophyletic line of arthropod evolution quite separate from that of the distinct and primarily aquatic Crustacea, Merostomata and Trilobita.

FIG. 6.—(A) SPERMATOPHORE ON BODY WALL OF PERIPATOPSIS; (B) SECTION OF BODY OF PERIPATOPSIS SHOWING SPERMS THAT HAVE PENETRATED SURFACE AND ARE ON THEIR WAY TO THE OVARIAN EGGS

The fossil remains of arthropods are recognizable as far back in geological time as the Cambrian era, but even at that time various classes of marine Arthropoda were well differentiated in the form of Trilobita, Merostomata and Crustacea. Many millions of years later the land became habitable to animals. Little is known of the earliest land fauna because there are few suitable fossil-bearing deposits of the right ages: scorpions appear in the Silurian, well-differentiated diplopods in the Devonian and Carboniferous and wingless insects in the Lower Permian. An apparently marine deposit has yielded the middle Cambrian *Aysheaia;* this creature is remarkably like the present-day onychophorans in general body form, skin texture and limbs, but its head is ill preserved and the proposed restorations are not generally accepted. Thus the Onychophora may well be a very ancient group. Comparative anatomy, embryology and experimental work, moreover, suggest that the Onychophora are persistent specialized relicts of an early land stock of animals that also gave rise to the modern pauropods, millipedes, centipedes, Symphyla and insects.

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ONYX is a striped agate (*q.v.*), a variety of quartz (*q.v.*), in which white layers alternate with black. When brown or red bands occur instead of black the stone is termed sardonyx. The Romans applied this name originally to a species of marble, now called onyx marble, because of a resemblance between its well-defined white and yellow veins and the shades in the fingernail (Greek *onyx*, "claw" or "fingernail"). Onyx has always been largely employed in cameo work because the design and background could be cut so as to occur in differently coloured layers. The best cameos are those produced by the ancients, though a revival of the art was occasioned by the discovery in the middle of the 19th century of the South American sources of onyx. Many agates are made suitable for the cutting of cameos by artificially dyeing the layers (*see* GEM: *Colour Improvement*). Beads, brooches, ring stones and other small ornaments are frequently made of onyx, and larger pieces are fashioned into cups and vases. Onyx marble is much softer and less precious than true onyx (for varieties and uses *see* MARBLE). The chief localities for onyx are South America and India. (W. A. W.; X.)

OÖLITE. Oölites resemble the roe of a fish, hence their name (from the Greek *ōon*, "an egg"; and *lithos*, "a stone"). They are a millimetre or less in diameter, are generally ovoid or spherical and most commonly consist of a concentric or radial crystalline deposit of calcium carbonate. Less commonly, oölites are siliceous (SiO_2), sideritic ($FeCO_3$), phosphatic (tricalcium phosphate) or ferruginous (iron silicate or iron oxide).

The term has been applied both to the microspherical concretionary bodies and to the rock composed largely of such structures: to avoid ambiguity these structures have been called oöids, oöliths or ovulites, and the term oölite has been reserved for the rock composed of such bodies. The term is also used in an adjectival sense, such as oölitic limestone, oölitic chert, etc. False oölites are small spherical or ovoid bodies bearing superficial resemblance to oölites but devoid of a regular internal structure.

The calcareous oölites appear to be forming today where cold oceanic waters flow onto warm shallow banks, as in the Bahamas. The carbonate is precipitated on bits of shell, quartz grains or other nuclei. They are also known to form in springs and caves, as "cave pearls." *See* also CALCITE; LIMESTONE; SEDIMENTARY ROCKS. (F. J. P.)

OOPHORECTOMY, the operation for removal of one or both ovaries, including the removal of an ovary containing a tumour. *See* GYNECOLOGY. (R. W. TEL.)

OORT, JAN HENDRIK (1900–), Dutch astronomer and co-founder with B. Lindblad of the Lindblad-Oort theory of galactic rotation, was born at Franeker, Friesland, Neth., on April 28, 1900. Educated at the University of Groningen, he was appointed astronomer at the Leiden observatory in 1924 and director in 1945. Four years later he became director of the Netherlands Foundation of Radio Astronomy. He served as a visiting professor at the California Institute of Technology and at Princeton university in 1952.

A student of both J. C. Kapteyn and P. J. van Rhijn, Oort worked mainly in the fields of galactic dynamics and galactic structure. When Lindblad, in 1925, advanced the theory of the rotation of the galactic system, Oort modified it to meet observational tests and developed it into the form used thereafter. His subsequent work, as well as that of the school of astronomy he developed in the Netherlands, was directed toward strengthening and testing the Lindblad-Oort theory. (O. J. E.)

OOTACAMUND, popularly known as "Ooty" and sometimes called the "queen of hill stations," a town and headquarters of the Nilgiris (*q.v.*) district of Madras, India. It lies about 7,000 ft. above sea level within the basin formed by two spurs of the Dodabetta (8,640 ft.), 65 mi. S. of Mysore, and approached by a rack railway, and by road, from Mettupalaiyam. Pop. (1961) 50,140. It has several fine buildings built by the British, including the churches of St. Thomas and St. Stephen, the Stone house (the former summer offices of Madras government) and Government house. Government Arts college (1955) is affiliated to Madras university. Ootacamund enjoys perpetual spring with a mean annual temperature of 14° C. (58° F.) (mean maximum 20° C. [68° F.] and mean minimum 9° C. [48° F.]). Open-air recreational facilities include a narrow artificial lake (2 mi. long; constructed 1823–25), a racecourse, botanical gardens, fishing and hunting. At Lovedale, 3 mi. S., is the Lawrence Memorial school (1858). Other hill stations nearby are Coonnoor, Keti, Kotagiri and Wellington. Nearby are eucalyptus estates and cinchona plantations, and there is a government quinine factory at Naduvattam, 20 mi. N.W. (G. KN.)

OPAH (*Lampris regius*), a large, oval oceanic fish, the sole member of the family Lampridae, widely distributed in warm seas but nowhere abundant. The opah, which may reach a length of six feet and a weight of more than 500 lb., is most remarkable for its striking colours. The fins and jaws are bright scarlet and the upper body is bluish-gray blending to deep rose beneath, the body being marked with oval spots of silvery-white. The flesh is eminently edible. Opahs are occasionally taken on lines off Madeira and Japan but no commercial fishery has been established because of the lack of knowledge of this fish's life history and habitat. *See* also FISH.

OPAL, a mineral consisting of amorphous silica and variable amounts of water. Many kinds are recognized, and a few of these, highly valued as gem stones, are known collectively as precious opal. In ancient times precious opal was included among the noble gems and was ranked second only to emerald by the Romans. Many superstitions have centred about this stone; in the middle ages it was supposed to be lucky, but in modern times it has been regarded as unlucky.

Opal is fundamentally colourless, but such material is rarely found. Disseminated impurities are common and impart various dull body colours ranging from the yellows and reds of iron oxides to the black of manganese oxides and organic carbon. The milkiness of many white and gray opals is due to an abundance of tiny gas-filled cavities. Most varietal names are applied on the basis of general appearance; *e.g.*, milk opal, resin opal, liver opal, agate opal, plasma and prase opals (green), jasper opal (red), sunstone opal (yellow) and carnelian opal (orange-red).

Precious opals, which are translucent to transparent, are distinguished by a combination of milky to pearly opalescence and an attractive play of many colours. These colours flash and change as a stone is viewed from different directions and are caused by interference of light along minute cracks, veinlets of younger opal and other internal inhomogeneities.

In the variety known as harlequin opal the rainbow colours origi-

STONES FROM: (TOP) WASHINGTON UNIVERSITY, ST. LOUIS, MO.; (BOTTOM) COLLECTIONS OF W. C. BLATT, ST. LOUIS, MO., AND W. V. SCHMIDT, NEW YORK CITY; PHOTOGRAPH BY JOHN H. GERARD

OPALS: (TOP) INCLUSION IN ROCK MATRIX FROM MEXICO; (BOTTOM) POLISHED OPALS FROM AUSTRALIA

nate from little angular surfaces, forming a mosaic. Black opal, with a very dark gray or blue to black body colour, is both rare and highly prized. White opal, with light body colours, and fire opal, characterized by yellow, orange or red body colour, are much more common. The finest specimens of all varieties show an intense play of colours among large, even-size patches, each of uniform colour.

The composition of opal is represented by the formula $SiO_2 \cdot nH_2O$. Common opal contains 1% to 21% water and precious opal 6% to 10%. The mineral has a hardness of 5.5 to 6.5 and is easily scratched by quartz. It is brittle, with an irregular to conchoidal fracture, and is minutely porous. An extremely porous variety, known as hydrophane, can absorb surprising quantities of water and will adhere to the tongue. It is almost opaque when dry but nearly transparent when saturated. Another porous variety is cacholong, which has a lustre like mother-of-pearl.

Opal is deposited from circulating waters as nodules, stalactitic masses, veinlets and encrustations and is widely distributed in nearly all kinds of rocks. It is most abundant in volcanic rocks, especially in areas of hot-spring activity. It also forms pseudomorphs after wood and other fossil organic matter, and after gypsum, calcite, feldspars and many other minerals that it has replaced. Some pseudomorphic aggregates are known as pineapple opal. As the siliceous material secreted by organisms such as diatoms and radiolarians, opal constitutes important parts of many sedimentary accumulations.

The finest gem opals have been obtained from Queensland and New South Wales in Australia, and the Lightning Ridge field is famous for superb black stones. Deposits of white opal in Japan, fire opal in Mexico and Honduras and several varieties of precious opal in India, New Zealand and the western United States also have yielded much gem material. Most of the precious opal marketed in ancient times was obtained from occurrences in Czechoslovakia. Various forms of common opal are widely mined for industrial uses; *e.g.*, as abrasives, insulation media, fillers and ceramic ingredients.

Fire opals usually are facet cut, but most other precious opals are finished *en cabochon*, as their optical properties are best displayed on smoothly rounded surfaces. Undersized fragments are used for inlay work and small pieces scattered throughout a natural matrix commonly are sold as such under the name "root of opal." Drying of opal gems through heating or use in arid regions can cause cracking and significant loss of colours. Many finished stones are protected by water or films of oil until they are sold. Opals absorb liquids very readily, and light-coloured stones often are dyed to resemble rarer, more deeply coloured varieties. *See also* GEM; SILICA: *The Silica Minerals.* (R. H. J.)

OPATIJA (Ital. ABBAZIA), a seaside town in Istria, Rijeka *srez* (district), Socialist Republic of Croatia, Yugos. Pop. (1961) 7,974. It lies on the gulf of Kvarner (Quarnero) at the foot of Mt. Ucka (4,580 ft.) 7 mi. (11 km.) W. of Rijeka city. The town's name is derived from the old *abbazia* or *opatija* ("abbey") of S. Giacomo al Palo, situated in the main park. With an average of 50,000 visitors each year, it is one of the best-known seaside resorts in the north Adriatic. Opatija belonged to Austria before World War I, but was ceded to Italy in 1923 and to Yugoslavia after World War II. (V. DE.)

OPAVA (Ger. TROPPAU; Polish OPAWA), a town in the North Moravian *kraj* (region) of Silesia, Czech., lies on the south bank of the Opava river, 20 mi. (32 km.) N.W. of Ostrava and close to the frontier with Poland. Pop. (1961) 44,216. There was a settlement there at the end of the 12th century, and Opava was once the capital of Austrian Silesia. The surrounding countryside is fertile, and much of Opava's prosperity derives from its function as a market centre between the local farms and the industrial region of Upper Silesia. Manufactures include textiles, timber and food products, machinery and pharmaceuticals.

Some buildings in the town are evidence of a long and prosperous past, although Opava sustained some damage toward the end of World War II. In the Horni Namesti (Upper square—the centre of Opava) is the Mestska vez, a tower 237 ft. high (1618). The cathedral was built by the Teutonic knights in the late 15th century. In the Dolni Namesti (Lower square) is the restored church of St. George (a 17th-century Jesuit foundation). In 1820 the congress of Troppau was held in the town by the members of the Holy Alliance (*q.v.*). Opava is the headquarters of the Silesian institute of the Czechoslovak Academy of Sciences. It has good rail and road connections with the rest of Czechoslovakia and with Poland. (H. G. S.)

OPEN DOOR POLICY, a policy associated largely with the relations between China and the United States. It originated in the representations of Commodore Lawrence Kearny of the U.S. navy in 1843 expressing concern that Great Britain, as a result of its victory in the Opium War, might seek exclusive commercial privileges in China. The Chinese and the British incorporated in the treaty of Nanking the principle that all nations should enjoy equal access to any of the ports open to trade in the empire. (*See* CHINA: *History.*) During the 19th century Great Britain had greater interests in China than any other power and successfully maintained the policy of the open door.

The open door principle was not challenged until after the Chino-Japanese War of 1894–95 when Russia, Germany and France staked out spheres of influence in China. Unable to prevent this development, Great Britain forsook the policy of the open door and laid claim to a sphere of influence in the Yangtze valley. Within the spheres of the major powers each claimed exclusive privileges of investment, and it was feared that each would likewise seek to monopolize the trade. It was generally thought that the breakup of China into economic segments each dominated by a single power would lead to the division of the country into colonies.

The crisis in China coincided with three major developments in the United States. A new interest in foreign markets emerged out of the economic depression of the 1890s, and much attention was focused on China where U.S. textile manufacturers had made important inroads on the market for cheap cotton goods, especially in Manchuria. United States interest in the future of China was likewise stimulated by a rapid growth of the missionary movement. Finally, a highly influential group of intellectuals and political leaders, including Brooks Adams, Henry Cabot Lodge, Alfred Thayer Mahan, and Theodore Roosevelt, were actively engaged

in publicizing the view that the United States must assume the responsibilities that Great Britain had borne or the rapidly changing configuration of world power would lead to the eclipse of Anglo-Saxon influence. They feared especially an alliance of Russia and China.

These three groups brought about a more assertive U.S. foreign policy. In Sept. 1899 Secretary of State John Hay dispatched the open door notes to each of the major powers. The notes were written jointly by W. W. Rockhill, Hay's adviser, and A. E. Hippisley, a British subject formerly employed in the Chinese customs service who was then visiting the United States. The notes called for equality of commercial opportunity within the spheres of influence in China and specified that customs duties should be collected by Chinese officials. The replies from the various powers were evasive, but Hay interpreted them as acceptances. The aim of the notes went beyond protection of the Chinese market for American goods and, in the words of the authors, aimed at supporting China's territorial and administrative integrity and independence. The latter aim was made explicit by Secretary Hay's circular note of July 3, 1900, dispatched during the Boxer uprising.

The United States found it difficult to implement the open door policy, and some observers have called it a major blunder of American foreign policy. China itself lacked an effective government and found it necessary to yield to foreign demands that threatened its sovereignty. The United States, bound by a long tradition against alliances, could not bargain effectively in behalf of its interests in China and was not willing to use the ultimate threat of force to defend those interests. The other great powers paid slight attention to the policy. As a result, the diplomacy of the United States was marked by ambivalence although the open door continued to win strong affirmations in U.S. diplomatic notes. World War I compelled the European nations to put their long-term interests in China on the shelf, thereby offering Japan the opportunity to pursue a more aggressive course. The conflicting aims of the United States and Japan were thrown into bolder relief, but after the war tensions were lessened by the Washington conference of 1921–22 and by the Nine-Power treaty, which defined the open door and gained Japan's adherence to the principle. (*See* WASHINGTON, TREATIES OF.) The Manchurian crisis of 1931 and the outbreak of war between China and Japan in 1937 sharpened the clash between the open door policy of the United States and Japan's "New Order" in Asia. A tradition of friendship for China and a deep concern over the immediate prospect of Japan's dominance of all of eastern Asia led the United States to adopt a rigid stand in favour of the open door, including the cutting off of supplies to Japan. The latter, increasingly dominated by aggressive military elements, concluded that the dangerous impasse could be resolved only by war. Japan's defeat in the war, followed in 1949 by the victory of the Communists in China's civil war, completely altered the conditions that had originally called forth the open door policy.

For subsequent history, and relations of China with the West, *see* further FAR EAST: RELATIONS WITH THE WEST: *The 19th Century.*

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(P. A. V.)

OPEN-FIELD SYSTEM. The open-field system was the method of cultivating arable crops by a group of farmers, in common, in large unfenced fields, each man's holding being a number of narrow strips intermixed with those of his neighbours. Its origins go back into prehistory, and some form of it was practised over most of Europe and parts of Russia—in fact wherever men lived in small communities and worked together to supply their basic needs by tilling the soil with oxen and the moldboard plow. Evidence for the existence of open-field farming has been found over most of England and parts of Wales. It was practised in pre-Roman times, but came gradually to its full development after the Norman Conquest, when it fitted in well with the manorial system of land tenure. With local variations, it was the prevailing system of farming over the greater part of England and much of Europe for many centuries.

The chief characteristics of open-field farming at the time of its full development in the English midlands were fourfold: a common rotation of cropping, usually a three-course of winter grain (wheat), spring-sown crops, and fallow; holdings scattered in strips throughout the common fields; common grazing, carefully regulated as to numbers and kinds of stock; and the control of the whole system by the manor court, consisting of all the freeholders and tenants. The court made bylaws regulating the use of the arable fields, common meadows and grazing places, and an elected jury enforced its decisions.

The open-field system was admirably suited to a small community producing all its own food, but as society became more complex it gradually gave place before the necessity for farming for the market instead of for self-supply. In England as population increased, fresh land was taken in from the woodland and waste, but instead of being added to the open fields it was fenced off and farmed separately. With the growth of the wool trade in the 15th century many open fields disappeared altogether, giving place to sheep pasture. As knowledge of new crops and better methods of farming spread, progressive farmers wanted to farm as they pleased instead of conforming to the general pattern. Landlords, too, found they could get higher rents from land held in severalty. At first by voluntary agreements to exchange strips and consolidate holdings, and then by private acts of parliament from the 18th century onward, one village after another gave up its open fields and was carved up into separate farms, the process being accelerated by the high grain prices during the Napoleonic Wars. Very little open field remained through the 19th century, but in the village of Laxton, Nottinghamshire, open-field farming in many of its essential features was still being practised in the middle of the 20th century.

See also LAND TENURE: ECONOMIC AND AGRARIAN ASPECTS; COMMONS; AGRICULTURE: *Commonwealth of Nations.*

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(C. S. O.)

OPEN-HEARTH STEEL PROCESS: *see* IRON AND STEEL INDUSTRY: *Open-Hearth Process.*

OPEN SHOP: *see* CLOSED SHOP.

OPERA, a dramatic work in which the words, instead of being spoken in verse or prose, are wholly or partly sung to an instrumental accompaniment almost always assigned to an orchestra. The size of the orchestra varies. The music of an opera may be divided into separate, formal pieces for single or combined voices (arias, concerted numbers), and sometimes for instruments only (interludes, dances), that are connected either by spoken dialogue or by sung recitative; or it may be composed continuously in a more or less symphonic manner, with structural sections still discernible or entirely submerged in an organization spread over whole acts. Whatever the composer's procedure, which depends partly on his individual disposition and partly on his place in operatic history, there must be musical structure of some kind in opera. Most operas up to the early 19th century began with an overture, but after that time this practice gradually died out.

Public taste is to a great extent responsible for the different emphases placed at different times upon the elements of opera as a whole. Thus, 17th-century audiences often paid more attention to elaborate spectacle than to words, music or performance; a strong element in the 18th century preferred natural, simple opera to formal, artificial opera, the audience for which seemed to pay too much attention to the brilliant performances of rival singers; probability and improbability have each been exalted in turn, as have topicality (evident or veiled), remoteness from everyday life, naturalistic staging and the use of a picture-frame stage.

Beginnings.—The opening date of the history of opera can be

placed in the year 1600, when J. Peri's *Euridice* was produced at Florence, though he had collaborated in 1597 with J. Corsi in a setting, now almost entirely lost, of O. Rinuccini's *Dafne*. But opera has a long prehistory, which with justification can be traced back to Greek tragedy of the Periclean age, portions of which were undoubtedly sung. The share music may have had in the Roman theatre and in quasi-dramatic performance up to the middle ages is so uncertain as to be unprofitable to speculate upon, but from the 10th century onward the medieval church had an elaborate form of sacred music drama that was performed on particular feast days by clergy in costume, with the chancel for a stage, and intoned in plainsong. Allowing for the conditions of the time, these performances had every feature of opera, including, probably, instrumental accompaniment. An outstanding example is *The Play of Daniel* (Beauvais, *c.* 1140).

Italy.—Outside the church, and nearer the time of opera proper, performances of mystery and miracle plays made enough of music, then certainly instrumental as well as vocal, to show distinctly operatic ingredients, and out of them grew in Italy a special type of acted oratorio or allegorical drama with music, the 16th-century *rappresentazione*. The most famous, and one of the last before opera came into its own, was Emilio de' Cavalieri's *La Rappresentazione di Anima e di Corpo*, performed in Rome in Feb. 1600. The "soul" and the "body" of the title are impersonated by human characters, and so are various abstractions, such as virtues and vices.

Cavalieri also wrote incidental music for at least three pastoral dramas. Here was another genre, going back at least to the *Orfeo* of Poliziano (Angelo Ambrogini), performed at Mantua between 1472 and 1483, that can be seen as a forerunner of opera. More important than pastorals or even *rappresentazioni* were the *intermedii* performed at the leading ducal courts—notably at the Medici court at Florence in the intervals of plays. Their texts were usually a static, allegorical treatment of subjects from the plays with which they were given. The words might be set as solos or choruses, many instruments might be used and the scenery might be elaborate. The last two conditions were invariably fulfilled in *intermedii* performed at wedding celebrations, and in the most sumptuous of these, which marked the wedding in Florence in 1589 of the grand duke Ferdinando I de' Medici and Christine of Lorraine, the vocal music, too, was extremely elaborate. These *intermedii* were planned by Count Giovanni Bardi (*q.v.*) of Vernio, who, as one of the moving spirits behind the first *Camerata*, revealed himself as an ardent enemy of complex polyphony and in favour of simply accompanied song as the ideal medium for communicating words and emotions to an audience. The composers included such diverse figures as the "traditional" madrigalist L. Marenzio and the dramatically inclined Cavalieri.

The madrigal comedy, of which Orazio Vecchi's *L'Amfiparnaso* of 1594 is the best-known example, was anticipated by A. Striggio and others and imitated by A. Banchieri and others; but it cannot really be regarded as a direct forerunner of true opera, except insofar as it was a kind of dramatic form. Vecchi, however, did not intend his works of this kind to be staged, though there is evidence that Banchieri did.

Thus it can be seen that various kinds of dramatic music were current in the 1580s and 1590s at about the time that the first of the three *Cameratas* was deliberating about monodic music and the last two about its application to drama. The Peri-Corsi *Dafne*, as presumably the first through-composed dramatic work and hence the first true opera, was thus the first work to show this application in practice. It cannot have been very different from Peri's *Euridice*, or from G. Caccini's setting of the same libretto (also by Rinuccini), also of 1600. Here the entire story moves forward in recitative, exiguously accompanied from the *basso continuo* and interrupted only occasionally by ensembles or instrumental pieces. The declamation notably in Peri's score is sometimes eloquent but it pales beside that of C. Monteverdi's *Orfeo* (Mantua, 1607), the first incontestably great opera. Monteverdi, apart from being a much greater composer, did not make the mistake of throwing overboard the musical forms of the previous century: madrigals and instrumental pieces therefore appear along with recitative and songs in a unified whole, while the large *ad hoc* orchestra [illegible] exactly the kind that appeared in *intermedii* in the 16th century. An even greater surviving work by Monteverdi is his last, *L'incoronazione di Poppea* (Venice, 1642), interesting also [illegible] treatment of a subject from history instead of mythology. [illegible] two chief sources opened up from which serious opera during the 17th century was to draw its librettos exclusively.

At Venice, Monteverdi, who moved from Mantua in 1613, took his share in the establishment of opera for the first time as a public entertainment, as distinct from a court function. In his last years four public theatres in the city were devoted to music. An important feature in Venice and one that remained true of opera, on the whole, for some 150 years, was that the orchestra was small; it was based on strings and *continuo*. The [illegible] Venetian composers succeeding Monteverdi before 1660 were F. Cavalli, P. A. Cesti, P. Sacrati and Pietro Andrea Ziani. Their works were elaborately spectacular, and there is small doubt that the staging was regarded as more exciting than either the plot or the music, both of which were apt to stiffen into conventions that escaped being tedious only in the best composers' best moments. Nowhere else did opera yet flourish outside the courts. For example, in Rome, where S. Landi, L. Rossi and D. Mazzocchi were the main composers, operas were usually presented in the cardinals' palaces.

Germany.—Meanwhile there had been an abortive beginning in Germany. A German adaptation of Rinuccini's *Dafne* libretto by Martin Opitz was set as an opera (now lost) by Heinrich Schütz and produced at Torgau in 1627. But Schütz was diverted into other activities and never again wrote an opera. Nor did any other German composer for half a century, and even then there was only one public opera house in all Germany (at the free Hansa city of Hamburg, which had no court). The courts themselves cultivated Italian opera and a little later some of them fostered French opera. Had it not been for the German princes, who vied with each other in keeping up luxurious establishments, opera might have suffered the same neglect in Germany as it did in England, for it was from the courts that the larger towns [illegible] inherited the tradition in the 19th century that opera must be subsidized.

England.—The neglect in England seems to have been rooted in a typically English compromise and in that insularity that has so often kept England lagging as much as 50 years behind the continent in musical matters. For one thing Italianate recitative simply did not take root in England, at any rate in stage [illegible] and a love of compromise was displayed by the continuing [illegible] adherence to the hybrid form of the masque which was [illegible] through-composed and where, indeed, music did not have [illegible] claim on the audience's attention. What is usually referred to as the first English opera is lost: this was *The Siege of R*[illegible] (1656), with text by Sir William Davenant and music by M. Locke, H. Lawes and three lesser composers. Even late in the 17th century, the play with music (including masques) re[illegible] the favourite English stage entertainment involving the [illegible] music. Most of H. Purcell's greatest stage music takes th[illegible] *e.g.*, the five masques he wrote for *The Fairy Queen* (1[illegible] really independent of the play in which they appear. He [illegible] four other "semi-operas" of this kind; only one, *King Arthur* (1691), with text by J. Dryden, was specifically conce[illegible] such, the others were adaptations of existing plays. J. B[illegible] *Venus and Adonis* (*c.* 1682) and Purcell's *Dido and Ae*[illegible] or 1690) are the only two real operas surviving from 17th[illegible] England. Both are untypical of opera elsewhere in be[illegible] short (about an hour in performance); both show more [illegible] than Italian influence. *Dido* is a masterpiece of the [illegible] intensely inventive and dramatic and shows what Purcell [illegible] have achieved within a vital operatic tradition. But th[illegible] only chance; his isolated, insular position conspired with [illegible] death, the absence of any sufficiently strong successor [illegible] system of patronage in damming up what might have grown [illegible] an operatic main stream in Britain.

France.—In France tournaments and masquerades led to the immediate predecessor of opera, the court ballet, the most [illegible]

specimen of which, *Le Ballet comique de la reine* of 1581, shows dramatic elements. But the composer, Baldassarino de Belgiojoso (Balthasar de Beaujoyeulx), was Italian-born. The first real French opera is sometimes claimed to have been *Andromède* (1650); but in this play by Corneille the words immeasurably overtowered what was little more than incidental music, by C. d'Assoucy. A better claim to priority is made for M. de La Guerre's *Le Triomphe de l'amour* (1655) and R. Cambert's *Pastorale d'Issy* (1659). The latter is rather more important musically, but both pieces are pastorals, lyrical and spectacular, and both give as much scope to dancing as to drama. The earliest French operas had some influence in London, particularly those of Cambert, who went there to live.

In Paris the next great figure, indeed the first truly great one in French opera, was Jean Baptiste Lully, again originally an Italian (Giovanni Battista Lulli of Florence) but belonging to French music as much as Handel later did to English. Nevertheless, it is significant that before him Italian opera was cultivated in Paris to some extent. Lully's musical technique is limited, and he tended to avoid counterpoint except in the fugal allegro section of his overtures, where he created a type of instrumental piece that remained in force, by no means only in France, until well into the 18th century, being used frequently, for example, by Bach and Handel. On the other hand Lully had a great fund of graceful and sometimes pathetic melody, and he laid much stress, especially in his recitatives, on correct declamation of the French language, a difficult problem where so little syllabic stress occurs, and yet one to which the French attached great importance.

French recitative, more dignified and more melodic than the Italian, was accompanied by the orchestral strings, whereas in Italian opera recitative was accompanied by the harpsichord that played the *continuo* throughout the opera and was supported in the recitatives by bass strings alone.

Later 17th-Century Italian Opera.—During the last third of the 17th century, while France and Italy continued to develop opera in their several ways, with M. A. Charpentier, P. Colasse, A. Campra, H. Desmarets and A. C. Destouches as new figures in France and A. Draghi, B. Pasquini, A. Stradella and A. Steffani in Italy, there were some isolated events in Spain and Germany. They were the work of J. Hidalgo in Madrid, J. Theile at Hamburg and Nicolaus Adam Strungk there and at Leipzig. H. I. F. von Biber at Salzburg brought out the first work by an Austrian (strictly speaking, a Bohemian) in 1687. But this had an Italian libretto, and the court in Vienna had already patronized Italian opera on a lavish scale, with P. A. Cesti's *Il pomo d'oro* (1666) as the most extravagantly spectacular work.

Alessandro Scarlatti was the finest Italian opera composer of his time. He did nothing, however, to alter the Italian operatic conventions, which by his time had become too rigid to be easily altered; he simply did first-rate work within their limitations. Among these conventions was an exclusively Italian phenomenon which, however, found its way until well into the middle of the 18th century into opera elsewhere—that of the male soprano and contralto. The practice of castrating boys before their voices broke had begun in the church, where women singers were not allowed (see CASTRATO). It became the fashion to admire artificial treble voices in opera, especially since these singers were capable of performing incredibly difficult florid passages—not only those written down by the composers but also those passages the singers themselves improvised in long cadenzas as elaborate as those incorporated later into instrumental concertos. The apparent incongruity of seeing male sopranos and contraltos taking the roles of heroes and sometimes even of women was accepted as one of the conventions of opera. There were, of course, many brilliant female singers too, parts for tenors and basses, however, were usually of lesser importance.

Scarlatti's numerous and splendid operas are among the chief pillars of this phase of excessive artifice, which causes them to survive all too precariously as historical curiosities. It has also robbed other composers of this period of any but the slenderest chance of survival, however fine the music of such men as A. Caldara, L. Vinci, L. Leo, J. A. Hasse, N. A. Porpora and G. B. Bononcini may have been. R. Keiser is also an offshoot of this school—he brought the Hamburg opera to its culmination with works of the Scarlatti type in a mixture of German and Italian words set to wholly Italianate music. J. Mattheson was associated with him; and so was the youthful Handel, who thus knew the Italian style of the day before his visit to Italy and his settling in England. Handel's first opera was like Keiser's and appeared at Hamburg in 1704. Those produced by him in London (36 works between 1711 and 1741) are all Italian and contain much fine music. It is true that this work is confined mainly to arias, there being far fewer ensembles, choruses and instrumental pieces; though in these, too, he reaches a higher level than his contemporaries, as he also does in some of his more dramatic, impassioned recitatives. Handel, who was one of the very greatest melodists who ever lived, wrote more arias than Schubert did songs; these are frequently of the utmost beauty, and time and again they reveal his acute psychological insight. They are mostly *da capo* arias (*see* ARIA) but sometimes he turns this conventional form to dramatic ends. A number of important mid-20th-century revivals, notably in England and Germany, show that Handel's operas, when well sung and imaginatively produced, are not the shapeless, undramatic works they were too long assumed to be and are not necessarily less stageworthy than his admittedly dramatic oratorios.

18th-Century Developments.—The greatest 18th-century librettist was Pietro Metastasio. It was chiefly he who influenced composers for some years to come to persist in an artificial kind of opera, which he handled with consummate skill. Between 1724 and 1771 most of the important and many of the unimportant opera composers in Italy and abroad set Metastasio's texts, many of which were used over and over again. He worked exclusively in the field of *opera seria*. Another species—the *opera buffa*—then began to emerge in Italy and to revitalize the musical stage with characters more directly in touch with the audiences than the gods and heroes of antiquity, though even they at first appeared in the conventional guise of the harlequinade figures of the *commedia dell'arte*. The first Italian comic operas were not independent works but instead were interludes inserted, scene by scene, between the acts of the serious operas to enliven the evening. These intermezzi were very slight, and only one is still much performed: *La serva padrona* by G. B. Pergolesi (1733).

It was this work that in 1746 brought the *opera buffa* to Paris, where on reappearing six years later it was used as a model for French comic opera; it also then unleashed the quarrel known as the *guerre des bouffons*. This dispute lasted until 1754 and was nothing more than an argument, for argument's sake, between the partisans for Italian and for French opera, between men of letters rather than musicians. It is significant that the first French comic opera—*Le Devin du village* (1752)—was written by J. J. Rousseau, a man of letters who was also a musician.

The next great figure in French serious opera after Lully was J. P. Rameau, another fine composer whose operas—by far his greatest achievement—were neglected after his death. He worked within the Lully tradition but his orchestral writing and his dramatic choruses, with their consummate counterpoint, are in particular superior to Lully's. He also anticipated some of Gluck's reforms. His works are as nobly classical in their way as the tragedies of Corneille and Racine, and they are bigger and much more distinguished than the French type of comic opera, which developed in the hands of small-scale but delightful composers like A. Dauvergne, F. A. Philidor, P. A. Monsigny and, a little later, A. E. M. Grétry and N. Dalayrac. Their pieces were often tearfully sentimental, although also freshly and charmingly human. Out of them developed the quite peculiar *opéra comique*, which is not necessarily comic but always contains spoken dialogue. As late a work as Bizet's *Carmen*, with its original dialogue, is still an *opéra comique* for all its tragic ending, and so were the "rescue operas" of the Revolution period, one of which, P. Gaveaux's *Léonore*, led by way of a close translation of its libretto straight to Beethoven's *Fidelio*, which is thus also in a sense an *opéra comique*. In Italy the *opera buffa* continued, and one of its major composers, B. Galuppi, had the advantage of

finding a playwright of genius, C. Goldoni, for his librettist.

In Germany opera in the vernacular at last began to emerge in the middle of the 18th century. It did so as modestly as the English so-called opera, which had started with the most famous of the ballad operas, *The Beggar's Opera* (1728), and was to continue for a long time with slight pieces by T. A. Arne, S. Arnold, C. Dibdin, W. Shield and others. Indeed, the first impulse came to Germany from England; a translation of C. Coffey's ballad opera *The Devil to Pay*, with music by J. C. Standfuss, given at Leipzig in 1743, began the vogue of the Singspiel, a simple, sentimental and naïvely humorous play with music restricted mainly to songs and choruses of an easy, popular kind. The first full-scale German opera, Mozart's *Die Entführung aus dem Serail*, was still 40 years off, and even this retained some elements of the Singspiel.

With Gluck began the period that still supplies the regular modern repertory, although in the mid-20th century a few isolated works of earlier date were added. But Gluck himself was slow to produce anything capable of surviving a first production; indeed, up to nearly the end of the 18th century operas were not intended to do so. His numerous Italian operas, not all of them written before his *Orfeo ed Euridice*, are in fact technically weaker than those by the best of his contemporaries, such as D. Terradellas, N. Jommelli and T. Traetta. There is more vitality in his French comic operas, written for the Viennese court, but they are little more than plays with songs. For German opera he did nothing; indeed, like Handel, he set very few German words to music.

Orfeo ed Euridice, Gluck's first "reform opera," appeared in Vienna in 1762 and *Alceste* followed in 1767. French versions of both (1774 and 1776), together with his four original French serious operas (1774–79), spread his influence to Paris (though he was himself influenced by Rameau to some extent) and they provoked another literary dispute there among his partisans and those of N. Piccini, an Italian who wrote as nobly as Jommelli but remained conservative. He and Gluck respected each other and took no part in the quarrel. Gluck's reforms—which did away with vocal virtuosity shown off for its own sake, suited the character of the music to the situation and turned stock figures into human beings—were really due as much to R. Calzabigi, the librettist of *Orfeo*, as to Gluck; but that the composer knew very well what he was doing is evident from his preface to *Alceste*. Gluck still had to concede conventionally happy endings, however, and in the works specially written for Paris he was obliged to retain the traditional ballet, which remained a feature of French *grand opéra*.

The 19th Century.—When what may be called the modern repertory is reached, it is possible to survey the rest of operatic history much more briefly because its major works are still familiar, or at least accessible.

The entry of Mozart into German opera with *Die Entführung aus dem Serail* has already been mentioned, and in his last year he was to reach the heights of the Singspiel with *Die Zauberflöte* (1791), which still belongs to the category, exalted and for the most part solemn and uplifting though it be. But he had already written several Italian works and produced *Idomeneo*, his first masterpiece in that class, in 1781. The three greatest, which place him with Wagner and Verdi in the triumvirate of opera composers who have so far remained unmatched, are *Le Nozze di Figaro* (1786), *Don Giovanni* (1787) and *Così fan tutte* (1790). In some ways Mozart stands alone in supreme mastery. Never has opera achieved such ideal balance between the conflicting elements that go into the making of it. In him alone music of the purest shape and quality, and of the most flawless workmanship, is reconciled with all the dramatic claims made by a libretto: perfect delineation of characters, faultless timing of every situation, simultaneous handling of conflicting emotions in unified concerted pieces.

Some minor Germans continued to set Italian words; others tried their own language. But the first great opera in German was Beethoven's *Fidelio* (1805, revised 1806, 1814), though its model was French and the musical influences behind it were Franco-Italian (L. Cherubini, F. Paer, É. Méhul). As an opera it is not perfect, and the spoken dialogue lowers its temperature; but its high moral tone is divested of smugness or ingenuousness by the incomparable elevation of the composer's musical thinking and feeling. *Fidelio* had no influence on later German works: its form was unsatisfactory and its music unapproachable.

The progress of German opera was threatened at the outset by the enormous success of Rossini, whose first opera was produced in 1810. His new type of *opera buffa*, with its enticing, peppery music, was made as welcome in Vienna and Germany as anywhere and interfered with the operatic careers of Germanic composers making Schubert's impossible and Weber's difficult and driving Meyerbeer first to Italy and then to Paris. Still, in 1821 Weber managed to bring out *Der Freischütz* in Berlin, and here for the first time was a musically important opera that was thoroughly German in every respect, so much so that it never took a firm footing anywhere else. It was also the first romantic opera of any consequence.

Romanticism, by this time established in literature, poured into opera after Weber's lurid story of the magic bullet. He also dealt with a French subject in *Euryanthe* (1823) and set an English libretto in *Oberon* (London, 1826). In Germany, though, a strongly romantic vein had already been apparent by 1816 in E. T. W. Hoffmann's *Undine*, a musically rather feeble work by a man whose major gift was literary, and to a lesser extent in Spohr's *Faust*. Soon, however, romanticism in German opera verged on hysterical extravagance, as in H. Marschner's *Der Vampyr* (1828) and *Hans Heiling* (1833). Marschner also wrote *Der Templer und die Jüdin* (1829), an opera based on Sir Walter Scott's *Ivanhoe*. Another *Undine* (1845), by A. Lortzing, enjoyed some favour in Germany in the mid-20th century; but Lortzing's talent was particularly suited to comic opera, which flowered charmingly in Paris during the first half of the century and whose composers include D. F. E. Auber, F. A. Boieldieu, A. Adam and L. J. F. Hérold. Two other comic operas, O. Nicolai's somewhat Italianate *Die lustigen Weiber von Windsor* (1849) and P. Cornelius' more Wagner-influenced *Der Barbier von Bagdad* (1858), should also be mentioned; both are among the lesser masterpieces of the time.

In France romanticism took a rather different, semihistorical form in Auber's *La Muette de Portici* (1828), a revolutionary opera, and in Meyerbeer's works, especially *Robert le Diable* (1831). These belong to a type usually known as grand opera, with a strong accent on rather sensational spectacle.

Even in Italy, which was far less open to conventional romanticism, a streak of it is perceptible in works based on Sir Walter Scott: Rossini's *La Donna del lago* (1819) and Donizetti's *Lucia di Lammermoor* (1835). But both Rossini and Donizetti were at their best in *opera buffa*, which, with the exception of the suavely lyrical works by the short-lived Bellini, remained the most vital operatic phenomenon in Italy until the advent of Verdi. Verdi furnished only two examples of *opera buffa*, a failure in 1840 and *Falstaff* (1893); the latter, written when the composer was 79, is one of his most perfect works and, unlike the operas of his earlier years, is incomparably refined. It improves immeasurably on conventional *opera buffa* by removing its heartlessness and by adding poetry.

Verdi up to *Otello* (1887), and even there once or twice, could be crude. His *Aida*, for example, is a traditional grand opera. But from the first he never failed to be strikingly effective, and at his best he had not only an unfailing sense of the stage and a wonderful melodic gift but also great technical mastery and a discriminating and resourceful musicianship far exceeding that of any of his Italian, and most of his other, contemporaries. He also possessed much more mastery in technical matters than is generally acknowledged. He was matched in skill only by Wagner, his exact contemporary, who, however, matured later.

Wagner's *Rienzi* (1842), another grand opera, still shows the influence of G. L. P. Spontini, Marschner and Meyerbeer, whose works he knew well as a conductor. Wagner also knew what to his mind was feeble, artificial and illogical in conventional opera and by much theorizing arrived gradually at a thoroughgoing reform. Though this reform did not prove as vital in the hands of

his imitators as he doubtless hoped (and it found even less general acceptance among later composers), it was more than suited to his own needs. What ultimately saved his work for future generations was not his feat of turning opera into music drama: rather it was his eminence as a composer. His resources are endless and serve his special requirements perfectly; his use of the *Leitmotiv* (*q.v.*) is wonderfully eloquent and flexible, not only because it allows the orchestra to express what the characters on the stage are doing and even thinking but also because his handling of these themes developed into the very highest art of symphonic composition.

In Russia, which came on the operatic scene with Glinka, opera took a rather different turn, its subjects being as a rule either historical or fairy-tale material of national interest. Glinka's two operas represent both tendencies: *A Life for the Tsar* (1836) and *Ruslan and Lyudmila* (1842) followed the historical and the fairy-tale patterns respectively. They also show features commonly found in later Russian operas: episodic treatment of plot, negligible love interest, the use of exotic melodies and bare and uncompromising harmonies, and a lack of musical development that can be heard only as a fault by ears overaccustomed to German procedures. Subsequent historical works were Mussorgsky's *Boris Godunov* (1874), easily the greatest Slav opera; Borodin's *Prince Igor* (posthumously, 1890); and Rimski-Korsakov's *Ivan the Terrible* (1873). Most of Rimski-Korsakov's librettos were based on fairy tales. All these were nationalist composers, but Tchaikovsky was more cosmopolitan. Except for *Eugene Onegin* (1879), however, he was never quite happy in his choice of subjects; his inspiration was unequal and his dramatic sense weak, but his technical competence and lyrical charm are considerable.

The nationalist operas of Smetana are the most distinguished outside Russia; those of the other great Bohemian composer of the day, Dvorak, are less important. There were similar though lesser figures in other musically awakening countries; *e.g.*, S. Moniuszko in Poland and F. A. Barbieri in Spain. Not until the 20th century was there comparable nationalist opera in England (*e.g.*, Vaughan Williams' *Hugh the Drover*), another instance of the time-lag mentioned above; 19th-century English operas palely reflect German or Italian opera, though Sir Arthur Sullivan's light pieces proved successful counterparts to the much more sophisticated operettas of composers like Offenbach and Johann Strauss the younger.

The greatest French operas of the 19th century are without doubt those of Bizet and Berlioz, which are in marked contrast to the stuffiness or sentimentality of operas by composers such as Gounod or Massenet. Bizet's work culminated in the inventive, realistic and splendidly scored *Carmen* (1875), Berlioz' in *Les Troyens* (composed 1856–58 but not performed in its entirety until 1890). *Les Troyens*, one of the greatest of all operas, is really a grand opera treated with classical restraint in Berlioz' original style deriving ultimately from Gluck. The realistic operas of A. Bruneau at the end of the century stem from *Carmen*, though G. Charpentier's *Louise* (1900) is probably the most successful later French work of this kind.

In Italy the corresponding school of *verismo* began at that time. A. Ponchielli, R. Leoncavallo, P. Mascagni and U. Giordano turned out crudely effective works. Puccini followed the same lines, but with better musicianship and a rather more refined artistic conscience. Both his earlier operas, *La Bohème* (1896), *Tosca* (1900) and *Madama Butterfly* (1904), and his later works, the three one-act operas *Il Tabarro, Suor Angelica* and *Gianni Schicchi* (1918) and *Turandot*, completed by F. Alfano, remained popular beyond the middle of the 20th century.

The 20th Century.—Two of the most important younger composers of the day then turned to the writing of opera. Richard Strauss's *Feuersnot* (1901) was still Wagnerian in its music, but Strauss attempted to scandalize the public by a modern and "immoral" libretto. Debussy's *Pelléas et Mélisande* (1902) made a new departure from operatic convention by using a spoken play by M. Maeterlinck instead of a specially written libretto, and it shocked its hearers as much as Strauss's work had done, though in quite a different way, by disappointing every expectation of accustomed procedures. It was uneventful, unemphatic, undervitalized and almost devoid of action. But those who looked for musical quality of the finest kind and were not to be put off by understatement and harmonic innovations learned to cherish this ultrarefined work, which remained unique, for Debussy never wrote another opera. Strauss did write more operas after *Feuersnot*, continuing into old age and retaining his mastery to the last but falling back too often on what had served him well before. Even at his best he is uncertain in style and taste, but astonishingly inventive and vibrant. *Der Rosenkavalier* (1911), a sort of "grand operetta," is his most glamorous success, *Elektra* (1909) his most expressionistic and uncompromising score and *Ariadne auf Naxos* (1912) his most enchanting, although just beginning to show the first cracks of decay.

E. F. C. d'Albert (*Tiefland*, 1903), R. Zandonai, I. Montemezzi and E. Wolf-Ferrari (in *I Gioielli della Madonna*) continued along the line of *verismo*. Wolf-Ferrari also revived the Goldonian comedy of the 18th century, with a charm that seemed faded and a humour more Germanic than Italian. High comedy of the most sophisticated kind is represented by Ravel's brilliant *L'Heure espagnole* (1911). Busoni's operas, revealing both German and Italian elements, are extremely eclectic.

One of the most interesting figures of the 20th century is the Moravian Leos Janacek, as thorough a nationalist as Mussorgsky and one of the most original minds in all opera; he was untouched by any fashion and was free from preconceived theories except those connected with the natural declamation of words, which unfortunately make his work almost untranslatable. He was the leading 20th-century nationalist, far more important operatically than his counterparts like Manuel de Falla in Spain or Vaughan Williams in England. The extremely concentrated, atonal, expressionistic operas of Arnold Schoenberg, such as *Erwartung* (1909) and *Moses und Aron*, his later 12-note opera (unfinished), belong to the central European tradition at its most fruitful time. Alban Berg in his remarkable *Wozzeck* (1925) and his unfinished *Lulu* (posthumously, 1937) used the 12-note system only as far as it would bend to his intentions. What is more remarkable about his works is that they are cast in various traditional musical forms scene by scene without allowing the least constraint to appear in the dramatic events, though these forms are not necessarily perceptible to the listener. The operas of the outstanding Italian composer of the mid-20th century, L. Dallapiccola, *e.g.*, *Il Prigioniero* (broadcast 1949; stage premiere 1950), owe something to Berg, with an admixture of Italianate lyricism; the resulting music is often deeply impressive.

Two other great figures of cardinal importance in 20th-century music have, like Schoenberg and Berg, composed only one or two operas, though these are highly distinctive. Bartók's *Duke Bluebeard's Castle* (1918) is a one-act work of great power owing something to Debussy. Stravinsky wrote two Russian operas in his earlier years but his major achievement in this sphere is *The Rake's Progress* (1951), an 18th-century pastiche that sounds nevertheless typically Stravinskyan, brilliant, refined and witty, and first-rate entertainment. Hindemith and Prokofiev are two somewhat lesser, but still considerable, figures of the age who showed more persistent interest in opera and put some of their best music into their diverse works in this medium. Carl Orff and Kurt Weill, two German composers, won great reputations by writing operas whose importance is enhanced by music that is not consciously "great" but is extremely effective, whether in the "naïve" works of Orff or in the savage social commentaries of Weill.

U.S. operas have also earned some success by their composers' skilful handling of more "popular" elements of various kinds, whether jazz in the left-wing, socially critical works of M. Blitzstein and, with other Negro elements, George Gershwin's *Porgy and Bess* (1935) or Puccinian realism in a work like G. C. Menotti's *The Consul* (1950). The operas of most other older 20th-century composers failed to hold the stage.

The most arresting feature of the international scene after World War II was the emergence of an Englishman, working within no established tradition, as the outstanding new operatic

composer. Benjamin Britten is the first English composer to write more than one great opera and is the first to earn an international reputation (mainly through opera). English operas produced before the war contained charming things but were often undramatic and scarcely held the stage. Britten's *Peter Grimes* (1945), his first surviving opera, continued to show every sign of doing so by observance of traditional (in this case somewhat Verdian) operatic methods: the music, of high quality, is psychologically penetrating and constantly used for characterization. Some of his maturer operas are even more distinguished, through greater terseness and musicodramatic organization and through solution of the problem of what to do to keep going between climaxes in the absence of recitative or symphonic organization. This is shown in *Billy Budd* (1951), possibly his masterpiece; *The Turn of the Screw* (1954), one of a series for chamber forces; and *A Midsummer Night's Dream* (1960). Britten's example prompted several other English composers to write operas, though none has shown anything like his flair for the stage, allied to fine music. Arthur Benjamin offered the former quality, and Michael Tippett overwhelmingly showed the latter in *The Midsummer Marriage* (1955), the most distinguished of these operas.

Of other post-World War II composers of opera the most prolific and promising is the German H. W. Henze, composer of some wonderfully imaginative music. His copious invention and gift for orchestral colour were not always matched in his early works by comparable discipline or great individual personality. Other 20th-century composers, both old and young, wrote occasional operas that on the whole do not add greatly to their reputations; none, except Menotti, devoted himself to the genre as assiduously as Britten and Henze.

See also references under "Opera" in the Index. Additional information will be found in the biographical articles on many of the composers and other persons mentioned in this article.

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(E. W. BM.; N. FO.)

OPÉRA COMIQUE, the French form of that kind of opera in which simple, self-contained musical numbers, with orchestra, alternate not with recitative but with spoken dialogue; it compares with ballad opera (*q.v.*) in England and Singspiel in Germany. The term was first used in 1715. *Opéra comique* derived from the entertainments of comedians who had long performed at fairs, but the traditional characters stemming from the *commedia dell'arte* were gradually supplanted by those from everyday life, especially (under the influence of J. J. Rousseau and the French Encyclopaedists) by the *ingénu*, male and female. The genre also received a musical impetus from the Italian *opera buffa*. Rousseau himself composed an early example, *Le Devin du village* (1752), which Mozart parodied in *Bastien und Bastienne* (1768). Lesser 18th-century French composers such as N. Dezède, E. R. Duni, F. A. Monsigny and F. A. Philidor specialized in *opéra comique*. Gluck, writing for audiences in Vienna, was the only great composer to devote himself extensively to it. The tradition continued through the work of A. E. M. Grétry, F. A. Boieldieu and D. F. E. Auber, who treated more serious and romantic subjects and made more extensive use of the orchestra. The form merged, toward 1830, with grand opera and gradually lost its originally comic and, later, socially critical character. Bizet's *Carmen* (1875) is a late, isolated example of *opéra comique*, possessing spoken dialogue but dealing with a tragic theme.

See M. Cooper, *Opéra Comique* [illegible]. (N. FO.)

OPERATIONS RESEARCH, a term originally used during World War II by military agencies in the United States and Great Britain to describe the work of teams of scientists who studied and analyzed military operations. These scientists were able to bring to bear upon military problems a knowledge of mathematics, engineering, psychology and other appropriate specialties. The term has since been applied to the scientific analysis of any operations controlled by managers and is often used interchangeably [illegible] "management science." *See* MANAGEMENT SCIENCE.

OPERATORS, THEORY OF. The theory [illegible] deals with transformations (also called mappings, [illegible] functions) from one linear space to another. [illegible] term operator is used in reference to a mapping of a [illegible] into itself; this usage will be adopted here.

The plane is a familiar example of a linear space. [illegible] geometry it is learned that a point in a plane can be [illegible] a pair of numbers that describe its distances from a p[illegible] pendicular lines (the co-ordinate axes). The plane [illegible] space is considered as the set of pairs of numbers with [illegible] tions of addition of two pairs (co-ordinate by co-ordi[illegible] scalar multiplication by a number (again by co-ordi[illegible] new pairs. Similarly, three-dimensional space is regarded [illegible] of numbers with the corresponding vector add[illegible] ordinates) and scalar multiplication. It is a short [illegible] from the plane and 3-space to the higher-dimensional [illegible] of quadruples, quintuples, and more generally, n-tuple[illegible] bers (denoted by E^n). The reassuring geometric [illegible] disappeared, but it was never a prerequisite for succ[illegible] valid application.

An example of an operator T on the plane is the mapp[illegible] assigns to the point (vector) (x,y) the point $(x^2,y^2$ [illegible] written $T(x,y) = (x^2,y^2)$; *e.g.*, $T(2,3) = (4,9)$. [illegible] which maps each vector into the 0 vector, and the ident[illegible] ator I, which maps each vector into itself, are simple ex[illegible] operators defined on an abstract linear space. In cont[illegible] squaring operator of the first example, I and 0 are line[illegible] A linear operator T is an operator on a linear space [illegible] $T(ka + b) = kTa + Tb$ for all numbers k and all vect[illegible] b. The vector $ka + b$ is an example of a linear com[illegible] the vectors a and b (*i.e.*, a sum of scalar multiples of the [illegible] The vector Ta is referred to as the image of the vector [illegible] T). The fact that T is linear can be rephrased: T maps [illegible] combination of vectors into the same linear combinatio[illegible] images. Similarly, one speaks of linear transformations [illegible] linear space to another). These transformations can be [illegible] terized geometrically as those which map lines into [illegible] and 0 into 0 (an easy consequence of the fact that the [illegible] a linear space are the sets of vectors $ka + b$ with a [illegible] vectors, a not 0, and k taking all numerical values). [illegible] tice, operator theory deals primarily with linear operators, [illegible] to other disciplines the detailed investigation of the va[illegible] of nonlinear transformations: *e.g.*, the birational transform[illegible] of algebraic geometry (*q.v.*), the homeomorphisms of [illegible] (*see* TOPOLOGY, ALGEBRAIC). In what follows, the term[illegible] and transformation will mean linear operator and linear [illegible] mation.

Operators on Abstract Linear Spaces.—The [illegible] linear transformation theory in systems of simult[illegible] equations was a primary stimulus to its developm[illegible] as an illustration, the familiar example of a pair of sim[illegible] linear equations in two unknowns: $x + y = 2$, $x - y$ [illegible] T be the operator that maps the point (x,y) into $(x +$ [illegible] To solve the equations, find a point that T maps int[illegible] course $(1,1)$ is such a point (*i.e.*, $x = 1$, $y = 1$ is a so[illegible] given equations). It is entirely possible that a trans[illegible] such as T maps several points or no points into $(2,0)$ [illegible] a single point. (Recall the terms indeterminate and [illegible] equations for the case of many and no solutions, re[illegible] The set of points that T maps into 0 (called the null [illegible] and the images of all vectors under T (called the range [illegible] linear spaces obviously related to these matters. In f[illegible] ference of two vectors which T maps into the same [illegible] vector in the null space of T. Although the illustrat[illegible] above is a particularly simple example involving two eq[illegible] two unknowns, nothing stands in the way of applying [illegible] considerations to five equations in seven unknowns or [illegible] tions in m unknowns, in this general case a transform[illegible] E^m to E^n is associated with the system of equations.

The sum $T + S$ of two transformations T and S is defin[illegible]

... $= Ta + Sa$, for each a in the space from which T and ... domain space). The product kT of T and the number ... by: $(kT)a = k(Ta)$. Both $T + S$ and kT are linear ...ns. The operations of addition and scalar multipli... ...ned for transformations from one linear space to an... ...e the structure of a linear space on the set of all such ...ations. The linear space of transformations has dimen... ... if the domain and range spaces have dimensions n and ... For operators T and S, a product TS is defined by $(TS)a =$ ... It may be verified that $R(ST) = (RS)T$, $(R + S)T =$ ...ST, $T(R + S) = TR + TS$, and $k(ST) = (kS)T =$ ... for operators R, S, T and a number k. A set with the ...re of a linear space and a product satisfying the foregoing ... is called an (associative) algebra. If the set consists ... operators with the sum and product as defined it is called an ... of operators. While $S + T = T + S$, it is not necessarily ... that $TS = ST$; *e.g.*, with T and S operators on the plane ... by $T(x,y) = (y,0)$ and $S(x,y) = (0,x)$, $ST(1,1) =$ ... $\neq (1,0) = TS(1,1)$. When $TS = ST$, one says that T and ...

A problem of considerable importance in operator theory and ... applications to physical situations is the so-called eigenvalue ... It is required to find for an operator T those numbers ... nonzero vectors a such that $Ta = ka$. In this case, a is said ... eigenvector (also characteristic vector and proper vector). ... ideal situation T has a basis of eigenvectors (*i.e.*, each vec... ... the space is a unique linear combination of certain eigen... ... of T). If T is an operator on the plane with eigenvectors ... b corresponding to eigenvalues 2 and 3, respectively, then ... T can be described physically as the result of stretch... ... two-fold (from the origin outward) in the direction ... line on which a lies and then three-fold in the b direction. ... operator need not have a basis of eigenvectors; *e.g.*, the ... that maps (x,y) into $(0,x)$ has only multiples of $(0,1)$ ... eigenvectors, each corresponding to the eigenvalue 0. In this ... a more involved description of its action is necessary. How... ... operator on a linear space over the complex numbers ... one eigenvector.

...ory of abstract linear spaces and their operators is the ... the needs of several distinct mathematical subjects. ... reformulated and expanded over many different pe... ...nsequently has a mixed history. During the period of ...rowth the transformations of the finite-dimensional ... referred to as linear substitutions (on the co-ordinates) ... the process of substituting linear expressions such as ... for the co-ordinates of the (generic) point (x,y) ... the effect of the transformation (as in the transforma... ... simultaneous linear equations above). This terminology ... viewpoint that conceived of the operators as insepa... ... to the particular linear spaces E^n. It has since proved ... both algebraically and analytically, to deal with trans... ... on abstract linear spaces and to treat them as entities ... right. The current terminology reflects this shift in ... without diminishing the possibility of application of ... viewpoint for important special computations). A. ... J. J. Sylvester were among the most active in the early ...opment (late 19th and early 20th century) of finite-dimen... transformation theory. Their main techniques were those ... determinant theory (*see* MATRIX).

...rators on Topological Linear Spaces.—The applications ... theory usually involve operators acting on linear spaces ... structure. In most instances the linear spaces that ... have a topology (*i.e.*, a notion of closeness; *see* TOPOLOGY, ... that is compatible with its structure as a linear space ... to which the operations of vector addition and mul... ... scalars are continuous). Such spaces are called ... linear spaces. The plane with its usual Euclidean dis... ...tructure is a simple example of such a space. The function ... to two points of the plane the distance between them ... to be a metric for the plane. This metric provides the ... special type of topological structure: that of a metric ... the compatibility of the linear space structure with the topology amounts to the following: the sum of two vectors will be small if each is chosen small; and the product of a scalar and a vector will be small if each is chosen small.

The topological linear spaces that were first studied are the so-called normed spaces. They are linear spaces in which each element a is assigned a length or norm denoted by $\|a\|$ satisfying the following conditions: if $\|a\| = 0$ then $a = 0$, $\|ka\| = |k| \cdot \|a\|$, and $\|a + b\| \leqq \|a\| + \|b\|$. The space E^n with its Euclidean norm (a vector has norm equal to the square root of the sum of the squares of the absolute values of its co-ordinates) is an example of such a normed space. A more complicated example that appears frequently in mathematical analysis is the normed space of integrable functions defined on the interval $[0,1]$ provided with the norm that assigns to such a function the integral of its absolute value (*see* POINT SET). More generally, the various linear spaces of functions provided with appropriate norms are of crucial importance to the mathematical analyst. The study of operators on these spaces is the substance of some of the major branches of analysis (*e.g.*, integral transforms and differential equations).

With the distance between two vectors in a normed space defined as the norm of their difference, in the metric topology so induced, the normed space is a topological linear space. The continuous linear transformations (those which map suitably small vectors into small vectors) are of prime interest in the operator theory of topological linear spaces. A simple test of continuity for transformations T is available in the case of normed spaces. The set of vectors of norm 1 (the unit sphere) must be mapped into some sphere of radius r by the transformation T (*i.e.*, there must be a finite number r such that $\|Ta\| \leqq r$ when $\|a\| = 1$; r is said to be a bound for T). T is said to be bounded and the continuous transformations are precisely the bounded ones. (In view of this result, the terms continuous transformation and bounded transformation are used interchangeably in discussing linear transformations on normed spaces.) If T is bounded, the smallest bound is said to be the bound or norm of T and is denoted by $\|T\|$. Recall that the set of transformations from one linear space to another is itself a linear space. If both spaces are normed spaces the set of continuous transformations is a linear subspace, and with the norm just defined for bounded transformations, it is a normed space. The operators 0 and I are always bounded on a normed space, and $\|0\| = 0$, $\|I\| = 1$ (this last, when the space is not 0). Each transformation of a finite-dimensional normed space into some other normed space is continuous (the linearity and finite dimensionality guarantee the continuity). If the plane is normed with its Euclidean norm (described before) the operator mapping (x,y) into (y,x) has norm 1; the transformation mapping (x,y) into x (from the plane into the line) has norm 1; and the operator mapping (x,y) into $(2y,x)$ has norm 2.

The transformations from a linear space into 1-dimensional space (the set of scalars) are called (linear) functionals. The transformation that maps each n-tuple into its first (or any fixed) co-ordinate is such a functional on E^n. If the linear space consists of functions on some fixed space, the transformation that maps each function into its value at some fixed point is a functional. In the case of topological linear spaces, the continuous (bounded) functionals are of main interest. There are, however, topological linear spaces for which the only continuous functional is the 0 functional. The situation is better for normed spaces. The Hahn-Banach theorem states that for each vector in a normed space there is a functional of norm 1 that maps the vector into its norm. There are several useful variants of the theorem; an interesting general result in this direction states that each nonzero vector in a locally convex space is mapped into a number different from zero by some continuous functional. (A convex set in a linear space is one that contains the entire line segment joining each pair of its points. The locally convex topological linear spaces are those in which the topology is describable in terms of convex sets; technically, each pair of distinct points can be separated by convex open sets.) All normed spaces are locally convex, since the interiors of spheres are convex.

A sequence of points in a metric space is said to be Cauchy

convergent, when for each assigned distance, points of the sequence occurring after a certain term are less than that distance apart. A sequence of points in such a space is said to converge to a given point, when for each assigned distance, all points of the sequence past a given term are closer to that given point than the assigned distance. The metric space is said to be complete when each Cauchy convergent sequence converges to some point of the space. With the Euclidean metric, each E^n is complete as are the various function spaces with their usual metrics. A complete normed space is called a Banach space. The normed linear space consisting of bounded transformations from a normed space into a Banach space is itself complete. In particular, the space of bounded functionals on a normed space (called the continuous dual or adjoint space to the original space) is always a Banach space (since the scalars, real or complex, are complete). An important fact of operator theory, the uniform boundedness principle, states: if a set of bounded transformations from a Banach space into a normed space maps each given vector of norm 1 into a set of vectors contained in some sphere (which may vary with the given vector), then there is some one number greater than the bound of each transformation in the set; *i.e.*, there is some number that is a (uniform) bound for each of the transformations.

A normed space, called the direct sum, can be constructed from two normed spaces by considering the set of all pairs consisting of a vector from each of the spaces (in a definite order) with the operations of addition and scalar multiplication performed termwise and norm defined as the sum of the norms of each of the vectors in the pair. A transformation with domain in one normed space and range in another has associated with it a linear subspace of the direct sum called the graph of the transformation; it consists of those pairs of vectors the second term of which is the vector into which the first term is mapped by the transformation involved. The transformation is said to be closed when its graph is a closed subset of the direct sum of the two normed spaces (*i.e.*, when each vector of the direct sum which is the limit of a convergent sequence of vectors in the graph is itself in the graph). The closed transformations hold a key position in the physical applications of operator theory. The closed graph theorem states that a transformation with a domain that is a Banach space and a range that is contained in a Banach space is continuous (bounded) if and only if its graph is closed (*i.e.*, if and only if it is a closed transformation). Several results closely allied to the closed graph theorem have proved very useful. If T is a transformation from one linear space to another and S is a transformation from the second to the first, then defining ST by $(ST)a = S(Ta)$, it follows that ST is an operator on the first space. Similarly TS is an operator on the second space. If ST and TS are the identity operators on their respective spaces, one says that S is an inverse (two-sided) to T. Of course, then T is an inverse to S. The inverse to T, if such exists, is denoted by T^{-1}, and T is said to be a (linear) isomorphism of the first space onto the second. Another form of the closed graph theorem asserts: if T is a bounded linear isomorphism of one Banach space onto another, then T^{-1} is bounded. A third variant of this theorem states: if T is a transformation with a domain that is one Banach space and with a range that is all of another, then T maps each sphere with positive radius onto a set containing another such sphere.

For a finite-dimensional operator T, the fact that k is an eigenvalue of it is equivalent to the fact that $T - kI$ does not have an inverse. With T an operator on a Banach space, it is still the case that if k is an eigenvalue for it then $T - kI$ does not have an inverse; but the converse is no longer generally valid. Although $T - kI$ may fail to have an inverse while k is not an eigenvalue, for the infinite-dimensional situation, such numbers k are of critical importance in the analysis of the operator T. A number k such that $T - kI$ does not have an inverse is said to be a spectral value for T and the set of all such numbers is called the spectrum of T. It is a basic fact of operator theory that the spectrum of each bounded operator is a bounded and closed (hence compact) subset of the complex numbers and has at least one member. If S and T are operators on a normed space and R is the inverse to $I - ST$, then $I + TRS$ is the inverse to $I - TS$, as can be verified by algebraic computation. It follows that, with the possible exception of the number 0, ST and TS have the same spectrum. These results yield the fact that the Heisenberg relations of quantum mechanics, $PQ - QP = ihI$, cannot be represented by bounded operators.

At the turn of the 20th century, modern operator theory received a strong impetus through the work of D. Hilbert, E. Schmidt, F. Riesz and many others, on integral equations. An integral equation is one in which a function to be determined appears in combination with given functions in the integrand of some integral. One of the earliest such equations studied is that called a Fredholm equation. A function f is sought such that

$$f(x) = g(x) + \int_a^b K(x,y)f(y)dy$$

The function K of two variables is referred to as the kernel function. When g is 0, the equation is referred to as a Volterra equation. In dealing with such equations, the concern is with conditions on the given functions (involving continuity and integrability) and it is required that the solution be a function satisfying certain other conditions. The mapping that carries a function f with domain the unit interval into the function h defined by

$$h(x) = \int_0^1 K(x,y)f(y)dy$$

when applied to functions f in a linear space of functions for which the integral exists is called an integral transformation of that linear space. Under these circumstances, the transformation involved is linear. With this point of view, the Volterra equation is seen to be an eigenvalue problem for an integral operator. The many problems of physics involving integral equations and the relation of integral equations to boundary value problems that arise in the theory of differential equations stimulated an intensive study of integral transformations and operators. Such problems as heat and electrical conduction on surfaces and the motion of vibrating membranes are cases in point.

Under very mild restrictions on the kernel function (*e.g.*, integrability) the integral operators on Banach spaces of functions are completely continuous (also called totally continuous and compact) operators. The completely continuous operators are those which map each sequence of vectors of norm less than 1 into a sequence that has a convergent subsequence (those operators which map the unit sphere and its interior into a set whose closure is compact). Each operator with a range that is finite-dimensional is completely continuous (though the converse is not true). The fact that each nonzero spectral value of a completely continuous operator is an eigenvalue is the critical property of such operators. The study of completely continuous operators and their application to physical problems first drew widespread mathematical attention to the techniques of normed spaces and operator theory.

A much more restricted class of normed spaces than those which have been discussed thus far actually occupies the central position in operator theory. These are the so-called Hilbert spaces. The Hilbert spaces are those normed spaces in which the metric structure is Euclidean (*i.e.*, in which a geometry like the familiar Euclidean geometry is valid). They can be described as those Banach spaces in which the parallelogram law, $2(||a||^2 + ||b||^2) = ||a+b||^2 + ||a-b||^2$, is valid (the sum of the squares of the lengths of the sides of a parallelogram is the sum of the squares of the lengths of its diagonals). If this is the case, to each pair of vectors in the space a number can be assigned, written (a,b) and called the inner product of a and b, satisfying the following conditions: (1) $(a,a) \geqq 0$, and if $(a,a) = 0$ then $a = 0$; (2) $(ka + b,c) = k(a,c) + (b,c)$; (3) $(a,b) = (b,a)$ if the space is real (*i.e.*, the scalars are the real numbers), and $(a,b) = (\overline{b,a})$ if the space is complex; (4) $(a,a) = ||a||^2$. A Hilbert space is usually defined as a linear space in which (1), (2) and (3) hold and which is complete relative to the norm defined by (4). With its Euclidean norm, E^n is a Hilbert space (the inner product of $(k_1, \ldots, k_n)$ and $(h_1, \ldots, h_n)$ is $k_1\bar{h}_1 + \ldots + k_n\bar{h}_n$). The linear space of sequences of numbers (addi-

tion and scalar multiplication co-ordinatewise), $(k_1,k_2, \ldots)$ such that $\Sigma |k_n|^2$ converges, with this sum as the square of the norm, is an infinite-dimensional Hilbert space; the inner product of $(k_1,k_2, \ldots)$ and $(h_1,h_2, \ldots)$ is $\Sigma k_n \bar{h}_n$. A more general example (see INTEGRATION AND MEASURE) is that of the square integrable functions on a measure space with $\|f\|^2$ as $\int |f|^2\, dm$; here, $(f,g) = \int f\bar{g}\, dm$. That the sums which define the inner product in each of these cases exist is a consequence of the basic Schwarz inequality. It states: $|(a,b)| \leq \|a\| \cdot \|b\|$ (equality holds if and only if one of b or a is a scalar multiple of the other). Two vectors are said to be orthogonal (perpendicular) when their inner product is 0; in the plane (*i.e.*, two-dimensional Hilbert space) such vectors are perpendicular in the usual sense. The (orthogonal) complement of a closed linear subspace of a Hilbert space is the set of vectors orthogonal to each of the vectors of the subspace. It is itself a closed subspace. (The orthogonal complement of a line thru the origin is the line through the origin perpendicular to it in the plane, and the plane through the origin perpendicular to it in E^3.) If a is a vector in the Hilbert space H, and M is a closed subspace of H, then there is a unique vector b in M such that $a - b$ is orthogonal to M, and $\|a - b\|$ is the shortest distance from a to M. (These facts result principally from the parallelogram law and completeness. In the plane and 3-space, b is the foot of the perpendicular dropped from a onto M.) The vector b is called the (orthogonal) projection of a on M. If N is the orthogonal complement of the closed subspace M, then M is the orthogonal complement of N. A set of vectors is said to be orthonormal when each pair of its vectors is orthogonal and each of its vectors has length 1. A method known as the Gram-Schmidt process allows one to construct from a finite set of vectors in a Hilbert space an orthonormal set of vectors which generates the same (finite-dimensional) subspace (the linear combinations of the original vectors). The vectors are listed in some order and the first vector is normalized (*i.e.*, replaced by itself divided by its norm). Successive vectors are replaced by the vector obtained by subtracting from them their projection on the subspace generated by the preceding vectors and normalizing the resulting vector (in case it is not 0; no replacement is made if it is 0). If $a_1, \ldots, a_n$ is an orthonormal set, the projection of a on the space they generate is $(a,a_1)a_1 + \ldots + (a,a_n)a_n$, from which fact an explicit formula for each vector obtained by the Gram-Schmidt process may be had. This process applied to various simple sets of functions (powers of x, for example) leads to the various families of orthogonal functions so important for the special computations of physics.

Certain orthonormal subsets of a Hilbert space are maximal in the sense that they are not contained in larger orthonormal sets. A maximal orthonormal set is said to be a (complete orthonormal) basis for the given Hilbert space. In the finite-dimensional case the orthonormal basis is a basis for the space in the sense noted before (and therefore has n vectors in the n-dimensional case; the n-tuples with 1 at one co-ordinate and 0 at the others is an orthonormal basis in E^n with its Euclidean norm). In infinite-dimensional Hilbert space the orthonormal basis is infinite and is not a basis in the linear space sense but rather in the topological sense. While a vector need not be a linear combination of a finite number of these basis vectors, it has an expansion as an infinite linear combination of them. Specifically, if (a_n) is the basis, with n in some indexing set, then a is $\Sigma(a,a_n)a_n$, where the infinite sum is understood in the sense of vector convergence of the finite partial sums. The term $(a,a_n)a_n$ of the sum is the projection of a on the line containing a_n (so that this sum is the higher-dimensional version of the resolution of a vector into its components along perpendicular axes in the plane). The numbers (a,a_n) are called the coefficients of a, in its expansion relative to (a_n). In Hilbert spaces of functions, when the orthonormal basis is chosen appropriately, this process gives the expansion of a function in terms of the special set of orthogonal functions which forms the basis. (Of very great importance is the special case where the Hilbert space consists of the square summable functions on the interval $[0,2\pi]$ and the orthonormal basis is the set $(2\pi)^{-\frac{1}{2}}(\cos nx + i \sin nx)$ where n takes all positive and negative integer values. In this instance, the expansion of a function is its Fourier series [*q.v.*], and much of the basic theory of such series can be developed most efficiently with these methods.) The cardinality of a basis (*i.e.*, the number of elements in it, in a suitable sense; *see* SET THEORY [THEORY OF AGGREGATES]) is called the dimension of the Hilbert space. This one cardinal number, its dimension, determines the Hilbert space in the sense that if two Hilbert spaces have the same dimension there is a linear isomorphism of one onto the other which maps each vector onto one with the same norm. (Equivalently, pairs of vectors are mapped into pairs with the same inner product. Such mappings, called unitary transformations, preserve all the structure with which one deals in a Hilbert space.) This uniqueness property of Hilbert spaces makes their theory much more tractable than that of the more general Banach spaces.

If f is a bounded linear functional on a Hilbert space, there is some fixed vector b such that $f(a)$ is (a,b) for each vector a in the space (*e.g.*, the functional on E^n that assigns to a vector its first co-ordinate corresponds to the inner product with the n-tuple that has a 1 in the first co-ordinate and 0 elsewhere). The transformation E that maps a vector into its (orthogonal) projection on the closed subspace M is linear and has norm 1; unless M is (0), in which case E is the 0 operator and has norm 0. It is immediate that E^2 is E (E is said to be idempotent), that $I - E$ is the projection (operator) on the orthogonal complement of M, and that $E(I - E)$ and $(I - E)E$ are 0. In addition $(Ea,b) = (a,Eb)$ for all a and b. An operator A with this last property is said to be self-adjoint. An operator which is idempotent and self-adjoint is a projection. The definition given merely represents a convenient test for self-adjointness of an operator. The actual significance of this property resides in the so-called spectral theorem, the fundamental theorem of operator theory for Hilbert spaces. In the case of finite-dimensional Hilbert spaces, this theorem asserts that the self-adjoint operators are those which have an orthonormal basis of eigenvectors corresponding to real eigenvalues (*i.e.*, those which correspond to diagonal matrices with real entries relative to some orthonormal basis). If T is a self-adjoint operator and a is an eigenvector for T corresponding to the eigenvalue k then $(Ta,a)/(a,a) = k$. But $(Ta,a) = (a,Ta) = \overline{(Ta,a)}$, from (3) in the definition (given earlier) of Hilbert spaces, and self-adjointness of T; so that (Ta,a) is real; thus k is real. If M is an invariant subspace for T (*i.e.*, is mapped into itself by T), a is orthogonal to M, and b is in M, then $(Ta,b) = (a,Tb) = 0$, since Tb is in M; so that the orthogonal complement of M is invariant. (The properties of having real eigenvalues and leaving the orthogonal complement of each invariant subspace invariant characterize self-adjoint operators in finite-dimensions.) If T is a self-adjoint operator on a (complex) finite-dimensional space and a is an eigenvector for T, then T leaves the orthogonal complement M of a invariant; and T acting on M is a self-adjoint operator. Repeat this argument for the restriction of T to M. Continuing this process, a (diagonalizing) orthonormal basis of eigenvectors is constructed for T. The set of vectors b such that $Tb = kb$ is called the eigenspace for T corresponding to k, and the projection operator F_k whose range is this eigenspace is called the spectral projection for T corresponding to k. The finite-dimensional spectral theorem establishes the formula $T = kF_k + \ldots + jF_j$, where $k, \ldots, j$ are the distinct eigenvalues of the self-adjoint operator T. If each of the operators of a set is diagonalized by the same basis, it may be shown that the operators of the set commute with one another. For a set of commuting self-adjoint operators on a finite-dimensional Hilbert space there is a simultaneous diagonalizing orthonormal basis, and the proof just sketched applies, once the existence of a simultaneous eigenvector is established. Toward this end, note that an eigenspace for an operator is invariant under each commuting operator. Let M be a nonzero subspace of smallest dimension invariant under the set of commuting self-adjoint operators (the full space is an instance of one such subspace). Observing the action of the set of operators on M, a properly smaller such subspace can be found (making use of an eigenspace for one of the operators) unless M is 1-dimensional. Since M has the

least dimension for such subspaces, it is 1-dimensional, and each nonzero vector in it is a simultaneous eigenvector for the set.

It is tempting to conjecture that the self-adjoint operators on infinite-dimensional Hilbert spaces are those for which there is a complete orthonormal basis of real eigenvectors. There are such operators, and they are certainly self-adjoint. However, they are not all the self-adjoint operators. In fact, a self-adjoint operator may have no eigenvectors; *e.g.*, the operator that maps a square summable function f on the interval $[0,1]$ into the function g defined by $g(x) = xf(x)$. Nevertheless, it is true that each self-adjoint operator has convergent to it a sequence of (commuting) self-adjoint operators with diagonalizing bases. This last result could be taken as an infinite-dimensional spectral theorem; but it is possible to formulate a much more forceful statement. If A is a bounded self-adjoint operator there is associated with it a family of projections (E_k), one for each real number k, called its spectral resolution, each of which commutes with A, having the properties that the range of E_k is precisely the set of vectors contained in the ranges of each E_j, $j > k$; E_k is 0 for $k < -\|A\|$ and is I for $\|A\| < k$; and $\|A - \Sigma_m k_m' (E_{k_m} - E_{k_{m-1}})\|$ is small provided each $|k_m - k_{m-1}|$ is small, where $-2\|A\| = k_1 < k_2 < \cdots < k_{m-1} \leqq k_m' \leqq k_m < \cdots < k_n = 2\|A\|$ (one writes $A = \int k dE_k$ in place of this last statement). The formula $A = \int k dE_k$ is the infinite-dimensional analogue of the formula $A = kF_k + \cdots + jF_j$ in the finite-dimensional case (in this instance, E_k is the sum of all F_j with $j \leqq k$), where integration replaces finite summation.

A great many of the operators that arise in physical problems and in other mathematical disciplines are not bounded. Moreover, they are rarely defined on the entire space; but usually on some dense subspace (*i.e.*, one for which each vector is the limit of a sequence of vectors in the subspace). In fact, it is a simple consequence of the closed graph theorem that a self-adjoint operator defined on the whole space is bounded. The linear differential and partial differential operators (sums of multiples of repeated differentiations or partial differentiations) are a case in point; they are applicable only to functions with a sufficient number of derivatives; and not all square summable functions are differentiable. The theory of closed operators and of closed extensions of unbounded operators is of particular importance in applications. If T is an operator on a Hilbert space (not necessarily bounded) with dense domain M; for each vector y for which there is a vector z such that (Tx,y) is (x,z) for every x in M, define T^*y to be z. (With M dense there will be at most one z, and from the description of bounded linear functionals on Hilbert space there is one z when T is bounded.) The transformation T^* mapping such a y into T^*y is linear and is called the adjoint of T. In particular, with T bounded, T^* is bounded (and $\|T^*\| = \|T\|$) with domain the whole space. If T and T^* are the same operator (in particular, have the same domain) T is said to be self-adjoint (unbounded). (This definition agrees in the bounded case with the one previously given.) The theorem that occupies the central position in the theory of unbounded operators is the extension of the spectral theorem to include unbounded self-adjoint operators. In this case, the theorem is unchanged except that the conditions E_k is 0 for $k < -\|A\|$ and I for $k > \|A\|$ are dropped and the integration in the last condition is extended to the entire real line.

The spectral theorem for finite-dimensional operators leads to consideration of operators that correspond to a diagonal matrix relative to some orthonormal basis but whose entries may be complex numbers. These are the operators such that A and A^* commute: the so-called normal operators. In infinite dimensions, such operators have a spectral resolution consisting of projections corresponding to points in the plane of complex numbers (with integration taken over some square containing the complex spectrum). If U is a unitary operator, U^* is the inverse of U; so that U is an example of a normal operator. In this case, the spectrum of U consists of numbers with absolute value 1.

The various proofs of the spectral theorem involve polynomials and other functions of the self-adjoint operator being studied (*e.g.*, many proofs require a square root of the operator). It has proved profitable to consider at the outset algebras of commuting (bounded) self-adjoint operators (closed in the space of all bounded operators). The algebraic content of the spectral theorem is embodied in and extended by the theorem which states that there is a linear isomorphism between such an algebra and the space of all continuous functions on some compact (Hausdorff) topological space which maps a product of operators into the product of their corresponding functions. In particular, if the algebra of operators is the closure of the set of polynomials in a single operator A then it is isomorphic with the (algebra of) continuous (real-valued) functions on the spectrum of A (I corresponds to the constant function 1 and A to the function that assigns to a number in the spectrum that number itself). The operator in the algebra corresponding to a particular function is said to be that function of A (for polynomials, in particular, there is no conflict between this and the standard interpretation of a polynomial in A, by virtue of the product-preserving nature of the isomorphism).

The deeper analysis of operators that are not self-adjoint, applications to quantum mechanics, and applications to other mathematical subjects (*e.g.*, measure theory and group representations) introduce operator algebras that are not commutative, contain A^* if they contain A, and are closed in any of several distinct operator topologies. Notably, those algebras B with the property $B = (B')'$, where B' denotes the set of bounded operators commuting with B, have been intensively studied since the mid 1930's. These are the so-called von Neumann algebras. A broader class of such algebras, those closed in the metric (norm) topology, have received considerable attention since the early 1940s (these are called C^* algebras).

During the first decade of the 20th century, D. Hilbert conducted a systematic investigation into the geometry and operator theory of particular examples of Hilbert spaces. Hilbert's interest in operators was inspired by the work being done on integral equations (notable in this connection were the results of E. I. Fredholm and V. Volterra). The spectral theorem for completely continuous self-adjoint operators is one of Hilbert's fundamental contributions to the subject. At the end of the first decade E. Schmidt introduced many of the geometrical concepts which have proved so useful in the study of Hilbert spaces. At the same time, F. Riesz began his research in this subject which was to have such a profound effect on its development. His book, *Les systèmes d'équations linéaires à une infinité d'inconnues* (1913), developed the subject with such elegance that his methods have undergone very little change. The description of the form of continuous linear functionals and a great deal of the general theory of completely continuous operators are among Riesz's contributions. Throughout the 1920s and 1930s a vigorous school developed whose research centred about normed spaces and their operator theory. In particular, one may mention S. Banach who described his own fundamental research and that of the rest of this school in his book, *Théorie des opérations linéaires* (1932), which has been the standard reference in the subject since its publication. Among Banach's many contributions are the Hahn-Banach theorem and the isomorphism variant of the closed graph theorem (as well as one of the first cases of the uniform boundedness principle).

The modern theory of operators may be said to have begun with the research of J. von Neumann in the late 1920s and with the appearance of M. H. Stone's monumental treatise, *Linear Transformations in Hilbert Space and Their Applications to Analysis* (1932), summarizing his research and the state of operator theory at that time. (It has remained the standard reference on Hilbert spaces and their operator theory.) In particular, von Neumann introduced the concept of abstract Hilbert space by means of the defining conditions discussed above, and initiated the study of rings of operators (von Neumann algebras). The systematic development of the theory of unbounded operators on Hilbert spaces is to a great extent the creation of von Neumann and Stone. In particular, the spectral theorem for unbounded operators and the theory of extensions of unbounded transformations are among their numerous contributions. In this connec-

tion, the work of A. Wintner should be mentioned. He studied Hilbert space operator theory from the point of view of infinite matrices and produced several of the important results of the subject simultaneously with von Neumann and Stone. In the mid-1930s von Neumann in collaboration with F. Murray undertook the investigation of operator rings which has formed the basis for most subsequent research in and application of abstract operator theory. This work continued into the early 1940s and continues to be actively pursued by many mathematicians in the 1960s. This same period saw the development by Stone of a topological algebraic theory which was to lead to his statement of the algebraic form of the spectral theorem in the early 1940s (the one that has been discussed).

The works mentioned above plus the additional references below should give an adequate detailed account, including many areas in operator theory that have not been mentioned.

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OPERETTA, a term in music that has two distinct meanings: originally it was a short comic opera deriving in Italy from the *commedia dell'arte* and in France from the *vaudeville*, and in this form the operetta is hardly distinguishable from the intermezzo; in the 19th century the term came to be applied to longer plays with music, in which the action was farcical and which usually included elements of social or political satire and musical burlesque. It is difficult to draw a boundary between operetta and *opéra comique* (*q.v.*), since the former made no attempt to define the nature of its action or characters. It also made no pretense of establishing a genuine sentimental scene, except of the most superficial nature. Adolphe Adam's *Le Postillon de Longjumeau* (1836), in which the pretensions of opera singers are parodied, is an early example of French operetta. This form of entertainment became especially popular in Paris during the second empire, its most successful practitioner being Jacques Offenbach, whose *Orphée aux enfers* (1858) and *La Belle Hélène* (1864) satirized contemporary Parisian life under the guise of classical Greek mythology. Offenbach's influence spread to London, where, from the end of the 1870s, Gilbert and Sullivan created a characteristic English form of operetta, satirizing the follies of contemporary society and parodying current operatic conventions, but without the cynical and other daring elements of the French models. In Vienna from about 1870 another distinct form of operetta appeared; it was more sentimental in style and relied on a warm melodiousness rather than on the garish brilliance characteristic of Offenbach. The chief composers of this school were Johann Strauss the younger, whose *Die Fledermaus* (1874) remains the best example of the Viennese type of operetta; Franz von Suppé, who produced *Boccaccio* (1879); and Karl Millöcker, composer of *Der Bettelstudent* (1882).

After 1870 the Parisian tradition of operetta was carried on by A. C. Lecocq (*La Fille de Madame Angot*, 1872), in a more sentimental style by Robert Planquette (*Les Cloches de Corneville*, 1877) and by Edmond Audran (*La Mascotte*, 1880). By this time operetta had lost something of its incisive satirical quality and in the elegant and melodious works of André Messager (*La Basoche*, 1890, *Les P'tites Michus*, 1897, and *Monsieur Beaucaire*, 1919) became transformed into what is called musical comedy (*q.v.*). A similar transformation occurred in Viennese operetta in the popular works of Franz Lehár (*Die lustige Witwe*, 1905), Oscar Straus (*Der tapfere Soldat*, based on G. B. Shaw's *Arms and the Man*, 1908) and Leo Fall (*Die Dollarprinzessin*, 1907). Puccini made a solitary, and for Italy an exceptional, contribution to Viennese operetta with *Le Rondine*, produced at Monte Carlo in 1917. In England the "Savoy operas," as Gilbert and Sullivan preferred to style them, found no true successors, though Sidney Jones's *The Geisha* (1896) owed an obvious debt to *The Mikado* and Edward German took *The Yeomen of the Guard* as a model for *Merrie England* (1902).

BIBLIOGRAPHY.—M. Cooper, *Opéra Comique* (1949); M. Mackinlay, *Origin and Development of Light Opera* (1926); E. W. White, *The Rise of English Opera* (1951). (Dy. H.)

OPHICLEIDE, a brass wind instrument with a cup-shaped mouthpiece and padded keys; it is the bass version of the old key bugle, from which it was derived by the inventor, Jean Hilaire Asté, known as Halary, in 1817. The name (from Gr. *Ophis*, "serpent," and *cleides*, "keys") alludes to its improvement upon the military-band "upright serpents" through the provision of 11 brass keys to replace open fingerholes. The ophicleide was normally built in C or B flat, with the same compass as a euphonium and with a similar tone. It was extensively used in French and British bands and orchestras until it was replaced by the tuba (*q.v.*) toward the end of the 19th century. (A. C. Ba.)

OPHIOGLOSSACEAE, the adder's-tongue fern family of usually small herbaceous ferns, found in both hemispheres. The family, with 4 genera and about 50 species, constitutes the order Ophioglossales. Two of the genera are native to North America, *Botrychium*, the moonworts or grape ferns, and *Ophioglossum*, the adder's-tongue ferns. *See* FERN: *Classification*.

OPHIR, an unidentified region, famous in Old Testament times for its fine gold (Gen. x, 29; I Kings x, 11). The geographical list of Gen. x places it apparently in Arabia, by association with Sheba and Havilah, but in the time of Solomon (*c.* 950 B.C.) Ophir was thought of as an overseas Eldorado, the object of joint Phoenician-Hebrew expeditions in "ships of Tarshish," the journey to which and back took three years, a year's sail each way, with a year's stop between. Gold, *almug* (or *algum*) wood (*i.e.*, sandalwood), ivories, monkeys and peacocks were procured there (I Kings x, 11 and 22; II Chron. ix, 10 and 21). Some substance was given to the previously shadowy existence of Ophir by the discovery in 1946 in excavations at Tel Qasile, near Tel Aviv–Jaffa (Israel), of a sherd inscribed in Hebrew script of the 8th century B.C., mentioning "gold of Ophir for [belonging to] Beth-horon, 30 shekels." The two locations—Arabia and overseas—obviously conflict and seemingly belong to different periods or traditions. Many coastal and some inland areas of the Arabian peninsula have been proposed as the site of Ophir. The principal alternative identifications proposed for the overseas Ophir are set out below.

East Africa.—The naval expeditions of the Egyptian Pharaohs to Punt (Somaliland), one of which, in Hatshepsut's reign (*c.* 1500 B.C.), is illustrated and described in great detail at Dayr al Bahri, furnished monkeys, ivory, frankincense and slaves. It is clear that there is at least some similarity in planning between the Solomonic expeditions and those of the Egyptians, and the equation of Somaliland with Ophir is plausible.

The other East African possibility is Zimbabwe (*q.v.*), in Southern Rhodesia, the site of the famous and mysterious stone-built ruins about 200 mi. inland from Sofala, where there are gold mines. The elliptical stone wall enclosing the site of Zimbabwe resembles both in dimensions and orientation that of the Sabaean temple of 'Almaqah at Ma'rib (Yemen), but the ruins at Zimbabwe do not appear to be earlier than the 9th century A.D. and no earlier connection between Zimbabwe and Arabia or the near east has as yet been discovered.

The African theory has been supported by deriving the Latin words *Afer*, *Africa* ("an African," "Africa") from Ophir.

India.—Josephus (*Antiquities*, viii, 6, 4) and Jerome (commentary on Job xxviii, 16) evidently understood that India was the location of Ophir, which they spelled "Sophir." This spelling would seem to represent Supara, or Surparaka (an ancient port 37 mi. N. of Bombay), the name of which in Gujarati might be pronounced without the initial "S." This identification might be held to imply that the expeditions of Hiram and Solomon made use of the monsoon to sail southeast in summer across the Indian ocean, returning by the northwest monsoon in winter. It is claimed that the use of the monsoons to sail to and from India across the Indian ocean was unknown until it was "discovered" by Hippalus, a Greek pilot in the 1st century B.C., but this may mean merely that the secret was then first wrested from the oriental sailors and their monopoly broken.

Unfortunately, there have been no archaeological excavations

at Supara to obtain evidence; but there is no inherent improbability in locating Ophir in India; some commercial contacts between India and Mesopotamia certainly existed as early as the mid-3rd millennium B.C. This theory is supported by the fact that the Hebrew words for the products of Ophir can be derived from Indian languages. Furthermore, sandalwood and peacocks are commonly found in India, whereas, at least in modern times, they do not exist in east Africa.

See G. Ryckmans, "Ophir" in *Dictionnaire de la Bible, Supplément*, ed. by L. Pirot (1960). (R. D. B.)

OPHIUCHUS, in astronomy, a constellation of the northern hemisphere, anciently named Aesculapius, and mentioned by Eudoxus (4th century B.C.) and Aratus (3rd century B.C.). According to the Greek fables, it variously represents: Carnabon (or Charnabon), king of the Getae, killing one of the dragons of Triptolemus, or Heracles killing the serpent at the Sangarius (or Sagaris) river, or the physician Asclepius (Aesculapius). Like Sagittarius (which it adjoins) it includes a region of the sky rich in globular clusters and diffuse nebulae. A very bright nova was observed in Ophiuchus in 1604.

OPHIUROIDEA, a class of echinoderms commonly called brittle stars. The animals' slender fragile arms are responsible for the common name. *See* ECHINODERMATA.

OPHRYS, a genus of plants of the orchid family (Orchidaceae), comprising about 30 species native to Europe, western Asia and north Africa. They are characterized by a large spurless lip, which in the various species resembles an insect or spider; among them are the bee, spider and fly orchids. *See* ORCHID.

OPHTHALMOLOGY is the science that deals with the structures, functions, disorders and diseases of the eye. It is a specialty in the practice of medicine and as such is a broad field including basic sciences pertaining to animal life and the art of applying remedial measures for the relief of symptoms and the cure of diseases. Education and training in ophthalmology is a function of medical schools. Studies that are necessary before taking up ophthalmology are included in the curriculum of the medical school as required subjects for graduation as a physician and surgeon. To a limited extent all graduates of schools of medicine have studied ophthalmology.

Ophthalmology was one of the first branches of medicine to attain separate status, being recognized as a specialty by the ancient Egyptians. The fundamentals of the modern science were known to Kepler and Descartes in the 17th century. Herman Boerhaave lectured on ophthalmology at Leiden in 1708 and Jacques Daviel advocated lens extraction for cataract in 1752. Early descriptions of visual defects included those of glaucoma in 1750, night blindness in 1767, colour blindness in 1794 and astigmatism in 1801. The invention of the ophthalmoscope in 1851 by Hermann von Helmholtz led to the development of ophthalmology as an exact science. Other important contributions to modern ophthalmology were made by Albrecht von Gräfe (1828–70), who introduced the use of the ophthalmoscope in medicine and is considered the founder of modern eye surgery; Frans Cornelis Donders (1818–89), who introduced modern methods for correcting visual defects with spectacles; and Allvar Gullstrand (1862–1930), winner of the 1911 Nobel prize in medicine for his work on light refraction in the eye.

The function of the eye is vision. Whatever adversely affects vision in any way is the concern of the ophthalmologist, whether it be caused by faulty development of the eye, disease, injury, toxemia, degeneration, senescence or refraction. He makes tests of visual function and examines the interior of the eye as part of a general physical examination for symptoms of systemic or neurologic diseases. He prescribes medical treatment for eye disease, glasses for refraction, and performs surgical operations where indicated.

Ophthalmology is closely related to other clinical sciences, particularly neurology and internal medicine. In some medical schools ophthalmology and neurology are included in the department of medicine or surgery. It is frequently referred to as a surgical specialty because of the importance of surgical procedures on the eye. In most medical schools the department of ophthalmology is on a par with other departments such as surgery, medicine and pediatrics.

For more than a century physicians seeking to specialize in ophthalmology have studied as postgraduate students in schools and hospitals. In 1916 the American Board of Ophthalmic Examiners (later changed to the American Board of Ophthalmology) was established by joint sponsorship of the American Academy of Ophthalmology and Otolaryngology, the American Ophthalmological society and the American Medical association. This is a national examining and certifying body that stipulates the requirements a doctor of medicine and surgery must meet in order to be certified by the board as an ophthalmologist.

See also OPTOMETRY. (W. L. BE.)

OPIE, AMELIA (1769–1853), English novelist, whose best work, *Father and Daughter*, had lasting fame and influenced many subsequent popular novels, was born in Norwich, the daughter of James Alderson, physician, on Nov. 12, 1769. She had no formal schooling, but moved in intellectual circles that included William Godwin, Mary Wollstonecraft (Shelley) and John Horne Tooke. In 1798 she married John Opie, the self-educated painter. Between 1790 and 1834 she wrote 13 works of prose, including *Adeline Mowbray* (1804) and *Simple Tales* (1806), and five books of verse. *Father and Daughter* (1801) tells with moral earnestness and much pathos of the heroine's seduction, and her father's resultant insanity. Mrs. Opie later became torn between Quaker asceticism, which is reflected in her writings, and love of society, in which she cut a lively figure. She died in Norwich on Dec. 2, 1853.

See *Works*, 3 vol. (1848); J. Menzies-Wilson and H. Lloyd, *Amelia; the Tale of a Plain Friend* (1937). (W. L. G. JA.)

OPIE, JOHN (1761–1807), English portrait and historical painter, was born at St. Agnes, Cornwall, in May 1761, the son of a carpenter. He received instruction from John Wolcot ("Peter Pindar") in Truro from about 1775; and in 1781 Wolcot successfully launched him in London as a "Cornish Wonder," a self-taught genius. Opie attempted fashionable portrait painting but was most at ease with unsophisticated subjects, where his gifts for depicting rough textures in strong chiaroscuro could best be displayed, as in "A School" (1784; C. L. Lloyd collection) or the rugged portrait of "Lloyd Kenyon, 1st Baron Kenyon" (1789; Lord Kenyon collection). The works of Rembrandt, M. da Caravaggio and Velázquez were strong formative elements in his art. His first exhibited historical work was the "Assassination of James I of Scotland," followed by "The Murder of Rizzio," which secured his election, in 1786, as associate of the Royal Academy. In that year, also, he was commissioned to paint seven illustrations for John Boydell's "Shakespeare Gallery," becoming a full academician the following year. Just before his death in London on April 9, 1807, Opie delivered four lectures on painting to the academy students which were remarkable for their lucid exposition. The lectures were published in 1809, with a memoir by his wife Amelia. Ten works are in the Tate gallery, London. Opie also wrote a *Life of Reynolds*, in Wolcot's edition of Pilkington, and a *Letter on the Cultivation of the Fine Arts in England*, in which he advocated the formation of a British national gallery.

BIBLIOGRAPHY.—J. J. Rogers, *Opie and His Works* (1878); Ada Earland, *John Opie and His Circle* (1911); *John Opie*, Plymouth Art gallery exhibition catalogue (1957). (D. L. FR.)

OPIS, a lost city of Babylonia (southern Iraq), renowned for the decisive defeat of Nabonidus, last king of Babylon, by Cyrus of Persia in 539 B.C. The theory that Opis is to be identified with Akshak (*q.v.*) appears to have been disproved by two documents from Ischali; neither is there any proof that Opis can be identified with Seleucia (Tall 'Umar). It perhaps lay on a canal which joined the Tigris near Khafajah. (M. E. L. M.)

OPITZ VON BOBERFELD, MARTIN (1597–1639), German poet and literary theorist who introduced Renaissance poetic theories into Germany, was born at Bunzlau, Silesia, on Dec. 23, 1597, and studied at Frankfurt an der Oder, Heidelberg and Leiden, where he met Daniel Heinsius. He led a wandering life in the service of various territorial nobles. In 1625, as a reward for a requiem poem on the death of Archduke Charles of

Austria, he was crowned laureate by the emperor Ferdinand II, who later ennobled him. In 1629 he was elected to the Fruchtbringende Gesellschaft, the most important of the literary societies which aimed to reform the German language. In 1630 he went to Paris, where he made the acquaintance of Hugo Grotius. He settled in 1635 at Danzig, where Ladislaus IV of Poland made him his historiographer and secretary. There he died of plague on Aug. 20, 1639. For portrait *see* article GERMAN LITERATURE.

Opitz was the head of the so-called First Silesian school of poets and during his life was regarded as the greatest German poet. He was the "father of German poetry," at least in respect of its form. His *Aristarchus sive de Contemptu Linguae Teutonicae* (1617) defended his native tongue. His influential *Buch von der deutschen Poeterey*, written in 1624 and based on the work of Joseph Scaliger, Pierre Ronsard and Daniel Heinsius, established rules for the "purity" of language, style, verse and rhyme. It insisted upon word stress rather than syllable counting as the basis of German verse and recommended the alexandrine. The scholarly, stilted and courtly style introduced by Opitz dominated German poetry until the middle of the 18th century. Opitz' poems follow his own rigorous rules. They are mostly didactic and descriptive—formal elaborations of carefully considered themes—containing little beauty and less feeling. His *Trostgedichte in Widerwärtigkeiten des Krieges* (1633) praised Christian stoicism. He translated from Heinsius, Grotius, Seneca and Sophocles; partly translated from the text by O. Rinuccini the libretto of *Dafne*, the first opera in German; introduced the political novel (John Barclay's *Argenis*) into Germany; and edited (1638) the German version of Sir Philip Sidney's *Arcadia*, and the 11th-century *Annolied*.

Opitz's *Opera Poetica* appeared in 1646. His *Ausgewählte Dichtungen* were edited by J. Tittmann (1869) and by H. Oesterley, in J Kürschner's *Deutsche Nationalliteratur*, vol. 27 (1889). There are modern reprints of the *Buch von der deutschen Poeterey* by W. Braune, 6th ed. (1954), and, together with *Aristarchus*, by G. Witkowski (1888).

Opitz's *Teutsche Poemata* (1621) were also edited by G. Witkowski (1902).

See F. Gundolf, *M. Opitz* (1923); J. B. Birrer, *Die Beurteilung von Martin Opitz in der deutschen Literaturgeschichte* (1940). (A. Gs.)

OPIUM. The drug known as opium is obtained from the immature fruits of the opium poppy, *Papaver somniferum*, family Papaveraceae, by slightly incising the fruits and collecting and partially or completely drying the exuded juice. The juice is white and liquid at first, but it coagulates and turns brown on exposure to the air, and some types of opium are virtually black. The raw opium is made into lumps, cakes, bricks, etc., which when fairly fresh are generally soft inside, similar in consistency to fresh putty. The chief active principle of opium is the alkaloid morphine.

Uses.—Demands for opium may be (1) for medical (and scientific) uses, partly of opium as such, but chiefly of purified alkaloids extracted from it and their derivatives; (2) for opium eating (and drinking of infusions), from "quasi-medical" to illicit; (3) for opium smoking; and (4) for the manufacture of illicit morphine and heroin for drug addicts (*see* DRUG ADDICTION).

Possible Sources.—In general, poppies have a milky juice and produce various alkaloids, but only *P. somniferum*, the "sleep-bearing" poppy, and its close relative *P. setigerum* are known to produce morphine. The former species is almost wholly a cultivated plant, and any specimens found growing wild are likely to be merely escapes from cultivation. *P. setigerum* is an unimportant wild plant of the Mediterranean region; it was formerly considered by many botanists to be a mere variety of *P. somniferum* and the ancestral or "truly wild form." It has, however, twice the chromosome count of *P. somniferum* and probably should be considered as a distinct species, though similar to the semiwild forms of *P. somniferum*. These two poppies are the only ones thus far found with haploid chromosome numbers of 11 or a multiple. *P. setigerum* is not the source of any opium of commerce, either licit or illicit. The oriental poppy, *P. orientale*, a perennial native to the Caucasus (*see* POPPY), is not an opium poppy and does not produce morphine.

The Plant.—Although extremely variable, and cultivated in different, distinct types, the opium poppy plant can generally be recognized easily, especially by its foliage. Most varieties are tall, when well grown about three to four feet in height, and the flowers are large, four to five inches across. The foliage is smooth and of a characteristic whitish dull green colour, called "glaucous." There is a main stalk, ending in the largest flower and largest capsule, and (unless the plant is quite small) side branches end in smaller blooms and capsules. The plant is an annual. It can be identified chemically, for morphine is present even in tiny seedlings. The seeds, however, do not contain morphine and are virtually alkaloid free.

Reasons for Cultivating the Plant.—The opium poppy—in Europe also called the garden poppy or oil poppy—is grown over a large part of the world, in some regions primarily for opium and in others for its edible and oil-containing seeds. Since the 1930s some countries in the latter group, particularly Hungary, have utilized the chaff left after obtaining the seeds, consisting primarily of the dried, mature capsules, for the direct extraction of morphine from the plant material. Conversely, the seeds can be collected from capsules incised for opium. Rarely, the poppy may be grown primarily for its capsules, which have a limited use in pharmacy. The capsules, dried and gilded, are also used as decorations. *P. somniferum* is also often grown merely for its flowers, largest of any annual poppy. In the United States the cultivation of the opium poppy was prohibited, except under licence, by the Opium Poppy Control act of 1942 and seedsmen ceased to offer it, even for floral purposes.

Varieties of the Plant.—Floral forms may be either single or double, and the petals may be either plain or fringed. The flowers may be white, pink, red, purple, lavender or violet, generally with a white or violet spot at the base of each petal. The utilitarian varieties have large single flowers, possibly the commonest kind

FROM E. F. HEEGER, "HANDBUCH DES ARZNEI- UND GEWURZPFLANZENBAUES," VEB DEUTSCHER LANDWIRTSCHAFTSVERLAG, LEIPZIG, 1956

OPIUM POPPY (PAPAVER SOMNIFERUM)

being white with large dark violet spots at the base of each petal. There seems to be an unfounded idea in many parts of the world (not in the actual opium-producing districts) that the variety with pure white flowers and white seeds is the "true" opium poppy. In descriptions of varieties cultivated for opium or for seeds, stress is often laid on the colour of the flowers, but this has no bearing on the quality or quantity of either the opium or the seeds, and little, if any, even on the colour of the seeds. The latter characteristic has also been stressed in descriptions of varieties and even supposed species (*Papaver album* and *P. nigrum*), but there is no evidence that it has any relation to any morphological or useful characteristics. The seeds may be white, yellow, pink, blue, gray, brown or black.

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INCISED CAPSULES OF OPIUM POPPY

The capsules of the semiwild and floral forms are relatively small, and are dehiscent (opening pores to scatter their seeds at maturity). The cultivated varieties most highly developed for utilitarian purposes have large capsules, which may be the size of a hen's egg or bigger, and are largely indehiscent; in some cases, however, dehiscent varieties are cultivated for opium.

There are agronomic and ecological varieties, and geographical races or even subspecies. There are chemical varieties, differing in the proportions of the various alkaloids produced. The principal opium-producing countries each have their own varieties, adapted to the local soil and climate over hundreds of years. The different varieties of the plant account for many differences in the opium produced; there are also differences due to methods of collection and handling of the opium. However, the differences between varieties of *Papaver somniferum* should not be exaggerated. The European "garden poppy," despite its culture for centuries without collection of opium, is capable of yielding opium with 10% or more of morphine, just like the poppies which have long been cultivated primarily for their opium.

Historical Spread of the Plant.—The original home of the wild opium poppy is believed to have been the region around the eastern Mediterranean. It was probably first domesticated for its seeds, though some knowledge by the herb women of the properties of "poppy tea" may be equally old. The culture for seeds spread westward through central Europe, probably in the Neolithic Age, and still exists there today.

The garden poppy was well known to the ancient Greeks. Homer in the *Odyssey* described the use of an infusion of a drug as a beverage of hospitality; this sort of use of opium has been known in India down to modern times. Dioscorides in the 1st century A.D. described modern opium exactly. The drug was also known in ancient Mesopotamia; Assyrian herb lists and medical texts, as translated from cuneiform, refer to the opium poppy plant and to opium, the latter known as "lion fat," among other names.

From these lands, the culture of the poppy for opium spread slowly eastward. Apparently it was unknown in ancient times in either India or China; the widespread cultivation in those countries in modern times is a comparatively recent development. Some knowledge of the opium poppy first reached China about the 7th century A.D., while Japan probably did not begin its cultivation until the 15th century. Opium smoking, the vice of the far east, in any case did not even begin until well after the discovery of America, for previously there was no custom of smoking anything in the old world. It first became a terrible problem in China about the middle of the 17th century. Between World Wars I and II the illicit cultivation of the poppy for opium crossed the Pacific and became established in the mountains of western Mexico. Later, it was begun to some extent in Peru and Ecuador.

Cultivation for Opium.—Although the cultivators who produce opium may also use some of it, the chief reason for producing it is to exchange it for money, whether in the licit or illicit market. For an agricultural product it has high value in proportion to bulk and weight, and offers no considerable problems of storage or transport. Thus opium is a good cash crop, especially for undeveloped regions, which are often mountainous, where there are few or no roads and where farming may be mainly for subsistence. It can be profitable licitly in some fairly well-developed regions with a peasant economy.

The poppy is not a plant of the tropics (as is often supposed); but it is grown for opium in suitable districts from the subtropics to as far north as Manchuria. The climate should be dry at the time the opium is to be harvested. Much labour is required at this time; frequently the poppy is grown in small plots and such labour is supplied by the peasant's family. On a larger scale, rotation of crops is often used, and the poppy is grown in a given field only one year in three. The plant grows best in a rich soil but may, nevertheless, in many cases be a profitable crop for a poor soil.

The seeds are frequently sown in the autumn, and the opium harvested the following summer. They may also be sown in the spring, the harvest being only a little later. The capsules are ready for incision generally from 9 to 15 days after the petals fall. In Turkey and the Balkans the capsules are generally incised only once; in most other countries they are normally incised several times, as long as they will continue to yield juice. The morphine content of the opium falls with repeated lancings.

Cultivating Countries.—The cultivation for opium, both licit and illicit, is chiefly in Asia. Production is negligible in Africa and in Europe apart from the Balkans (Yugoslavia, Bulgaria and Greece). Turkey, Iran and India were the chief producers for export after World War II. At the suggestion of the United Nations Commission on Narcotic Drugs most producing countries eventually prohibited the production of opium or restricted it to medical uses. Production was permitted, however, in the Shan states of Burma and in northern Vietnam and Laos. It was made illicit in China, but there was enormous production in Yünnan, the middle western provinces and Manchuria. Formerly licit in Korea under Japanese rule, it was later declared illicit there. In Japan cultivation was prohibited under the occupation after World War II but was later revived to meet Japanese medical needs. There was some illicit production in Mexico, Peru and Ecuador; otherwise there was only negligible experimental production in the Americas. Under a United Nations protocol introduced in 1953, world opium production would be decreased from 2,000 tons annually to 500 tons, which would be sufficient to meet medical needs. The protocol was to become effective when 25 nations ratified or acceded to it. The signatories were to include at least three of the opium-producing countries (Turkey, Iran, India and Yugoslavia) and three drug-manufacturing countries. (C. C. F.)

Medicine.—The alkaloids of opium are of two types in chemical structure and action. Members of one group (morphine and codeine; *qq.v.*) are analgesic, narcotic and potentially addicting; principally, though, these two differ markedly in all three respects. Members of the other group (*e.g.*, papaverine [*q.v.*] and noscapine [formerly called narcotine]) are not analgesic, narcotic or addicting. Morphine has long been the standard and the physician's mainstay for the relief of severe pain, although powerful synthetic substitutes, *e.g.*, methadone and meperidine, whose side effects are less objectionable, are now available. Codeine is effective for mild pain and relieves cough. Papaverine is used in circulatory diseases and noscapine has been shown to be as effective as codeine in the relief of cough but is free of narcotic properties and is nonaddicting.

A drug as complex as opium is necessarily incompatible with many substances. Tannic acid precipitates codeine as a tannate; salts of many of the heavy metals form precipitates of meconates and sulfates; and the various alkalis, alkaline carbonates and ammonia precipitate the alkaloids.

The effect of opium and its preparations, including the mixtures of all its alkaloids marketed under various names, *e.g.*, Pantopon, or Omnopon, is essentially that of its principal ingredient, morphine; the presence of the other constituents does little to modify the effect of morphine, either to exaggerate its desirable or to offset its undesirable properties. If one takes body weight into ac-

count the effect of morphine is not greatly different in children and adults. However, partly at least because of their sensitivity to convulsant agents, infants under one year of age should never be given opium since it contains thebaine, a potentially convulsant alkaloid. Opium, as well as morphine, taken by mouth is less reliable and less effective as a pain reliever but is especially valuable as an antidiarrheic. It may upset digestion or it may relieve vomiting, differing with the individual and with the dose.

Toxicology.—Under this heading must be considered acute poisoning by opium and the chronic intoxication seen in those who eat or smoke the drug.

Chronic Intoxication.—The chronic taking of laudanum, tincture of opium—as in the famous 19th-century case of Thomas De Quincey (*q.v.*)—was later almost entirely supplanted by the use of the hypodermic syringe; but opium smoking continues to be a major problem in some parts of the world (*see* below).

Acute Poisoning.—Acute opium (or morphine) poisoning presents symptoms that may be confused with those produced by alcohol, cerebral hemorrhage, an overdose of sleeping pills and other morbid conditions. The differential diagnosis is important. It has been facilitated and recovery has been speeded by the discovery of the morphine antagonists. The patient who has swallowed a toxic or lethal dose of opium, of laudanum for instance, usually passes rapidly into the narcotic state without any prior excitement. Drowsiness yields to sleep and coma which ends in death from failure of respiration. The comatose patient has a cold and clammy skin, livid lips and ear tips and "pinpoint" pupils. The heart's action may be feeble, the pulse small, irregular and slow. Except for the slowness of the pulse the action on the circulation is largely secondary, however, to the all-important action of opium (morphine) on the respiratory centre in the medulla oblongata (the prolongation of the spinal cord into the brain). The centre is directly affected by the circulation through it of morphine-containing blood and the patient's breathing becomes progressively slower, shallower and more irregular until it ceases altogether.

Treatment.—If the opium was taken by mouth, it is important to rid the patient of any unabsorbed drug by emptying the stomach. Apomorphine, ordinarily a powerful emetic, is contraindicated because it may fail to break through existing depression of the vomiting centre, and its depressant effect may add to that of the opium. It is better to wash out the stomach with plain warm water followed by a solution containing about ten grains of salt to the ounce of water or with a weak solution of potassium permanganate, which may decompose morphine by oxidation. The essential of treatment is restoration of normal breathing and for this specific morphine antagonists, nalorphine and levallorphan, are available. Either of these given by injection, intravenously if the situation is urgent, promptly restores normal breathing though the patient may not awake immediately. Morphine is longer acting and the respiration may slow again, requiring a repetition of the antagonist. Nalorphine and levallorphan are effective against respiratory depression due to morphine and related substances only, so that if their use is not promptly beneficial the case is probably not one of poisoning by this class of substances. If the specific antagonists are not at hand one must, of course, resort to other means to stimulate the respiration. Hot strong coffee by mouth or rectum or caffeine by injection may help; mechanical stimulation by flicking with a towel, or other means of stimulating the skin, getting the patient on his feet, making him walk, and repeated application of smelling salts may be of some benefit. Artificial respiration should be used if necessary and persisted in as long as the heart continues to beat. The patient should be kept warm and if he can be kept awake the danger will pass. (*See* also POISON: *Systemic Poisons.*)

(N. B. E.)

Opium Eating.—This is mostly practised in Iran and India, and in the latter country on a larger scale than elsewhere. Studies by Sir R. N. Chopra show that in India little opium is used by the practitioners of indigenous and western medicine. It is, however, used extensively as a household remedy to relieve pain, especially in gastric and respiratory ailments. Though less common now than formerly, it is still the practice to give opium to infants to keep them quiet. Opium is usually taken in the form of a pill or as a solution in water. Because of restrictions on production and sale and an increase in price, its use greatly decreased after the early years of the 20th century. Indian addicts can be divided into three groups: (1) about 50% take it for relief from ailments; (2) 20% to 30% take it to obtain escape from difficulty or worry; (3) 15% to 20% take it simply for pleasure. The dose taken by the first two groups is always small and not rapidly progressive, but in the third group it is large and ever increasing. In a series of 1,000 cases, the average daily dose was found to be about ten grains. Habitual use of opium produces physical, mental and moral deterioration, proportional to the dose taken. Those taking small doses such as one to three grains daily show no apparent signs of the dulling of physical and mental faculties or the chronic toxemia that are marked effects of larger doses.

Opium Smoking.—This is indulged in on a large scale in China, Indonesia and India, although opium smoking is prohibited in all parts of the world except for a few small areas in the middle and far east. It is the outcome of tobacco smoking and presents a serious problem. In India the habit was held in contempt, and stringent regulations were enacted against it. By 1950, therefore, opium smoking was dying out in India, except in Assam and Madhya Pradesh, where social and economic factors were responsible for its continuance. In Chopra's series of 300 cases, it was found that the habit had been contracted in 50% of the cases by association with other smokers purely for its pleasurable effects, in 33% for relief of ailments and in 17% to overcome worry and strain. Much larger quantities of opium were used for smoking than for eating, and the effect on the general health of even moderate smokers was much more marked. The dose ranged from 2 to 180 gr. a day, the average being 25 gr. The abstinence symptoms were also more severe. The racial factor was significant; although the average daily doses taken by a Chinese were two to three times larger than those of an Indian, the ill effects in the former were much less marked. In the case of the Indians, excessive indulgence seriously damaged health, caused loss of physical energy and deterioration of intellect and so reduced earning capacity and shortened life.

Opium is prepared for smoking by prolonged boiling with water and removing impurities in the form of scum, by evaporating and, lastly, by a process of toasting. The preparations used in India are: (1) chandoo, which is opium prepared as above and which is also the form smoked in China; (2) madak, which is purified opium diluted with charred leaves of *Acacia arabica* (babul); (3) opium dross, which is the residue left in the pipe after smoking and contains more than 7% of morphine and is smoked again. The smoker does not absorb more than one-tenth of the total amount of morphine contained in opium; there must, therefore, be other unrecognized factors responsible for the intense effects produced.

The method of smoking opium followed by the Chinese and Indian smokers is similar. The apparatus consists of a pipe, a stylet, a lamp and a headrest. The dose of prepared opium is heated over the flame at the end of the stylet until a small ball of roasted opium is formed. This is then pushed into the pipe head and the pipe is ready for smoking. The opium mass is held over a flame or live charcoal, while the smoker inhales deeply a number of times, taking the smoke well into the lungs. The actual smoking of the pipe takes about a minute; more prepared opium is taken if the smoker desires to continue. The effects produced are immediate since the lungs present a large surface for absorption.

(R. N. C.; X.)

Opium Traffic.—Organized use of the poppy and the coca leaf for the purposes of commerce and revenue seems to have developed after 1700, in spite of protests against its use for other than medical and scientific purposes. The importation of opium into China by foreign traders led to the war of 1839–42 between Great Britain and China. The Chinese, in spite of the fact that they were not the victors and despite any pressure brought to bear upon them, still refused to legalize the opium trade. China was now open to the world and a huge smuggling trade in opium sprang

up which gave rise to endless difficulties, both to the Chinese and to the British government.

The second war broke out between China and Great Britain, with France as its ally, 15 years later, and, after its close, not only was the cultivation of opium in China itself permitted, but the import of opium from India was also legalized. Yet the Chinese government still continued to regard the use of opium as an important moral and economic question, and in 1906 it decided to put an end to the use of the drug within ten years. For this reason, in the following year, China entered into what is known as the "Ten Years' Agreement with India," by which China should cease the cultivation of the poppy and forbid the consumption of opium on the understanding that the export of Indian opium to China should be reduced in equal proportion and cease altogether in ten years. At first this undertaking was carried out faithfully by both parties concerned, and according to a statement made by Sir John Jordan at one of the meetings of the opium advisory committee, China in 1917 had almost freed itself from the curse of the poppy. Political troubles, however, broke out, effective government in China was suspended and the production of opium in China became not only a great national but also an international problem.

International Action.—It was first realized in 1906 that if the Chinese government were to suppress the opium evil, it must be assisted by other nations. In 1909 U.S. Pres. Theodore Roosevelt proposed that an international investigation be made. As a result, an international opium commission, at which 13 powers were represented, met that year at Shanghai.

The recommendations made at this meeting formed the basis of the first opium convention, which was drawn up at The Hague in 1912. International opium conferences, at which a number of powers ratified the convention, were held at The Hague in July 1913 and June 1914. During World War I all action in this connection was suspended until the Paris peace conference in 1919. In the peace treaties of 1919–20, the signatory powers agreed that the ratification of these treaties should constitute a ratification of the convention of 1912.

The League of Nations.—Under the covenant (art. 23c), the duty of supervising the execution of agreements with regard to the traffic in opium and other narcotics devolved upon the League of Nations. In order to carry out this obligation, the first assembly of the League constituted an advisory committee on opium and other dangerous drugs. The committee, which sat once a year except in special circumstances, obtained certain important and definite results, such as additional ratifications to The Hague convention and the adoption by a large number of countries of an important certificate system. Under this system no government could allow the export from its territories of any dangerous drugs covered by The Hague convention, except on the production by the exporter of a licence from the importing country, certifying that the drugs in question were required for legitimate purposes.

The council, on the recommendation of the advisory committee, invited the governments and members of the League to prepare an estimate of total annual requirements for the inhabitants of their territories for medical, scientific and other uses, with a view to proposing at some future date to the states concerned a new distribution of production which would limit the total output of raw material to the amount required for legitimate medical and scientific purposes. Subsequently two important conferences met during 1925 and 1931.

The result of the deliberations and discussions of the conference of 1925 was a convention providing for the more effective restriction of the production and manufacture of narcotics, and establishing stricter control and supervision of the international trade. Among the suggestions made in the convention was the creation of a central board, whose task it would be to follow the course of international trade and the general acceptation of the export and import certificate system. The conference also drew up a protocol by which the signatory states, recognizing their obligations to establish such control over the production, distribution and exportation of raw opium as would put a stop to illicit traffic, agreed to take within five years of the date of the coming into force of the protocol such measures as might be required to prevent the smuggling of opium into those territories where such use was temporarily authorized. A final act, containing further recommendations, was drawn up.

The international convention of 1931 for limiting the manufacture and regulating the distribution of narcotic drugs introduced the obligatory estimate system to carry out the principle of limiting the manufacture and trade of narcotic drugs to medical and scientific needs. Each country is required to furnish, annually, advance estimates of the narcotic drugs needed for these purposes. These estimates are binding and determine the maximum amounts to be manufactured or imported in any given year. They are examined by the supervisory body, which is composed of four experts who are not government representatives.

Limitation of Manufacture.—Actions to limit manufacture of narcotic drugs and control international distribution were taken through six international conventions and agreements concluded between 1912 and 1936, supplemented by two international protocols concluded under the auspices of the United Nations in 1946 and 1948 respectively. Seventy-one sovereign countries being parties to one or more of these treaties, their application became universal.

United Nations Commission on Narcotic Drugs.—The United Nations took over from the League of Nations, and the governments signatory to the treaties, by the protocol of 1946, vested in the appropriate agencies of the United Nations the powers formerly held by the League agencies. The opium advisory committee became the Commission on Narcotic Drugs, appointed by the UN Economic and Social council, and other modifications in form were made to correspond with the new situation.

At the 1953 session of the UN Commission on Narcotic Drugs, the protocol restricting production (see *Cultivating Countries*, above) was introduced.

See also NARCOTICS, LAWS RELATING TO.

(R. E. C.; H. J. A.; X.)

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OPOLE (Ger. OPPELN), a town in southwestern Poland, capital of Opole *wojewodztwo*, and seat of a bishopric, lies on the Oder about 80 km. (50 mi.) S.E. of Wroclaw. Pop. (1960) 63,489. It has few old buildings (churches, the remains of the town walls and of the Piast castle). Half the town was destroyed in World War II. It is a junction on the railway from Wroclaw to Upper Silesia, a road junction and a river port. The principal industry is cement production.

The crossing of important routes from the Moravian Gate to the Baltic sea and from Ruthenia via Cracow to Wroclaw encouraged trade at Opole. A Slavonic fortress existed in the 9th century. The town was capital from 1202 of the Opole principality, part of the independent Piast kingdom. It was ceded to Bohemia in 1327, and with Bohemia passed to the Habsburgs in the 16th century. In 1742 it was seized by Prussia and returned to Poland in 1945.

OPOLE WOJEWODZTWO borders on Czechoslovakia. It consists of 14 counties and 4 separate towns, all of which were joined to Poland after World War II. Area 9,506 sq.km. (3,670 sq.mi.). Pop. (1960) 929,033. The Oder, navigable for barges to Kozle, and linked by the Gliwice canal with Upper Silesia, flows through the province. Southwest are the Sudety (Sudeten) foothills, with highly developed agriculture and market gardening. The northeast is mainly flat with sandy soils and forests, which comprise about one quarter of the total area. The occurrence of chalk marl limestone and Triassic dolomite has given rise to the lime and cement industry (Groszowice; about one third of Poland's total production). Other industries include chemicals (nitrogen at

Kedzierzyn), power, leather and footwear (Otmet), textiles, paper (Krapkowice) and metallurgy. There is a good network of roads and railways.

One-third of the population are urban. The largest towns include Raciborz (pop. [1960] 32,523), Brzeg (24,152), Nysa (23,-638), Kedzierzyn (20,000). (T. K. W.)

OPORTO (PORTO), the second city of Portugal, capital of the Douro Litoral province and seat of a bishop, lies on the Douro river in the most densely populated area of the country, 175 mi. N.N.E. of Lisbon. World famous for its port wine, Oporto is the commercial and industrial centre for the zone north of the Mondego river. Pop. (1960) 305,445.

The approach to Oporto up the winding and fjordlike Douro gorge is of great beauty. The city lies chiefly on the north or right bank, its streets and terraces rising steeply from the riverside; in many cases the houses, looking more oriental than European, are built in granite overlaid with plaster, so that white is the prevailing colour of the city. The older districts of the town in the east are extremely picturesque where the steep narrow lanes are overhung by lofty balconied houses. On the south bank are the hamlets of Gaia and Afurada, and the red-tiled wine lodges (*armazens*) of Vila Nova de Gaia where vast quantities of port are blended and stored.

The Douro is spanned by three bridges. The Dom Luís I bridge (560 ft.), built in 1881–85 by Alexandre Gustave Eiffel, has one of the largest arches in Europe, its high and low carriageways serving different levels of the town on the north and Gaia on the south. The Maria Pia bridge (1876–77), which rests on a granite substructure, carries the Lisbon railway line across the high ravine at a height of 200 ft. The arch of the Arrábida bridge (885 ft.), completed in 1962, is one of the largest in the world.

The population density of Oporto is greater than in any other city of Portugal, and overcrowding is common. A number of housing projects have improved conditions, and the town's program, when completed, will house 50,000 people. By the mid-1960s extensive residential quarters had been built by the approaches of the new Arrábida bridge. The principal suburbs are Bomfim to the east, Monte Pedral and Paranhos to the north, Vilar, Lordelo and Foz do Douro to the west and Ramalde, Vilarinho, Matosinhos, Leça da Palmeira and the port of Leixões to the northwest. The surroundings of Oporto are full of interest and charm and the town is a favourite tourists' centre; in addition to the seaside resort of Foz do Douro, within the city limits, there are the beaches of Leça and Boa Hora to the north and those of Miramar, Granja and Espinho to the south, the last, with its casino, swimming pools and large hotels, being especially popular.

The main square and traffic centre of Oporto is the Praça da Liberdade. One of the busiest streets is the Rua do Infante Dom Henrique where many of the banks, warehouses and steamship offices are situated. The English club, formerly an English factory (built 1790), serves the large British community whose members are chiefly connected with the wine and shipping trades. The Rua da Alfândega skirts the right bank of the Douro and passes the customhouse. On the eastern side of the colourful Rua das Flores are the shops of the cloth dealers, while opposite are the jewelers with their remarkable displays of gold and silver filigree work and enameled gold, the ornaments worn by the women on feast days.

Oporto has many historic churches. The cathedral (Sé), which stands at the highest point of eastern Oporto, on the site of the Visigothic citadel, was originally a Romanesque building of the 12th century; its Gothic cloisters are of the 14th century, but the greater part of the fabric was renewed in the 17th and 18th centuries. The interior of the cloisters is adorned with blue and white tiles, painted to represent scenes from the Song of Solomon. The Romanesque and early Gothic church of São Martinho de Cedofeita is the most interesting ecclesiastical building in Oporto, its pillars having curiously carved capitals. Though the present structure is not older, except in details, than the 12th century, the church is said to have been "hastily built" (*cedo feita, cito facta*) by Theodomir, king of the Visigoths, in 559, to receive the relics of St. Martin of Tours, which were then on their way there from France. The Torre dos Clérigos, a granite tower 246 ft. high, built in the middle of the 18th century at the expense of the local clergy (*clérigos*), stands on a hill behind the 18th century church built by Niccolò Mazzoni and forms a conspicuous landmark for sailors. São Francisco is a Gothic basilica dating from 1410; and Nossa Senhora da Serra do Pilar is a secularized Augustinian convent used as artillery barracks, and marks the spot at which Wellington forced the passage of the Douro in 1809.

Oporto has a university (founded 1911), district archives, a municipal library, several museums including the Museu Nacional de Soares do Reis (with collections of prehistoric and Roman antiquities, sculpture, paintings, numismatics, etc.), an opera house and institutes of botany, anthropology, zoology and climatology. The Palacio de Crystal, a large glass and iron structure, was built for the industrial exhibition of 1865. The Bolsa (exchange) was begun in classic style in 1842; its main hall is a pastiche of the palace of the Alhambra. Modern public buildings of note include the new county hall at the top of the main avenue, the university hospital, the sports arena and the football stadium; wide modern roads such as Marginal avenue are completed or in process of construction.

Transport and Communications.—Oporto is well served for transport. Three main railway lines meet there, from Valença do Minho on the northern frontier, from Barca de Alva on the northwestern frontier and from Pampilhosa where the connection with the Sud-Express and other international trains is made. Express trains connect with Lisbon. The airport, at Pedras Rubras, is growing in importance. In addition to daily Lisbon services, it is used by a number of foreign aircraft, mainly carrying tourists.

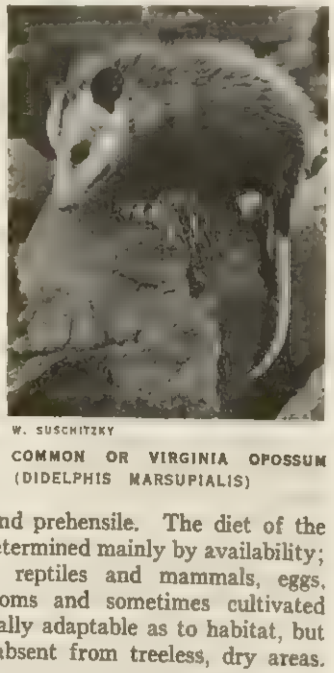
Trade and Industries.—Oporto is chiefly famous for the export of the wine which bears its name. An act passed on Jan. 29, 1906, defined "port" as a wine grown in the Douro district and exported from Oporto, and with an alcoholic strength of more than 16.5%. The grapes from which it is made grow in the Pais do Vinho, a hilly region 27 mi. long and 6 mi. broad about 60 mi. up the river. The trade was established in 1678, but the shipments for several years did not exceed 600 pipes (of 115 gal. each). In 1703 the British government concluded the Methuen treaty with Portugal, under which Portuguese wines were admitted on easier terms than wines from France and Germany, and from that date "port" was drunk in England. In 1747, 17,000 pipes were exported. In 1754 the great wine monopoly company of Oporto was set up, and shipments rose to 33,000 pipes. At the beginning of the 19th century the policy of the government favoured the port wine trade, and the vintages from 1802 to 1815 were splendid both in Portugal and in Madeira—that of 1815 was, in fact, of rare excellence. For the next few years the grape crop was not at all good, but the 1820 vintage was extremely remarkable. It was singularly sweet and black, besides being equal in quality to that of 1815. In 1852 the powdery mildew *Oïdium* which spread over Europe destroyed many of the Portuguese vineyards and in 1865 grape Phylloxera did much damage; from 1867, when the second monopoly company was abolished, exports again increased. Some more recent good vintages were 1908, 1927, 1934, 1935, 1947, 1948, 1955. The port wine is brought down from the "Quintas" to the lodges at Vila Nova de Gaia by train or by the typical *barcos Rabelos*, flatbottom barges with huge rudders, which are able to navigate the fast rapids of the Douro.

About a third of the population is engaged in the manufacture of cottons, woolens, leather, silk, gloves, hats, shoes, pottery, corks, tobacco, slates, spirits, beer, aerated waters (soft drinks), preserved foods, soap and jewelry. Among industrial products are tires, tire cloths (casings) and inner tubes, electric apparatus and appliances, piston rings, motor bicycles and chemical products. The fisheries are important, catches being chiefly of hake, bream and sardines. The town of Matosinhos nearby is a fish-canning centre. Between Oporto and Matosinhos, on the Atlantic coast, is the artificial port of Leixões, with its huge sea walls, the harbour consisting of two basins which provide anchorage and unloading facilities for big ships.

History.—Oporto dates from an early period. The Portus Cale of Roman times, it was previously a flourishing settlement on the

south bank of the Douro; the Alani subsequently founded a city on the north bank, calling it Castrum Novum. About A.D. 540 the Visigoths under Leovigild took possession, but yielded in 716 to the Moors. The Christians, however, recaptured Oporto in 997, and it became the capital of the counts of Portucalia for part of the period during which the Moors ruled in the southern provinces of Portugal (*see* PORTUGAL: *History*). The Moors once more became its masters for a short period, but in 1092 it was brought finally under Christian domination. Henry the Navigator was born in Oporto on March 4, 1394. Popular rebellions occurred in 1628 and 1661 against an unpopular tax, in 1757 against the wine monopoly and in 1808 against the French. The town is renowned in British military annals for the duke of Wellington's crossing of the Douro, by which he surprised and put to flight the French army under Marshal Soult, and captured the city on May 12, 1809. During a severe siege in 1832–33, Oporto was bravely defended against the Miguelites by Dom Pedro with 7,000 soldiers; 16,000 of its inhabitants perished. In the constitutional crises of 1820, 1826, 1836, 1842, 1846–47, 1891 and 1908–10 the action of Oporto, as the capital of northern Portugal, was always of the utmost importance. In 1919 the monarchy was proclaimed at Oporto and lasted for three weeks. In Feb. 1927 Oporto was the scene of an army rising and was bombarded during three days by government troops. After World War II there was large-scale planning and development and the city increased in size. (A. B. F. M.)

OPOSSUM, in North America the name given to the only surviving family of American pouched mammals (marsupials; *q.v.*), the Didelphidae, the most notable member of which is the common or Virginia opossum (*Didelphis marsupialis*), which ranges from southern Canada into South America. In Australia "opossum" or "possum" is applied to the phalangers (*q.v.*), distantly related marsupials native to Australia and nearby islands.



W. SUSCHITZKY

COMMON OR VIRGINIA OPOSSUM (DIDELPHIS MARSUPIALIS)

The Virginia opossum is the size of a house cat. Its coarse coat is grizzled gray; the large dark eyes and black mottled ears are conspicuous on its white face. It has a long pointed muzzle in which are set 50 teeth (no extant placental mammal has more than 44). Each black foot has five toes, with the first digit, or hallux, being clawless and, like a thumb, opposable. The tail, almost half as long as the body, is ratlike and prehensile. The diet of the common opossum is varied and determined mainly by availability; it includes invertebrates, small reptiles and mammals, eggs, nestlings, fruit, berries, mushrooms and sometimes cultivated crops. Opossums are almost equally adaptable as to habitat, but being largely aboreal, they are absent from treeless, dry areas. Dens are often found in hollow trees.

Breeding takes place from mid-winter to late autumn. One litter is produced annually in cooler regions, but as many as three in warmer ones. Actual gestation is only 12 to 16 days, and the young, of honeybee size, are born partially developed. As the female remains crouched in parturition the newborn instinctively and without maternal assistance crawls into the small pouch, where it locates and grasps a teat. The teat immediately swells and the young 'possum is secure till he outgrows the union and is weaned. Many newborn never succeed in entering the pouch. Often more young are born (as many as 18) than there are teats to serve them (usually 12); thus newborn mortality is high.

Although adults are preyed upon by many larger animals, they are remarkably tenacious of life. The opossum has a habit when hard pressed of feigning death—"playing 'possum"—until danger has passed. It has a life span of about eight years. Opossums are sometimes considered pests and are often hunted. The flesh is enjoyed as food locally in the southern United States; the fur, though coarse and brittle, finds some use locally and is cheap.

Several other opossums are known, mainly from the Central and South American tropics. These include *Chironectes*, the water opossums; *Philander*, the four-eyed opossums, so named because of the white spot above each eye; *Marmosa*, the mouse opossums; *Caluromys*, the woolly opossums; *Monodelphis*, the short-tailed opossums; and *Metachirus*, the brown-masked opossums. (K. R. KN.)

OPPENHEIM, LASSA FRANCIS LAWRENCE (1858–1919), German-born jurist, was born on March 30, 1858, at Windecken, near Frankfurt am Main. He studied law at Göttingen, Berlin and Heidelberg between 1878 and 1880. For a short time he also studied philosophy, medicine and theology. He taught at Freiburg im Breisgau for about seven years, and for three years was professor at Basel, where he lectured on constitutional and international law. He moved to London in 1895.

In London he began an exhaustive study of public international law, and the opening of the London School of Economics afforded him opportunities to teach the subject. As a result he wrote the treatise *International Law* (two volumes, 1905–06) for which he is best known. It was written from the point of view that international law is positive law and not a form of natural law or mere diplomatic usage. In 1908 he was elected to the Whewell professorship of international law at Cambridge and subsequently was primarily concerned with the teaching of international law and the assimilation of new material for future editions of his treatise.

His other published works included his earlier writings on German criminal law and criminal responsibility, his editions of John Westlake's papers (1914) and the series of *Contributions to International Law and Diplomacy* (1917–), *Land Warfare* in collaboration with Col. J. E. Edmonds (1912) and *The League of Nations and Its Problems* (1919). (E. H. LD.)

OPPENHEIMER, SIR ERNEST (1880–1957), South African industrialist and financier who was one of the most successful leaders in the mining industry in South Africa and Rhodesia, was born at Friedberg, Ger., on May 22, 1880. He began work at the age of 16 with Dunkelsbuhlers, London diamond brokers, and was sent as their representative to Kimberley, South Africa, in 1902. His first success was achieved in 1919 when, with considerable backing from J. P. Morgan of New York, he formed the Anglo-American Corporation of South Africa for the exploitation of the east Witwatersrand goldfield. Two years later he formed a corporation for diamond prospecting in South West Africa, and this was so successful that he gained control of the De Beers diamond firm and also established the Diamond corporation. In 1929 Oppenheimer formed the Rhodesian Anglo American corporation for exploiting the rich copper deposits in Northern Rhodesia, and his last project was the pioneering of new goldfields in the Orange Free State.

He was mayor of Kimberley from 1912 to 1915 and a member of the Union parliament. A philanthropist and an outstanding figure in South African life, he furthered commonwealth studies at Oxford university. Knighted in 1921, he was one of the richest men in the world, his success lying in his business acumen and his courage in undertaking mining enterprises of vast scope. Oppenheimer died at Johannesburg, S.Af., on Nov. 25, 1957.

OPPENHEIMER, J. ROBERT (1904–1967), U.S. theoretical physicist and science administrator, was born in New York city on April 22, 1904. He was educated at Harvard, Cambridge (England) and at the University of Göttingen, where he studied with Max Born and where he received his Ph.D. in 1927. After two years of further study in Europe (Leiden and Zürich) he became professor of physics at the University of California and at the California Institute of Technology, and he taught in both institutions till World War II. In these years he had a great influence on the rapid development of physics in the U.S., both through his own work (quantum theory of electrons and positrons, theory of cosmic rays, theory of nuclear structure) and through the work of his students. His qualities of leadership became apparent during the war when the U.S. government appointed him director of the Los Alamos laboratory near Santa Fe, N.M., where, from 1943 till 1945, Oppenheimer led a group of outstanding scientists in an ef-

fort which was crowned by the successful testing of an atomic-bomb explosion at Alamogordo.

After the war, in 1947, Oppenheimer became director of the Institute for Advanced Study, Princeton, N.J. Through various government committees and as chairman of the General Advisory committee of the U.S. Atomic Energy commission (1946–52), he continued to take an active part in the further development of atomic energy and in the great debate about its social consequences. These activities came to an abrupt end in 1954 when Oppenheimer's government security clearance was withdrawn, against the advice and testimony of many leading scientists. Subsequently, Oppenheimer continued to write about the role of science in the modern world (*The Open Mind, Science and the Common Understanding*). In 1963 he was the recipient of the U.S. Atomic Energy commission's Fermi prize. He retired as the Institute's director in 1966. Oppenheimer died in Princeton on Feb. 18, 1967. (The initial J. refers to no particular personal name.)

(G. E. U.)

OPPIAN, the name given to the authors of two (or three) didactic poems in Greek hexameters; formerly identified, they are now generally regarded as two persons.

Oppian of Corycus (or Anazarbus) in Cilicia flourished in the reign of Marcus Aurelius (A.D. 161–180). His father was banished to Malta by Verus. Oppian, who had accompanied his father into exile, returned after the death of Verus (169) and went on a visit to Rome. There he presented his poems to Aurelius and regained the imperial favour. He returned to his native country and died of the plague at the age of 30. His poem on fishing (*Halieutica*) has little poetic merit. The first two books deal with the kinds of fish and their habits, the remaining three with fishing methods.

A poet of Apamea in Syria, possibly not named Oppian, wrote a poem on hunting (*Cynegetica*) of about 2,150 lines, in four books. It is dedicated to the emperor Caracalla and is therefore dated A.D. 211 or later. The first book deals with the qualities of a hunter, with dogs and with horses. The second is concerned with horned animals, the third with wild animals, and the fourth, which is apparently incomplete, deals with the kinds of hunting. It is inferior throughout to the *Halieutica* in style and versification.

A third poem, on bird catching (*Ixeutica*, from *ixos*, "bird-lime"), once attributed to an Oppian, is lost; a paraphrase in Greek prose by a certain Eutecnius is extant.

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(G. B. KD.)

OPPLAND, a *fylke* (county) of south central Norway, extending from the hilly lowlands between lakes Mjøsa and Randsfjord northwestward to the alpine region of Jotunheimen (*q.v.*) and the watersheds between eastern and western Norway, contains the scenic valleys of Gudbrandsdal (*q.v.*) and Valdres with their tributary valleys. Area 9,773 sq.mi.; pop. (1960) 162,444. Apart from Jotunheimen with its summit peak, Galdhöpiggen (8,100 ft.), and several others above 6,500 ft., the upland plateaus between the valleys vary between 1,500 and 3,500 ft. above sea level. The tree line of conifers is about 3,000 ft., and is higher for birches. Barley is cultivated up to 2,000 ft. In the northern valleys precipitation is low and the fields are irrigated. Valley farming is based on animal husbandry; in the lowland districts cereals, vegetables, potatoes and fruit are grown. Forestry products (wood, pulp and paper) are important, especially in Lillehammer, the county capital, and Gjövik at the border of Lake Mjøsa. Metal products, munitions and glassware are also manufactured. Tourism is important. The Oslo-Trondheim railway goes through Gudbrandsdal, and Valdres also has rail connection with Oslo. Main roads between eastern and western Norway cross Oppland. (L. H. HG.)

OPPOSITION, in logic, means the various relations which can exist between judgments or propositions having the same subject and predicate but differing in quality or quantity. *See* LOGIC.

OPS, an obscure Roman goddess (originally perhaps of the earth's fertility) with an ancient shrine in the Regia, the office of the Pontifex Maximus, which only he and the Vestal virgins might enter. She was early equated with Rhea, wife of Saturn, and like her was later identified with Cybele. She also had connections with the rustic god Consus. Her title, Consiva, and the nomenclature and dating of her festivals (the Opalia on Dec. 19 and the Opiconsiva on Aug. 25) illustrate her affinities; *cf.* the Saturnalia, Dec. 17, and the Consualia (of Consus), Dec. 15 and Aug. 19.

(D. E. W. W.)

OPTIC, OLIVER: *see* ADAMS, WILLIAM TAYLOR.

OPTICS. The study of optics is usually divided into three parts: physical, physiological and geometrical. Physical optics is primarily concerned with the nature and properties of light itself and is treated under LIGHT. Physiological optics deals with the mechanism of vision, and is treated under VISION.

Geometrical optics, which is the subject of this article, is the name applied to that part of optics which deals with the properties of optical instruments such as telescopes, microscopes, photographic lenses, spectroscopes and the elementary lenses, mirrors and prisms from which they are constructed. (For the history and development of these instruments and for theory as particularly applied to them, *see* TELESCOPE; MICROSCOPE; LENS; SPECTROSCOPY; PHOTOGRAPHY; MIRROR.) This article is divided into the following sections:

I. INTRODUCTION

A study of the wave theory of light shows that the practical usefulness of geometrical methods applied in this branch of optics is a direct consequence of the extremely short pulse length or wavelength of light. Because the pulse length is finite, however, there are inherent limitations to geometrical ray theory; for example, it cannot explain the ultimate resolving power of ideal optical instruments. In spite of this fact, an account of the geometrical ray theory must be given here, partly because of the simplicity with which it explains many of the essential properties of optical instruments, but also because much of the literature on this subject still employs geometrical concepts and terminology.

The basic conception of geometrical optics in this theory is the ray of light. The fact that light travels in straight paths was well known to the Greek mathematicians and the transition from optics to pure geometry was thus simple. More precisely in geometrical optics we assume that the ray of light continues in the same straight line while it travels in the same homogeneous medium. When it meets a surface separating one medium from another, such as the surface between air and water, the light flux divides, in general, and follows two paths, one of which remains in the original medium while the other passes into the second. Both of these paths continue as straight lines, insofar as the media are homogeneous, until another surface is encountered, at which there may be another division of path. At each surface, the original light path will be called the incident ray, the light path in the

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PATH OF LIGHT THROUGH A TRIANGULAR PRISM

second medium, the refracted ray, and the path that returns into the original medium, the reflected ray. The relative intensity of the light flux in the directions of the reflected and refracted rays depends on the optical properties of the two media and on the angle of incidence. If the second medium is a metallic substance, the reflected light flux is much greater than that refracted, and the latter is absorbed after penetrating a very short distance. On the other hand, if both media are transparent, the refracted light flux is much greater than that reflected, except at grazing incidence or beyond some critical angle. The specific amounts of reflectance and transmittance under various conditions may be computed by Fresnel's formulas. These can be derived by an application of the electromagnetic theory of light as explained in the article LIGHT.

The new paths of the light flux are determined by simple geometrical laws. The law of reflection states (1) the incident ray, the reflected ray and the normal to the surface at the point of reflection lie in one plane; (2) the incident and reflected rays lie on opposite sides of the normal; and (3) the angles made by the incident and reflected rays with the normal are equal. The law of refraction states (1) the incident ray, the refracted ray and the normal to the surface at the point of refraction lie in the same plane; (2) the incident ray and the refracted ray lie on opposite sides of the normal; and (3) the sine of the angle made by the incident ray with the normal bears a constant ratio to the sine of the angle made by the refracted ray with the normal. This ratio depends only on the composition of the two media separated by the surface, and is known as the relative index of refraction.

A comparison of these two laws suggests that one may, for convenience, consider the law of reflection as a special case of the law of refraction. Let us adopt the convention that angles are to be measured by the value of the anticlockwise rotation needed to reach the ray position from the onward drawn normal. Thus in fig. 1, left, the angles of incidence and refraction ϕ and ϕ' are positive, and if μ is the relative refractive index $\sin\phi = \mu\sin\phi'$. When reflection occurs the angle of reflection is equal to but opposed in sign to the angle of incidence (*see* fig. 1, right), and μ should therefore receive the value -1. It will be noted also that the reflected ray travels in the opposite direction to that contemplated in the law of refraction. As we shall see later all lengths entering into optical equations are either multiplied or divided by a refractive index and the double reversal of sign frees us from all difficulties regarding the signs of the quantities we employ. We are therefore enabled to dispense with any detailed consideration of reflecting instruments and can proceed to deal with refraction as an inclusive process.

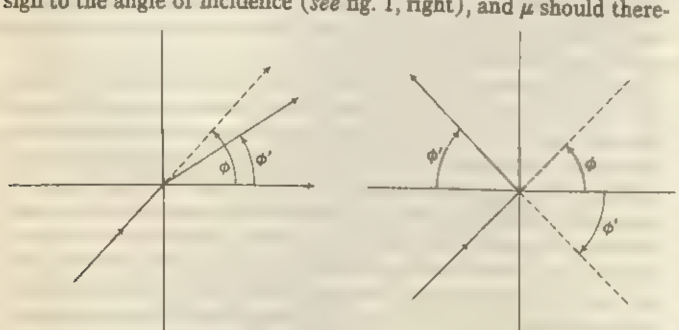

FIG. 1.—ANGULAR-SIGN CONVENTIONS, SHOWING (LEFT) REFRACTION: ANGLES OF INCIDENCE AND REFRACTION BOTH POSITIVE; AND (RIGHT) REFLECTION: ANGLE OF INCIDENCE POSITIVE, ANGLE OF REFLECTION NEGATIVE

For a reason which will become apparent later it is necessary for the reflecting and refracting surfaces used in optical instruments to approach very closely to ideal geometrical forms. The manufacturing processes by which the necessary degree of perfection can be reached impose severe limitations on the types of surface which may be employed, and in practice any surface but a portion of a sphere—with the plane as a special case—is rarely employed. Therefore, the following consideration of the refraction of light at a spherical surface should be helpful.

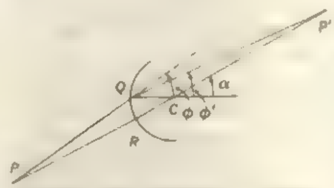

FIG. 2.—REFRACTION AT A SPHERICAL SURFACE

In fig. 2 let a ray passing through the point P be refracted at Q, a point on a spherical surface whose centre is at C. The refracted ray lies in the plane PQC containing the incident ray PQ and the normal QC, and it will therefore in general meet PC at some point P'. Let PC meet the surface in R and make an angle α with QC, and let ϕ and ϕ' be the angles of incidence and refraction. Then from the triangles PQC, $P'QC$

$$\frac{\sin\alpha}{\sin\phi} = \frac{PQ}{PC} \qquad \frac{\sin\alpha}{\sin\phi'} = \frac{QP'}{CP'}$$

and therefore by the law of refraction

$$\mu\frac{PQ}{PC} = \frac{QP'}{CP'}$$

If now Q is near R, PQ and QP' differ from PR and RP' by small quantities of the second order, and the equation becomes

$$\mu\frac{PC - r}{PC} = \frac{r + CP'}{CP'}, \text{ or}$$

$$\frac{\mu - 1}{r} = \frac{\mu}{PC} + \frac{1}{CP'}$$

where r is the radius of the surface. It follows from this expression that all rays which, before refraction in the neighbourhood of R, pass through P, will afterward pass through P'. Physically this means that light energy diverging from a particle of matter placed at P will converge to P' or alternatively will diverge in the new medium as though it were liberated at P'. The reunion of the rays at P' is thus of the greatest significance, and P' is called the image of the object P. If P' is so situated that the rays can actually pass through it the image is called real, but if it is so placed that they may merely be regarded as having originated there the image is called virtual. It should be observed that there is no need for the rays to have actually passed through the point P, that is to say we may deal with virtual objects as well as virtual images.

The final equation above may be converted into a similar but more convenient form in terms of the distances of P and P' from the vertex point R on the axis PP' that passes through the centre of curvature C. Thus substitution of $PC = PR + r$ and $P'C = P'R - r$ gives

$$\frac{\mu - 1}{r} = \frac{\mu}{PR + r} + \frac{1}{P'R - r}$$

Multiplication of both sides of this equation by the product of the denominators gives many terms that disappear by subtraction and leaves

$$(\mu - 1)PR\cdot P'R = rP'R + \mu rPR$$

This may be written in the usual form

$$\frac{\mu-1}{r}=\frac{1}{PR}+\frac{\mu}{P'R}$$

that relates the distances of P and P' from the point R on the refracting surface instead of their distances from the centre of curvature C. The requirement that Q and R be close together still applies. Rays such as PQ and QP' that are close to and nearly parallel to an axis are called paraxial rays.

Consider now a succession of spherical surfaces which are all met by rays under the conditions just described. Corresponding to an object point P, real or virtual, the first surface forms an image at a definite point P_1. The point P_1 may be regarded as a source of rays falling upon the second surface, which forms an image P_2 of P_1. Each surface in turn forms a point image of that due to the preceding surfaces, and we conclude that the whole series of surfaces will form at a definite point P' in the final medium, an image, either real or virtual, of an arbitrary point P in the object space. The relation connecting P and P' may be shown to be unique and reversible, so that it is a matter of convention which of the spaces external to the system is regarded as the object space and which as the image space. It will be observed that we have not assumed axial symmetry in the system, so that this conclusion holds whether the centres of curvature of the various refracting surfaces are collinear or not.

II. SYMMETRICAL OPTICAL INSTRUMENTS

The refracting surfaces in a great majority of optical instruments are surfaces of revolution with a common axis of symmetry. In consequence of this rotational symmetry the theory of these instruments is particularly simple. Rays which lie initially in a plane containing the axis remain in that plane, and the general one-one correspondence between the points of the two spaces degenerates to a one-one correspondence between points of a plane.

The theory of the symmetrical instrument has been treated very comprehensively by James Clerk Maxwell and later by Ernst Abbe on the assumption that this two-dimensional point-to-point correspondence holds. From symmetry it is clear that the image of each point on the axis is itself a point on the axis. Thus the axis is a self-conjugate ray, for the system, that is to say the axis, regarded as a whole is its own image. Corresponding to the point at infinity on the axis in the object space there corresponds a point F' (*see* fig. 3), usually at a finite distance, in the image space. This is named the second principal focus of the system. Then all rays which in the object space are parallel to the axis will be refracted so as to pass through F' in the image space, and conversely all rays in the image space which pass through F' correspond to

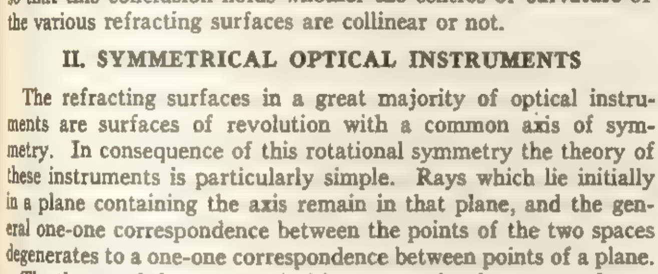

FIG. 3.—DETERMINATION OF SURFACES IN AN IDEAL INSTRUMENT IN WHICH OBJECT AND IMAGE ARE EQUAL TO ONE ANOTHER, AND ALSO EQUAL BUT INVERTED

rays which are parallel to axis in the object space. Similarly there is a point F on the axis in the object space such that all rays passing through F emerge in the image space as rays parallel to the axis. This point is called the first principal focus of the system. Since the incident portion of any ray refracted parallel to the axis lies in the same axial plane as the emergent portion, the two will meet if produced in some point K. The point thus determined on the incident ray is at the same distance from the axis as the whole of the emergent portion of the ray, and the height of the image of an object extending from K to the axis is equal to the height of the object itself, a fact usually expressed by saying that the transverse magnification is 1. The locus of points K determined in this manner is therefore called the first unit surface. It is to be considered as situated entirely in the object space.

In a similar way by considering the intersections of the incident and emergent portions of rays which pass through F' in the image space we determine the second unit surface situated in the image space. Clearly these two surfaces have rotational symmetry about the axis and are conjugate to one another, that is, the one surface is the image of the other, and any ray striking the first unit surface in the point H will follow a path in the image space passing through H' in the second unit surface where HH' is parallel to the axis. Now let $PHH'F'P'$ and $PFKK'P'$ be two rays meeting in P and P', the former being parallel to the axis in the object space and the latter in the image space. Let these two parallel portions be at equal distances from the axis and on opposite sides of it. The image extending from P' to the axis is of equal height to an object lying between P and the axis, and is inverted. P and P' therefore trace out conjugate surfaces corresponding to the transverse magnification -1. F and F' are the midpoints of PK and $H'P'$ and the new surfaces are therefore precisely equal to the corresponding unit surfaces but face opposite ways. Now let $phh'F'p'$ be another ray parallel to the axis in the object space meeting the unit surfaces in h and h' and the negative unit surfaces in p and p'. From symmetry Ph and pH intersect in a point f situated in the plane through F normal to the axis of the system, and from the congruent triangles $h'F'P'$ and $H'F'p'$, $h'P'$ and $H'p'$ are parallel. In other words a normal plane through F is conjugate to the surface at infinity in the image space, and similarly the normal plane through F' is conjugate to the infinitely distant surface in the object space. By taking a pair of rays similar to $KK'P'$ and PHH' but with distances from the axis in any assigned ratio we can construct the conjugate surfaces for a magnification equal to this ratio by drawing rays from K through F and from H' through F'.

It is a simple matter to show that the object space surfaces are all similar and similarly situated about F, and the image space surfaces also similar and similarly situated about F'. Since we have taken the ratio of the distances of corresponding points from the axis as the measure of the magnification, any corresponding secondary elements of length (that is elements normal to the plane through the axis of symmetry) in the image and object surfaces are in this ratio. Now consider two parallel incident rays inclined to the axis, not intersecting it but situated symmetrically with respect to it on the two sides of F, the separation between them being small. They determine on every constant magnification object surface a secondary element of unvarying length. In the image space these rays intersect in a point f' in the focal plane through F'. The lengths of the secondary elements intercepted on the constant magnification surfaces in the image space are therefore proportional to the distances of the points of intersection from f'. In other words these surfaces must be similarly situated with respect to any point f' in the focal plane.

It follows that all the constant magnification surfaces are planes normal to the axis, and that the magnification in every such plane is uniform in all directions. All the properties of the system may therefore be related to the points in which these planes meet the axis of symmetry. With the aid of rays passing through F and F' (fig. 4) we readily prove, if U and U' are the unit points (that is, the points in which the unit planes meet the axis) and P and P' are any pair of conjugate axial points, that

$$\text{transverse magnification}=\frac{FU}{FP}=\frac{P'F'}{U'F'}$$

so that conjugate points are determined by $FP\cdot P'F'=FU\cdot U'F'$. If we draw through f a straight line fN, parallel to the direction

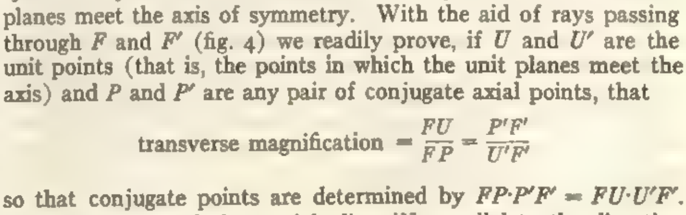

FIG. 4.—COLLINEAR IMAGERY SHOWING THAT ANY RAY THROUGH THE NODAL POINT N EMERGES IN A PARALLEL DIRECTION THROUGH N'

of the emergent rays arising from f, to meet the axis in N, we have $FN = U'F'$. The conjugate point N' by the above relation is given by $N'F' = FU$. These points, from the circumstance that the incident and emergent rays through them are parallel to one another, are called the nodal points of the system. FU and $U'F'$ are named the first and second focal lengths of the system. When these two focal lengths are equal the unit points coincide with the nodal points and are frequently called the principal points.

It is easy to show with a system consisting of a single surface that if an object point is moved along the axis, the image moves in the same direction. It follows that this holds also for any compound instrument, and hence FU and $U'F'$ are always measured in the same direction. There are thus only two types of system—positive systems, illustrated in fig. 4, in which the principal foci F and F' are reached by proceeding from U and U' toward the real distant part of the corresponding space (the focal lengths thus being positive), and negative systems in which all these signs are reversed. The unit planes are usually situated close to or between the extreme refracting surfaces of the lens, and in a negative instrument all the real portions of the object space and of the image space are thus on a single side of the respective focal planes. It follows that such a negative system cannot yield a real image of a real object, and since the focal planes separate upright from inverted images, there is no inversion if either object or image is real. With a positive lens we can obtain a real inverted image of a real object, but if there is no inversion either the object or the image or both are virtual.

As we have based this discussion on the general correspondence of object and image points, the conclusions hold whenever the initial assumptions are satisfied irrespective of the way in which the system is constructed. Had we first considered the properties of a single spherical surface and extended the result to a combination of several such surfaces, our conclusions would not necessarily have applied to a system in which aspherical surfaces are employed.

Formulas are frequently used in which measurements are made from the unit points instead of from the principal foci. If we denote the transverse magnification by m, we have

$$\frac{PF}{FU} = -\frac{1}{m} \qquad \frac{F'P'}{U'F'} = -m$$

from which it follows that

$$\frac{PU}{FU} = 1 - \frac{1}{m} \qquad \frac{U'P'}{U'F'} = 1 - m \qquad \frac{U'P'}{PU} = -m\frac{U'F'}{FU}$$

and

$$\frac{FU}{PU} + \frac{U'F'}{U'P'} = 1$$

When the two focal lengths have the common value f the last two equations become

$$m = -\frac{U'P'}{PU} \text{ and } \frac{1}{PU} + \frac{1}{U'P'} = \frac{1}{f}$$

Systems which yield on a uniform scale a plane image of a plane object (and incidentally a plane image of every plane object) are admirably fitted for many practical purposes, for example the photographic reproduction of maps. The scheme we have just described, which is known as collinear imagery, has therefore been widely used as a standard with which the performance of real instruments may be compared. It is of value as an artificial reference frame, rather than as a scheme to which real instruments tend to conform.

Collinear imagery follows from geometrical theory when only paraxial rays are considered and one can make the approximation that the sines of all slope angles and angles of incidence and refraction can be replaced by the angles themselves. This means that in the power series expansion of the sine functions one retains only the first term. Consequently, the resulting theory is called the first-order theory. It is often attributed to the mathematician Carl Gauss (1777–1855). In this restricted theory image formation is strictly collinear. Deviations from collinear imagery due to each of the neglected higher powers in the series expansion are called aberrations of the same order as the power of the neglected term. Equations for the five third-order aberrations were first derived by Ludwig von Seidel in 1855 in connection with the design of lenses of high quality. While von Seidel's equations are seldom used in computations, they do provide the conventional basis for classifying the principal defects of optical systems. These aberrations are discussed in other paragraphs in this article.

A. The Wave Theory and Lenses

We will now consider the properties of lenses according to the wave theory of light. The postulates of this theory, which have been justified by the most varied experiments, are that monochromatic light may be regarded as an undulatory disturbance of unvarying period which spreads out in all directions from the source at a uniform speed which depends only on the medium in which it is traveling. In common with other forms of wave motion the disturbance at a given instant at any point may be obtained by replacing the actual wave system by a system of secondary sources of proper intensities and phases distributed over a surface. The statistical distribution of light energy is assumed to be that of the energy distribution of the wave system on the assumption that a long train of waves is involved. On this basis the phenomena observed in the neighbourhood of an optical image—that is, the point where the energy of the wave motion has its greatest value through the contributions of the secondary sources arriving in the same phase—have been very satisfactorily accounted for. It is shown in treatises on physical optics (see LIGHT) that these assumptions involve (1) propagation of light in straight paths normal to the wave front (so that the rays of the geometrical theory are to be regarded as normals to the wave front), and (2) changes in directions of these paths in agreement with the laws of reflection and refraction, provided the relative refractive index is made equal to the ratio of the times taken by light to travel equal distances in the new and old media. It would therefore appear that we should find agreement between the deductions to which we are led by the geometrical and the wave theories. This conclusion however is incorrect. An essential condition in deducing the law of rectilinear propagation is that the wave front should be of considerable lateral extent. When light approaches a real focus this condition is violated, with the result that the direction of propagation in fact is not constrained to the straight paths assumed in the geometrical theory. It is therefore not surprising to find that while the geometrical theory indicates correctly the positions in which images are formed and the conditions which should be satisfied if an instrument is to yield images of the highest quality, it is misleading in the character of the image it leads us to expect, and the effects to be observed in the neighbourhood of the image. The two theories also differ in the course they would lead us to adopt when any of the conditions corresponding to perfect imagery are not satisfied.

Since the relative refractive index depends only on the relative speed with which light travels in the two media, we may, by assigning the value unity arbitrarily as the refractive index of a suitable substance under specified physical conditions, obtain an absolute refractive index for any other substance. As an absolute standard medium empty space is taken, but for practical purposes the refractive index of air at standard temperature and pressure is adopted. We shall hereafter, when we speak of refractive index, imply the absolute refractive index of a substance on one or other of these conventions. We will now show that the two focal lengths of any symmetrical optical system are in the ratio of the refractive indices of the two external media.

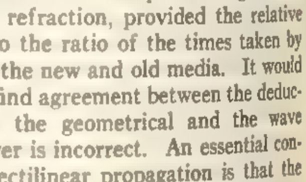

FIG. 5.—RATIO OF FOCAL LENGTHS

Let a plane wave normal to the lens axis in the object space of refractive index μ travel from the position PF, fig. 5, until, after being converted by the instrument into the spherical wave

$U'J$, in the image space of refractive index μ', it reaches the principal focus at F'. Let another plane wave in the image space travel in the reverse direction from $F'Q$ to F. As different parts of the same wave front take equal times to reach the focus, the time taken by the light to travel by the path $PHH'JF'$ is equal to that taken along the axial path $FUU'F'$, and similarly the paths $QK'KIF$ and $F'U'UF$ take equal times. The time taken to traverse the same axial path $FUU'F'$ is independent of the direction, and the times for all these paths are thus equal. Now the times taken along PH and FU are equal, and the times along the equal distances $U'F'$ and JF' in the same medium are equal. It follows that the time taken to travel from U to U' exceeds that between H and H' by the time needed to traverse the distance $H'J$. Similarly the time for the journey UU' exceeds that between K and K' by the time taken to cover the distance IK. Now if H and K are at equal distances y from the axis the time taken to travel between H and H', from the symmetry of the instrument, is equal to that taken between K and K'. It follows that $\mu \cdot IK = \mu' \cdot H'J$, or

$$\mu[\{(FU)^2 + y^2\}^{\frac{1}{2}} - FU] = \mu'[\{(U'F')^2 + y^2\}^{\frac{1}{2}} - U'F']$$

that is, if the terms in y^4 and higher powers of y are negligible,

$$\tfrac{1}{2}\mu \frac{y^2}{FU} = \tfrac{1}{2}\mu' \frac{y^2}{U'F'}$$

and since this holds for finite values of y we must have

$$FU : U'F' = \mu : \mu'$$

In particular if the two external media are composed of the same kind of matter the two focal lengths are equal to one another.

1. The Size of a Point Image: Resolving Power.—The extent of the divergence between the two theories may be illustrated by considering properties of importance to the user of the instrument. First we will consider the size of the image of a point source. Of the spherical wave which spreads out from the source only a portion can enter the instrument, and corresponding to the perfect reunion of the rays in an image point we have an emergent wave of spherical form. In fig. 6, BAC represents a wave front filling the aperture BC: the wave is in the form of a portion of a concave sphere of which F is the centre. According to geometrical optics the image is the point F, and is formed by rays filling the cone BFC of which AF is the axis and α is the semiangle. By the principles of physical optics the disturbances produced by the train of waves are the same as would be produced by a suitable series of disturbances situated in the wave front BAC. Now any disturbance at A gives rise to a spherical wave with A as centre. If we confine ourselves to a region around F of dimensions small compared with AF we may consider the wave from A to be a plane wave PP' at F. Similarly from B and C we get plane waves QQ' and RR' making angles $\mp \alpha$ with PP'. Now all parts of the wave front BAC are equidistant from F, and the component disturbances at F are therefore all in the same phase—that is to say, all the displacements are in the same direction and reach their maximum values at the same instant.

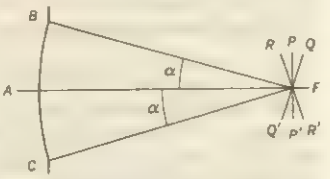

FIG. 6.—DEPENDENCE OF RESOLVING POWER ON APERTURE

The energy of the wave motion is therefore a maximum at F, for there the co-operation is as great as possible. The wave from B will, however, have already passed beyond P, and that from C will not yet have reached P by the time the wave from A has arrived at the position PFP'. To find the disturbance at P we therefore have to take the displacement at B when the wave front BAC is short of the position shown by the distance PQ, and similarly the displacement at C when this wave front has advanced beyond the position shown by the distance PR. That is to say the component displacements at P vary in phase, the total range being found by measuring the difference of path, *i.e.*, the length $2PF \sin \alpha$, along the train of waves in the direction of their motion. Now if P is near enough to F the differences of phase are small, and the displacements differ very little from those at F; in other words at points very close to F the light energy is practically the same as at F, so that the image is of finite dimensions, and not a point. As P moves farther away from F the range of phase increases, and at a certain stage we begin to receive contributions from points near B which tend to neutralize those contributed from points near C, so that the light energy as we pass through these positions of P diminishes rapidly. Finally we reach a position of P at which the range of phase is great enough for the various contributions to neutralize one another, or at least to so nearly neutralize one another that our impression on looking at this point is that we have reached or passed the edge of the image.

Since the changes of intensity are due wholly to differences of phase, the image edge will be reached when the difference of path is some constant θ times the wavelength λ of the light, *i.e.*,

$$2PF \sin \alpha = \theta\lambda, \text{ or}$$

$$\text{image diameter} = 2PF = \frac{\theta\lambda}{\sin \alpha} = d$$

If λ_0 is the wavelength of the light in the standard medium $\lambda_0 = \lambda\mu$, and the last fraction becomes $\theta\lambda_0/\mu \sin \alpha$. As the aperture which limits the light passing through the instrument is reduced, $\sin \alpha$ decreases and the size of the image increases. If two near object points are to be distinguished on examining them through the instrument their images must be separate, and the resolving power of the instrument, as its capacity for rendering distinct images of near objects is called, is measured by the reciprocal of the image diameter, that is by $\mu \sin \alpha/\theta\lambda_0$. With light of a given wavelength the denominator is invariable, and as $d\mu \sin \alpha$, as we shall see later, is unaltered by refraction, the resolving power of an instrument is measured by $\mu' \sin \alpha'$, where the accented quantities relate to the object space. Because of its importance in microscopy this quantity is known as the numerical aperture of the instrument. The utility of an optical instrument evidently depends upon the variation in path having a small value compared with the wavelength of the light used. Since the wavelength is very small, a very close approach to the theoretical form, as has already been mentioned, is necessary in the refracting surfaces.

2. Depth of Focus.—We will now consider according to the two theories how far we may expect to be able to depart along the axis of the instrument from the ideal focus F and still retain a satisfactory image. According to geometrical optics light rays fill the cone BFC, fig. 7, and the image in the plane XY will be a circle of diameter IJ. The image is considered satisfactory if IJ does not exceed a certain diameter, say d, so that the permissible range for G is given by the condition

$$FG = \tfrac{1}{2}d \cot \alpha$$

or very approximately

$$FG = d \cdot \frac{I}{a}$$

where I is the distance of the image from the principal point and a is the effective diameter of the lens aperture, supposed situated in the unit plane. The important feature of this formula is that the depth of focus is inversely proportional to the diameter of the aperture.

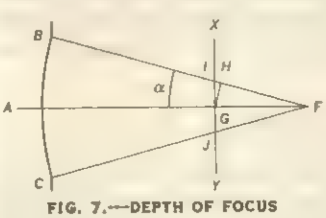

FIG. 7.—DEPTH OF FOCUS

Let us now consider the same problem from the point of view of the wave theory. Instead of relying on the geometrician's hypothesis we are able to rest on the well-attested fact that an image begins to appear less sharp when the extreme difference between the phases of the component waves at the centre of the image reaches a definite value, that is to say, when the path difference at G amounts to $\phi\lambda$ where ϕ is a definite number. This criterion differs from that considered on the geometrical theory less radically than might at first sight appear, for the existence of an appreciable phase difference at the image centre means that

in this neighbourhood the light energy is less: but the total light energy of the waves is the same wherever the plane may be placed, and energy removed from the central regions must therefore appear in some other place. But to say that an appreciable amount of energy is found farther from the centre is only another way of stating that the image is sensibly enlarged.

Resuming, however, the determination of the range for G, the distance of this point from B differs by an unimportant amount from BH, where GH is perpendicular to BF. Since the extreme paths obviously arise from A at one limit and marginal points such as B at the other, and since all path lengths to F are equal, the extreme path difference is the difference between FG and FH, or $FG(1 - \cos\alpha)$ or

$$FG = \frac{\phi\lambda}{1 - \cos\alpha}$$

Now $a = 2I\sin\alpha$, and therefore approximately

$$FG = 8\phi\lambda\left(\frac{I}{a}\right)^2$$

This formula indicates a law of a quite different type from that derived geometrically, the range varying inversely as the square of the aperture diameter, instead of as the first power.

3. Depth of Field.—By reasoning of a character essentially similar to that of the foregoing section we can find expressions for the nearest and greatest distances x and x' at which objects may be situated from the lens for their images to appear sharp on a screen focused for a distance X. According to the geometrical theory the conditions are

$$\frac{1}{x} - \frac{1}{X} = \frac{1}{X} - \frac{1}{x'} = \frac{d}{Ia}$$

and the conditions derived from a limiting difference of path are

$$\frac{1}{x} - \frac{1}{X} = \frac{1}{X} - \frac{1}{x'} = \frac{8\phi\lambda}{a^2}$$

where the symbols bear the same meanings as in the previous section. Thus assuming the objects are at a considerable distance from the lens, so that I is approximately equal to the focal length of the lens, according to geometrical optics the focal length of the lens and the aperture are equally important, the range being inversely proportional to both. On the other hand according to the wave theory the focal length has nothing whatever to do with the question, and the range is inversely proportional to the square of the aperture. Both theories, it will be observed, indicate the selection of the same plane for the theoretical focus to secure the utmost sharpness for all objects between two given extreme planes.

The quantity Ia/d in the first equation is generally called the hyperfocal distance, H, and is often used in computing the depth of field, x to x', corresponding to an object distance, X, in exact focus. For example, X may be the setting on the focusing scale of a camera. For this application, one usually assumes an acceptable diameter for the image spot, IG, in fig. 7 of $d = 0.004$ in. The effective diameter of the lens aperture a is obtained from the focal length f and the f-number N of the stop by the relation $a = f/N$. When the objects are many focal lengths distant from the lens, one may write $I \cong f$. The hyperfocal distance is then given by the equation

$$H = \frac{Ia}{d} = \frac{f^2}{dN} \cong 250\frac{f^2}{N}$$

where f and H are in inches. For example, when $f = 2$ in. (35 mm. camera) and $N = 4$ (stop setting $f/4$), the value of H is 250 in. or about 21 ft. If images of objects at a distance of $X = H = 21$ ft. are precisely in focus, one obtains acceptably good focus for object distances from $x = X/2 \cong 10.5$ ft. to $x' = \infty$. This illustrates the principle of the fixed-focus camera. Thus if one desires a depth of field from 5 ft. to ∞ one must use a hyperfocal distance of $H = 10$ ft. and therefore make $f^2/N = 0.5$. Unless the focal length is rather small, however, this requires so large a value of N (*i.e.*, so small a stop) that diffraction effects will cease to be negligible as assumed in geometrical theory. Under this condition the first equation loses its applicability and one should use the second equation that is based on wave theory.

It is instructive to compare the equations for the hyperfocal distance according to the two theories and consider why they differ and how they might be reconciled. For objects at several focal lengths distance one finds, according to wave theory, that

$$H = \frac{a^2}{8\phi\lambda} = \frac{f^2}{8\phi\lambda N^2}$$

Comparing this with the previous formula for H, one observes that the wave theory implies an acceptable diameter of the image circle equal to $8\phi\lambda N$, where $\phi\lambda$ is the acceptable path difference to the centre of the image. Thus for a fixed value of ϕ, which might be 0.6, the acceptable diameter of the image circle in wave theory is proportional to the f-number of the stop. For small values of N this diameter is much smaller than the standard 0.004 in., which is based primarily on the resolving power of the usual photographic emulsion.

Diffraction theory indicates that in the ideal image nearly all of the light flux is concentrated in a spot, called the Airy disk, having a diameter of

$$D = 2.44\frac{I\lambda}{a} \cong 2.44\,\lambda N$$

For reasonable values of N, this is quite small because of the smallness of the wavelength of light. A comparison of the size of the Airy disk and that of the acceptable diameter of image spot in the wave theory shows that one is effectively assuming that the latter is a constant multiple $8\phi/2.44$ times the former, since both are proportional to N. In the geometrical ray theory, on the other hand, one assumes a fixed diameter for the acceptable image spot that is independent of N. This theory becomes inapplicable if the diameter of the Airy disk is not negligible compared with the assumed tolerance of 0.004 in. It also ceases to apply if the aberrations of the lens are so large that the image disk cannot be as small as the standard 0.004 in. tolerance. If a larger tolerance is adopted, the computed depth of field is naturally larger whether the lens is good or poor. A poor lens would, however, give a poorer image over the entire depth of field.

B. Aberrations of Optical Systems

Returning to geometrical ray theory, the reader will recall that the approximations used in developing the equations for the location and magnification of the image are such that the results are accurate only when the rays are close to and make small angles with the axis of symmetry of the lens or optical system. Even if these conditions are satisfied, however, perfect sharpness of the image cannot be obtained. A certain degree of diffuseness is always present due to diffraction of light waves. (*See* Light.) Fortunately this effect is small because of the smallness of the wavelength of light, and may be neglected in an introductory discussion of the principal faults of optical systems.

When one considers object points removed from the axis and computes rays that make appreciable angles with the axis, one finds deviations from the ideal behaviour of an optical system as predicted by the first-order theory. These deviations are classified as aberrations of several varieties. Since in practice a lens is usually expected to give sharp and undistorted images of objects having an appreciable extent (field) and utilizing cones of rays having an appreciable angular divergence (aperture), the reduction of aberrations is an important part of lens design. The design of high quality optical systems is an extremely technical operation that calls for great skill, experience and familiarity with optical theory. The details will not be discussed here but the nature of the principal aberrations and the general procedure followed in their reduction will be explained in an elementary fashion. A knowledge of aberrations helps the user of lenses to make an intelligent selection and application of available lenses.

1. Spherical Aberration.—When light rays from an object point on the axis of a lens pass through the lens, it is found that the rays through the various circular zones of the lens around the

axis are focused at different points along the axis. This defect is called longitudinal spherical aberration. The refracted rays create a locus of intersections in space along a caustic curve the tip of which is the focus of paraxial rays.

The same kind of focus can be created by rays reflected from concave or convex spherical mirrors. Spherical aberration may be eliminated by using an aspherical surface whose shape depends on the location of the object point and its image. Because such aspherical surfaces cannot be constructed by mass-production methods with sufficient accuracy, they are seldom used, there being some notable exceptions. The longitudinal spherical aberration of lenses with spherical surfaces varies as the square of their aperture and inversely as their focal length. The amount of spherical aberration of a given simple lens depends greatly on the ratio of the radii of curvature of the lens surfaces, being least, but not zero, when the light rays pass through the lens symmetrically so that they make equal angles with the normals to the surfaces of the lens. For a thin lens made of glass having a refractive index of 1.5 and for a distant object, this is achieved when the second surface has a radius of curvature six times that of the first surface and of opposite sign. With a given shape of lens, one obtains the least spherical aberration when the flatter side is toward the object or image, whichever is the closer, for this gives the more symmetrical ray passage through the lens. Spherical aberration is eliminated by using a combination of positive and negative spherical lenses with radii computed so that their spherical aberrations are equal and of opposite sign but yield lens powers such that the combination has the desired focal length.

Images formed by reflection also suffer from spherical aberration unless suitable, often aspherical, mirrors are employed. The best-known example is the parabolic reflector which is free from spherical aberration when one of the conjugate points is located at infinity in the axial direction, the other conjugate point being at the geometrical focus of the paraboloid. When both conjugate foci are at finite distances from the mirror, an ellipsoidal mirror will be free from spherical aberration for conjugate points at the geometrical foci of the ellipsoid. When one of the conjugate foci is virtual, a hyperboloidal mirror gives focusing without spherical aberration.

It should be noted that all of the above surfaces produce images free from spherical aberration only for a single object point that is located at some specific place on the axis of the mirror. Since one is generally interested in securing high quality images of objects having some lateral and longitudinal extent, it is imperative to consider aberrations of correspondingly displaced object points. The nature and seriousness of the problem may be illustrated by considering the ellipsoidal mirror. All rays leaving an object point at one focus will, after reflection, pass through the other focus regardless of the aperture of the mirror, which may even surround the two foci in the extreme case. If we consider an object of some lateral extent at one of the foci, it is well known that the image at the other focus will have a magnification that is given by the ratio of the distances of the image and object measured from the reflecting surface. If this magnification is m, for example four, when the light is reflected from the nearest portion of the ellipsoid, it will be $1/m$, for example one-fourth, when the light is reflected from the farthest portion. Other zones will give magnifications between these two extremes. It is evident that a superposition of images having such diverse magnifications for the different zones of the mirror will result in an intolerably imperfect image. The defect may often be reduced to an acceptable amount by using only a small enough portion of the mirror, but it can never be completely eliminated in this way. This particular variety of aberration, arising from a variation in magnification with aperture angle or zone of a mirror or lens, is called coma.

Abbe has proved that an optical system will be free of coma if, in addition to being free of spherical aberration, it satisfies the equation, known as Abbe's sine law: $\mu' \sin \alpha' = m\mu \sin \alpha$ where m is the transverse linear magnification, μ' and μ are the indices of refraction of the media in the object space and in the image space, respectively, and α' and α are the slope angles of conjugate rays through the axial object point and image point. Since the absence of coma requires that m be constant for the various zones of the lens or mirror, the condition that must be satisfied is

$$\frac{\sin \alpha'}{\sin \alpha} = \text{constant}$$

which is known as the sine condition. All optical systems of high quality satisfy this condition. If the object is at a very great distance, one may consider $\sin \alpha'$ to be proportional to the axial height h of the entering ray so that the sine condition becomes

$$\frac{h}{\sin \alpha} = \text{constant}$$

A system that is free of spherical aberration and satisfies the sine condition is said to be aplanatic.

2. Schmidt System.—Neither an ellipsoidal nor a paraboloidal mirror is truly aplanatic. A parabolic mirror therefore can be used with only a very restricted field for a given aperture, and vice versa, if serious marring of the image is to be avoided. It is in this respect that a Schmidt system is greatly superior to the parabolic reflector. Because of its considerably greater useful field with a large light-gathering power, many astronomers consider the big Schmidt telescope at Palomar observatory, for example, to be superior to the 200-in. reflector, particularly for mapping the skies and determining the location and distribution of distant galaxies. This 48-in. Schmidt telescope has a relative aperture of $f/2.5$ and covers a field of 44 square degrees while the 200-in. paraboloid covers only $\frac{1}{20}$ of a square degree with a considerably smaller relative aperture.

The Schmidt system employs a concave spherical mirror with a transparent corrector plate designed to correct for spherical aberration and coma. This plate is a disk of glass or plastic of variable thickness and is located at the centre of curvature of the spherical mirror. The aspherical curves on the plate need not be very steep to correct for spherical aberration. The location of the plate at the centre of curvature is essential for the correction of coma. Chromatic aberration is negligible because of the shallow curves on the corrector plate and the fact that the spherical mirror is, of course, achromatic.

To gain an elementary understanding of the Schmidt system, first consider the spherical aberration of a spherical mirror. It is expedient to do this by computing the optical path for a ray entering parallel to a line or axis through the centre of curvature, the ray being at a distance h from that axis. The ray path is computed from a starting point on a reference plane that is normal to the axis and proceeds along the ray to the mirror and back to the focal point on the axis. It is known that all such paths are equal for rays reflected from a paraboloid that has the same vertex as the sphere. Hence twice the distance between the sphere and paraboloid at the height h gives the amount of spherical aberration expressed as an error in optical path. For a sphere of radius R, the distance from a plane that is tangent to the sphere and paraboloid at their common vertex is

$$x = R - R\left(1 - \frac{h^2}{R^2}\right)^{\frac{1}{2}}$$

which may be expanded into a power series in terms of h/R giving

$$x = \frac{h^2}{2R} + \frac{h^4}{8R^3} + \cdots$$

For the paraboloid the value of x is just the first term in this expansion. Hence the sphere reflects the ray too soon by the amount $h^4/8R^3 \cdots$ and the error in optical path that causes the spherical aberration of the spherical reflector is just twice this amount.

First Schmidt System.—In a Schmidt system of the simpler "first" type the advance in path at the mirror is compensated by a retardation of the same amount in the corrector plate. If t represents the thickness of the corrector plate and μ its refractive index, the necessary correction is obtained when

$$(\mu - 1)t = \frac{h^4}{4R^3}$$

This shows how the thickness of the plate must depend on the distance h from the axis. The thickness of the plate may be increased by any constant amount so long as the variations in thickness are such as to equalize the optical paths.

Correction for spherical aberration does not fix the location of the plate and indeed suggests that it should be close to the mirror because of the divergence of the rays resulting from refraction in the plate. As stated before, correction for coma requires that the plate be located at the centre of curvature of the spherical mirror, for only then is the sine condition satisfied. Using F_0 to represent the distance of the focus of paraxial rays from the mirror vertex, the sine condition is

$$\frac{h}{\sin\alpha} = F_0$$

Now, in general, the location of the second unit surface of any optical system is the locus of points at which the projection of entering rays intersects the projection of the conjugate emerging rays. Thus the sine condition is seen to require that this locus be a spherical surface of radius F_0 which is half the radius of curvature in the case of a spherical mirror. This surface is indicated in fig. 8 by the dotted circle. Let the corrector plate be located at some distance S from the vertex of the mirror. We need to show that S must equal R in order that the projected entering ray intersects the reflected ray at some point U on the unit circle of radius $R/2$. To show this, one first notes that the entering ray is deviated outward through the angle

$$\delta = (\mu - 1)\frac{dt}{dh} = \frac{d}{dh}\left(\frac{h^4}{4R^3}\right) = \frac{h^3}{R^3}$$

at the corrector plate. The resulting linear deviation at the mirror is

$$\Delta y = \frac{h^3 S}{R^3}$$

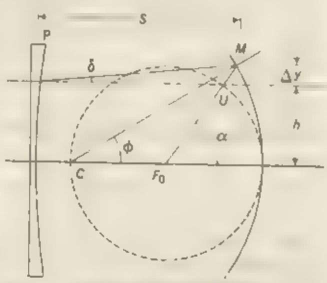

FIG. 8.—THE FIRST SCHMIDT SYSTEM. THE ASPHERICAL SURFACE ON PLATE P CORRECTS THE SPHERICAL ABERRATION AND COMA OF THE MIRROR *M*

This must equal the y component of the distance between the points U and M at which the reflected ray, whose slope angle is α, intersects the unit sphere and the mirror, respectively. Referring to the figure, we must equate $UM \sin\alpha$ to h^3S/R^3 and find the value of S for which this equality holds. It is not very difficult to show that the required value of S is the radius of curvature R of the spherical mirror.

Second Schmidt System.—The second Schmidt system is an improvement over that described above, since it requires less steep curves on the corrector plate and the small residual chromatic aberration introduced by the plate is still smaller than that of the first Schmidt system. The corrector plate in the second system not only compensates for spherical aberration and coma, as explained above, but also shifts the focus from the paraxial ray location to the point at which the width of the reflected beam from the spherical mirror is smallest. At this point the radius of the beam is one-fourth the radius of the aberration circle at the paraxial focus. The smaller correction required for spherical aberration, particularly for ray s at large distance from the centre line, requires less steep curves on the plate. The plate in this case is not uniformly concave, as in the first system, but has a weak convex central portion which displaces the paraxial focus to the desired point. The required thickness t is given by the equation

$$(\mu - 1)t = -\frac{3}{8}\frac{H^2 h^2}{R^3} + \frac{h^4}{4R^3}$$

in which H is the maximum height of the ray that strikes the mirror. The height h_0 of the ray that is undeviated at the corrector plate is obtained by setting $dt/dh = 0$ from which one finds that $h_0 = 0.866\,H$.

The image formed by a Schmidt system is not flat but has a concave curvature toward the entering light, or convex toward the mirror. The image must accordingly be projected on a curved surface, for example, the film must be curved in photographing with a Schmidt camera. Since, however, lens systems characteristically tend to produce the opposite sense of curvature, one can compensate for the curvature of the Schmidt image when necessary.

3. Aplanatic Points of a Sphere.—It can be shown that a spherical refracting surface is aplanatic for conjugate points at distances μR and R/μ from its centre where μ is the relative refractive index of the sphere. In fig. 9, P and P' are two such points with $PC = \mu AC$ and $P'C = AC/\mu$. Consider any point S on the forward side of the sphere and construct the rays PS and $P'S$. The triangles PCS and $P'CS$ are similar because they have one angle, at C, in common and the sides adjacent to this angle are in the same ratio, μ, by construction. Hence the corresponding angles are equal and one may apply the sine law of trigonometry $\sin PSC : \sin CPS = \mu : 1$ to show that $\sin PSC/\sin P'SC = \mu$, proving that the rays PS and $P'S$ satisfy the law of refraction. Hence any ray from a source P' inside a sphere of radius R at a distance R/μ from its centre will emerge in a line that passes through a fixed conjugate point P regardless of the point S at which refraction occurs on the sphere. There is consequently no spherical aberration. To show that Abbe's sine law is also satisfied one compares the sines of the slope angles $CP'S \equiv \alpha'$ and $CPS \equiv \alpha$ and finds that $\sin\alpha' = \mu \sin\alpha$ which is the sine condition for absence of coma.

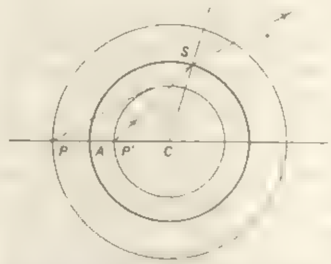

FIG. 9.—LOCATION OF APLANATIC POINTS P' AND P OF A SPHERICAL REFRACTING SURFACE

The first lens of an immersion type of microscope objective utilizes these aplanatic points in the first stage of magnification. A second pair of aplanatic points coincide at the centre of any sphere, but for these there is no magnification. This seemingly trivial situation may, however, be applied at one surface of an aplanatic lens with the second surface satisfying the principle previously discussed. Such a lens is often used as the second element in a compound microscope objective. This construction is generally not applied more than twice because of the necessity of correcting for other aberrations than spherical aberration and coma.

4. Herschel Condition.—It has been seen that the condition for accurate focusing of rays that are laterally displaced from an axial point at which there is no spherical aberration is Abbe's sine condition. The analogous condition for points that are displaced longitudinally along the axis is

$$\mu \sin^2\frac{\alpha}{2} = \mu \sin^2\frac{\alpha'}{2}$$

which is known as the Herschel condition. Comparison of the two equations shows that they are in general incompatible except for rather special cases such as $\alpha = \alpha'$. Hence, a lens system can be corrected for spherical aberration and coma only for a definite location of the object. This implies that a lens designed for creating high-quality images of distant objects, for example, a telescope objective or a conventional camera lens, cannot give equally good images of objects that are close to the lens. Conversely, the best lenses for copying or enlarging, for example, must be designed for this specific purpose and cannot be as satisfactory in photographing distant objects as a lens designed for that purpose. There is no such thing as a universal-purpose lens if one requires the best possible results.

5. Astigmatism.—When the field of an optical system is extended laterally in such a way that coma is eliminated, one observes that in general, object points off the axis are imaged as two sharp lines at right angles to each other and at different locations. This defect, called astigmatism, is illustrated in fig. 10. One may account for this defect as due to the conversion of a spherical wave front from an object point into a toroidal wave front with two principal curvatures similar to those of a portion of the surface of a doughnut or tire. Light rays associated with

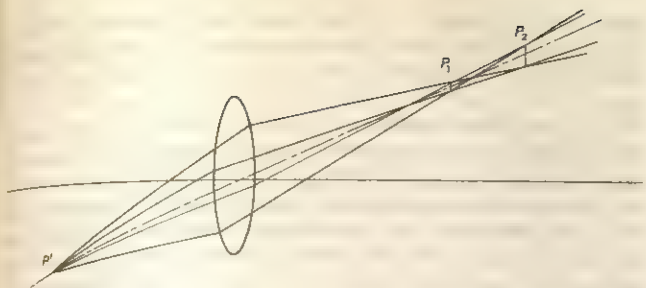

FIG. 10.—ASTIGMATIC FOCUSING. RAYS FROM AN OBJECT POINT P' FOCUS ALONG TWO MUTUALLY PERPENDICULAR LINES AT P_1 AND P_2

such waves focus on two lines passing through the two mutually perpendicular loci of the centres of principal curvature.

The line foci corresponding to object points distributed in a plane normal to the axis of symmetry are located on two curved surfaces. The so-called primary or tangential focal surface is the surface on which concentric circles of object points are sharply focused since the short line focus conjugate to each object point on the circle is directed along the circumference of a circle in image space. The secondary or sagittal focal surface, on the other hand, is a surface on which object points that lie on radial lines in object space are sharply focused as radial lines in image space. Astigmatism is particularly serious in photographic objectives since these are normally required to give point images of object points that are located in a field extending 25° or more from the axis of the lens.

The many designs of excellent objectives (*see* PHOTOGRAPHY) show the nature of the lens combinations that are required to overcome astigmatism, coma and spherical aberration as well as several other aberrations to be discussed.

6. **Curvature of Image and Distortion.**—One may eliminate astigmatism by "bending" the elements of a lens system and by changing the location of the aperture stop. This alters the shape of the two astigmatic surfaces and brings them into coincidence on a common surface called the Petzval surface. This surface, which is conjugate to a plane in object space, is in general a curved surface. If the image is to be projected on a plane (*e.g.*, a photographic plate, film or paper) it will be impossible to simultaneously obtain a sharp image of the entire object plane. Hence, for these and many other applications, such a curvature of the image must be considered as another aberration that must be corrected by making the Petzval surface approximate a plane within the useful field of the optical system. For a simple system of two thin lenses whose focal lengths are f_1 and f_2 with refractive indices μ_1 and μ_2 respectively, J. Petzval has shown that a flat field requires that

$$\frac{1}{f_1\mu_1} + \frac{1}{f_2\mu_2} = 0$$

This equation is known as the Petzval condition.

Another defect of particular importance in producing images that are to be measured accurately is distortion. This aberration consists of a variation in magnification radially outward from the central point in the image. If the magnification increases outward from the centre, a square object is imaged in the shape of a pincushion, hence the name "pincushion distortion." If the magnification decreases radially outward, the image of a square has laterally bulging sides and the distortion is said to be "barrel-shaped." Distortion is greatly influenced by the location of the aperture stop. The lens elements must be corrected for spherical aberration for rays passing through the centre of the aperture stop at various slope angles and the ratio of the tangents of conjugate slope angles must be constant.

7. **Chromatic Aberrations.**—Since the refractive index of any medium depends on the wavelength or colour of the light, all of the properties of a refracting optical system will vary with wavelength. The chromatic variations in the aberrations discussed above are of a second order of smallness and are therefore usually negligible. The change in focal length of the lens system and the location of its unit planes, however, leads to important defects called chromatic aberrations. Of these there are two principal forms. The first, longitudinal chromatism, is a variation in location of the image with change in wavelength. The second, lateral chromatism, is a variation in image size or magnification with wavelength. In thin lenses the absence of one is accompanied by the absence of the other, but in general they are two independent chromatic defects.

Consider, for example, the image of a distant object formed by an anastigmatic camera lens. This necessarily must be a lens of several elements, a thick lens. The locations of the unit planes and the focal planes will depend on the colour of the light. Absence of longitudinal chromatism requires, for a distant object, that the location of the second focal plane be independent of the wavelength of the light. Actually this correction can be accomplished accurately for only two or three specific wavelengths, and this usually proves sufficient. Since in a thick lens the locations of the principal planes are also dependent on wavelength and are determined by entirely independent equations, the coincidence of the focal planes does not necessarily imply that the unit planes are also coincident for different wavelengths. Thus the focal length of the lens, and therefore the magnification of the image, in general varies with colour even when the image location does not. The lens in our example is said to be corrected for longitudinal chromatic aberration but not necessarily for lateral chromatism. The converse may also be true. In fact, oculars of telescopes and microscopes are often primarily corrected for lateral chromatism, which is the more serious defect in this case, and they often possess large amounts of longitudinal chromatism. Such lenses are said to be partially corrected for chromatic aberration.

To gain some insight into the method of correcting for chromatism, consider two thin lenses whose focal lengths are f_1 and f_2 made of glass whose refractive indices are μ_1 and μ_2, respectively, for some particular wavelength. Let d represent the axial separation of the lenses. The power $1/f$ of the combination is given by the equation

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1f_2}$$

The power of each individual lens $1/f_1$, or $1/f_2$, may be written in the form

$$\frac{1}{f_1} = (\mu - 1)K_1$$

where K_1 represents a geometrical factor that depends on the shape of the lens and is therefore independent of colour. The change in power of the first thin lens due to a change in wavelength is related to the change in refractive index $\Delta\mu_1$ by the equation

$$\Delta\left(\frac{1}{f_1}\right) = \Delta\mu_1K_1 = \left(\frac{\Delta\mu_1}{\mu_1 - 1}\right)\frac{1}{f_1} = \frac{\omega_1}{f_1}$$

where ω_1 is called the dispersive power of the glass of which the lens is made. A similar equation holds for the second lens.

The change in power of the lens combination is then

$$\Delta\left(\frac{1}{f}\right) = \frac{\omega_1}{f_1} + \frac{\omega_2}{f_2} - \frac{d(\omega_1 + \omega_2)}{f_1f_2}$$

If this quantity is zero, the combination has the same power or focal length for the two wavelengths used in determining ω. The combination is then partially achromatized. Two special cases are of particular importance. If the two lenses are made of the same kind of glass $\omega_1 = \omega_2 = \omega$, partial achromatization is realized when $d = \frac{1}{2}(f_1 + f_2)$. This principle is used in the construction of the simpler forms of eyepieces for telescopes and microscopes where lateral chromatism is the principal defect that must be corrected. Since, however, longitudinal chromatism is quite large in such a two-lens combination, this construction cannot be used in a lens intended for a telescope or camera objective, where both varieties of chromatism are serious faults.

The simplest suitable achromat for the latter purposes consists of a cemented doublet of thin lenses for which one may assume that

d is approximately zero. Consequently the above equation for zero change with colour of the power of the combination becomes simply

$$\frac{\omega_1}{f_1}+\frac{\omega_2}{f_2}=0$$

Since the dispersive powers ω_1 and ω_2 are always positive, it is evident that one of the lenses must be of negative focal length and the other positive. Moreover

$$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}$$

gives the desired power of the combination and must be considered simultaneously with the other equation. Since the desired power is some value other than zero, it follows that ω_1 must not be equal to ω_2. In other words, the two components of the doublet must be made of different kinds of glass, usually some variety of crown glass for one and a flint glass for the other. Flint glass is one that contains lead oxide and is characterized by a relatively high dispersive power, sometimes as high as twice that of crown glass. In a converging achromatic doublet the converging component is made of crown glass, and the weaker diverging component is made of flint glass. As before, the conditional equation for correction of chromatic aberration really applies directly to the correction of only lateral chromatism, but if the two lenses of the doublet are thin, the combination of the two in contact will also be a thin lens, and the locations of the unit planes of a thin lens are only negligibly affected by colour. Hence, longitudinal as well as lateral chromatism are corrected in such a combination. For a combination of two or more thick lenses, however, the conditions for achromatism cannot be stated so simply for one must consider the variation in location with colour of the unit planes as well as the focal planes. The analysis becomes quite complicated and may be found in the technical literature on lens design.

C. Theory of Stops

Diaphragms or stops in optical systems serve (1) to restrict the field of view to that portion that is imaged acceptably well; (2) to control the light flux per unit area of the image; (3) to control the depth of focus and depth of field; (4) to reduce some of the residual aberrations and obtain a sharper image; and (5) to serve as light baffles to eliminate disturbing internal reflections from the walls of the optical system.

1. Aperture Stops.—Of prime importance is the aperture stop, which is that lens rim or diaphragm that determines the size of the cone of rays that enters and leaves the system. The plane angle between diametrically opposite entering rays from a given object point is the angular aperture. The corresponding angle between conjugate rays through the image point is called the angle of projection. In a complicated lens system it is often difficult to see immediately which lens rim or diaphragm determines these angles. The standard procedure for solving this problem is to first translate, by the use of the equations for locating conjugate points and determining the associated magnification, every lens rim and diaphragm rim into object space. In this space rays may be drawn as straight unbroken lines from any given object point to any other point in the same space, for example, to any translated lens rim or diaphragm. That translated rim of lens or diaphragm that subtends the smallest angle at the object is called the entrance pupil and the angle subtended by diametrically opposite points is the angular aperture. The f-number rating of the optical system is the ratio of the focal length of the system to the diameter of the entrance pupil. Every camera user has a practical acquaintance with this f-number rating of lenses and stops. The illuminance of the image, light flux per unit area, is inversely proportional to the square of the f-number. The smallest resolvable angular separation of two distant points is inversely proportional to the first power of the f-number if the lens is perfect.

The aperture stop is that actual physical lens rim or diaphragm that corresponds to the entrance pupil. The conjugate of the entrance pupil with respect to the entire optical system is the exit pupil. It is also conjugate to the aperture stop with respect to the optical components that follow it in the optical system. The angle subtended by the exit pupil from the location of the image is the angle of projection. The illuminance of the image is directly proportional to the square of the sine of half the angle of projection.

Rays that pass through the centres of the entrance pupil, aperture stop and exit pupil are called chief rays. They define the axes of the entering and emerging cones of rays. Their maximum angular separation determines the field of view. To determine this angle, consider again the object space translation of lens rims and diaphragms. That translated rim that subtends the smallest angle from a point at the centre of the entrance pupil is called the entrance port or entrance window. That actual lens rim or diaphragm to which the entrance window corresponds is the field stop. The angle subtended by diametrically opposite points on the entrance window from the centre of the entrance pupil is the angular field of view in object space. The conjugate of the entrance window with respect to the entire system is the exit window. This is also the conjugate of the field stop with respect to the optical elements that follow it in the system. The field of view in image space is the angle subtended by the exit window from the centre of the exit pupil. Unless the exit window coincides with the image, the boundaries of the image are not sharp. This effect is called vignetting.

2. Functions of Aperture Stops.—As an example of stops and their functions, consider a telescope or prism binocular. The aperture stop is usually found to be the rim of the objective unless the image of some internal light baffle is smaller. Since the objective is in object space, its diameter is generally the diameter of the entrance pupil. The exit pupil is the image of the entrance pupil created by the entire system and may be seen as a bright circle just beyond the eyepiece when the telescope is pointed toward the sky or some other bright area. The magnification of a telescope may be conveniently determined as the ratio of the diameters of the entrance and exit pupils. When a binocular is designated as 7×50, for example, the first number is the magnification, and the second is the diameter of the entrance pupil in millimetres. Hence the diameter of the exit pupil is $50/7 = 7+$ mm. If the diameter of the pupil of the observer's eye is less than or equal to the diameter of the exit pupil there is no reduction in visual brightness of the object areas seen through the instrument. For purpose of calculation, visual brightness is defined as the light flux per unit area of the retina. For an eye pupil diameter e that is larger than the exit pupil diameter p, there is a reduction in visual brightness in the ratio of the square of p to the square of e. Hence it is desirable to have the exit pupil larger than the eye pupil or of equal size at least. Since the diameter of the eye pupil varies with illuminance from about 2 mm. in very bright light to about 7 mm. at night, a telescope should have an exit pupil of at least 2 mm. diameter for use in the daytime and at least 7 mm. for use at night. The latter type of telescope is frequently called a night glass.

Astronomical telescopes often have such a high magnification that, in spite of their large objective, the exit pupil is much smaller than the pupil of the observer's eye. Hence visual brightness of areas, such as the sky background, is greatly below their brightness with the unaided eye. On the other hand, the stars are effectively point objects, their image size being determined by diffraction rather than magnification. Consequently their images appear brighter than with the unaided eye in about the ratio of the area of the objective to the area of the pupil of the observer's eye. This large increase in brightness of star images combined with the reduction in brightness of the background makes it possible to see at least the brighter stars in full daylight through a large astronomical telescope.

3. Field Stops.—The field stop in a telescope is usually the boundary of the reticle on which the eyepiece is focused. In telescopes intended for angular measurements, the reticle carries cross hairs or some kind of scale etched on glass. The image of the boundary of the reticle created by the eyepiece is the exit window, and the image of the reticle created by the objective is the entrance window. Since these respectively coincide with the image and object in a properly focused telescope, the field is sharply

bounded. If there is no reticle, the field is generally determined by the first lens in the eyepiece, which is then the field stop. In such a case the boundary of the field is not sharp.

In a Galilean type of telescope or opera glass, which has a diverging lens as its eyepiece, the identity of the field stop and of the aperture stop depends on the magnification. At high powers the field is limited by the pupil of the observer's eye, while at low powers it is limited by the diameter of the objective. The switch from the latter to the former situation occurs when the exit pupil of the telescope considered by itself becomes smaller than the pupil of the observer's eye. In either case the boundary of the field is not sharp.

In a camera, the iris diaphragm, which is generally between the elements of the objective, is the aperture stop. Its image created by the front element is the entrance pupil and the diameter of this image divided into the focal length of the objective is the f-number designation of the stop. The exit window is the frame which limits the exposed area of the film. Being at the location of the image, the field is sharply bounded.

4. Line Images.—An optical system may not produce a single point image for a given point object. This is true, for example, of an axially symmetrical system for points off the axis when the system is astigmatic. It has been shown that there are then two line images at right angles to each other for each object point.

A mirror or lens with cylindrical or toroidal surfaces will produce two astigmatic line images for any location of the object point. One or both of these line images may be virtual depending on the location of the object point which itself may be real or virtual. The locations of these images may be found by considering two plane sections in which the aspherical surface has its maximum and minimum curvature. The length of each line image is proportional to the aperture of the system and may be determined by geometrical considerations.

Another example of a line image is provided by the axicon. This name has been applied by J. H. McLeod to any optical system whose surfaces are figures of revolution and that creates a line image along its axis for a point source on its axis. The simplest example of an axicon is a reflecting or refracting conical surface. Such a system may be said to possess a universal focus. It may be used as an objective in a telescope that enables one to see two or more axial point sources in equally good focus even though the sources are at different distances. The axial line image of the axicon is finding application in the accurate alignment of the parts of an optical or mechanical system.

D. The Eikonal

Strictly speaking there is no such thing as a geometrically exact point image nor a line image, but rather a distribution of intensity in space which ideally approximates a point or a line. The exact distribution of intensity in the image can only be computed exactly by the methods of physical optics in which one considers the superposition of an infinite number of infinitesimal wavelets arriving at any selected point in image space by all routes through the optical system. The relative phases of the wavelets are determined by the optical paths from a given object point to the selected image point via the various elements of area in the exit or in the entrance pupil. It will be recalled that optical paths are the sums or line integrals along the chosen paths of the product of each increment in path distance multiplied by the refractive index of the medium in which the increment is located. Since refractive index is the speed of light in free space divided by the speed in the medium, optical path is equal to the time taken for light to travel the selected path multiplied by a constant c, the speed of light in free space.

1. Optical Path Functions.—To define the frequently used terms, stationary path and nonstationary path, consider an infinitesimal change in any one of the co-ordinates that define an arbitrarily chosen path of light. If the resulting change in the optical path changes by an amount that depends on the first order, or power, of the infinitesimal, the path is said to be nonstationary. If, however, the resulting change in optical path depends only on second or higher powers of infinitesimal changes in all co-ordinates that define the path, the path is said to be stationary. A principle due to Pierre de Fermat states that actual ray paths are always stationary paths. One may derive the laws of rectilinear propagation, reflection and refraction by the use of Fermat's principle. Conversely, the introduction of the laws of reflection and refraction into optical path equations, for the purpose of simplification by reduction of the number of variables, restricts these equations to stationary paths or actual rays of light.

If the optical paths along different routes through an optical system are nearly the same, the wavelets arrive in nearly the same phase and there is a high intensity at the point of arrival. The maximum intensity is found at that point in image space to which there is the least variation in optical path from the object point. This is the location of the optical image point in the sense of physical optics. The sharpness or quality of the image depends on how rapidly the variation in optical path increases with displacement from the image point at which there is the least variation. It is evident that one must work with optical path functions to obtain exact information on image quality and the consequent resolving power. Further applications, leading to actual intensity distributions in image space, require complicated integrations and will not be considered here.

Optical path functions may also be used to determine the location, magnification and the aberrations of images without calculating actual intensity distributions. Such functions were first applied to these problems by W. R. Hamilton. His work was ignored for 60 years until redeveloped independently by H. Bruns in 1895. Hamilton defined four optical path functions expressed in terms of four different sets of variables. The best known of Hamilton's functions, called the eikonal by Bruns, is applied in the following paragraphs to the development of a mathematical theory of optical systems. This theory not only provides a mathematically elegant and powerful means of solving many optical problems but is considered to be more adaptable to modern machine computation than the older trigonometric ray-tracing methods. All calculations will therefore be related to geometrical paths, but variation in the lengths of these paths, rather than their distances from a mean point in the neighbourhood of an image, is to be regarded as the significant factor on which the quality of the image depends. The two sets of magnitudes are not independent, and we proceed to find the connection between them.

2. Application of the Eikonal.—Take origins of rectangular co-ordinates in both object and image spaces. Suppose in the first space that a point source of light is situated at (x, y, z) in the object space. Light is radiated from this point in all directions, and some traverses the optical system and finds its way into the image space. Generally the wave front in the image space will be a curved surface, and the normals or rays at different points of this surface differ in direction. A particular emergent ray may therefore be specified by its direction cosines. Let these be (L', M', N'), and suppose also that (ξ', η', ζ') is a point on this ray. The disturbance has taken a definite time to reach (ξ', η', ζ') from (x, y, z): let the corresponding optical path length, that is, the distance light travels in a standard medium in this time, be denoted by $\mathcal{V}$. Let $\mathcal{V} + \delta\mathcal{V}$ be the path length for a neighbouring ray starting from (x, y, z) and finishing at $(\xi' + \delta\xi', \eta' + \delta\eta', \zeta' + \delta\zeta')$, the final direction being $(L' + \delta L', M' + \delta M', N' + \delta N')$. If μ' is the refractive index of the final medium, the second path exceeds the first by

$$\mu'\{(L' + \delta L')\delta\xi' + (M' + \delta M')\delta\eta' + (N' + \delta N')\delta\zeta'\}$$

since the wave front, which marks the locus of points optically equidistant from (x, y, z), is normal to the ray. Now suppose that the tangent planes to the wave fronts at (ξ', η', ζ') and $(\xi' + \delta\xi', \eta' + \delta\eta', \zeta' + \delta\zeta')$ pass through the image space origin. Then

$$L'\xi' + M'\eta' + N'\zeta' = 0$$
$$(L' + \delta L')(\xi' + \delta\xi') + (M' + \delta M')(\eta' + \delta\eta') + (N' + \delta N')(\zeta' + \delta\zeta') = 0$$

and these conditions enable the expression we have found for the path difference to be written

$$-\mu'\{\xi'\delta L' + \eta'\delta M' + \zeta'\delta N'\} = \delta\mathcal{V} \quad (1)$$

Now L', M', N' are connected by the relation

$$L'^2 + M'^2 + N'^2 = 1$$

and therefore only two of them, say M' and N', may be regarded as independent variables. On eliminating L' (1) becomes

$$-\mu'\left(\eta' - \frac{M'}{L'}\xi'\right)\delta M' - \mu'\left(\zeta' - \frac{N'}{L'}\xi'\right)\delta N' = \delta\mathcal{V}$$

Since $\mathcal{V}$ is now regarded as a function of M' and N', for any small variations of M' and N' we shall have

$$\delta\mathcal{V} = \frac{\partial\mathcal{V}}{\partial M'}\delta M' + \frac{\partial\mathcal{V}}{\partial N'}\delta N'$$

and, since M' and N' may be varied independently, we find, by comparing these equations,

$$\mu'\left(\eta' - \frac{M'}{L'}\xi'\right) = -\frac{\partial\mathcal{V}}{\partial M'} \qquad \mu'\left(\zeta' - \frac{N'}{L'}\xi'\right) = -\frac{\partial\mathcal{V}}{\partial N'}$$

Now $\eta' - \frac{M'}{L'}\xi'$ and $\zeta' - \frac{N'}{L'}\xi'$

are invariants for any given ray, and represent the y' and z' co-ordinates of the intersection of the ray with the plane $x' = 0$. If we understand that y' and z' are the co-ordinates of a point in this plane we may write these equations

$$\mu'y' = -\frac{\partial\mathcal{V}}{\partial M'} \qquad \mu'z' = -\frac{\partial\mathcal{V}}{\partial N'} \quad (2)$$

If then we know $\mathcal{V}$ as a function of M' and N', that is to say if we know how the length of the optical path from the source to a plane through the image space origin varies as the direction of this plane alters, we can find where the common normal to this plane and the wave meets an arbitrary fixed plane through the origin.

If, instead of starting with a source of light at a known point of the object space, we had assumed it to be situated in the image space, some of the light diverging from this point would reach the lens and after refraction would emerge into the object space. We could take $\mathcal{V}'$ as a measure of the time taken by the light to reach a plane in the direction (L, M, N) passing through the object space origin, and obtain the equations

$$\mu y = \frac{\partial\mathcal{V}'}{\partial M} \qquad \mu z = \frac{\partial\mathcal{V}'}{\partial N} \quad (3)$$

for the point (y, z) in which the common normal to the wave front and the plane $L\xi + M\eta + N\zeta = 0$ meets the plane $x = 0$. The change of sign that will be observed on comparing equations (2) and (3) is due to the assumption that the positive directions of the axes are unaltered, so that a positive displacement of (ξ, η, ζ) corresponds to a decrease in the time $\mathcal{V}'$.

The function $\mathcal{V}$ suffers from the grave disadvantage that it is unsymmetrical, the variables in the object space being point co-ordinates, and in the image space direction cosines. A function that is symmetrical is at once obtained by considering the particular case in which the source of light is at infinity. It is inconvenient to include in the function the infinite term representing the length of the path between the source and a reference position near the lens, so the path is measured from the wave front which passes through the object space origin. Since all points on the same wave front are at the same optical distance from the source, $\mathcal{E}$, the new finite path length, which is a function of (M, N, M', N'), differs from $\mathcal{V}$ only by a constant, and, as in the case of $\mathcal{V}$, the equations

$$\mu'y' = -\frac{\partial\mathcal{E}}{\partial M'} \qquad \mu'z' = -\frac{\partial\mathcal{E}}{\partial N'} \quad (4)$$

are satisfied. In a similar way from $\mathcal{V}'$, by placing the source at infinity in the image space in the direction L', M', N', and rejecting the constant infinite part of the path, we obtain a finite function $\mathcal{E}'$ having (M, N, M', N') as its variables and satisfying the equations

$$\mu y = \frac{\partial\mathcal{E}'}{\partial M} \qquad \mu z = \frac{\partial\mathcal{E}'}{\partial N} \quad (5)$$

Now $\mathcal{E}$ and $\mathcal{E}'$ measure the time taken by the light to travel between the same two planes in opposite directions along the stationary path. This stationary path between two planes is unique and independent of the curvature of the wave front at either plane. Moreover the speed of light is independent of direction. It follows that $\mathcal{E}$ and $\mathcal{E}'$ are equal; and, since they are expressed in terms of the same variables, they must be identical.

In the application of this function the planes $x = 0$ and $x' = 0$ will be chosen to coincide with the object and image planes, or at least to be parallel to them. Equations (4) and (5) then show how this function, which itself expresses the length of a path carried through the refracting surfaces, and is thus particularly suitable for investigations according to the wave theory, enables the points in which rays traveling in specified directions meet the object and image surfaces to be found.

Focal Lengths and Principal Foci.—The rays, being the normals to the wave front, are the loci of points for which the path is stationary for slightly displaced routes, and conjugate foci are points of a particular path between which the path length is stationary for larger deviations. In an axially symmetrical system we can see immediately that a pair of such points for a skew ray (that is to say, a ray which does not lie entirely in an axial plane) are the intersections of any axial plane with the incident and emergent rays. By considering a ray in an axial plane as the limiting position of a skew ray, we can extend the definition to all rays. We shall call such conjugate points secondary foci. We proceed to find the positions of the principal secondary foci and the magnitudes of the corresponding focal lengths.

Take the axes of x and x' in coincidence with the axis of symmetry, so that $\mathcal{E}$ may be regarded as a function of three variables only, viz., $\frac{1}{2}\mu^2(M^2 + N^2)$, $\mu\mu'(MM' + NN')$ and $\frac{1}{2}\mu'^2(M'^2 + N'^2)$. Denoting these by the subscripts a, b, c respectively, and differentiation by the addition of a suffix, equations (4) give

$$y' + \mu M\mathcal{E}_b + \mu'M'\mathcal{E}_c = z' + \mu N\mathcal{E}_b + \mu'N'\mathcal{E}_c = 0 \quad (5a)$$

that is to say, the ray goes through the point $(\rho'L', Y', Z')$ distant ρ' along the ray from the reference plane $x' = 0$, where $\rho' = \mu'\mathcal{E}_c$ provided

$$Y' = -\mu M\mathcal{E}_b \qquad Z' = -\mu N\mathcal{E}_b \quad (6)$$

These equations show that at this point the ray goes through a point in the axial plane containing the infinitely distant origin of light (L, M, N). In other words the secondary principal focus lies on the ray at the distance $\mu'\mathcal{E}_c$ beyond its intersection with the reference plane $x' = 0$. Similarly the secondary principal focus in the object space lies on the ray at a distance $-\mu\mathcal{E}_a$ from its intersection with the reference plane $x = 0$, the measurement being made in the positive direction. By partial analogy with the properties associated with the nodal points of collinear imagery, if f is the object space secondary focal length, the y' and z' co-ordinates of the secondary image of the infinitely distant object (L, M, N) are Mf and Nf respectively. Equations (6) thus give $f = -\mu\mathcal{E}_b$, and similarly the image space secondary focal length is given by $f' = -\mu'\mathcal{E}_b$.

The secondary conjugate points corresponding to the magnification S must satisfy

$$\frac{Y'}{Y} = \frac{Z'}{Z} = s$$

and if these points are distant ρ' and ρ from the corresponding principal foci, by equations (5) we have

$$\frac{\rho'M' - \mu M\mathcal{E}_b}{\rho M + \mu'M'\mathcal{E}_b} = \frac{\rho'N' - \mu N\mathcal{E}_b}{\rho N + \mu'N'\mathcal{E}_b} = s, \text{ or}$$

$$\rho = -\frac{\mu\mathcal{E}_b}{s} \qquad \rho' = \mu'\mathcal{E}_b \cdot s$$

since for a skew ray M/M' and N/N' are not equal. The connection between the principal foci, the focal lengths, a pair of conjugate foci and the magnification for any ray thus correspond exactly to those found for the instrument as a whole in collinear imagery. The fact that this law is followed for lengths measured

along the ray itself, and not their projections on the axis, clearly involves the failure of collinear imagery. The constant magnification surfaces in fact tend to be spherical rather than plane.

We will next determine the primary principal foci, which are the points of intersection of successive parallel incident rays lying in the same plane through the axis of the system. Without loss of generality we may suppose $z = z' = N = N' = 0$, and the y' co-ordinate of the point in which the ray meets the plane $x' = X'$ is

$$\frac{M'}{L'}X' - \mu' M' \mathcal{E}_c - \mu M \mathcal{E}_b$$

If this point is conjugate to the infinitely distant point (L, M), this value of y' will be unaltered by substituting

$$\left(L' - \frac{M'}{L'}\delta M', M' + \delta M'\right)$$

for (L', M'). Since $\delta M'$ is finite, we see that we must travel along the ray from its intersection with the reference plane the distance

$$\frac{X'}{L'} = \mu' L'^3\{\mathcal{E}_c + 2a\mathcal{E}_{bb} + 2b\mathcal{E}_{bc} + 2c\mathcal{E}_{cc}\}$$

to reach the primary principal focus. The corresponding distance for the object space is

$$-\mu L^3\{\mathcal{E}_a + 2a\mathcal{E}_{aa} + 2b\mathcal{E}_{ab} + 2c\mathcal{E}_{bb}\}$$

To determine the focal lengths we note from (5a) that the ray $(M + \delta M, M')$ meets the reference plane in the point $y' + \delta y'$ where

$$\delta y' = -\mu\delta M\{\mathcal{E}_b + 2a\mathcal{E}_{ab} + b(\mathcal{E}_{bb} + \mathcal{E}_{ac}) + 2c\mathcal{E}_{bc}\}$$

Now the separation between these parallel emergent rays is $L'\delta y'$, and the angle between the two incident rays is $\delta M/L$. We define the focal length as the distance at which this separation is subtended by this angle, or

$$F = -\mu L L'\{\mathcal{E}_b + 2a\mathcal{E}_{ab} + b(\mathcal{E}_{bb} + \mathcal{E}_{ac}) + 2c\mathcal{E}_{bc}\}$$

and similarly

$$F' = -\mu' L L'\{\mathcal{E}_b + 2a\mathcal{E}_{ab} + b(\mathcal{E}_{bb} + \mathcal{E}_{ac}) + 2c\mathcal{E}_{bc}\}$$

where F and F' are the first and second primary focal lengths respectively. Substituting these values in generalized variations of (5) we find for points distant ρ and ρ' from the principal primary foci

$$L\delta Y - M\delta X = \rho\frac{\delta M}{L} - F'\frac{\delta M'}{L'}$$

$$L'\delta Y' - M'\delta X' = \rho'\frac{\delta M'}{L'} + F\frac{\delta M}{L}$$

showing that conjugate points for the transverse magnification p are given by $\rho = F/p$, $\rho' = -F'p$, in harmony with the laws found in other cases. Just as we extended the conception of secondary foci from skew rays to rays in an axial plane, we may extend the primary concept to rays in general by basing generalized definitions upon the expressions we have derived.

Construction of the Eikonal.—Before the expressions which have been derived can be applied the eikonal must be constructed. We proceed to show how this may be done.

Suppose that the surface whose homogeneous equation is $f(a, x, y, z) = 0$ separates media whose refractive indices are μ and μ' respectively. Let the reference planes for the two media both pass through the origin of co-ordinates and have direction cosines (L, M, N) and (L', M', N') respectively. Since for the stationary path the light travels perpendicularly to these planes, the distances of (x, y, z) from these planes for the light are $Lx + My + Nz$ and $L'x + M'y + N'z$ respectively. It readily follows that in the time taken by the light to travel from the plane (L, M, N) to the plane (L', M', N') via the point (x, y, z) the distance traveled in the standard medium is

$$\mathcal{E} = \mu(Lx + My + Nz) - \mu'(L'x + M'y + N'z)$$

If (x, y, z) determines the neighbourhood of the surface for which the time is stationary between the planes, we must have

$$(\mu L - \mu' L')\delta x + (\mu M - \mu' M')\delta y + (\mu N - \mu' N')\delta z = 0$$

for all infinitesimal values of δx, δy, δz that satisfy

$$f_x\delta x + f_y\delta y + f_z\delta z = 0$$

That is to say, we shall have

$$\frac{\mu L - \mu' L'}{f_x} = \frac{\mu M - \mu' M'}{f_y} = \frac{\mu N - \mu' N'}{f_z}$$

and each of these will be equal to

$$\frac{\mu(Lx + My + Nz) - \mu'(L'x + M'y + N'z)}{xf_x + yf_y + zf_z}$$

Now, since f is homogeneous in a, x, y, z,

$$af_a + xf_x + yf_y + zf_z = 0$$

and therefore

$$\frac{\mathcal{E}}{af_a} = \frac{\mu' L' - \mu L}{f_x} = \frac{\mu' M' - \mu M}{f_y} = \frac{\mu' N' - \mu N}{f_z}$$

Now f_a, f_x, f_y, f_z are four homogeneous functions of a, x, y, z, between which the three ratios of these variables may be eliminated, giving $\phi(f_a, f_x, f_y, f_z) = 0$ where ϕ is a homogeneous function. It at once follows that $\mathcal{E}$ satisfies the equation

$$\phi(\mathcal{E}/a, \mathcal{L}, \mathcal{M}, \mathcal{N}) = 0$$

where $\mathcal{L}, \mathcal{M}, \mathcal{N}$ denote $\mu' L' - \mu L$, $\mu' M' - \mu M$, $\mu' N' - \mu N$ respectively. This equation expresses $\mathcal{E}$, the stationary path length between the planes (L, M, N) and (L', M', N'), in terms of their direction cosines, so that $\mathcal{E}$ is the eikonal.

As an example, consider refraction at the paraboloid of revolution $y^2 + z^2 - 4ax = 0$. Here

$$\frac{f_a}{-4x} = \frac{f_x}{-4a} = \frac{f_y}{2y} = \frac{f_z}{2z}$$

so that $f_y^2 + f_z^2 - f_a f_x = 0$ and

$$\mathcal{E} = a\frac{\mathcal{M}^2 + \mathcal{N}^2}{\mathcal{L}}$$

Or, again at the spherical surface $x^2 + y^2 + z^2 - r^2 = 0$ we have

$$\frac{f_x}{x} = \frac{f_y}{y} = \frac{f_z}{z} = \frac{f_r}{-r}$$

and therefore $f_x^2 + f_y^2 + f_z^2 = f_r^2$ or $\mathcal{E} = \pm r(\mathcal{L}^2 + \mathcal{M}^2 + \mathcal{N}^2)^{\frac{1}{2}}$. One root corresponds to the part of the surface that is convex, the other to the part that is concave, to the incident light.

By a similar process the equation of the refracting surface may be found when $\mathcal{E}$ is given as a homogeneous function of the first order in $\mathcal{L}, \mathcal{M}, \mathcal{N}$. The equation of the eikonal for the sphere may be written

$$\mathcal{E} = r[\mu'^2 + \mu^2 - 2b - 2(\mu^2 - 2a)^{\frac{1}{2}}(\mu'^2 - 2C)^{\frac{1}{2}}]^{\frac{1}{2}} = r(\mu'\cos\phi' - \mu\cos\phi)$$

where ϕ and ϕ' are the angles of incidence and refraction. If then we write

$$\kappa = \frac{\mu'\cos\phi' - \mu\cos\phi}{r}$$

we have $\mathcal{E} = r^2\kappa$, $\mathcal{E}\mathcal{E}_b = -r^2$ or the secondary focal lengths are μ/κ and μ'/κ respectively, where κ is called the secondary power. The equations

$$\kappa\mathcal{E}_a = \frac{\mu' L'}{\mu L} \qquad \kappa\mathcal{E}_c = \frac{\mu L}{\mu' L'}$$

merely mean that the refracting surface is the unit surface. Again

$$\mathcal{E}_b + 2a\mathcal{E}_{ab} + b\mathcal{E}_{bb} + b\mathcal{E}_{ac} + 2c\mathcal{E}_{bc} = -\frac{\cos\phi\cos\phi'}{LL'\kappa}$$

so that the primary power is $\kappa\sec\phi\sec\phi'$; also

$$\mathcal{E}_c - L'^2\{\mathcal{E}_c + 2a\mathcal{E}_{bb} + 2b\mathcal{E}_{bc} + 2c\mathcal{E}_{cc}\} = \frac{\sin^2\phi}{■}$$

the quantity on the left when multiplied by μ' being the distance between the primary and secondary principal foci in the image space, that is to say the astigmatism. It is worth noting that at the two principal foci the astigmatism is inversely as the refractive index.

When the incidence is normal both powers become equal to $\frac{\mu'-\mu}{r}$, an expression of importance because in a symmetrical instrument incidence is normal for paraxial rays, that is rays which lie close to the axis of symmetry. As the unit in which powers are expressed, the diopter, the inverse of a metre, is universally employed. Thus a lens of power 5 diopters (written 5D.) has a focal length of 20 cm. in air.

The Combination of Systems.—Having found the eikonal for the separate surfaces of the instrument it is now necessary to find those for the combination. The process involved may be illustrated by combining two systems. Let O_0, O_1 and O_2 in media of refractive indices μ_0, μ_1 and μ_2 be the reference points on the axis, $\mathcal{E}_1$ the eikonal for the first portion between planes through O_0 and O_1, $\mathcal{E}_2$ that for the second part between planes through O_1 and O_2, and $\mathcal{E}_{12}$ that for the whole. From the definitions of the eikonal it follows that $\mathcal{E}_{12} = \mathcal{E}_1 + \mathcal{E}_2$. Moreover

$$-\frac{\partial \mathcal{E}_1}{\partial M_1} = \mu_1 y_1 = \frac{\partial \mathcal{E}_2}{\partial M_1} \text{ or } \frac{\partial}{\partial M_1}(\mathcal{E}_1 + \mathcal{E}_2) = 0$$

with a similar equation involving N_1. These two conditions enable M_1 and N_1 to be eliminated from $\mathcal{E}_1 + \mathcal{E}_2$, leaving $\mathcal{E}_{12}$ expressed in terms of the external variables only.

3. Paraxial Laws.—From the formulas reached in a previous section we see that the refraction of paraxial rays is determined by the part of $\mathcal{E}$ which is linear in a, b and c. Let us put

$$\mathcal{E} = \text{const.} + \alpha a + \beta b + \gamma c + \cdots$$

then the conditions from which M_1 and N_1 are to be found are

$$\mu_0 M_0 \beta_1 + \mu_1 M_1 \gamma_1 + \mu_1 M_1 \alpha_2 + \mu_2 M_2 \beta_2 = 0$$
$$\mu_0 N_0 \beta_1 + \mu_1 N_1 \gamma_1 + \mu_1 N_1 \alpha_2 + \mu_2 N_2 \beta_2 = 0$$

Squaring and adding we find for the combination

$$\mathcal{E} = \text{const.} + \alpha_1 a - \frac{\beta_1^2 a + \beta_1\beta_2 b + \beta_2^2 c}{\gamma_1 + \alpha_2} + \gamma_2 c + \cdots$$

This expression shows that if we put

$$\alpha = \frac{A}{B} \qquad \beta = -\frac{1}{B} \qquad \gamma = \frac{C}{B} \qquad AC - BD = 1$$

the paraxial constants of the compound instrument are given by the matrix law

$$\begin{pmatrix} A_{12} & D_{12} \\ B_{12} & C_{12} \end{pmatrix} = \begin{pmatrix} A_1 & D_1 \\ B_1 & C_1 \end{pmatrix} \begin{pmatrix} A_2 & D_2 \\ B_2 & C_2 \end{pmatrix}$$

the extension of which to any number of systems is simple.

E. Practical Applications

1. Main Types of Optical Instruments.—Optical instruments tend to assume one of a few forms. Telescopes are systems of very great or even infinite focal length; they may invariably be regarded as a combination of two systems of finite focal length placed with their inner principal focal surfaces nearly or exactly in coincidence. The one part, often of large absolute aperture and long focal length, usually conforms to the thin lens type and is corrected for coma and central aberration. In the other part, the eyepiece, attention is chiefly given to the curvature and astigmatism. Telescopes are essentially instruments for increasing the angle an object appears to subtend at an observer's eye, and in most of them the field of view is small. At the opposite extreme are microscopes, also divisible into objective and eyepiece, but the former is of short focal length and small absolute, but large numerical, aperture. In the higher powers (that is, shorter focal lengths) the objectives tend to be very complex. As with telescopes the most important objective corrections are those for colour, central aberration and coma. The eyepiece is of simple construction. Only a small part of an object can be viewed at once. Camera lenses form a class in some respects intermediate between telescopes and microscopes. The field is large and the numerical aperture moderate. In general they are not separable into parts having distinct functions, and all aberrations must be considered. The use of lenses at appreciable axial separations is necessary for the attainment of satisfactory corrections.

2. Ray Tracing.—The professional optical designer in evolving complex instruments finds it expedient to use formulas for the aberrational coefficients merely as a general qualitative or roughly quantitative guide to indicate the modifications he should make in a partially developed system to reduce as far as possible the remaining aberrations. The outstanding difficulty in the way of using algebraic expansions for the whole of his work is the uncertain value of the terms of the expansion he must neglect. As he aims at taking into consideration lengths as small as a quarter of a wavelength or less, that is to say about one ten-thousandth of a millimetre, it will be appreciated that our knowledge of the higher-order aberrations must be thorough before reliance can in general be placed on expansions. The method adopted by the designer is to trace step by step through the system a selected set of rays, and to infer from their positions in the image space the aberrations remaining in the system. For tracing these rays many methods have been devised, of which particulars may be obtained from practical treatises. They are usually entirely trigonometrical, and logarithmic tables are generally employed. The calculations for skew rays are necessarily much more troublesome than those for rays in an axial plane, and in practice skew rays are rarely computed. A method of computing rays in an axial plane, suitable for use with a calculating machine, is as follows.

The incident ray is defined by $\mathfrak{b}$, the length of the perpendicular to the ray from the vertex of the surface, and $\sin\psi$, where ψ is the angle between the ray and the axis. The refractive index is denoted by μ, the angle of incidence by ϕ, the curvature of the surface by R, and the separation between the vertices of this and the next surface by t. The same letters, with accents where necessary, are used for the refracted ray, and with the suffix 1 for the following surface.

In the customary methods of calculation ψ_1 is found by the angular relation $\psi_1 = \psi' = \psi - \phi + \phi'$ which necessitates references to tables. In the present method the use of these tables is avoided by first finding an approximate value $\sin\theta$ for $\sin\psi'$ given by $\sin\theta = \sin\psi - \sin\phi + \sin\phi'$. In the absence of aberration this value is correct, and also $\mathfrak{b}' = \mathfrak{b}$. In general aberration is present and corrections of aberrational magnitude are required. The working equations are

$$\begin{aligned}
\sin\phi &= \sin\psi + R\mathfrak{b} \\
\sin\phi' &= \sin\phi \times \mu/\mu \\
\sin\theta &= \sin\psi - \sin\phi + \sin\phi' \\
N &= \mathfrak{b}\,(\sin\phi - \sin\phi')\,(\sin\psi + \sin\phi') \\
D &= \tfrac{1}{4}\{\sin^2\theta + (\cos\psi + \cos\phi + \cos\psi')^2 - 1\} \\
\mathfrak{b}' - \mathfrak{b} &= N/D \\
\sin\psi' &= \sin\theta - R(\mathfrak{b}' - \mathfrak{b}) \\
\mathfrak{b}_1 &= \mathfrak{b}' + t\sin\psi_1
\end{aligned}$$

It is to be noted that $\frac{1}{2}N$ and $\frac{1}{2}N\mu\sin\phi$ are the linear first order coma and spherical aberration respectively for the single refraction, D is the ratio of twice the first order aberration to the total aberration, and

$$\frac{(\mathfrak{b}' - \mathfrak{b})\mu\sin\phi}{\{(1+\cos\psi)\,(1+\cos\phi)\,(1+\cos\phi')\,(1+\cos\psi')\}^{\frac{1}{2}}}$$

which is represented at most refractions with ample accuracy by $\frac{1}{4}(\mathfrak{b}' - \mathfrak{b})\mu\sin\phi$, is the difference in path between the route along the ray and that along the axis from their first to their second crossing point. Brief tables are used for finding D.

Graphical methods of representing the state of correction of the system are widely used. For example, the central aberrations may be shown by taking as ordinate the distance from the axis at which a ray crosses the unit surface and as abscissa the distance of its intersection with the axis from a suitable fixed point. The type of curve thus secured is widely used. The paraxial por-

tion of the curve touches the ordinate axis. A more useful curve is obtained by taking the square of the height at which the unit surface is crossed as ordinate. The inclination of this curve to the ordinate axis for rays near the axis depends on the lowest order central aberration, and the curvature gives higher order aberrations. Moreover, if we draw through any point X on the abscissa axis a straight line parallel to the ordinate axis, the areas intercepted between this line and the curve measure the differences of path for light passing through the corresponding zones of the unit surface when the image point is at X. By choosing this ordinate so as to cut off alternately equal areas on opposite sides of the curve we can determine the point for which the differences of phase will be least. Corresponding to each geometrical figure a second curve may be drawn with the same ordinates, and the phase at a given image point as abscissa. When only first order aberration is present the geometrical figure is an inclined straight line, the phase curve is a parabola, and the best focus will be at the midpoint of the projection of the straight line on the abscissa axis. This result is at variance with the geometrical prediction that the best position of focus is three times as far from the position where the paraxial rays come to a focus as from the intersection of a marginal ray with the axis.

III. ASYMMETRICAL OPTICAL SYSTEMS

We have discussed at some length the properties of symmetrical lens systems because they form by far the most important section of geometrical optics. The expressions that have been given enable all the ordinary problems to be dealt with—for example, the paraxial expressions are sufficiently accurate to determine how large any simple lens must be to pass the rays the instrument should transmit. It is also a simple matter to derive a number of well-known conclusions from the general laws that have been given—for example, that the use of an optical instrument will not enable a brighter image of an object subtending an appreciable angle to be formed on the retina of an observer's eye. The reader is not likely to encounter any difficulty arising from the use of prisms inserted for the reflection of light at plane surfaces into the system, for they are equivalent to the insertion of a thick plate of glass with plane parallel faces. Methods of designing prisms to produce desired results cannot be considered in detail here. As a rule a trigonometrical procedure is adopted, but algebraic methods employing matrices appear to offer decided advantages.

IV. EXPERIMENTAL METHODS

The marked changes in the way optical instruments have come to be regarded in recent years is reflected in experimental applications of the theory. A good example is afforded by the use of modified types of Michelson interferometers for the testing of optical instruments. This application of interference is due to F. Twyman. An early instrument of this type, equipped for varied work, was constructed by Adam Hilger, Ltd., for the National Physical laboratory, at Teddington, Eng. In the Twyman interferometer, monochromatic light passes through a pinhole and is collimated by a good objective so that plane waves strike the 45° beam-splitting plate. The lens to be tested is placed in one arm of the interferometer between the beam-splitter and a movable convex mirror. The centre of curvature of the mirror is made to coincide with a principal focus of the lens being tested. If the aberrations of this lens are negligible, the incident plane wave is converted into a spherical wave that is reflected back through the lens and returns as a plane wave. Interference between this wave and the plane wave from the other arm of the interferometer produces a few straight equally spaced fringes that can be reduced in number to zero by tilting the side mirror. The fringe system is viewed with the aid of a lens with the observer's eye at its principal focus. The presence of aberrations in the test lens causes the returning wave to deviate from a plane. One then sees distorted, elliptical or circular interference fringes that indicate, in steps of half waves, the deviations of the wave from flatness. In simple cases, the form of the fringes reveals the nature of the aberration, showing whether it is principally spherical aberration, coma, astigmatism, curvature of image or distortion. Space does not permit a further discussion of many interesting points that arise in the use of this and other methods for investigating the properties of optical instruments experimentally.

See also references under "Optics" in the Index.

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OPTIMISM (Lat. *optimum*, "best"), in philosophy, is the theory that the world is the best of all possible worlds, or, in ethics, that life is worth living. The philosophical view may involve theodicy, or argument to "justify" God as creator of the world, and it was with reference to the *Théodicée* of Leibniz that the French Jesuits of Trévoux coined the word *optimisme* in 1737 and that Voltaire used it as subtitle to his *Candide* (1759). The ethical theory was much discussed with the spread of atheistic philosophies in the 20th century (*see* for instance EXISTENTIALISM) and found a notable defender in Albert Camus (*Le Mythe de Sisyphe*, 1942). *See* also PESSIMISM.

OPTION (STOCK). A stock option gives the holder a contracted-for option or election, for a specified period, to buy or sell a given number of shares of a specified stock at a price fixed at the time the option is entered into and unaffected by subsequent movements in the market price for those shares.

Warrants and convertible stock, puts and calls, and options to promoters and executives (known as "rights" in England) are types of stock options that perform different functions.

Warrants and Convertibility Features.—A warrant is a transferable option. In the United States, when corporate financing is undertaken, the sale of bonds or shares can often be induced by adding the bonus or "sweetener" of a warrant, with each certain number of bonds or shares purchased, evidencing a right to purchase a stated number of shares in the specified future (sometimes a year, five years or without time limitation) at a price which has the prospect of being favourable in relation to the market price in the future. Since warrants are detachable from the bonds or shares with which they are originally issued, they can be exercised by purchase of the shares or can be bought and sold as warrants. An active market in unexercised warrants for a particular stock will often develop, with prices quoted and fluctuating daily on the exchanges on the basis of the spread between the exercise price and the market price for the stock, the prospects for a future rise or decline in the price of the stock and the length of the remaining exercisable period of the warrant.

In U.S. practice the convertibility feature of a convertible bond, preferred share or debenture is also a type of option, but it is not independently transferable. Like a warrant, such a feature is an added financing inducement. It entitles the holder to elect, for a stated period during which he can observe the trend in the corporation's fortunes, to retain the safety advantages of the relatively lower-income senior security or switch, by converting, into a junior security having no fixed maturity date or a subordinate position on liquidation but some or greater potential participation in profits. A warrant holder, however, can retain his originally purchased security and either sell his warrant or exercise it to purchase shares at a favourable price, while the holder of a convertible security has the option only to convert, to the extent that he elects to do so

from the originally purchased security to a different one.

Warrants, as described above, are virtually nonexistent in England; there "convertible stock" usually refers to loan stock or debentures, with the right to convert to ordinary shares at a given ratio.

Puts and Calls.—Put and call option contracts are means by which speculation in anticipated future market rises or falls, or hedging protection against such developments, can be accomplished without immediate outright sale or purchase of the shares. To illustrate first the speculative possibilities of a call contract, assume that the investor feels that XYZ stock is priced low at $70 a share and that it could advance to $85 a share in three months. To buy 100 shares would require a cash investment of $8,500 (or whatever lesser amount was permitted by margin requirements then in effect). Unwilling to tie up this amount of cash and take the market risk that such a commitment involves, the investor buys a "call" option for $400, giving him the right to buy 100 shares at 70 within 90 days.

In that period, suppose XYZ climbs to 82. The investor could exercise his right to buy 100 shares at 70 from the endorser of the contract (a member firm of the New York or London Stock exchange) and immediately sell it in the open market at 82 for a profit of $1,200 less $400, the price of the contract, and usual brokerage commissions and taxes. If his judgment is wrong and XYZ drops to 50, his loss is limited to $400, the price of the call option, whereas an outright owner of the stock would have a paper loss of $2,000 and the possibility of further decline. At no time is the possible loss greater than the cost of the option contract.

To show the use of a put contract for speculation, assume that the investor feels that XYZ selling at 70 has a good chance of declining to possibly 50 in the next 90 days. He buys a "put" option contract at 70 good for 90 days for $350. If at any time in the 90-day period XYZ should decline to 50, he buys 100 shares in the market at 50 and delivers it to the maker of the put contract at 70, showing a profit of $2,000 less $350, the cost of the option contract less brokerage commissions and taxes.

The protective feature of options may be illustrated as follows. A person owns 100 shares of XYZ selling at 70; believing that some political or other event might change the course of the stock temporarily, he buys a put option at 70 for 90 days for $350. Now through his put contract, he is guaranteed that regardless of how low the stock should decline in the next 90 days, he can deliver his stock at 70 to the maker of the contract. On the other hand, if the expected decline does not take place and instead the market rises and the stock goes to 85, his profit from the advance in the value of the security can more than offset his cost of $350 for the protection.

The call option serves the same purpose in insuring against unlimited loss in connection with a "short" sale, which is a sale of shares that the seller does not own but is expecting to acquire later in a declining market, meeting his sale obligation in the meantime by borrowing shares to deliver to the buyer. For example: a man short 100 shares of stock at 70 with no protection of a call contract has an unlimited liability in the event of an unexpected rise in the market, which would require his "covering" the borrowed shares with shares costing him more, instead of the anticipated less, than the 70 already received on the short sale. But the man who, when he sells short at 70, protects his commitment with a call contract at 70 for 90 days at a cost of $400, knows that even if the stock should rise to 100 in 90 days he can cover his short position by calling for his stock at 70. Thus his loss is limited to $400 plus commissions instead of an actual market loss of $3,000.

A call contract can be useful to an owner of stock who, because of need for cash, desires to sell his security and still would like to have an interest in the stock. As an example, a man owns 100 shares of XYZ which he bought at 70 and is now selling at 85. He sells his stock in the market at 85 and buys a call option contract at 85 good for 90 days for $400. If after selling his stock XYZ continues to rise, he can in the 90 days recapture the stock at 85 through his call option.

If on the other hand, however, the stock should decline again to 70, he is in a position to buy back at 70 the stock that he sold at 85. While the cost of such "recapture protection" was $400, the gain afforded by the ability to buy back the stock 15 points lower than where it was sold made the purchase of the call worthwhile.

The put on XYZ mentioned above was probably sold by an individual or company who was willing to issue a contract guaranteeing to the holder of the contract that for that premium it would accept the risk of being required to buy 100 shares of XYZ at 70 any time during the life of the contract. If the stock should decline and the issuer of such a contract has the stock delivered to him at 70, his cost would be 70 less the $350 already received for the contract, or a price of 66½. If the stock is not put to him, he has benefited by the $350 premium, which he considered an adequate return in 90 days on the $7,000 investment.

The seller of a call, on the other hand, is probably one who owns XYZ shares and who for the sum of $400 would "give" someone a call on his stock at the current price of 70 good for 90 days. If the stock is called, the holder of the security loses his 100 shares at 70 plus the $400 already received. In other words, he has sold his stock at a price equivalent to 74. On the other hand, if the call is not exercised, the seller of the call has benefited by the $400 received in premium.

Practically all of the put and call option business in the United States is handled by about 25 option dealers located in New York city who are members of an association. Quotations on and orders for put and call option contracts may be obtained through local brokers or directly from a dealer in options. All contracts are guaranteed or endorsed by member firms of the New York Stock exchange, and the Association of Put and Call Brokers and Dealers, Inc., operates under the supervision of the Securities and Exchange commission.

Compensation Stock Options.—U.S. corporations frequently issue incentive options to purchase shares in the future at favourable prices to promoters and executives as compensation for their services. In England such "rights" are issued much more sparingly. The percentage of original issuance of these shares must be disclosed for issuances registered under U.S. federal securities regulations and is limited under many state laws. In some states the reservation of more than 15% of an issuance for future acquisition by promoters is regarded as so "unfair" to public investors as to require prohibition of sale of the issue in the state or other protective measures.

Options are often offered to executives as a fringe benefit or as an inducement to enter into long-term contracts, on the theory that an option constitutes an incentive to do what will improve the company's fortunes and thus raise the value of its shares. The use of such options was given impetus by the enactment in 1950 of federal income tax provisions which permit the profit or "spread" between high market price and the lower option price to be treated, on sale of the stock, as capital gain taxable at a 25% ceiling rather than income taxable at possibly higher personal income tax rates. Known as "restricted stock options," these were widely used in large corporations after 1950 as a means of supplementing the compensation of executives whose salaries and bonuses put them in high tax brackets, but there is, of course, the risk that such a person will realize no gain from the option plan if the market price for the stock falls and remains below the option price. (G. T. Fr.)

OPTOMETRY is defined by its practitioners as "the art and science of vision care." It includes refracting the eye (measuring defects of refraction that cause faulty vision) by methods that can be applied without the use of drugs. On the basis of his findings the optometrist may supply eyeglasses (*q.v.*), including contact lenses, and he may prescribe eye exercises to correct muscular dysfunctions. Optometrists do not treat diseases of the eye or practise medicine or surgery; this is the work of physicians who are known as ophthalmologists or oculists (*see* OPHTHALMOLOGY). However, optometrists are concerned with the detection of ocular disease and with the personal and environmental factors that contribute to safe, efficient visual performance in school, at work,

and in such activities as driving a car or piloting an aircraft.

The term optometrist came into use in the United States at the beginning of the 20th century to designate opticians (lensmakers) who emphasized the enhancement of visual performance above the making of glasses. This led to professional training in physiology, psychology, and the like, as well as optics. With the advent of licensing laws (*see* below) the term optometrist became, in the U.S. and Canada, a legal designation. The term is also used in Latin America, Australia, the Philippines, New Zealand, and Israel, and to some extent in Great Britain; in most European countries optometrists are called refracting opticians or ophthalmic opticians.

In the mid-1960s there were ten schools or colleges of optometry in the United States, two in Canada, five in Great Britain, one in Ireland, one in New Zealand, five in Australia, one in almost every major European country, and one in India. The schools in the U.S. were accredited by the Council on Optometric Education, a body recognized by the National Commission on Accrediting. Colleges of optometry in the U.S. during this period provided two years of preprofessional studies followed by three or four years of professional training. In all but one of the schools the terminal degree granted was that of doctor of optometry (O.D.).

Optometry is licensed as a profession and regulated by state laws in the U.S. and Australia, by provincial laws in Canada, and by national laws in Great Britain, New Zealand, Ireland, Sweden, and Belgium. In the U.S. an optometrist, in order to be licensed, must pass the state board examination of the state in which he intends to practise. Most of the approximately 18,000 optometrists in the U.S. in the 1960s were in private practice, but significant numbers were employed in clinics, hospitals, schools, industry, public health centres, and research and development laboratories, or served professionally as commissioned officers in the armed forces.

(T. F. S.; M. W. Mo.)

OPTOPHONE, basically a selenium cell that electrically converts variations in light intensity to sound patterns. As a type of sensing equipment (*see* AUTOMATION), it was hopefully introduced (1914) as a way for the blind to read, but had generally failed to fulfil such a purpose by the 1960s. *See* SELENIUM CELL.

OPUS (OPOUS), in ancient Greece, the chief city of the Opuntian Locrians (*see* LOCRI). Its exact site is disputed; it may have been at modern Atalandi in the *nomos* of Phthiotis, or at Kiparissi, about 4½ mi. to the E.

It is mentioned in the *Iliad* of Homer among the towns of the Locrians, who were led by Ajax, son of Oileus; there were games called Aianteia and a shrine in honour of Ajax at Opus in historical times. Pindar's ninth Olympian ode is mainly devoted to the glory and traditions of Opus. By the 5th century B.C. Opus was important enough to give its name to part of the eastern Locrians; Opuntian Locrians fought in the Greek forces at Artemisium and Thermopylae, but then surrendered to Xerxes and fought in the Persian army at Plataea (479). In 457 the town was obliged to supply 100 leading men as hostages to Athens. The Opuntian Locrians supported Sparta in the Peloponnesian War, supplying cavalry and raiding Euboea.

Opus went over to the Romans in 198 B.C., though a Macedonian garrison held the acropolis for Philip V until his defeat at Cynoscephalae in the following year. The city retained its importance under the Romans, in spite of the fact that it suffered repeatedly from earthquakes.

ORACH (MOUNTAIN SPINACH; *Atriplex hortensis*) is a tall-growing hardy annual, called also sea purslane, whose leaves when young, though coarsely flavoured, are very often used as a substitute for spinach. It is a member of the goosefoot family (Chenopodiaceae).

The white and the green are the most desirable varieties. The plant should be grown in rich soil. Seeds may be sown in rows two feet apart, and about the same distance in the row, about April, and for succession again in June. Water should be made readily available so as to maintain a rapid growth. A variety with reddish foliage, a hardy annual three to four feet high, is sometimes grown for ornament. *See* also SPINACH.

ORACLE, a shrine of a god or a hero at which inquiries may be made of him; the word also stands for the answer given at such a shrine. (The Latin word is *oraculum* from *orare*, "to speak"; the corresponding Greek expression is *chresterion*, *manteion*, and for the answer itself, *chresmos*.) Such shrines were numerous in antiquity, among the most celebrated being those of Dodona (*q.v.*), of the hero Amphiaraus (*q.v.*) in Boeotia, of Trophonius at Lebadea and, above all, of Apollo at Delphi, although Apollo had several other famous oracles. In Italy, perhaps the best-known oracle was that of Fortuna (*q.v.*) at Praeneste (Palestrina). No one method of consultation and answer was used in all cases. The commonest methods were incubation, when the inquirer slept in the holy precinct and received an answer in a dream; divination by lot, as at Praeneste and at least sometimes at Delphi; and direct inquiry of an inspired person who answered orally. This last was the most characteristic Apolline method. Individuals not confined to oracular shrines were on occasion thought to be inspired to give prophecies, and many collections of their utterances were extant, among the most celebrated being those of a certain Bakis, of the sibyl (*q.v.*) or sibyls and, for Rome, of Marcius or the Marcii. Apollo's propagandists often claimed that these prophets were inspired by him, and sometimes that they were his offspring.

Incubation in temples and other holy places was but a special application of the widespread belief that dreams were significant, a notion by no means confined to Greece and Rome or to antiquity. Dream communications from deities could take place anywhere. This can be seen, for example, from their occurrence, according to epic narratives, when the recipient was in his or her own bed; but, naturally, the dream was all the more likely to be genuine if received at a sacred spot. Thus, Pindar (*Olympians* 13, 75) shows Bellerophon sleeping at the altar of Athena. She appears to him in a vision so real that the bridle she gives him is actually in his hand when he awakes. This type of procedure took place most characteristically, though by no means only, at the temples of Asclepius at Epidaurus, and elsewhere. Of the surviving tablets which record cures, a great number tell of dreams in which the god or some of his attendants performed operations, not seldom of an impossible and fantastic kind. It need not be doubted that a certain number of genuine cures resulted, whatever the scientific explanation of them may be. In some cases the consultant wore or lay upon the hide of a victim recently sacrificed to the deity, thus reinforcing the sacredness of the place.

The only kind of oracles seemingly native to Italy were the lot-oracles (*sortes*). Something of the procedure at Praeneste is known from Cicero, who says that the *sortes* were slips of wood inscribed in antique lettering, that they were stirred and that one of them was then pulled out by a boy. An idea of the content of the inscriptions can be got from Livy. He records a portent: the *sortes* shrank and one, bearing the ominous words "Mars shakes his weapon," fell out. It appears, then, that the *sortes* were kept in a bundle when not in use, and that only a limited number of possible replies was available, no doubt couched in general terms, like the one quoted by Livy. This, however, as Cicero shows, was at a time when the oracle had fallen into disrepute among the upper classes; in earlier and more believing times the procedure may well have been less mechanical. One could throw down uninscribed *sortes* and draw conclusions from their relative position to one another, or the like. That this was an ancient method of eliciting responses at Delphi is indicated by the recurrent use of the locution *aneile* for "gave answer," as in Herodotus. The literal meaning of the word is "took up," and this expression would obviously be appropriate in describing the action of picking up (and examining) objects such as the Praenestine *sortes*. There is indeed no sufficient reason to suppose that this method of oracle taking did not continue in use in fully historical times.

The history of Delphi, the most celebrated of ancient oracles, is long and complicated, and the early period of the shrine is very imperfectly known. Although in historical times Apollo gave answers there, tradition is unanimous that the shrine was not originally his. According to the "Homeric" hymn (or hymns) in his honour, Apollo guided a shipload of Cretans from Knossos to

Pytho, as Delphi was then called, and appointed them his first clergy. In other words, it was believed that the origins of the oracle went back to Minoan times. The hymn recounts how Apollo, far from being the first occupant of the holy place, kills a female dragon or serpent who is already in possession. Her name, according to later informants, was Delphyna. The more usual account, however, makes the serpent a male named Python.

There is an obvious connection between these names and the names of the place itself; underworld powers, moreover, very commonly manifest themselves in the form of a serpent. This belief fits the story in Aeschylus (*Eumenides* i, ff.), which seems to be the legend of the shrine. According to him, the original giver of oracles was Earth. Earth was succeeded by her daughter Themis and Themis by Phoebe, who gave the shrine to Apollo as a birthday present. There is nothing unlikely in the supposition that originally the oracles were given by an underworld power, whether by the earthgoddess or some other, and this possibility would bear out Delphi's reputed antiquity, for the worship of goddesses is known to have been prominent in pre-Hellenic cults. The most sacred object at Delphi was the omphalos or navel. This was allegedly the centre of the earth, which was conceived of as flat. (Its true form was not discovered until several centuries after any possible date for Apollo's arrival.) Artistic representations show the omphalos to have been a conical object, presumably of stone. For a time it was believed that French excavations on the spot had discovered it, but closer investigation of the object found revealed that it was simply an ornamental stone from one of the many buildings in the precinct. But that the centre of the earth should be marked is appropriate in the shrine of an underworld power, and in shape the omphalos resembles other sacred objects that are not statues, as, for instance, the idol of Aphrodite at Paphos.

Hardly less sacred than the omphalos was the tripod, on which the Delphic priestess sat while awaiting the inspiration that should stimulate her oracular utterance. Concerning the cause of this inspiration many theories have been put forward. One of the most celebrated is the ancient one, found in several Hellenistic and later authors, that a vapour issued from a cleft in the floor of the *adytum* (holy of holies), where the tripod was, and intoxicated the priestess. Geologically and architecturally this is quite impossible; there was no such cleft, and the local strata have never been capable of producing any kind of gas. But that the Pythia, as she is regularly called, did pass into some kind of trance is highly likely. She was not an expert on divination but a simple woman chosen from the local inhabitants. According to Diodorus Siculus she was a young virgin, but "in later times," he says, a certain Echecrates violated the then Pythia, and consequently the Delphians resolved in future to appoint women not less than 50 years old to the office. When these "later times" were is not known, nor if there is any truth in the story, which even the credulous Diodorus introduces with "they say." Certainly the Pythia was old by the time of Aeschylus.

After Apollo's willingness to inspire her had been ascertained by preliminary ceremonies, she took her seat on the tripod and there was supposedly filled with his divine power. P. Amandry has shown that there is no reason to suppose that she underwent the violent convulsions described in Virgil's *Aeneid* as seizing the Cumaean Sibyl. It is furthermore clear both that the divine will was not always ascertained through the Pythia and that she need not be seated upon her tripod in order to prophesy. As already stated, there is reason to suppose that divination by lot was practised on occasion; and inscriptional evidence, together with an isolated mention in literature, shows that sometimes at least the lots were simply beans, doubtless of different colours or distinguished in some other way.

Presumably the lot procedure took place on days when inspiration of the Pythia was not expected. She was inspired during nine months of the year, on the seventh day of each, as Apollo was born on that day, according to tradition, and it was sacred to him. The other three months belonged not to Apollo but to Dionysus. When, on the prescribed days, she mounted the tripod, the Pythia would be already in a very receptive condition. She would have been brought up in the atmosphere of Apolline cult; she certainly would be a wholehearted believer in the god's power and in his willingness to dictate messages to her; and the preliminary ceremonies would have confirmed her in her belief. Under such conditions, self-hypnotism or some allied phenomenon would be not unlikely to occur. While in her abnormal state, the Pythia would speak, intelligibly or otherwise. But her words were not directly recorded by the inquirer; he was handed a written document supposed to contain what she had said and, in the great days of the oracle, regularly couched in hexameters. This was the official response. Manifestly there was room here for extensive editing or even for wholesale forgery, which would account, among other things, for the good advice frequently given by the oracle (especially on such matters as the right place to found a colony) and also for the fairly numerous cases in which the response was couched in language so obscure, vague or ambiguous as to leave room for different interpretations. Thus there would be a sufficient explanation if events did not agree with the meaning which the inquirer had attached to the reply given him.

But it is only fair to acquit the Pythia herself of any share in such pious frauds. If sundry legends of the shrine may be believed, there were occasions when she gave an answer without waiting for the usual preliminaries. A famous story concerns Alexander the Great. He arrived at Delphi on a day when inspiration of the Pythia did not take place and was told that she would not prophesy; he then laid hands on her and started to drag her to the tripod. She cried out, "My lad, you are invincible," and he took this as a sufficient reply. In other words, it was held that she might be inspired at any moment, and some such belief may have been current as early as the 5th century B.C. In Aeschylus' *Eumenides* she clearly sees the Erinyes in all their hideousness, whereas they are invisible to the chorus in the *Choephoroe* and are seen only by Orestes, as in the later play they are visible to the supernatural characters. The Pythia, however, has not yet mounted the tripod, but merely uttered her prayer for success in her prophecies.

As to the method of consultation, in early times at least it would seem from Aeschylus that if there were a number of inquirers, they cast lots to see who should be answered first, and this may have remained the normal procedure. But the Delphians not only claimed the right of first inquiry, but granted it to whom they would. Plutarch gives a vivid picture of the way in which business increased and decreased at various periods. According to tradition, there was a time when the Pythia was inspired but once a year, on the seventh day of the local month Bysios (in early spring). Later, the press of consultants was so great that there were two Pythias on duty and a third in reserve; but in Plutarch's own time, one was enough. Whether consultation was allowable on other days than the seventh of those months during which Apollo was supposedly present (Dionysus gave no oracles at Delphi) is a debated question. There is evidence that sometimes at least it could take place, perhaps by special arrangement. Presumably the god was a free agent and might depart from normal procedure if and when he would.

Delphi, with its numerous and obviously far from unintelligent clergy, was the nearest approach to a head-centre of Greek religion. The prestige of the oracle, from early times to the Hellenistic period, together with the fame of the great Pythian games, held every fourth year, ensured a steady stream of visitors from all parts of the Greek world. People came from abroad also; the consultations said to have been made by Croesus of Lydia and by the Romans in the time of the Etruscan dynasty have at least some historical foundation. Thus the priests had good opportunities of learning far more about foreign countries and out-of-the-way corners of the Hellenic world than most Greek city-states' rulers were ever likely to discover. Therefore, if advice were asked about a good site for a new colony, it could be given, by what prompting of the Pythia before she went into her trance or by what "editing" of her reply is unknown. But certainly Apollo deserved his common title of *archegetes*, or leader (especially of colonists). Given any reasonable system of recording the information which judicious questioning would obtain from visitors to the holy place, the amount of Delphian knowledge concerning advantages and disadvantages of sites, accessibility of water supply and trade routes

and other relevant matters would soon be very great. Hence, for instance, the two different accounts of the founding of Byzantium (Istanbul) need not be disbelieved nor regarded as hopelessly contradictory. According to the earlier record, in Herodotus, a Persian satrap, having the not uncommon name of Megabazos (Bagabusha) and said to have been contemporary with Darius I, was remembered in the Hellespontine district for having said that the founders of Chalcedon (modern Kadiköy), across the Bosporus from the site where Istanbul now stands, must have been blind to choose the inferior position when the better one was available. In the other account, doubtless current in Delphi, the Megarians, 17 years after the foundation of Chalcedon, sought advice about the position of a new colony and were told to build the city "over the way from the blind." The immediate advantage was that the tunny fishing was much better at the Golden Horn. The only adjustment necessary to the stories is to put Megabazos earlier than Darius, for Byzantium was traditionally founded about 657 B.C., nearly a century and a half before Darius came to the throne. A local jest, such as that credited to Megabazos, is precisely the kind of information which a visitor from that region would be likely to have, and some further questioning would soon produce the explanation. Certainly the stories of the foundation of colonies by Delphic advice are far too numerous to be thought of as mere pious legends or as propaganda by Apollo's servants.

Politically the importance of Delphi was considerable from early times down to the age of Alexander the Great. The oracle was not consulted on questions of ritual alone, such as recognition of a new cult, the proper measures to be taken to stop a plague or a famine, the method of dealing with a portent and so forth. Constitutions also were felt to need its sanction, and more than one system of laws, notably that of Sparta, was claimed as an actual dictation from Apollo or as a production of authors designated by him. There can be little doubt that, at most, approval of a draft constitution was signified in such cases. In what may perhaps be called international politics, it would seem that the oracle was in favour of the union of Greece under a strong ruler, native or foreign. This is not surprising in view of the constant bickering of the city-states; it was in effect the policy which Isocrates urged in the 4th century B.C., and from the standpoint of self-interest it was natural enough. An emperor of Greece, should one arise, would be likely to encourage the cult of an already popular god who supported him; and thus the Delphians, whose little community was insignificant apart from its religious prestige, might hope for a brilliant future under him. A hope of this kind makes it understandable that on the two noteworthy occasions when Greece was in danger of foreign conquest, Delphi more or less openly supported the invader (Xerxes I in the early 5th century B.C. and Philip II of Macedon in the 4th). In the Peloponnesian War, too, its sympathies were decidedly on the side of Sparta. This state, besides being solidly conservative, had for a long time held together a confederacy of the mainland powers of Greece, while Athens, though strong at sea and in the islands, had failed to do this.

But in an age when the reliability of oracles, like every other traditional idea, was under criticism, such partiality no doubt contributed to the decline in real importance of Apollo and his clergy. One symptom of this is the sorry figure which the god cuts in more than one play of Euripides, notably in the *Ion* and the *Orestes*. After Alexander the Great, the prestige of Delphi declined. There appears to be no certain instance (apart from fairly obvious fictions) of any of the new powers consulting it on really important political matters, though religious questions continued to be referred to it.

The holy place itself was occupied and its treasures plundered by the Phocians in 356 B.C. It was not freed until ten years later, Philip of Macedon taking the credit for its liberation and winning the support of the oracle. During most of the next century, Delphi was more or less under the power of the Aetolian league. A Gaulish raiding force endangered it in 279 B.C.—the tale of the defeat of this force has survived bedecked with miracles and an appropriate pronouncement of Apollo. The oracle was treated with respect and occasionally consulted by the Romans, but on the whole gradually declined in importance. After the fall of Macedon, danger from the Illyrians and Thracians threatened Greece, and in 85–84 B.C. Delphi, along with several other places, was taken and sacked by them. Most of the treasures, however, had already been appropriated (theoretically on loan) by the Roman Sulla. The emperor Hadrian brought about a temporary revival of the place, but after him its decline continued. The giving of oracles had ceased by the time Julian the Apostate made his attempt at a pagan revival. His inquiries elicited the famous "last oracle," to the effect that the shrine was in ruins and that no prophetic inspiration was forthcoming.

The growing feeling that religion ought to be associated with enlightened ethics led, not perhaps to any noteworthy change in the nature of the oracles given at Delphi or to modifications of Delphi's priestly policy, but certainly to a development in the opinions commonly held about the god and about his advice. Apollo had been concerned with at least some aspects of morality and with a certain legalism from early times. Herodotus preserves a tale, allegedly dating from about the middle of the 6th century B.C., about a Spartan named Glaucus, who tried to get the Pythia to sanction his intended perjury, was warned of the consequences of false swearing and, on expressing repentance, was further told that to tempt the god was as bad as committing the actual offense. Much later there was current a story about three pilgrims on their way to Delphi. They were attacked by brigands, and in the scuffle one pilgrim ran away while another accidentally killed the third in driving the robbers off. On asking how he might be purified, the pilgrim was told that he was not polluted at all by the blood of the man whom he had slain in trying to defend him. Another story concerns a rich and ostentatious man who made an elaborate sacrifice, only to be told that a certain poor but pious countryman was the god's most acceptable worshiper.

A pretty little poem, alleged to be an oracular response, says that holy places are always open to the good, who need no purification before entering, whereas no lustrations will cleanse the soul of the wicked. This shows a development similar to that observable in the Hebrew writers, with their increasing insistence on the comparative unimportance of ritual beside inward holiness and virtue; it results from a like advance in ethical thought in the two nations.

While Delphi was the best-known Apolline oracle, it was by no means the only one. A very celebrated oracular centre was Claros in Asia Minor, which flourished especially in late imperial times. There was a mystery cult as well at Claros—this was unusual, for Apollo has as a rule nothing to do with mysteries (*see* MYSTERY). Not only have various records of offerings to and consultations of the god been found at the site, but inscriptions from distant parts of the empire, such as Britain, Africa and other provinces, testify to acts of piety resulting from an "oracle" (*chresmos*) or "interpretation" (*interpretatio*) of the Clarian god. Various late authors also mention oracles of theological content, a noteworthy example being preserved by Macrobius. This shows strong Jewish influence, for it proclaims that Iao (*i.e.*, Yahweh) is the chief of all gods, but it is far from being orthodox Judaism, for it proceeds to identify him with Hades, Zeus, Helios and a fourth deity whose name is corrupted past certain restoration, each at a different season of the year. Behind these pronouncements there evidently lies a philosophical religion akin to Gnosticism (*q.v.*). The Clarian oracle moved with the times, but Delphi was slow to imitate it, although a few late oracles attributed to the Pythian Apollo show decided Neoplatonic influence. Philosophical oracles were much in vogue in imperial times, and collections of them were made with commentaries. There were, for example, the so-called Chaldean oracles put forth by the seer Julian, a contemporary of Marcus Aurelius, which were extensively commented upon by the later Neoplatonists. It does not appear, however, that Julian claimed that his oracles belonged to any particular shrine; they were rather alleged personal revelations to himself.

Oracles were also a common form of propaganda. The extant collection of so-called Sibylline Oracles (*q.v.*) contain furious outbursts not only against paganism in general but specifically against Rome. In an age devoid of anything like historical criticism of

documents, these blatant forgeries were accepted in good faith as genuine pronouncements of the ancient sibyls.

It remains to mention a few instances of abnormal oracles. A curious one was that of Hermes at Pharae in Achaea, described by Pausanias. This town had a large market place (*agora*), and in the middle of it stood a statue of Hermes with a stone hearth in front, to which were attached bronze lamps. The consultant came in the evening, burned incense on the hearth, filled and lit the lamps, put a coin locally current in the right hand of the statue and whispered his question into its ear. He then stopped his own ears and left the market place, unstopped his ears and listened to the first sound that was audible; this contained the answer to his question. The rite was a local development of a belief in a recognized omen, the *kledon*, or utterance which meant more than the speaker realized. A classical instance is to be found in the *Odyssey* (xx, 100 ff.), where Odysseus asks for a sign from the palace and overhears a tired servant girl cursing the suitors who make more work for her and hoping that the meal which she is helping to prepare for them may be their last. The first sounds heard by the inquirer at Pharae would most likely be the talk of passers-by, and their words could easily be interpreted appropriately. Although there is nothing to indicate that Hermes' statue was very old, there are features of the cult of Pharae that seem archaic, and among these may be reckoned the treatment of the statue as if it were a living person. The oracle, or at least this oracular method, may have gone back to very ancient times.

A very remarkable oracle was that of Trophonius at Lebadea. Pausanias describes the method of consultation; in his time (about A.D. 150) it may well have been elaborated to suit contemporary tastes for the mysterious and impressive. The inquirer had first to spend several days in a building dedicated to the Good Daemon and to Tyche, where he was subject to certain restrictions, which included abstinence from bathing except in the local river, Hercyna. Animal sacrifices were made to several deities, and a diviner inspected the entrails to see whether or not Trophonius was favourably disposed. Finally a nocturnal sacrifice was made, the blood of a black ram being run into a ritual trench (*bothros*) and Agamedes, the legendary associate of Trophonius, being invoked. The entrails of the last victim contained the final indication whether the oracle might be consulted or not. If the answer was favourable, the inquirer was bathed and anointed by two boys called Hermai. (Their title is the plural form of Hermes' name—the god perhaps watched over this rite in his capacity of Guide of Souls.) The consultant was then made to drink of two springs called, respectively, Lethe and Mnemosyne (Forgetfulness and Memory), so that he should forget everything but what was revealed to him. After a few more preliminaries, he descended into the shrine and thrust his feet into a hole in the wall. Having been mysteriously sucked down, he had his revelation, sometimes by sight, sometimes by hearing, and returned by the same opening. He was then seated on the so-called Throne of Memory and questioned by the priests while still in a bemused state. He had also to make a written record of his experiences and dedicate it. Pausanias had himself consulted the oracle and is therefore a trustworthy witness (Paus. ix, 39). Clearly the inquirer was strongly influenced by the strange ritual and took some little time to recover his normal state of mind and in particular to be able to laugh. *See* also APOLLO; AUGUR; DIVINATION.

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ORADEA, (Ger. GROSSWARDEIN; Magyar NAGY-VÁRAD), town of Transylvania, Rum., centre of Crişana administrative and economic region (*regiune*), is situated in the Crişul Repede Valley, 152 km. (94 mi.) WNW of Cluj by road and rail. Pop. (1966) 122,509. Probably built on the site of a Roman settlement, Oradea was made a Roman Catholic bishopric *c.* 1080 by St. Ladislaus (*see* LASZLO I), whose remains lie in the 12th-century St. Ladislaus Church. Originally a Hungarian town, it was destroyed by the Tatars in 1241, rebuilt in the 14th century, held by the Turks (1660–92), and then became part of Austria-Hungary until 1919, when it was ceded to Rumania. Both the Roman Catholic and the Greek Orthodox cathedrals were built in the 18th century, and there are state and puppet theatres, a regional library, and an ethnographic museum. After 1945 Oradea became an important industrial centre, producing machine tools, mining equipment, chemicals, building materials, and processed foods. Nearby are the noted health resorts, Băile Victoria (Episcopeşti) and Băile 1 Mai (Felix), with thermal springs.

CRIŞANA REGION, formerly Oradea, lies between the headwaters of the Crişul Repede, Crişul Alb, and Crişul Negru (the Rapid, White, and Black Crişul) in the north, the Bihor Massif in the east, the Zarand Mountains in the south, and the Hungarian border in the west. Area 12,240 sq.km. (4,726 sq.mi.). Pop. (1962 est.) 873,393. The region includes the Codrului and Pădurea Craiului mountains and part of the Tisa (Tisza) plain. The natural resources include iron ore (Vaşcău, Moneasa), coal (Şărmăşag, Derna), bauxite, and building stone. About two-fifths of the region is sown to wheat, maize (corn), rye, hemp, sunflowers, potatoes, rape, flax, and tobacco and much livestock is raised. Industries include engineering, timber and food processing, and the manufacture of chemicals, building materials, textiles, and footwear. Apart from Oradea, the chief towns (pop. 1963 est.) are Salonta (16,546) and Şimleu Silvaniei (11,060).

ORAL LAW (JEWISH) (Heb. *Torah shebe-al pe*), unwritten laws and customs that are not found in the Pentateuch (Torah). The Oral Law was codified in the Mishnah. *See* TALMUD: *Oral Law.*

ORAL SURGERY is a specialty of dentistry that includes the diagnosis and surgical and adjunctive treatment of diseases, injuries, and defects of the human jaws and associated structures. In general, this includes the treatment of wounds; the reduction of fractures of the upper and lower jaw and cheekbones; treatment of acute and chronic infections of the mouth and jaws, including fascial abscesses and osteomyelitis; repair of acquired and congenital deformities, including the use of bone grafts; the surgical correction of prognathism and severe occlusal abnormalities; the conservative and surgical treatment of such conditions of the mandibular joint as inflammation, infection, and ankylosis; the excision of hard and soft tissue lesions of the mouth and jaws, such as cysts, as well as benign and malignant tumours; the extraction of teeth, including impacted and unerupted teeth; the preparation and improvement of the jaws for dental prostheses; the treatment of maxillary sinus infection of dental origin; the surgical treatment of diseases of the salivary glands; and operations on peripheral branches of the trigeminal nerve in cases of neuralgia.

History.—The Edwin Smith surgical papyrus of *c.* 1600 B.C. contains the oldest information regarding the treatment of jaw fractures, as practised in Egypt. The hieroglyphics deal with examination, diagnosis, and treatment. Other old documents dealing with the treatment of diseases of the jaws include the works of Hippocrates (400 B.C.) and the *De medicina* of the Roman Aulus Cornelius Celsus (A.D. 30), in which the treatment of jaw fractures with gold thread is described. In the Middle Ages Avicenna included in his *Cantica* a chapter on mandibular fractures. Guglielmo da Piacenza was the first to recommend, in his *Liber in Scientia Medicinale* (*c.* 1275), intermaxillary fixation.

In ancient times medical and dental care were combined, but separation gradually developed and they progressed independently. At the time of Pierre Fauchard, diseases of the teeth and jaws were treated by dental surgeons. In his *Chirurgien dentiste* (1728) Fauchard discussed many procedures in oral surgery. In Great Britain, *Treatise on the Disorders and Deformation of the Teeth and Gums* by Thomas Berdmore (1768); *Dental Surgery* by John Tomes (1859), who invented dental forceps; *System of Surgery* by T. Holmes (1870); and *Science and Practice of Surgery* by F. T. Grant (1878) consider some procedures in oral surgery. At that time, dental prostheses were already used to treat fractures of the jaws. Regarding other operations, the replantation of teeth accidentally lost is featured.

Today oral surgery is part of the dental profession, which considers oral surgery a dental specialty. The pioneers in oral surgery laid the foundation of the oral surgery specialty at a time when the practice of medicine was all-embracing. Physicians and surgeons, however, did not desire to treat diseases of the teeth and jaws because resultant deformities of the face might leave the operator open to criticism. Furthermore, oral diseases presented no emergency because patients, although suffering, rarely died of such ailments. This situation was recognized by Simon P. Hullihen (1810–57), who is recognized as the first oral surgeon in the United States. With but very limited background in medicine he performed more than 100 operations, and for some he invented ingenious instruments. James E. Garretson (1828–95), the father of oral surgery in the United States, named the specialty and in 1864 introduced it as a major subject in the curriculum of the Philadelphia Dental College (now the school of dentistry of Temple University). He was the first professor of oral surgery to be appointed to a dental faculty, and in *A System of Oral Surgery* (1869) he described both dental operations and oral surgery procedures.

Procedures.—*Special Surgical Techniques.*—The oral cavity presents a number of difficulties that make modifications of standard surgical techniques necessary. Complete asepsis cannot be achieved, and the natural protective mechanism of the oral tissues is lost if the surface is broken by a surgical wound. The jaws also differ from other bones in that they contain teeth and dental remnants that often are infected. The jaws are supplied with many vessels and nerves leading to the teeth and lip; damage to these may cause severe hemorrhage or anesthesia and paresthesia in the face. The soft tissue contains an extensive capillary system that sometimes causes excessive bleeding.

In operations performed inside the mouth, special methods are required to make the field of operation more accessible, among these being excellent lighting, good retraction, and hemostasis. The intraoral approach is often used to avoid disfiguring facial scars and because it facilitates the extraction of involved teeth and the preservation of functional occlusion. Good cosmetic results are of major significance, since the patient values them more highly than he does functional restoration.

Exodontia.—This, one of the commonest oral operations, includes the extraction of teeth. Usually the alveolar bone and surface mucous membranes require surgical modification to improve the shape and contour of the ridges after multiple tooth extractions so that the patient may wear prosthetic replacements more comfortably and efficiently. This technique is termed alveoplasty. When unerupted or impacted teeth (usually third molars) are excised from the jaw bones, the term odontectomy is used.

Implant Dentures.—When there is extensive atrophy of the alveolar ridges so that denture retention is impossible, a number of surgical procedures may be employed to produce a ridge. The sulcus may be extended by stainless steel, tantalum, or other inert metal implants attached to what remains of the jawbone. From oral projections of these implants, modified dentures may be firmly supported. Implant denture technique promises to rehabilitate orally patients who otherwise would remain without teeth.

Injuries.—These include fractures and other injuries of the maxilla, zygoma, and mandible, and damage to associated soft tissue. Uncomplicated jaw fractures are usually reduced and immobilized with wires, splints, or arch bars attached to the teeth. In more complicated fractures, open techniques for reduction are employed, with wiring or plating of the fractured segments; in some instances bone grafts are used.

Odontogenic Infections.—These are the commonest cause of oral inflammatory swellings. Prompt removal of the infected tooth, root, cyst, or other dental pathology is indicated. Antibiotics and general supportive therapy are commonly used; and when the infection has spread beyond the jawbone, extraoral drainage may be necessary.

Cysts and Tumours.—Cysts occur both in the soft tissues of the mouth, because of retention of secretions, and in the jaws, where they cause wide destruction. Nearly all types of tumours found in other parts of the body occur also in the mouth.

The Temporomandibular Joint.—This joint and associated structures may be involved in inflammations that interfere with proper function of the jaws. Conservative treatment, such as is used in the treatment of arthritic joints elsewhere in the body, is usually palliative. Mandibular joint surgery is indicated in severe joint disturbances that do not respond to nonsurgical therapy and that either are very painful or seriously impair function.

Neuralgia.—This distressing affliction requires expert diagnosis. In some instances the pain is due to infection associated with teeth, but many times a neuritis or trifacial neuralgia is the basic cause. The nerve branches involved are injected or removed.

Professional Organizations.—In the United States, the American Society of Oral Surgeons was founded in 1918. Members are elected after passing an examination; they must have confined their practice exclusively to oral surgery for at least five years. A certifying board conducts examinations for certification of specialists in oral surgery after they have had a minimum of three years of postgraduate oral surgical training in one of the university-sponsored training centres in the United States.

In Great Britain oral surgery has usually been performed either by surgeons or by medically qualified dental practitioners. In 1947 the Royal College of Surgeons of England instituted a fellowship in dental surgery, which is awarded after passage of primary and final examinations. This fellowship is now practically a requirement for a dentist who wishes to specialize in oral surgery. In 1949 the Royal College of Surgeons of Edinburgh also instituted a fellowship in dental surgery.

In western Europe, oral surgery is generally performed by medical practitioners who in some cases also have a dental qualification or training.

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ORAN (Algeria): *see* Ouahran.

ORANGE, HOUSE OF, the sovereign dynasty of the Netherlands, taking its name from the former principality of Orange, now included in the French *département* of Vaucluse (*see* Orange).

Counts of Orange were appointed in Carolingian times, but their successors' history is obscure. The rise of Orange to independence came about through the feudal disintegration of the kingdom of Arles (*q.v.*). While the counts of Toulouse from 1125 might claim suzerainty over Orange as part of their marquisate of Provence, the local heiress Tiburge in her will (*c.* 1150) declared herself an immediate vassal of the emperor; and the will of her son, the celebrated troubadour Raimbaut of Orange (d. 1173), who left his titles to his brother-in-law Bertrand des Baux (d. 1181), was in 1178 ratified by the Holy Roman emperor Frederick I Barbarossa, king of Arles. In the 1200s Bertrand's son Guilhem des Baux (d. 1218) was styling himself prince "by the grace of God"; and his successors, with their territory bounded north, east, and south by the Comtat Venaissin (papal from 1229) were not at first much troubled by France's vicariate over the kingdom of Arles (from 1378). Raymond des Baux, last prince of Bertrand's line, died in 1393, and his heiress Marie (d. 1417) brought the principality to her Burgundian husband Jean de Chalon (d. 1418). The House of Chalon, however, had to face intermittent French encroachments, and Philibert de Chalon, prince of Orange from 1502 (fifth in descent from Jean), reacted by attaching himself to the Habsburgs, in whose service he was killed in Italy in 1530.

Philibert was succeeded by his sister Claudia's son René of Nassau, who in 1538 succeeded his father, Henry III of Nassau-Dillenburg-Breda (*see* Nassau), not only in his German patrimony but also in scattered possessions in the Netherlands. Since René adhered to the Habsburgs, Orange was repeatedly occupied by the French. Dying in 1544, René bequeathed his titles to his 11-year-old cousin, reckoned as William I (*q.v.*) of Nassau-Orange.

Known as William the Silent, the prince of Orange played a crucial part in the revolt of the Netherlands against Spanish rule

(*see* NETHERLANDS, THE: *History*). His son Philip William, who succeeded to his titles in 1584, was taken to Madrid by the Spaniards and died unmarried in 1618. Then Philip William's halfbrother Maurice (*q.v.*), selfstyled "born prince of Orange" from 1586 and stadholder of several provinces of the Dutch republic, became prince by right. Frederick Henry (*q.v.*), who succeeded his halfbrother Maurice in 1625, was succeeded by his son William II (*q.v.*) in 1647.

William II died in 1650. His posthumous son William III held no office under the Dutch republic till 1672, when he was appointed to the posts of his ancestors in the face of the danger from France (*see* DUTCH WARS). Thereupon Orange, which the French had temporarily occupied in William's name early in the 1660s, was seized by France. Restored to William under the Peace of Nijmegen (1678), it was reoccupied by France in 1682 and restored again at the Peace of Rijswijk (1697), the prince having meanwhile become king of Great Britain in 1689 (*see* WILLIAM III).

William III died childless in 1702, during the War of the Spanish Succession. The principality was then disputed by rival claimants: John William Friso; Frederick I, king in Prussia, son of Frederick Henry's eldest daughter, Louise Henriette; and François Louis de Bourbon, prince de Conti, legatee of the House of Orléans-Longueville, which had counted Alix de Chalon, daughter of Marie des Baux, among its ancestresses. Conti, in possession, ceded his rights to Louis XIV of France in 1703. At the Peace of Utrecht (1713) the Prussian king Frederick William I acknowledged French sovereignty over Orange with the proviso that he should retain the title prince of Orange. After an interval from 1718, during which the princes de Conti were princes of Orange again under a French protectorate, the territory was put under direct French rule, as an exclave of Dauphiné, in 1731.

John William Friso's posthumous son William IV had not been a party to the Franco-Prussian settlement. In 1732, however, by treaty with Frederick William I, he secured most of the Nassau possessions in the Netherlands and likewise acknowledgment of his right to style himself prince of Orange.

Hereditary stadholder of the United Provinces from 1747, William IV was succeeded by his son William V. The latter's son and successor William VI became sovereign prince of the Netherlands in 1814 and king in 1815, as William I. He and his successors, William II and William III, were also grand dukes of Luxembourg; and the title prince of Orange was borne by heirs apparent to the throne. With King William III the male line died out in 1890; but Queen Wilhelmina decreed in 1908 that her descendants should be styled princes and princesses of Orange-Nassau.

ORANGE, a town of France in the *département* of Vaucluse, 17 mi. (27 km.) N of Avignon. Pop. (1962) 17,202. Served by rail and by national road, Orange stands at some distance from the left bank of the Rhône, amid meadows, orchards, and mulberry plantations, watered by the Meyne and overlooked by Mont Ventoux. The modern town exactly covers the ancient and medieval towns, but the residential quarters extend beyond this limit. Orange has grown up around its chief Roman monuments, the theatre and the temple. Little is left of the temple—only the podium (dais) and the lower structures. In length 40 m., in width 25 m., it stood in a paved courtyard, enclosed by a colonnade. From the temple yard rose two ramps, with stairs, which led to the capitol of the colony, on a hill overlooking the town. The foundations of the capitol are adjacent to the ruins of a medieval donjon and a 19th-century colossal statue of the Virgin. The theatre was built probably at the height of the empire. The semicircular portion, backed against a small hill, consists of seats (rebuilt) in tiers; a great wall, 103 m. long and 35 m. high, in a perfect state of preservation, closes the semicircle. In front of it, the yard, shaped like a peristyle, was connected with the stage by three large doors. Plays are staged at the theatre in August. (*See* also THEATRES [STRUCTURES].) Orange also has a Roman triumphal arch, on the Lyons road.

Orange is an important military station. As the centre of an agricultural region, it has always been chiefly a market town, the most significant agricultural products being early vegetables, millet, and cattle. Industrial products are brooms, preserved fruits and jams, shoes, and Angora wool. Orange is also at the centre of a region served by atomic power stations.

Orange (Arausio), capital of the Cavari, was in 105 B.C. the scene of the defeat of a Roman army by the Cimbri and Teutones. After Caesar it became an important Roman colony. Its ramparts and buildings were partly destroyed by the Alamanni and Visigoths and partly ruined by the building that was carried on in the Middle Ages. Orange became the seat of an independent countship in the 11th century, and later of a principality (for history, *see* ORANGE, HOUSE OF). In 1623 Maurice of Nassau fortified Orange, an islet of Protestantism in a Catholic country, but the donjon was destroyed in 1660 by order of Louis XIV. In 1672 Orange came under the rule of France. (St. R.-R.)

ORANGE, a city of Orange county, Calif., U.S., located 34 mi. SE of Los Angeles and just north of Santa Ana, has an average year-round temperature of 62° F. Situated in an orange-growing area, it was named after that crop. On July 1, 1810, the Spanish government granted Antonio Yorba and Juan Pablo Peralta the Rancho Santiago de Santa Ana, which included what is now Orange. A. B. Chapman and Andrew Glassell, law partners, received tracts of this land in payment of fees due them and founded the town as Richland in 1868. In 1871, the original townsite was laid out. The name was changed from Richland to Orange in 1875, and the town was incorporated in 1888.

The city is a centre of citrus- and walnut-packing, has aircraft, electronics, and other manufacturing industries, and is the home of Chapman College (founded 1861).

For comparative population figures *see* table in CALIFORNIA: *Population*. (B. J. OR.)

ORANGE, a city of Essex County, N.J., U.S., 12 mi. W of New York City and 4 mi. W of Newark, N.J., was named Mountain Plantation from the time of its original settlement in 1678, until its present name was adopted to honour William, prince of Orange, who became King William III of England. The city has been a centre for the making of hats since 1785.

The completion of the Morris and Essex Railroad, later a division of the Delaware, Lackawanna, and Western, in the 1830s, not only created an expanded market for the hatters of Orange but also brought the first commuters.

Long a part of Newark, Orange became a separate community in 1806. It was incorporated as a town in 1860, was chartered as a city in 1872 and adopted the commission form of government in 1914. It originally included within its boundaries the present municipalities of East Orange, West Orange, South Orange, and Maplewood. The five form a socioeconomic community that is unique in the U.S. They contain some industry, and plants in Orange manufacture calculating machines, aircraft parts, pharmaceuticals, and wearing apparel; but they are primarily residential suburbs of New York City and Newark, N.J.

For comparative population figures *see* table in NEW JERSEY: *Population*. (E. R. D.)

ORANGE, a city on the eastern boundary of Texas, U.S., and county seat of Orange county, lies at the head of the Sabine river; its deepwater harbour (32 ft.), which handles more than 1,000,000 tons a year, is connected with the Gulf of Mexico by the Sabine-Neches waterway.

The name of the settlement of Orange, originally called Green's Bluff, was changed to Madison in 1840 in honour of Pres. James Madison. In 1858 the city's name was changed to Orange to avoid confusion with another Texas town, Madisonville. By 1860 the Texas and New Orleans railroad was completed as far west as Orange. While the Civil War years marked a sharp decline in the activities of the town, recovery began in 1881.

Shipping and lumber were the pioneer industries, steam sawmills being used as early as 1840. In the years of World Wars I and II shipbuilding was a major industry; during the boom of World War II the population reached 60,000. After World War II the United States navy maintained a naval station and a "mothball fleet" at Orange.

Located in an area of major gas and oil fields, key industries include a large chemical plant manufacturing nylon, methanol and plastics; other industries consist of shipbuilding, steel fabricating,

pulp and paper, seafood canning, lumber and milling, rice processing and cement manufacturing.

The council-manager form of government was adopted in 1954. For comparative population figures *see* table in TEXAS: *Population*. (E. W. F.)

ORANGE, any of several species of small tropical and subtropical trees or shrubs of the genus *Citrus* (family Rutaceae) and their nearly round fruits, which, like those of other members of the genus—lemon, grapefruit, kumquat, citron, lime, shaddock (*qq.v.*)—have leathery and oily outer rinds and edible, juicy inner flesh. The species of orange most important commercially are the China orange (*C. sinensis*), which is the sweet or common orange; the mandarin orange (*C. reticulata*), some varieties of which are called tangerines; and the sour orange (*C. aurantium*), which is grown to a smaller extent than the common and mandarin oranges.

History.—The species of orange are believed to be native to the tropical regions of Asia and especially the Malay archipelago. Oranges have spread from these regions to practically all sections of the world that have suitable climates. Along with other citrus species oranges have been cultivated from remote ages, and records of the early distribution from the original habitat to nearby countries are incomplete and fragmentary. It appears that orange culture spread from its native habitat to India, the east coast of Africa and from there to the eastern Mediterranean region. Samuel

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BLOSSOMS AND FRUIT OF THE SWEET OR COMMON ORANGE TREE (CITRUS SINENSIS)

Tolkowsky in his book on the history of citrus fruits (see *Bibliography*, below) concluded that by the middle of the 1st century A.D. orange trees were being cultivated in Italy. Probably the four human activities that contributed most to the early spread and appreciation of oranges were: (1) the Roman conquests; (2) the Arab trade routes; (3) the following of and expansion of Islam entirely around the Mediterranean sea except the French and Italian coasts; and (4) the crusades. By the time Columbus sailed on his voyage of discovery, orange trees were common in the Canary Islands.

Oranges were introduced into the western hemisphere by Columbus when he established a settlement on the island of Hispaniola, Nov. 22, 1493, on his second expedition. The orange seeds for this first planting were obtained from the island of Gomera in the Canaries.

One of the first mentions of citrus trees being planted on continental America is to be found in an old manuscript in the official archives of Guatemala. In this manuscript, written in 1568 by Bernal Díaz del Castillo, is a direct reference to planting orange seeds in 1518. The coast of Darién (Panama) was reconnoitered by Rodrigo de Bastidas as early as 1501, and a permanent settlement was made in 1509. It seems certain that orange seeds and plants were taken by this expedition and planted at Caribana, Nombre de Dios and Graba. Oranges are among other citrus trees reported growing at Caribana as early as 1516. It seems probable, therefore, that additional references may be found to planting of oranges earlier than the time shown by the Díaz record.

Orange culture spread to South America by the middle of the 16th century. The exact date of the introduction of oranges into Florida is not known. A statement was made by Pedro Menendez at St. Augustine on April 2, 1579, that "There are beginning to be many of the fruits of Spain, such as figs, pomegranates, oranges, grapes, in great quantity. . . ." From this it may be assumed justifiably that oranges were introduced into Florida when St. Augustine was first settled in 1565. Two centuries later, wild citrus trees were to be found in various parts of the state.

Orange culture was introduced into Arizona on the establishment of the early missions between 1707 and 1710, and into California at the date of the establishment of the first mission in San Diego in 1769.

In the 18th century the orange tree became a favourite object of conservatory growth in England; in the open air, in protected locations, it has often stood the cold of many seasons in the southern English counties and has occasionally borne abundant fruit. The orange has usually been cultivated in England, however, for the beauty of the plant and the fragrance of the blossoms, rather than for the supply of edible fruit. In garden culture in southern Europe, the orange is sometimes trained as an espalier, and with careful attention yields fruit in great profusion when thus grown.

Oranges are extensively cultivated in certain regions of tropical and subtropical Americas, northern and eastern Mediterranean, Australia and South Africa.

Plant Characteristics.—*Growth Form.*—The tree of the sweet orange (*Citrus sinensis*) often grows to a height of 20 ft. and sometimes attains 35 ft. The broad, glossy evergreen leaves are medium sized and ovate; petioles (leaf stalks) have narrow wings. The white flowers are very fragrant. Although the usual shape of the sweet orange fruit is round, certain varieties are greatly elongated and others much flattened; several (*e.g.*, the Washington Navel) have a conical protuberance, the navel, at the apex. The pulp of the sweet orange is agreeably acidulous and sweet, the peel is comparatively smooth, and the oil glands are convex.

The mandarin orange (*Citrus reticulata*) was formerly classified as a variety of *C. nobilis*. Mandarin orange trees are smaller than those of sweet or sour oranges, the twigs are slender and the leaves lance-shaped. The fruit is somewhat flattened at either end, with very thin loose peel, easily separated from the segments —giving them the name kid-glove oranges—and is bright orange colour when ripe. Some varieties, especially tangerines, are decidedly reddish tinted; the segments are readily separated from each other and the flavour is mild and pleasing. Some varieties, such as Satsuma, are seedless.

The tree of the sour orange (*Citrus aurantium*), also called Seville, bigarade or bitter orange, rarely exceeds 25 ft. in height. The green shoots bear sharp axillary thorns. Leaf colour is a glossy dark green; petioles are more broadly winged than those of the sweet orange. Mature fruit is slightly depressed at both ends and sometimes nippled at the apex; the fruit surface is rough, dotted closely with concave oil glands. The fruit at maturity is brilliant orange with a slight reddish tint. The pulp of the sour orange is only moderately juicy, relatively low in sugar and decidedly acid flavoured (3.5% to 4.5% acid); seeds are numerous.

These three species of orange reproduce themselves true to type, in most cases, by seed; and, where hybridizing is prevented, the seedlings of the sweet, mandarin and sour oranges retain the more distinctive features of their respective parent plants.

The Fruit and Its Composition.—The fruit of the orange is, botanically speaking, a special type of berry called a hesperidium (*see* FRUIT: *Fleshy Fruits*). The peel, composed of two distinct portions, the flavedo and the albedo, is easily separated from the pulp, the edible portion of the fruit. The flavedo (epicarp), the outer portion of the peel, is composed chiefly of carotenoid pigments, vitamins, and essential oils. The albedo (mesocarp), the spongy inner portion of the peel, is composed chiefly of celluloses, soluble carbohydrates, pectic substances (protopectin and pectin),

flavonoids, amino acids and vitamins.

The pulp (endocarp) of citrus fruits, unlike that of most edible fruits, is divided into segments (carpels), the walls of which are not readily permeable; each segment is composed of hundreds of vesicles (juice sacs), the walls of which are still more impermeable, especially laterally. The vesicles are composed of celluloses, hemicelluloses, protopectin, pectin, sugars, flavonoids, amino acids, vitamin C, mineral salts and other nutrients. The juice, which is located in the vesicles, contains soluble constituents composed of soluble carbohydrates (glucose, fructose, and sucrose), organic acids (chiefly citric acids), vitamin C, vitamin B complex, mineral salts, a small concentration of pectic materials and many other nutrients. (L. D. B.; W. B. Sr.)

Varieties.—More than a hundred varieties of sweet and mandarin oranges have been recorded. In the older orange-growing countries of the Mediterranean region the best-known varieties include the Jaffa types, the most important and desirable of which is the Shamouti. The typical Shamouti is rather elongated, seedless, juicy with a skin about a quarter of an inch thick. The tree bears prolifically with a tendency for the fruits to be in clusters. The Belladi, a somewhat similar though inferior orange, is spherical and very thin-skinned but contains many seeds.

Two of the most important varieties of sweet orange, both of which have greatly spurred commercial orange production in the Americas and in South Africa and Australia, are the Washington Navel, which originated in Bahia, Brazil, and the Valencia Late, which is believed to have originated in Spain. The former is the principal winter variety grown in California and Arizona and the latter the principal summer variety. Among varieties favoured in Florida are Hamlin, Pineapple, Parson Brown and Homosassa. In South Africa, Mediterranean Sweet and Pineapple are favoured in some areas. Lue Gim Gong is of more recent origin. In Australia the two most extensively cultivated varieties of orange are Washington Navel and Valencia Late. In the Gayndah district of Queensland, the Ellendale mandarin grows to perfection, producing large fruits of excellent quality. The Beauty of Glen Retreat mandarin is also much favoured.

Blood oranges are much grown in Italy, Malta and adjoining countries. Many people regard them as the best of oranges for flavour though they have not become popular in the U.S. They are generally small or of medium size only. The skin and flesh are marked or streaked with red and there are few seeds. The tree is small and compact, with small leaves. Among tangerines the Dancy is a popular variety, much grown in Florida. A new hybrid citrus fruit rather like an orange but with a distinctive flavour is the Ortanique, a hybrid between a sweet orange and a tangerine. Another hybrid like a giant mandarin, grown in Jamaica, is the Ugli, a hybrid between a mandarin and grapefruit. (F. N. H.)

Another loose-skinned type of orange of the mandarin group is the Satsuma, which was introduced into the United States in 1876 from Japan, where it is widely grown. Satsumas ripen earlier in the fall and are more resistant to frost than other commercially grown citrus fruit. They have been rather extensively grown in certain areas bordering the Gulf of Mexico, where it is too cold for the production of sweet oranges, but freezes during the two decades 1922–42 greatly reduced the acreage.

Mandarin oranges are highly prized as dessert fruits because of their attractive appearance and because their loose skin and easily separable segments make them easy to handle. The mandarins are lower in vitamin C content than are sweet oranges, lemons or grapefruit.

The Calamondin orange appears to be a variant mutation from some mandarin type with small fruit containing 7 to 10 segments. The tree is quite cold resistant, being apparently as hardy as the Satsuma, and it is grown in various parts of the United States as an ornamental tree.

The sour orange is grown to some extent in all citrus-producing sections, but its production on a commercial scale has been mainly limited to southern Spain, where it was first planted by the Moorish conquerors. The most important commercial use of the fruit is in the manufacture of marmalade. The sour orange in general is too acid and bitter for use as a fresh fruit; the juice, however, has a distinctive flavour which makes it a pleasing addition to certain beverages.

The fruit is also used in making confections, liqueurs (curaçao) and other drinks. The fruit and leaves are used in making a number of medicinal preparations, and the flowers, leaves and fruits yield volatile oils (bigarade oils) of characteristic odour, much prized for perfumes.

The oranges of the bergamot group (*Citrus bergamia*) are largely grown in southern Italy and Sicily for the essential oil that is expressed from the peel for making perfume. The bergamot group is thought to be of hybrid origin, with the sour orange as one of the parent species.

Cultivation.—Oranges are not strictly tropical plants, and they thrive best where the trees are chilled somewhat by occasional slight night frosts in winter. The trees are semidormant at that season, and temperatures as low as 30° to 28° F. will not harm trees or fruits unless frost occurs early, before the trees have finished their annual growth. On the coldest sites, some means of heating the orchards is resorted to in California, and, to a lesser degree, in Florida. In such cases the critical temperature is 26° F. In California, the usual practice is to burn petroleum oil in small five- to eight-gallon-capacity heaters (40 to 50 per acre); and to use large power-driven fans mounted on permanent towers for raising orchard temperatures as much as 8° F. under ideal conditions of temperature inversion; in Florida, pine or oak wood is the most widely used fuel.

The orange thrives in a wide range of soil conditions, from extremely sandy soils to rather heavy clay loams; it grows especially well in the intermediate types of soil. Orange orchards are generally planted in relatively deep soil where drainage is good. The orange trees are usually budded on stocks grown from the seed of selected trees of mandarin, sour or sweet orange, or the so-called Rough lemon. The seeds are sown in well-prepared soil in a lath house; after about 12 months' growth there, the seedlings are removed to a nursery.

After 12 to 16 months in the nursery, the trees, then about $\frac{3}{8}$ in. in diameter at a distance 6 in. above the ground, are usually large enough to bud. When the budded tops are one to two years old, the trees are large enough to plant in the orchard. The number of trees planted per acre in the United States ranges from 48 to 110, depending upon vigour and variety and upon the method of culture. In Israel and other Mediterranean countries, orange trees are generally spaced three to four metres apart.

The culture of intercrops, such as beans, tomatoes or melons, helps to provide favourable conditions for the young orange trees for the first five or six years, until they reach the age of profitable production. The growth of cover crops during the winter months in California, and during the summer months in Florida, prevents erosion damage and makes use of the seasonal rainfall for the production of organic matter to be incorporated into the soil. In California, approximately 50% of the orchards have no cover crops and are noncultivated, which results in the reduction of soil compaction with an increase of water penetration to the root zone. In addition to organic material supplied by cover crops, it is essential to use relatively large amounts of fertilizers, such as various nitrogenous materials; in Florida, applications of phosphate and potash are essential. Some of the minor nutritional elements, especially zinc, copper, manganese and magnesium, are frequently lacking in citrus soils, and small applications are then necessary. In many areas where oranges are grown, it is necessary to supplement the rainfall with irrigation; this is generally the practice in California, Texas, Palestine, Spain, Morocco and parts of South Africa. Orange trees will continue to bear abundantly from 50 to 80 years or even more, and some old orange trees whose age must be reckoned by centuries still produce crops. These very ancient trees are generally of the sour orange and have probably been frozen back and then rejuvenated by sprouts from near the ground. Sweet orange trees growing under orchard conditions occasionally acquire a considerable size; a 67-year-old sweet orange tree near Pasadena, Calif., had a spread of 36½ ft.; its height was 33 ft., and its circumference 1 ft. above ground was 5 ft. 7 in.

Harvesting.—Oranges are picked when fully ripe, for, unlike

some deciduous fruits, they do not ripen or improve in quality after being picked. In the United States it is unlawful to sell oranges until they have reached a certain state of maturity, determined by the ratio of total soluble solids to acids in the fruit juice. In California the fruit must attain a maturity ratio of soluble solids to acids of 8:1 before it may be lawfully sold. As 80% to 85% of the soluble materials are sugars, and citric acid is the principle that gives oranges the typical mildly acid flavour, this ratio is often erroneously spoken of as the sugar-to-acid ratio.

In some sections oranges can be left on the trees for five to six months after they become mature enough to eat; during this period the sugars increase and the acids decrease, so that the ratio of soluble solids to acids at the end of the picking season is sometimes as high as 17:1. The vitamin content of oranges declines as the fruit becomes overmature.

Oranges are carefully handled during the picking and packing operations to prevent them from being punctured, scratched, bruised or scarred by abrasions. This care is necessary to prevent losses from decay caused by various molds, such as blue mold and other fungus organisms, which are widely distributed. The normal unbroken surface of the peel of the orange is very resistant to such diseases, but they readily gain entrance to the very susceptible inner portion of the peel and to the pulp of the fruit if the surface of the peel is injured even in the most minute way. To prevent such injury, and to prevent scarring of the fruit by the fingernails, oranges are picked by well-trained workmen wearing cloth gloves. The orange is removed from the twig by clipping the stem as close to the fruit as practicable. By this care in handling, millions of dollars worth of fruit is saved that otherwise would be lost by decay.

Packing.—As the oranges pass through the packing house, they are handled largely by machinery, from the time the field boxes are dumped until the fruit is finally ready for packing in the shipping boxes. The usual processes through which the fruit goes in the packing house are: (1) doused in hot soapy water (115° F.); (2) cleaned as it passes under revolving brushes; (3) rinsed in clear water and brushed simultaneously; (4) rinsed in water and borax solution; (5) rinsed in clear water; (6) dried by passing on a belt conveyor through a tunnel through which air is forced at a high velocity; (7) culled by hand as it passes over a belt conveyor; (8) graded for size; and (9) packed in wooden boxes or cartons. In many packing houses supplementary aids, such as biphenyl, are used in the cartons to prevent decay of the oranges. A very thin layer of wax is applied to most oranges to prevent undue drying in transit or in the market.

ORANGE PESTS AND DISEASES

Pests.—The insect pests most commonly troublesome to oranges in California are five species of scale: California red scale (*Aonidiella aurantii*), black scale (*Saissetia oleae*), yellow scale (*Aonidiella citrina*), purple scale (*Lepdiosaphes beckii*) and citricola scale (*Coccus pseudomagnoliarum*). Several species of mealy bugs cause damage during some seasons, but, because of parasites and predators, they are not so generally harmful as the scale insects. In some districts in California, the citrus thrips (*Scirtothrips citri*) are a serious pest.

The citrus red mite (*Panonychus citri*), an arachnid, as well as aphids and other injurious insects may be controlled by pesticides. Other especially important pests are the Mexican fruit fly (*Anastrepha ludens*) in Texas and the citrus rust mite (*Phyllocoptes oleivorus*), citrus white fly (*Dialeurodes citri*), Florida red scale (*Chrysomphalus aonidum*) and also purple scale in Florida. The control of insect pests in all citrus-producing areas is one of the most difficult and expensive factors in the commercial production of oranges.

One of the serious pests of oranges in subtropical areas of the world is the Mediterranean fruit fly (*Ceratitis capitata*). The fly lays its eggs in the peel of the fruit and the larvae develop in the pulp.

Most of the insect pests, as well as the various mites, are usually controlled satisfactorily by sprays or dusts. Applications are usually made with fully mechanized sprayers or dusters mounted on trucks or drawn by tractors. Mist spraying or dusting for the control of mites, thrips or certain other pests is sometimes done by properly equipped aircraft. One of the spray materials most commonly used for scale control is petroleum oil. Highly refined, light-medium or medium-grade oils applied at concentrations of 1½% to 2% in aqueous emulsions are in use. Organic phosphorus compounds, such as malathion or parathion, have been used extensively in recent years, either alone or in combination with the petroleum oils. Other materials used principally for mite control include dinitro-o-cyclohexylphenol, Ovotran, demeton, Chlorobenzilate, zineb and Kelthane. Demeton has also been used effectively for aphid control.

Fungus Diseases.—Several diseases of fungus or virus origin are generally distributed over most of the subtropical areas where oranges are grown. One of the most troublesome of these diseases, brown-rot gummosis or foot rot, is caused by several species of fungi (*Phytophthora species*). This disease affects the lower trunk and the crown roots of the tree and also produces a brown rot on the fruit, while it is still on the trees, in those years when weather is especially damp during the picking season. *Phytophthora* decays also cause loss of picked fruit. Spray mixtures in which copper is the lethal element are commonly used to spray the lower part of the tree, as the splashing of rain spreads the fungus spores most readily to the low-hanging fruits. When the disease is present on the crown roots and trunk, the tree has a devitalized appearance characterized by poor growth, pale small leaves and more than the normal number of dead twigs. The affected crown has dark-coloured areas from which gum exudes; beneath these areas the cambium is dead and discoloured. If not cut out and disinfected, the diseased areas continue to enlarge and finally girdle the tree. Preventive measures consist in avoiding both too deep planting and excessive water next to the trunk.

Loss of fruit in storage and transit is caused by rots produced by *Phytophthora* species, green mold (*Penicillium digitatum*), blue mold (*P. italicum*), black rot (*Alternaria citri*) and others. Loss from these diseases is greatly reduced by the care exercised in handling the fruit during picking and packing.

Virus Diseases.—The most devastating virus disease is *tristeza*, occurring in Florida, California, Africa, South America and Java. It is spread by propagating from diseased trees and also by two species of aphids. Trees are killed suddenly by this disease. Another virus disease is psorosis, formerly called scaly bark in California. Seriously affected trees become valueless. The disease is spread largely by propagating from diseased trees, and may be avoided by care in selecting healthy trees from which to take buds.

ORANGE PRODUCTION AND USE

The sweet orange and the mandarin orange are the principal species produced commercially in the following countries, listed in order of importance in the early 1960s: the United States, Brazil, Spain, Italy, Japan, Mexico, Argentina, Algeria, Egypt and Israel. The world production of oranges, of these and other countries, ranges from the equivalent of 332,000,000 to 352,000,000 boxes (70 lb. each) annually. This enormous production of oranges, in comparison with that of other citrus fruits, is evidence of their world-wide popularity. Florida, California, Texas and Arizona, in that order, are the principal producing states of the United States.

(L. D. B.; W. B. SR.)

Israel has a very high production of oranges in proportion to its size. Efficient methods of cultivation and irrigation have made citrus production one of the mainstays of the country's economy. Oranges are normally shipped from November to April. The fruit of the Jaffa orange is free of rag (inner skin), virtually seedless, of good size and very sweet and juicy. Israel competes in the European market with Italy and Spain but has the advantage of higher average quality of fruit.

In Australia oranges are grown on a commercial scale in many areas where climate and soil conditions are suitable, both under irrigation, where top quality fruit is produced, and under natural rainfall conditions in the coastal belts. There are important citrus-growing areas in Queensland, New South Wales and Victoria.

In South Africa there has been a flourishing orange industry

with exports to Britain and other countries for many years. The first orange trees were brought from the island of St. Helena to the Cape in 1654. The *voortrekkers* are credited with taking the first orange trees from the Cape to the Transvaal by ox-wagon immediately following the Great Trek, which began in 1835. There are large commercial orange orchards in the Transvaal.

(F. N. H.)

Prior to 1920 the orange was considered principally as a dessert fruit. The drinking of orange juice, in contrast with the eating of the fresh fruit, was a major factor in the increase in per capita consumption. Another important factor was the increase in knowledge of the dietary value of all citrus fruit. One of the primary reasons for the important dietary value of oranges is their high vitamin C content. Research showed the added value of citrus bioflavonoids from the pulp of oranges. This greatly increases the beneficial effectiveness of vitamin C in the juice and pulp.

The most important product made from oranges in the United States is frozen concentrated juice, nearly 40% of the crop being used for this purpose. Essential oils, pectin, candied peel and orange marmalade are among the important by-products. Stock feed is made from the waste material left from the processing of some of the aforementioned articles. This dried residue, known as orange meal, compares favourably with beet pulp and other semiconcentrates used as stock feeds and conditioners in preparing cattle for market.

See also references under "Orange" in the Index.

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ORANGE, COUNCILS OF. Two church synods were held at Orange, in southern France, in 441 and 529. The first, under the presidency of St. Hilary of Arles, dealt mainly with disciplinary matters. The second, and by far the more important, was concerned with refuting the Semi-Pelagianism of Faustus of Riez (*see* Faustus, Saint). Under the presidency of Caesarius of Arles, 15 bishops assembled primarily to dedicate a church. Caesarius had sought the aid of Rome against Semi-Pelagianism, and in response Pope Felix IV had sent certain *capitula* concerning grace and free will, drawn chiefly from the writings of Augustine and Prosper of Aquitaine. The synod subscribed 25 of these and adopted a supplementary statement reaffirming the Augustinian doctrines of corruption, human inability, prevenient grace and baptismal regeneration. Its decrees were later confirmed by Pope Boniface II, and they have become the Roman Catholic norm for doctrines on grace, predestination and free will. *See* Semi-Pelagianism.

ORANGE FREE STATE (Oranje Vrystaat) is the second smallest of the four provinces of the Republic of South Africa, having an area of 49,866 sq.mi., a little more than one-tenth of the republic. Its northern and northwestern boundary is the Vaal river and its headwater the Klip river. The western boundary is to some extent arbitrary, the Keate award of 1871 excluding the Kimberley diamond mines. To the south the boundary is the Orange river; to the east the boundary lies for most of its course along the Caledon river, to the north of which it follows the crest of the Low Drakensberg. The capital is Bloemfontein.

PHYSICAL FEATURES

Landforms and Drainage.—The structure is remarkably uniform: almost horizontal beds of Karroo sandstone and shale, with occasional sheets and dikes of dolerite cover the deeply buried pre-Karroo Ventersdorp and Witwatersrand formations. The surface is therefore even, broken only here and there by hills and kopjes ("hillocks") formed by outcrops of the harder sandstones or dolerite. To the east, the uppermost (Stormberg) sandstones and lavas introduce a new topographic element, the surface becoming more broken as it rises eastward to the Basuto highlands and many tabular mountains stand out. Of this type is Thaba 'Nchu (Black mountain) to the east of Bloemfontein, and the Witteberge (White mountains) and Rooiberge (Red mountains) to the north and northeast of Ficksburg. The surface of the province rises from the west, where its altitude is about 4,000 ft., to the east where its altitude is between 5,000 and 6,000 ft. although some of the Stormberg sandstone ridges rise to over 7,000 ft.

The province is drained by the tributaries of the Orange and Vaal rivers including the Modder, Riet, Caledon and Wilge.

Climate.—Temperatures vary slightly according to altitude. Mean January temperatures in the west are between 24° and 27° C. (75°–80° F.) and in the east between 18° and 21° C. (65°–70° F.). July averages are between about 7° and 9° C. (45°–48° F.) over most of the province except in the east where they fall below 7° C. (45° F.). Frost periods last rather less than 120 days in the west and about 150 days in the east. Rainfall occurs mainly in the summer and decreases from the east, where it is about 30 in. (Vrede, 28 in.), to the southwest where it is about 15 in. (Koffiefontein, 16 in.). An important feature of the rainfall incidence is the advance of the rain during the season from the east, so that the eastern part of the province generally receives earlier rains. The rains also retreat eastward at the end of the season, giving the eastern areas later rains than the western. This makes the eastern areas suitable for winter wheat growing.

Soils.—The soils vary from sandy types in the west (the sandveld) to heavier and more clayey soils in the middle and eastern areas. The western sandy soils are too light for good cropping under the existing marginal amounts of rainfall; in the middle and east the soils are classified as "gley-like podsolic soils": they are always most fertile in the vicinity of dolerite outcrops. In the southeast is a considerable area of solonetzic or alkali soils which are liable to deflocculate, or break up into fine particles, becoming impervious to water.

Vegetation and Animal Life.—Except for a small area of Kalahari thornveld in the west, and mixed Karroo in the southwest, the province is grass covered, the grass being "sweet" (*i.e.*, nutritious and palatable in the winter) in the west, "sour" (unnutritious and unpalatable in the winter) in the northeast and of mixed types over the greater part of the province.

The area was formerly the home of great herds of African antelopes (*see* South Africa, Republic of: *Animal Life*) which have now been eliminated except in places where they have been specially protected. Since 1924 the Free State game reserve, an area of about 25,000 ac. to the northwest of Winberg, has given protection to the blesbok and springbok of the area, to which have been added eland, black wildebeest, red hartebeest and zebra. The smaller Franklin game reserve on Naval hill, Bloemfontein, was established in 1928 and contains springbok, blesbok, zebra, eland, duiker, steenbok, rheebok and fallow deer. (J. H. Wn.)

HISTORY

At the beginning of the 19th century the great plateau between the Vaal, the Orange and the Drakensberg mountains was a no-man's-land, and the passes over the Drakensberg the haunt of cannibals and assassins. The indigenous tribal structure, mainly Bechuana (Tswana), had been broken by refugee Zulu impis (warrior regiments) that attacked and despoiled each other in the wilderness that they created. Matiwana between 1818 and 1829 ravaged the whole of the territory, annihilated Mpanazita at Mekwatleng (20 mi. N. of Ladybrand) and scattered the remnants of his tribe from the Vaal to Queenstown. Pursued by Shaka's impis, he fled across the Orange. His forces harried Pondoland but, mistaken for Shaka's, were dispersed by an expedition from the Cape. Equally formidable was the young Sikonyela and his mother Mantatisi, the amazon and witch who guided the last stand of the Batlokwa (Tlokwa) tribe.

There seem to have been only two stable focal points in the area. Immediately north of the Orange river, on both sides of the Vaal (in the Campbell lands; in the modern Griqualand West; and round Philippolis between the Orange and the Riet), there were

contiguous Griqua settlements, protected by the formidable missionary John Philip and encouraged by the government at the Cape as a buffer against incursions from the north. The Griqua frontiers fluctuated with their power, which, as they were the only people north of the Orange armed with rifles and as they were used to commando tactics, was greater than their numbers (*see* GRIQUALAND EAST AND GRIQUALAND WEST). The second nebular state was to the east, where, on the rocky slopes of the Drakensberg, Moshesh (*q.v.*) had rallied shattered groups of Bechuana and was forging the Basuto (Sotho) nation. When times were favourable, his family with their followers diffused over the fertile Caledon plains and peacefully surrounded the territories of minor rivals. Moshesh used tribal structure as the basis of a new diplomacy at a time when the whole political geography of the Transorangia was fluid and chaotic. In the 1830s systematic penetration of the lands across the Orange river began from the south. Missionaries, mainly Wesleyan in the west and Paris evangelicals in the east, embarked on a double and often rival program of conversion and settlement for displaced tribal groups. But even earlier than the Griqua settlement (1803) and the missionary penetration, a new kind of infiltration had begun, also from the south. Hunters and explorers had reported that there were great uninhabited plains north of the Orange river and fertile soil in the Caledon area. The trekboers (nomadic pastoral farmers), ever questing after new pastures and new land to farm, began seasonal grazing across the Orange and then, by what they defined as grant and purchase (though often there was no written deed), procured lands from the Griquas or squatted in the Caledon area. Thus, while the Cape government strove to make a stable frontier at the Fish river, the frontier became increasingly an administrative myth. Then, in 1835, Lord Glenelg advised Sir Benjamin d'Urban to abandon the newly annexed province of Queen Adelaide, and the retraction of the frontier was the signal for the Great Trek (*see* CAPE OF GOOD HOPE). North of the Orange river the cautious probing of the trekboers was engulfed in the exodus of about 2,000 frontier folk, mainly Boers, lured by the prospect of more land and impelled by resentment against British colonial policy in the Cape. It was the beginning of an invasion and revolution that altered the structure and to a great extent determined the future development of Transorangia.

A. H. Potgieter and his trekkers were assisted by the Barolong chief Moroka at Thaba 'Nchu. After initial reverses the trekkers mapped out and planned a republic, but dissensions led to a forking of their enterprise. While a core remained in the Winburg region, one branch pushed north across the Vaal and another, under Potgieter and Piet Retief, crossed the Drakensberg into Zululand and Natal (*qq.v.*). After the massacre of Retief's party in 1838, the Natal trekkers made a treaty with Panda, who overthrew his brother Dingaan and rewarded them with the cession of most of Natal. There the trekkers organized a republic with its capital at Pietermaritzburg. Exiled tribes flocking back perturbed the trekkers, whose proposal to resettle them south of Natal in territory flanking Pondoland threatened a shunting movement that would have reacted on the frontier structure of the Eastern province. Though a philanthropic native policy was one of their objectives, it was probably this threat and, above all, commercial interests that induced the British to annex Natal in 1843. This, coupled with the announcement that there would be no colour bar in Natal and with the British attempt to resettle displaced Zulus there, determined many trekkers to abandon Natal as they had abandoned the Cape. The Boers recrossed the Drakensberg and concentrated, some across the Vaal and some at Winburg. Thus Winburg in 1843 as in 1837 was the axis of Boer republicanism. In the same way, for different reasons, Transorangia became the axial point of British colonial policy.

Legally the attitude of the British government was based on the Cape of Good Hope Punishment act, passed in 1836 to extend criminal jurisdiction to all British subjects as far north as latitude 25° S. In political terms, this meant that the emigrants were not considered to have shed their allegiance by shaking the dust of the colony off their feet. Such, however, was the sole object of a resolute body of the trekkers; and men like Andries Pretorius, who abandoned ten farms in Natal to struggle back across the Drakensberg, made desperate sacrifices for their ideals. But British policy also had ideals, namely the controlled sale of crown lands so that some were held in trusteeship, the protection and civilization of native peoples and the extension of democratic institutions in areas of consolidated white settlement. The principles of British policy, especially in the "hungry forties," were crippled by lack of financial resources and by the interplay of crosscurrents of opinion on a disintegrated party structure in Great Britain. Ill-informed but sincere and powerful missionary interests in England demanded ever more protection for natives, while the equal eloquence of the Manchester school of economists demanded retrenchment and reform. In the swirl a policy coherent in principle was often impotent, sometimes mischievous in practice. Logically the annexation of Natal should have been preceded by the annexation of Transorangia. Instead the period 1837–48 was a disastrous interregnum which helped to jeopardize the experimental annexation between 1848 and 1854.

Between 1837 and 1848 the British fumbled to find means of enforcing the Punishment act and stabilizing native territories without incurring the responsibilities of sovereignty. The Napier treaties with Adam Kok III (allied since 1838 to Waterboer) and with Moshesh in 1843 tried to fix frontiers and tenures which in fact ignored Boer claims as well as the claims of minor chieftains in the centre. The signatories were to enforce the Punishment act. This led to armed protest from the Boers and almost consolidated a Boer front against Great Britain, until armed clash was followed in June 1845 by the Maitland treaties at Touwfontein. These planned to divide native lands into two: an inalienable tribal block; and lands which could be leased, the quitrents from which were to be divided between the chief and the expenses of a British resident to be established in the territory. This was a step forward; but many Boers had already purchased land outright, the frontiers claimed by Adam Kok were dubious, and Moshesh, who claimed inalienable sovereignty over lands wherever his people had fought or planted, was systematically surrounding the lesser chiefs between the Basutos and the Griquas with Basuto settlers. Inevitably the treaties failed to give stability or security. Though H. D. Warden was installed as resident at Bloemfontein, he had no white garrison in the whole of the area. More and more Boers relied on private enterprise, indifferently co-ordinated from Winburg.

When Sir Henry (Harry) Smith was made governor of the Cape and high commissioner for South Africa in Dec. 1847, it seemed as if the problem of South Africa was to be treated as a whole and no longer in segments. He had vigour and popularity and, up to the limits allowed by the colonial office, the courage of his convictions. He rounded off the Kaffir War of 1846 by annexing the Stormberg area and Kaffraria to the Cape; he speeded up the land commission in Natal with consideration for Boer demands there; and, after a tour that included an interview with Andries Pretorius at the Tugela Drifts, he annexed Transorangia to the crown and proclaimed the Orange River sovereignty in Feb. 1848.

The Orange River Sovereignty, 1848–54.—Thereafter, until 1854 Great Britain sought to evolve an effective policy that would satisfy all groups at home and give firm ground to all in the quicksands of the new sovereignty. On frontier policy, all settlers on the fringes tended to think alike, whether Boer, Scots or English, so that a local patriotism independent of racial or political theory tended to crystalize at Bloemfontein as it had done in the Eastern province. When the annexation was proclaimed, because it seemed to promise security it was on the whole welcomed by the majority of the white settlers. The Boer settlers seem to have fallen into two groups (apart from an indeterminate and scattered number of pioneers, who were not politicians) the pre-Great Trek settlers and loyalists; and the minority of irreconcilables, concentrated mainly in the Winburg area, who were moved by almost religious conviction that the theory of British policy was wrong and that their spiritual freedom lay in their political extrication from its clutches. It was this Winburg section that summoned Pretorius from Magaliesburg to lead revolt. To make that revolt successful, negotiations were conducted not only with Moshesh but with Panda, their former ally.

Such a tactic, if successful, would have exposed the whole of the sovereignty to the ravages of Zulu impis. The means could neither have justified nor served the end. More, extremists like Willelm Jacobs and Gert Kruger resolved at Winburg (Feb. 1848) to punish with fine, confiscation and death Boers who refused to cooperate. Many who joined the revolt did so because of compulsion; others claimed that they had thought an armed remonstrance was all that was intended; Potgieter sent no assistance from Ohrigstad across the Vaal. Pretorius and his party, having evicted British officials from Winburg, drove the embryonic administration out of Bloemfontein and across the Orange, while loyalist Boers went into laager. When troops were available, Smith made a leisurely crossing of the Orange and advanced until attacked by Pretorius at Boomplaats (Aug. 1848). A vigorous skirmish of three hours culminated with the withdrawal of Pretorius across the Vaal with a price on his head. Two rebels taken in arms were shot and fines were levied, but there was no wholesale policy of total eviction. In the Cape, the children of Pretorius kept their extensive farms. Boomplaats, which was later to assume a distorted significance, cleared the air at the time; and when the Sand River convention with Pretorius secured the Klip river and Harrismith to the sovereignty in Jan. 1852, it was possible for the latter to develop as a distinct geographical and political entity.

The Orange River sovereignty was divided into four administrative districts, Bloemfontein, Smithfield (Caledon River), Winburg and Harrismith. Each was equipped with a minimum official staff, but only Bloemfontein maintained a garrison. The colonists were responsible under their field cornets for their own defense. Quitrents and traders' licences were the main source of the sovereignty's revenue. There was a central legislative council, nominated but two-thirds burgher. There was, however, no burgher representation on the executive until July 1853. Thus the official government tended to get out of touch with burgher sentiment when it sought to tackle the land question. In the 20th century the plan of administration would be described as one of reciprocal apartheid (*q.v.*): the native chiefs were to remain undisturbed within surveyed frontiers, while their "foreign relations" one with another were subject to British control; they were otherwise to be "self-governing" through tribal structure, which, however, it was hoped would be modified by missionary guidance. But this ambitious policy could not be enforced by an understaffed administration. Moroka and Sikonyela and other minor chiefs, supported in some cases by their several missionaries, contested the frontiers claimed by Moshesh and his missionaries. No less than six frontiers were proposed to edge the Basuto lands off, and the Warden line (1849) satisfied no one—least of all the white settlers, because it cut through the fertile Caledon farming area. Bickering led to a series of local wars in the course of which Moshesh smashed his rivals (including Sikonyela). The administration was helpless, as the burghers were reluctant in disturbed times to abandon their farms for commando duty to enforce a policy of delimitation that, though it gave them full legal title to their farms, ran contrary to their traditions.

Given time, resources and sympathy, a solution was, though difficult, not inconceivable in the sovereignty. Warden laid the foundation stone of the Dutch Reformed Church in Bloemfontein in 1849 and that of St. Andrew's cathedral in 1850. Settlers both Boer and British were trickling in, together with a sprinkling of foreign immigrants. The *Friend of the Sovereignty* was being printed in both Dutch and English. Special Commissioners W. S. Hogge and Mostyn Owen, who had sponsored Transvaal independence, could urge that the case of the sovereignty was different and that its evacuation would be a betrayal of responsibility. But like Earl Grey, his counterpart at the colonial office, Sir George Cathcart, who became high commissioner on Sir Henry Smith's recall in March 1852, was bent on withdrawal after an abortive attack on and defeat by Moshesh in the Berea district (Dec. 1852). In Sept. 1853 Sir George Clerk arrived with special powers to "settle and adjust the affairs of the Sovereignty." This was a euphemism for abandonment, a decision which the spectacle of Moshesh's private wars served to harden. A convention, elected on universal manhood suffrage, refused to vote itself into a republic. A public subscription raised enough to send the Rev. Andrew Murray and A. J. Fraser to England to protest against abandonment. Before they arrived in England, the die was cast. Clerk began importing supporters from the Transvaal to cabal for the negation of British policy in the sovereignty. A contrived assembly accepted the convention of Bloemfontein, which thrust independence on what was by then the Free State, in Feb. 1854. Ten months later, Sir George Grey arrived in South Africa as high commissioner, a year too late to save the sovereignty. Great Britain abandoned not only the sovereignty but also all existing treaties with native states north of the Orange river, save only those with Adam Kok. Clerk undertook to "establish affairs in Griqualand," but neither then nor in 1861 (when Kok sold the remnants of his land to the Free State) were the Griqua lands defined.

The Orange Free State Republic to 1900.—The constitution devised by the burghers in April 1854 was a blend of traditional Boer institutions with U.S. and Dutch constitutional theory. The unicameral *volksraad* (elected council) had parliamentary sovereignty with control over taxation and over legislation and the right to ratify treaties and to declare war. No constitutional change could be made without a three-quarter majority in favour in each of two succeeding annual sessions (in 1885 the high court was given power to decide whether a law was against the constitution). Franchise depended on the possession of burgher rights, which were limited to adult male Europeans, qualified either by birth, or by property or by residence. Executive power was vested in a president and an executive council. The president was elected by direct vote of qualified burghers for five years and was eligible for reelection. Roman-Dutch law was declared the law of the land, Dutch the official language. Equality before the law, freedom of association and freedom of the press were among the rights secured to burghers. The Dutch Reformed Church was to be promoted by the *volksraad*. Local government and defense turned on the traditional election of field cornets and all burghers were liable for commando duty. The judicial structure, central and local, and the provision of municipal boards followed the Cape pattern. The constitution was liberal and worked well. The small quorum of 12, however, tended at times to let power slip into the hands of an inner circle; but as new districts were created and controversial issues were raised, burghers in the outlying areas, who had at first regarded the constitution as a superfluous addition to the Ten Commandments, took a more active part in politics. Since, moreover, the representative structure of single-member constituencies was related not to population but to districts, a small town like Hoopstad with 30 voters came by the end of the century to have as much weight as a large city like Bloemfontein.

Until 1871, and to a certain extent throughout its existence, the Free State had the same problems that the sovereignty had had. The southern area looked to the Cape for its commerce and was influenced by Cape traditions, while the eastern and northern parts were dependent on the Harrismith route to Natal and had even closer links with the Transvaal—a cleavage corresponding to that between the Winburg and the sovereignty men. But wise leadership and the facing of common dangers welded the Free State for a time into what James Bryce, the British statesman, defined with confidence as a model state.

The first president (1854–55) was J. P. Hoffman, chosen for his reputed ability to cope with Moshesh; but his diplomatic present of a keg of gunpowder to the chief raised an outcry that forced him to resign. He was followed by the *voortrekker* J. N. Boshoff, formerly secretary to the Natal *raad*. M. W. Pretorius, of Potchefstroom, heir to the Winburg policy of his father Andries, tried by a coup at Rhenoster river (1857) to force the alignment of the Free State with Potchefstroom (Transvaal), but force was met by force and in June peace was made between the two republics, through whose histories, however, the idea of fusion was to run like a theme. Peace was timely, for Moshesh had seized the opportunity to pounce again. A bold Free State move against Moshesh's stronghold at Thaba Bosiu failed so completely that Boshoff appealed both to Pretorius and to Grey, and the *volksraad* passed a resolution in favour of confederation with the Cape.

Grey, convinced that the conventions had been a blunder because it was bad strategy to handle the native question piecemeal, responded by arbitrating the first treaty of Aliwal North (Sept. 1858) on the basis of adjusting the Warden line to give the Basuto more land in the Caledon area. This made explicit what the convention of Bloemfontein had evaded, namely that the western frontier of Basutoland marched with the eastern frontier of the Free State, and neither state had jurisdiction over the lands of the other.

Thereafter constant encroachments on both sides led to outrages, murder and undeclared war. The issues were complicated by Basuto family and tribal politics. Moshesh's sons Molapo and Masupha favoured a forward policy that Moshesh professed, perhaps insincerely, to eschew. Not the least subtle part of Moshesh's propaganda was the insinuation that the Boers in the Free State were the common enemy of the Basuto and the British. With the Cape government in difficulties in the Transkei area and with the Transvaal disunited and menaced on two fronts, Moshesh awaited the attack that he had provoked.

M. W. Pretorius, president from 1859 to 1863 and who for a short time combined the presidencies of the Free State and of the Transvaal, achieved a brilliant coup when, in 1861, he purchased the lands of Adam Kok III, the Griqua, for £4,000. But Pretorius found that he could not keep his grip on the Free State without forfeiting his position in the Transvaal and resigned the presidency of the Free State in 1863, to be succeeded by Johannes Henricus (afterward Sir Johannes) (*q.v.*) Brand. Brand, who was president from 1864 to 1888, declared war on Moshesh in 1865. When the Free State forces were victorious (a belated Transvaal commando did little more than rescue for itself the lion's share of the booty), Moshesh played his last card and bestowed Basutoland as a Greek gift on Queen Victoria, but meanwhile he had accepted the treaty of Thaba Bosiu, which gave the Free State half his land. The Free State, however, was too weak to enforce the treaty, and guerrilla war was resumed. In March 1868 Sir Philip E. Wodehouse annexed Basutoland. Brand protested vigorously, but farmers who tried to move in on their allotted farms were often unable to hold them against Basuto raiders; and in safer zones those who had no share of the spoils protested that speculators in the new lands depressed land values in the old. Moreover, in the southwest of the Free State, the frontier resulting from Pretorius' Griqua purchase still needed definition. Brand then signed the second treaty of Aliwal North in 1869. This treaty reiterated the convention of 1854 and drew a final frontier between the Free State and Basutoland, by which a substantial portion of the conquered territories remained to the Free State. The *volksraad* ratified the treaty even though it cut off a possible outlet to the sea via Pondoland.

On the whole, by 1868, though coin was short and credit low, the Free State had made remarkable progress. The Grey college, nucleus of the future University College of the Orange Free State, had been founded, churches were established and municipal boards created. The resources of the state were greater than its assets, for it had steadily extended its land. The new Basutoland frontier left the bulk of the wheatlands to the Free State. Most of the native enclaves were in the process of disintegration, partly because of the early wars of Moshesh, partly because of European purchase and diplomacy. In marked contrast to practice in the Cape and Natal, native ownership was forbidden, while only two substantial reserves, at Thaba 'Nchu and at Witzieshoek, were destined to survive under Free State protection.

Even before he had resolved the Basutoland crisis Brand found himself involved in the ambiguities of Pretorius' Griqualand purchase. Adam Kok denied from the first that the purchase included the Campbell lands which Cornelis Kok had bequeathed to him. More vociferously, Nicholas Waterboer, in Griqualand West, claimed that, whatever his intentions, Adam Kok had had no power to sell them, or Cornelis any right to bequeath them, since Cornelis held the lands merely as vassal of Waterboer. The Campbel lands sprawled across both sides of the Vaal river, the eastern portion having in practice been administered by Warden from Bloemfontein and by the Free State from Jacobsdal. Quite apart from the claims of Waterboer, the British high commissioner was anxious to secure either for Great Britain or for the Cape the missionary-merchant road to the north; the Transvaal coveted most of the land west of the Vaal between the Langeberg mountains and the Molopo river; and the Free State could advance a common-sense claim to land in the angle of the Vaal and Orange rivers to reinforce its interpretation of the purchase of 1861.

The discovery of diamonds, first on both sides of the Vaal river and then in the dry diggings (1870), sharpened the conflict and made a leisurely solution impossible. There was the immediate problem of jurisdiction over the congested cosmopolitan diggings; there was the problem of controlling native and coloured vagrants and labourers, who flocked from every quarter; there was the question of trade and transport development; and there was the question of the ownership of the diggings, which was then tossed like an apple of discord by Waterboer to Great Britain. The British government made two separate but not unrelated decisions: to enforce the Keate award (1871) against the Transvaal (*q.v.*); and to annex Griqualand West. To the Free State this could only seem peremptory and, as evidence which was not brought forward until after the annexation suggested, unjust.

In 1876 Brand visited London on the invitation of the secretary of state for the colonies, the earl of Carnarvon. Understandably, the Free State was at that point averse to schemes of federation, and Brand took no part in the discussions of them. He did, however, secure £90,000 in compensation; and the Free State was promised a further £15,000 if a railway linked either with the growing Cape system or with the Natal line were completed in five years. The compensation had the present advantage of liquidating the public debts of the Free State. The blow was further softened by the discovery of diamonds at Koffiefontein (1875) and at Jagersfontein (1878), well within the state boundaries. The Free State was no longer terra incognita, but a busy highway to the diamond fields and a transport riders' paradise. Frontier security as well as the leaven of relative prosperity stimulated farming. It was during this diamond decade that, as a result of the work of J. Brebner, the first inspector general of education, the sound foundations of a general system of primary education were laid.

Brand saw more clearly than most of his contemporaries the importance of railways; he also perceived the sound strategic position of his state in the economic development of the hinterland, especially when the Rand gold rush succeeded that of the Lydenburg. But he also understood the temper of the Free State and how to make haste slowly. His first Railway bill was introduced in 1876. Thereafter, for 12 years it was a hardy annual. Brand's patience, imperturbability and concern for his people, which won and held their confidence, stood him in good stead during the sustained crisis of the first British annexation of the Transvaal (1877–81) and the climax at Majuba, where he mediated between the belligerents. He was troubled during the last decade of his presidency by the renaissance of old cleavages in a new guise. The pressure of the Afrikander Bond emphasized the divergences of the two white races. The political strategy of Paul Kruger in the Transvaal was a more formidable version of the policy of Pretorius and aimed at building an exclusive republican axis against both the Cape and Natal. A growing minority in the Free State favoured the Delagoa bay railway policy of Kruger, whereas Brand had to consider not merely the unity of his state as a political entity but also the geographical, economic and cultural links with the Cape. Brand worked unceasingly for the closer cooperation of the four white communities but was not prepared to make the Free State the footstool of any one of them. For him the immediate problem was that of railway construction, to which the whole question of transit rates and of customs duties at the ports was allied. An understanding at the convention of Bloemfontein was that the Cape would allow a customs rebate on goods in transit to the Free State; for reasons of Cape finance and parochial politics, this had not been fulfilled. Brand therefore prepared the ground for a customs agreement with the Cape, from which in the next decade the Free State was to reap substantial rebates. One week before his death, he secured the belated approval of the *volksraad* for the extension of the Cape railway system to Bloemfontein. Even then it was only secured

because the chairman, Sir John Fraser, used his casting vote. Opinion in the Free State, never well informed on economic issues but instinctively averse to the cosmopolitan commercialism of the new era, was falling back on the trekker tradition of occlusiveness. Old antagonisms revived, nourished on inbred misunderstandings now made manifest in the conflict between the South Africa of Kruger's dreams and the South Africa of Cecil Rhodes' calculations.

During the presidencies of F. W. Reitz (1889–95) and of M. T. Steyn (1896–1900) a metamorphosis took place in Free State politics and opinion. From one point of view this was but a local example of tendencies current in contemporary Europe, namely the basing of political loyalties on racial ties. From the Free State point of view, it was the revival of old traditions to meet new challenges. Frontier security, increased profits and greater literacy tended to give farmers in the outlying districts leisure for politics and to revel in the propaganda of the Bond with its program of an Afrikander renaissance. Conflict between Transvaal and Cape economic interests, even earlier than conflict between the Transvaal and Great Britain, tended to split Free State opinion.

The determinant, though, was the policy of Kruger in the Transvaal. His object was to secure an alliance or, if necessary, a federal as distinct from an incorporating union with the Free State. The alliance was concluded by Reitz in March 1889 and ratified by the *volksraad*. At first the implications which Sir John Fraser had foreseen were not apparent. The customs union with the Cape was fulfilled. In 1892 the Natal-Harrismith line was completed. In 1893 the first train from Cape Town to Pretoria crossed the Free State, while the line from Kimberley to Mafeking and the north skirted the Free State on the west. For the first time the economic integration of southern Africa was possible. But the drifts crisis and then the Jameson raid (Dec. 1895) inflamed public opinion, and the year 1896 opened with Free State commandos manning the frontiers, prepared and even anxious to assist President Kruger in the Transvaal.

For the Free State, the raid was a psychological shock and a political blunder. Steyn was elected president in Feb. 1896 on the crest of a wave of pro-Transvaal sentiment, though the opposition candidate, Fraser, knew that even before the raid his chances had been slender. Thenceforward, as the crisis in the Transvaal mounted, while still counseling moderation almost to the end, Steyn, with a clear majority behind him, kept both lines open in theory but so strengthened the links with the Transvaal that the legal obligations of the Free State government reflected the instinct and opinion of the majority. Steyn's move to introduce a referendum with its connotation of popular sovereignty failed; but the qualifications for obtaining burgher rights were stiffened, the arming of commandos was brought into line with Transvaal practice and equipment and a commission was appointed to study federal union with a view to bringing the legal structure of both states to move on parallel lines. Several Free Staters, among them R. Gregorowski and the former president, Reitz, entered the service of the Transvaal. Steyn urged Kruger to accept any compromise that would avert war without actually injuring the Transvaal and strove for peace at the Bloemfontein conference of May–June 1899 and for conciliation even after the ultimatum of October; but the Free State's refusal to accept the British offer of neutrality turned not on diplomacy but on the conviction that, once the issue was joined, moral obligation determined conduct. (For the events of the war *see* SOUTH AFRICAN WAR.)

The Orange River Colony (1900–1910).—Lord Roberts occupied Bloemfontein in March 1900; and on May 24 the Free State was annexed by Great Britain as the Orange River colony. For two more years Generals Christiaan Rudolf de Wet and James Barry Munnik Hertzog (*qq.v.*) blazed the commando trail in the Cape until definitive peace was concluded at Vereeniging on May 31, 1902, when British sovereignty was acknowledged. In June a nominated legislative council was set up and on this prominent burghers served as unofficial members. "It would take the pen of a Joshua and a Jeremiah," wrote Jan Christiaan Smuts, "to picture the condition of the Free State": it was a picture the more shocking in that, in spite of native wars, South Africa had never before experienced total war between equal contestants. Farms were denuded of crop and stock, fences were down, houses in ruin. It is true that by grant and loan much was done to accelerate recovery and to lay new foundations. For Bloemfontein an extension to the power station and new waterworks at Mazelspoort made civic development possible; but even as late as 1904 the yield of wheat and of wool and the number of cattle were strikingly less than they had been before the war. A reconstruction loan in 1903 led to the establishing of 556 new settlers, but even Viscount Milner's administrative genius could not with the stroke of a pen restore the ravaged veld.

By 1904 two groups, the nationalist Orangia Unie and the so-called Constitutional group, which was led by Fraser, were agitating for constitutional government. The latter group had the ear of the British Liberal party, which returned to office in Dec. 1905. The change in government in Great Britain meant a fresh approach to South African affairs. Lord Selborne, who had already replaced Milner as high commissioner and governor of the Transvaal and of the Orange River colony, was retained, and the intercolonial conferences, begun with those on native affairs and education, were continued; but the granting of the promised self-government was expedited. Royal letters patent conferred full responsible government on the Orange River colony in June 1907, and the first postwar election was held in November. Sir H. J. Goold-Adams, hitherto lieutenant governor of the colony, then became governor; his relationship to the new parliament was defined by well-established conventions such as had been observed, in the Cape for instance, since 1872. Of 38 seats in the new parliament, the Orangia Unie won 29. A. Fischer was prime minister, General Hertzog attorney general and minister of education, Cornelius Wessels commissioner of public works and General de Wet minister of agriculture. It was an able if somewhat uneasy team, whose task had been greatly simplified by five years' postwar economic rehabilitation. But the British administration was to reap where it had sown. In 1902 men like Brebner and Ryk de Villiers had been purged from the state service; in 1908 the new anglophile bureaucracy was in its turn winnowed.

Under Milner's administration education had been made free, compulsory and nonsectarian and the whole structure of the schools had been altered; but administration had been ruthlessly centralized, and English had become the medium of instruction, while the reliance in the main on English-speaking teachers meant that little use could be made of the five hours allocated to the teaching of the Dutch language, since the teachers did not understand it. It was to meet this situation that voluntary Christian National schools were founded.

When the colony was granted self-government, the pendulum swung back. While denouncing the Dutch Reformed Church, which he accused of "setting up a papacy in every village," Hertzog allowed dogmatic instruction in the schools; and while theoretically allowing for parallel dual medium instruction where numbers warranted, in practice he made Dutch increasingly the medium of instruction, so that by 1910 English children were being withdrawn into private schools. For Hertzog was a passionate devotee of Afrikander culture and claimed, understandably if inaccurately, that it had made the Free State.

The chief constructive work of the cabinet was continued participation in intercolonial consultation, notably the customs and railway conference of 1908 and full and constructive participation in the national convention which began in Oct. 1908. The outstanding personality from the Orange River colony was Steyn, who was conspicuously successful as a mediator and who secured that the future appeal court of the Union should sit at Bloemfontein, which was to become the judicial capital of the proposed Union. The bill for union was passed simultaneously by the parliaments of each of the four colonies and was enacted, in the form then submitted, by the imperial parliament in 1910, and the colony entered the Union under the name of Orange Free State province.

For subsequent history *see* SOUTH AFRICA, REPUBLIC OF.

(W. A. ML.; X.)

POPULATION, ADMINISTRATION AND ECONOMY

Population.—In 1960 the population of the province was 1,373,790, comprising 274,596 whites, 25,565 Coloureds and 1,099,-194 Bantu (a term that has officially replaced "native" or "African"). The Bantu are principally of the southern Sotho and Tswana, and the Zulu and Xhosa groups.

For purposes of administration the province was divided into 45 magisterial districts. Apart from the capital, Bloemfontein (pop. 140,924), the only other towns with populations over 25,-000 are Kroonstad and Welkom. A remarkable feature is the growth of townships in the Odendaalsrus area as a result of the

Township	Whites	Others	Total
Welkom	27,678	50,208	77,886
Virginia	12,675	34,359	47,034
Odendaalsrus	9,065	28,824	37,889
Allanridge	2,449	765	3,214

gold mining developments of the province. In 1946, before mining operations started, Odendaalsrus had a population of 483 whites and 614 nonwhites. By 1960 its population and that of the three new townships Welkom, Virginia and Allanridge had reached the proportions shown in the table.

In 12 years Welkom became the second largest town in the province. Although smaller than Welkom the new township of Sasolburg in the Vredefort district is similar in type.

Administration.—The relationship between the provinces and the government is described in SOUTH AFRICA, REPUBLIC OF. Some of the more important matters which concern the provincial council are local government, roads and road traffic, education, licences, pensions, shop hours and fish protection. The largest items of provincial revenue are the tax on persons, motor licences, tax on companies, hospital patients' fees, auction dues, entertainment tax and fines and forfeitures. Revenue contributions from the central government include general and special subsidies, a grant from South African railways for bus routes, and a payment for the cost of national road construction. The largest items of expenditure are on education, roads, bridges and local works, hospitals and capital investment.

Public Health.—The province is divided into two central areas for the purpose of hospital administration: the Bloemfontein hospital area and the Kroonstad hospital area. It has a total of 12,000 hospital beds provided by provincial and subsidized hospitals. There is also one of the largest mental institutes in South Africa at Bloemfontein.

Education.—There are approximately 330 white schools in the province and one teachers' training college. The schools include primary, intermediate, secondary and high schools. There are many primary schools and one intermediate school for Asians and Coloureds. Schools for Bantu pupils number about 650. The University of the Orange Free State (Universiteit van die Oranje-Vrystaat) was founded in 1855 at Bloemfontein as a constituent college of the University of South Africa (Pretoria); it attained university status in 1950 and has mainly Afrikaans-speaking students.

The Economy: *Agriculture.*—In the northeastern part of the province the climate, soils and surface are very suitable for maize (corn) cultivation, and this area forms the southern part of the so-called "maize triangle" which extends into the southern Transvaal. About 3,500,000 ac. are planted to maize by whites. The total production is 15,000,000 bags (of 200 lb.) of which one-tenth are produced by Bantu. The production of kafir corn (sorghum) is about 1,200,000 bags. Wheat is grown mainly in the east-central districts, on approximately 1,250,000 ac., of which 1,000,000 ac. is reaped, a varying proportion of the crop being used for grazing. Oats and barley are minor crops. Irrigation projects on the Riet, Kaffir, Leeuw and Caledon rivers bring nearly 2,000 ac. under the furrow. The Allemanskraal dam, near Winburg, was planned for a capacity of more than 190,000 ac.ft.

Except for the south and southwest the veld is moderately good pasture in summer but generally poor in winter. It supports nearly 2,000,000 head of cattle of which less than a quarter belong to Bantu. There are about 8,000,000 sheep, most of which are merino, though there are smaller numbers of Karakul and non-wooled types. Relatively small numbers of sheep belong to Bantu, but of the 70,000 goats, 80% belong to Bantu.

Mining and Industry.—In manufacturing the Free State has been the least productive of South Africa's provinces. It is largely with the gold mining development after 1950 that the province's industrial development is connected. In 1947 the first shaft was sunk in the Odendaalsrus area. In 1958 ten gold mines together produced 4,329,411 oz. of fine gold and 2,291,511 lb. of uranium oxide. To bring about such a development electric power on a large scale was necessary and this has largely been secured by the utilization of almost unlimited resources of low-grade coal in the northern part of the province, with ample supplies of water from the Vaal river. The establishment of the Vaal, Vierfontein and Taaibos power stations in the northern part of the province has been a work of capital importance. These stations produce more than 6,500,000,000 kw.hr. of electricity, consuming more than 5,000,000 tons of coal. A fourth Free State station (Highveld) was designed to have a capacity of 240,000 kw.

A further important industry is the production of oil from coal in the Vredefort district, about 15 mi. from Vereeniging. About 8,000 tons of low-grade coal is treated daily by the South African Coal, Oil and Gas corporation (S.A.S.O.L.) for the extraction of oil by a modified Fischer-Tröpsch process, to produce 55,000,000 gal. of gasoline a year, one-sixth of the republic's requirements.

The new township of Sasolburg is developing into South Africa's chemical industry centre. With new plant and equipment to cost R.80,000,000 the town was expected to double its 1963 population of 14,000 before 1970. Production was to include a variety of chemicals, including those needed for a synthetic rubber industry, fertilizers and the manufacture of polyethylene plastics. Most of the raw materials needed for these chemical industries are produced by S.A.S.O.L.

Transport.—Being the central province of South Africa the Orange Free State is the focus of communication networks and, Bloemfontein in particular is an important road and rail centre. There are 1,669 mi. of rail track and 674 mi. of bituminous surfaced national road. The main Transvaal-Cape road and railway pass through the entire length of the province. The J. B. M. Hertzog National airport is also at Bloemfontein.

See also references under "Orange Free State" in the Index.

(J. H. WN.; X.)

ORANGEMEN. In 1795, after a violent conflict between Protestants and Roman Catholics in County Armagh, Ire., known as the battle of the Diamond, a Protestant Orange society, named for William of Orange, was formed "to maintain the laws and peace of the country and the Protestant constitution." The Orange society spread its branches, called lodges, and by 1797 it had about 200,000 members. It was joined by many of the gentry, and it counteracted the influence of the United Irishmen, particularly in Ulster. During the early and middle years of the 19th century the movement fell into some obscurity and disrepute; but when Gladstone declared in favour of Irish home rule in 1885, the Orange order, as it came to be called, provided a core of resistance. The order had a great influx of new members, especially in Ulster. Through the controversies which followed, it provided both a means of expression and a restraining discipline for many Unionists. The membership in Ulster at mid-20th century contained a large proportion of farmers and skilled workers and a good many professional men, and there were lodges for women. The ethical obligations of membership are high. The movement is also active in Glasgow, Liverpool, Toronto, Ont., and many other places, but its social background and ethos are somewhat different outside Ulster. July 12, the anniversary of the battle of the Boyne, is celebrated by Orangemen each year.

(HU. S.)

ORANGE RIVER (Afrikaans ORANJERIVIER; Hottentot GARIB, "great water"), a river of southern Africa which rises in northeastern Basutoland near the Mont-aux-Sources (10,822 ft.) and flows in a general westerly direction across the South African plateau to the Atlantic, a distance along its course of

1,300 mi. Its basin (including its great tributary the Vaal river, *q.v.*) is well defined in the south and east by the Great Escarpment (*see* SOUTH AFRICA, REPUBLIC OF: *Physical Geography*). The northern boundary is partly the Vaal-Limpopo watershed in the east and the Southwest African highlands in the west, but between the east and the west is the Molopo-Nossob river system, which formerly—perhaps 1,000 years ago—drained into the Orange but now discharges into a depression known as Abiquas Puts, a little east of the South West Africa–South Africa border, forming, perhaps temporarily, an inland drainage basin. Because of this and the large areas of no surface flow, it is impossible to be precise about the area of the Orange river basin, which is officially estimated at 328,000 sq.mi.

The river falls into three fairly distinct tracts: the upper course from the source to Prieska; the middle course from Prieska to the Aughrabies falls; and the lower course from the falls to the sea. In the upper course the headwaters of the Sinqu (the Sotho or Sesuto name of the Orange) lie on the Stormberg lava where the longest headstream is the Madibamatso, rising to the west of the Mont-aux-Sources; but the main headwater is probably the Khubedu which rises in the flat, boggy ground near the plateau edge just south of the Mont-aux-Sources. Average gradients on the lava are between about 75 and 90 ft. per mile. Lower in the course, where the Stormberg sandstones are exposed, the gradients fall to about 14 ft. per mile, decreasing to about 8 ft. for about 150 mi. above Aliwal North. In Basutoland the Stormberg sandstones are associated with spectacular waterfalls; the highest (about 630 ft.) are the Semonkong falls on the Maletsunyane river.

Below Aliwal North (59 mi.) the Orange receives as a tributary the Caledon river which forms part of the boundary between Basutoland and the Orange Free State and has an annual discharge fluctuating between about 200,000 and 2,700,000 ac.ft. (1 ac.ft. = 43,560 cu.ft.). Between Aliwal North and the Vaal confluence (303 mi.), the river flows over Karroo sandstones and shales, with dolerite outcrops that cause rapids and considerable variations in gradient. The average gradient for this stretch is 3.46 ft. to the mile. Between the Vaal confluence and Prieska (about 100 mi.), the river cuts through the limestone of the southern end of the Kaap plateau at the Banhoek gorge and thereafter flows over Dwyka shales and tillite. At Prieska the river enters its middle course, bending abruptly to the northeast and cutting deep *poorts* or gaps through the hard Griquatown banded ironstones, the Ventersdorp lava and the Matsap quartzite, Onverwacht lava and Kaaien quartzite—all hard rock formations. The gradient in this tract is about 2½ ft. to the mile. Above Upington the river traverses the old granite for 84 mi. to the Aughrabies falls. In this stretch the stream is heavily braided, forming innumerable channels and many large and small islands, including Cannon Island, the largest, about 12 mi. below Upington. The average gradient on the granite is about 8 ft. per mile.

At the Aughrabies falls the river falls about 80 ft. over a series of steep rapids followed by an almost vertical fall of about 400 ft., broken by a ledge about 150 ft. below the top. At the bottom the depth of the large plunge pool probably exceeds 140 ft. The falls mark the beginning of the lower course of the river, about 400 mi. long, which, except for the last 70 mi. of coastal plain, consists of a gorge tract that has been cut by the river to a depth of between 1,000 and 3,000 ft. below the general level of the plateau. The gorge is closed and narrow, or wide and open according to the hardness of the rock formation. In this tract the largest tributary is the Fish river which has formed a spectacular canyon in the Nama formation.

The river crosses the coastal plain with a southwesterly sweep and enters the ocean by a single mouth 5 mi. N. of Alexander Bay. A sandbar about 2½ mi. long almost closes the entrance, but normally river and tidal flow maintain a narrow channel through the bar. During high floods a great part of the bar may be washed away. The river is at all times inaccessible to seagoing vessels but it is navigable by small boats for about 30–40 mi. There are two notable bridges: a high-level bridge at Vioolsdrift, carrying the main north-south road from South Africa to South West Africa; and the 3,000-ft. Ernest Oppenheimer bridge opened in 1951 near the mouth of the river, carrying the coast road.

The flow of the Orange river above the Vaal confluence was gauged for the period 1913–45 at Orange River station. The mean flow is at a minimum in August (93,000 ac.ft.) and at a maximum in March (1,100,000 ac.ft.). The maximum annual discharge in the period was approximately 16,000,000 ac.ft., the minimum 1,000,000, the average 6,000,000. The catchment area was 37,000 sq.mi.

Below the Vaal confluence at Prieska where the Orange-Vaal catchment is 130,000 sq.mi., for the period 1913–38 the mean minimum discharge was in August (114,000 ac.ft.), the maximum in March (1,600,000 ac.ft.), the annual maximum, minimum and mean discharge being respectively 24,000,000, 1,600,000 and 8,800,000 ac.ft. The maximum flood flow for the period was 537,000 cu.ft. per second. Below Prieska the tributary affluents bring very little water to the main stream and much is lost by evaporation and abstracted for irrigation purposes. At the Aughrabies falls the minimum flow may be less than one cu.ft. per second in any month from August to January inclusive. In exceptionally dry seasons the flow may cease altogether. At the mouth the mean annual runoff is 9,100,000 ac.ft.

Economic Aspects.—The only large dam at present in the Orange basin is at Buchuberg, below Prieska, where the river cuts a *poort* through the hard quartzite of the Ezel Rand. About 10,000 ac. have been brought under the furrow between Buchuberg and Upington producing sultanas, wheat, cotton and various fruits. In such projects the silt content of the water (0.8% by volume) forms fertile soil but rapidly fills the dam. Between Upington and Aughrabies about 30,000 ac. are irrigated by leading furrows directly from the river to the lands. Between Aughrabies falls and the sea only small pockets of soil are available for irrigation, the largest being at Vioolsdrift (about 2,000 ac.). In 1962 the South African government approved the Orange River Development multi-purpose project which provided for the development of irrigation and hydroelectric power in six phases over a period of 30 years at a cost of £112,000,000. Three major conservation dams were to be constructed, the first (the Hendrik Verwoerd dam) at Ruigte valley, 3 mi. upstream from Norvals Pont; the second at Van der Kloof, 10 mi. upstream from Havenga bridge (on the Petrusville-Luckoff road); and the third at Torquay, 25 mi. upstream from the Orange-Vaal confluence. Water was to be diverted from the Ruigte Valley dam through a tunnel 52½ mi. long southward to the headwaters of the Fish and Sundays rivers. It was estimated that 4,490,000 ac.ft. of water would be available for irrigating 522,000 ac. along the Orange and 240,000 ac. in the Fish and Sundays river valleys. The total power development under the comprehensive project would have a continuous assured power rating of 164.2 megawatts and an annual power output of 1,440,000,000 units.

In Basutoland the most promising of several projects was the Ox-bow Lake scheme, which involves the damming of the Madibamatso headwater of the Orange 11½ mi. W. of the Mont-aux-Sources to produce 350,000,000 kw.hr. per annum and to supply 40,000,000 gal. of water a day to the Orange Free State. The scheme was estimated to cost about £9,000,000.

Other economic features include the fabulously rich diamond deposits in coastal terraces to the north (Oranjemund) and south (Alexander Bay) of the Orange mouth. The Orange river is not particularly notable for its fish. There are trout in Basutoland, and in other parts the barbel (a catfish) is the principal fish.

Exploration.—Capt. Henry Hop first crossed the Orange in Sept. 1761, but left shortly afterward. In 1777 Capt. (afterward Col.) R. J. Gordon, a Dutch officer of Scottish extraction, who commanded the garrison at Cape Town, reached the river in its middle course and named it the Orange in honour of the prince of Orange. Next year Lieut. W. Paterson, an English traveler, reached the river in its lower course, and in 1779 Paterson and Gordon journeyed along the west coast of the colony and explored the mouth of the river. F. Le Vaillant also visited the Orange near its mouth in 1784. Mission stations north of the Orange were established, and in 1813 the Rev. John Campbell, after visit-

ing Griqualand West for the London Missionary society, traced the Harts river, and from its junction with the Vaal followed the latter stream to its confluence with the Orange, journeying thence by the banks of the Orange as far as Pella, in Little Namaqualand, discovering the great Aughrabies falls. These falls were in 1885 visited and described by G. A. Farini, from whom they received the name of the Hundred falls. The source of the Orange was first reached by the French Protestant missionaries T. Arbousset and F. Daumas in 1836.

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ORANGUTAN (Orangoutan, Orang), a Malay term signifying "man of the woods," designates the large manlike ape *Pongo pygmaeus*, restricted today to the lowland swamp forests in Borneo and a small part of Sumatra but formerly distributed also on the Asiatic mainland.

In general form, with its short, thickset body, long arms and short legs, the orang resembles its African cousins the gorilla and chimpanzee (*qq.v.*); it differs in its shaggy reddish hair, in the even greater disproportion between arm length and leg length and in the shape of the skull, which is high with rounded brain case, lacking the bony crests and the brow ridges. Males attain a height of 5½ ft. and a weight of 165 lb. and, when mature, develop curious fibro-fatty excrescences on the cheeks. Ears are small but humanoid. A huge air sac derived from the larynx forms a baglike swelling that hangs from the throat.

In temperament orangs are staid, rather dull and listless, but in captivity they show considerable intelligence, ingenuity and persistence, as, for example, in learning how to open their cages and escape. In the wild, though capable of progress through the trees at a rate exceeding that of the hunter at ground level, they exert themselves no more than is necessary to obtain their food. For the most part they live alone or in small family groups. A single young, produced after a gestation period of about 270 days, is nursed by the mother, who carries it at her breast. Sexual maturity is attained by eight years in the female and ten years in the male.

In the wild a sleeping platform is constructed each evening by weaving and bending branches together. Orangs also cover themselves with leaves; in captivity they display great resourcefulness in the choice of material for covering themselves. Orangs are almost entirely vegetarian, fruits forming the main part of the diet. A certain quantity of leaves, shoots and bark is also consumed. Orangs are remarkably silent vocally but can scream when angered or alarmed. In the young, low chuckling and grunting sounds indicate pleasure. *See* also Primates: *Manlike Primates (Anthropoidea): Apes and Men.* (W. C. O. H.)

ORAON, an aboriginal tribe of Chota Nagpur in Bihar, India, calling themselves Kurukh and speaking a Dravidian language akin to Gondi and other tribal languages of the Deccan. These linguistic affinities indicate, as does their own tradition, that their original homeland lay farther to the southwest. They once dwelt on the Rohtas plateau, but were dislodged by other populations and migrated to Chota Nagpur, where they settled in the vicinity of Munda-speaking tribes (*see* Ranchi). Their physical features conform largely to the Veddoid type predominant among many aboriginal tribes of peninsular India. Speakers of Oraon in Bihar numbered 461,203 in the 1951 census, but in urban areas and particularly among Christians many Oraon speak Hindi as their mother tongue; the total number throughout India was estimated as close to 800,000 in the 1960s. The tribe is divided into numerous exogamous clans associated with animal, plant and mineral totems. Every village has a headman and a hereditary priest; a number of neighbouring villages constitute a confederation known as *parha*, the affairs of which are conducted by a representative council. An important feature of the social life of a village is the bachelors' dormitory, a "club" for unmarried males.

The Oraon's traditional religion comprises the cult of a supreme god, Dharmes, the worship of dead ancestors and the propitiation of numerous tutelary deities and spirits. Hinduism has influenced ritual and certain beliefs. Many Oraon, including the majority of the educated members of the tribe, are Christians. Several religious movements, stimulated by Brahmanism and Christianity, have developed within the traditional religious system, some combining desire for religious reform with a longing to satisfy economic grievances. Members of the tribe have supported political movements demanding a measure of autonomy for the predominantly tribal regions of Bihar and Orissa. *See* also Bihar.

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ORATORIANS, a name applied to members of two Roman Catholic societies of common life. The name is derived from the oratory at S. Girolamo della Carita, Rome, where the first community held its "exercises."

The older of the two, the Institute of the Oratory of St. Philip Neri (*Institutum Oratorii S. Philippi Nerii*), was founded about 1575 at Rome, by St. Philip Neri. The autonomous houses called "congregations," retaining their autonomy, confederated in 1942 into the present institute. Congregations engaged in vastly varied apostolates exist in England, Germany, Italy, Latin America, Poland, Spain and the United States. Each consists of priests and brothers living in common without vows, oaths or promises, freely observing poverty, chastity and obedience under the authority of a major superior or provost called "the father," who is triennially elected. (*See* also Neri, Saint Philip.)

The French or Bérullian Oratory (*Congregatio Oratorii Jesus et Mariae Immaculatae*) was founded by Pierre Cardinal de Bérulle in 1611 and approved in 1613. It was formed on the lines of the Italian Oratory but has a centralized organization governed by a superior general. Dissolved in the French Revolution, it was reestablished in 1852 under its present name. Its many distinguished members include Nicolas Malebranche, Jean Baptiste Massillon, Jean Morin and St. John Eudes. *See* further Bérulle, Pierre de; *see* also Orders and Congregations, Religious. (E. V. W.)

ORATORIO, the name given to a large-scale musical composition for solo voices, chorus and orchestra on a sacred or semi-sacred subject but not intended for liturgical use. No completely accurate definition is possible. The meaning of the term varies, and, indeed, in Handel's England it bore two almost contradictory meanings at once. It has been applied to anything from a secular cantata to a biblical opera. A certain latitude is therefore necessary in tracing its development.

There are three principal schools of oratorio: (1) the Italian, in essentials a form of religious opera; (2) the German, developed from the liturgical treatment of the Passion story; and (3) the English, created by Handel from a synthesis of several forms. All three reached their climax in the work of J. S. Bach and Handel, the German and the English forms drawing sustenance from Italy. A more or less dramatic method is used in all successful oratorios, together with a contemplative or an epic quality. Oratorios may or may not be produced with theatrical action. Practice varied at different periods, and some works are obviously less suited to theatrical action than others. The association of the oratorio exclusively with concert performance tends to sever the link with the dramatic principle. From the middle of the 18th century to the middle of the 20th century only three or four oratorios attained the rank of masterpieces, a decay possibly due to the inability of composers to find a new formal framework.

Beginnings to the Mid-18th Century.—*Italy.*—Oratorio, like opera, was an Italian invention. Its name derives from the oratory of the church of Sta. Maria in Vallicella in Rome, where St. Philip Neri (1515–95) instituted musical entertainments designed to reform the youth of the city. These entertainments were divided in two by a sermon; hence the two-act form common in early Italian oratorio. The models were the traditional mystery plays, or *sacre rappresentazioni*, which included dramatic action, dances and religious songs in the vernacular (*laudi spirituali*),

often based on secular tunes provided with new words. These in turn can be traced back to the liturgical music dramas of the middle ages. The aim of all these productions was to reinforce a popular allegory or the moral of a tale from the Bible or from the lives of the saints by means of drama and spectacle. The Passion story itself was scarcely ever treated in this way.

The earliest surviving work sometimes classed as an oratorio—though the term was not so used till a generation later—is *La rappresentazione di anima e di corpo* by Emilio de' Cavalieri, produced in St. Philip's church in Rome in 1600 with elaborate dramatic action, including ballet. This is a morality with allegorical characters, written for choruses in the manner of the *laudi spirituali* and introducing the new monodic style of contemporary opera. It was followed by many similar works, some of them highly spectacular. Toward the middle of the 17th century Giacomo Carissimi introduced a more sober type with a Latin text based on the Old Testament. Carissimi's oratorios are short, simple in texture and free from extravagance. The story is told by a narrator and the composer aims at generalized expression rather than characterization. Nevertheless, the style is predominantly operatic; and the most memorable episodes are those in which the narrative is interrupted and the characters express their emotions.

A distinction is sometimes drawn between oratorio (with a narrator) and religious opera (*dramma sacro*), but it was seldom observed in practice. Arcangelo Spagna in 1706 published his sacred librettos under the title *Oratorii ovvero melodrammi sacri*. The Latin and Italian types continued in use, but the latter (known as *oratorio volgare*), sung by virtuoso singers including castrati, was the more popular and flourished till the end of the 18th century. It became a Lenten substitute for opera and musically indistinguishable from it. Alessandro Scarlatti's oratorios reduce the chorus to a minimum and employ all manner of operatic devices. It is not clear when or to what extent stage action was abandoned; it certainly continued into the 18th century, and the oratorio librettos of Apostolo Zeno (1668–1750) were designed for use with or without it, as circumstances required. The medieval habit of inserting comic interludes still persisted: oratorios as late as N. Porpora's *Sta. Eugenia* (1721) and G. B. Pergolesi's *La Conversione di S. Guglielmo d'Aquitania* (1731) have parts for comic characters who sing in Neapolitan dialect. New Testament subjects, such as those used in A. Stradella's *S. Giovanni Battista* (1676) and Handel's *La resurrezione* (1708), received an equally operatic treatment.

Germany.—The history of German oratorio begins with Heinrich Schütz, who wrote an Easter oratorio in 1623, a setting of the Seven Last Words about 1645 and a Christmas oratorio in 1664. His style, like J. S. Bach's after him, is a judicious blend of German and Italian elements; having spent two periods of study in Italy, he was able to graft the monodic arioso of Claudio Monteverdi and the instrumental splendour of Giovanni Gabrieli onto the solid contrapuntal trunk of German church music. His oratorios are confined to subjects taken from the Gospels. His handling of the text shows great powers of emotional expression, and his vigorous treatment of the *turba* choruses anticipates Bach; but the dramatic content is always at the service of the devotional. In the *Easter Oratorio* he retains the old convention of setting the words of each character polyphonically for two or more voices. Schütz's oratorios achieve a balance between the austerity of the unaccompanied Passions and the exuberance of the Psalms, which profoundly affected the history of the oratorio form in Germany.

By the end of the 17th century this balance had been disturbed. The early German Passion settings had been strictly liturgical, but the introduction of congregational hymns (chorales), meditative arias, instrumental tone painting and other features led gradually to the establishment of an independent Passion oratorio; and increasing Italian influence gave it a strong tilt in the direction of the theatre. A species of biblical opera had flourished for a few years at Hamburg, where the first opera house in Germany was opened in 1678 with Johann Theile's *Adam und Eva*, which included a ballet. Clerical opposition seems to have broken this link (an all too familiar event in Protestant countries) with the result that German opera soon died and German oratorio became more and more secular. Reinhard Keiser omitted both the chorales and the evangelist's narrative from his 1704 Passion *Der blutige und sterbende Jesus*. His eloquent and eclectic style, in which Italian and French elements are as conspicuous as German, influenced both Bach and Handel. The Passion oratorio texts of this period, when they are not openly operatic, often abandon the words of the Bible for a mixture of rhymed paraphrase and lyrical commentary of a more or less sentimental nature.

Bach's two great Passion oratorios (*St. John*, 1723, *St. Matthew*, 1729) deliberately reversed the German trend then current and restored the balance attained by Schütz, though they are written on a far greater scale and are enriched by the introduction of the later Italian aria style. Bach, besides increasing the significance of the chorale, brought back the evangelist's narrative as a framework binding the dramatic element (the words of the characters and the *turba* choruses) to the contemplative or epic sections (arias, chorales, opening and final choruses). There is nothing novel about Bach's settings except their genius, which holds the long and complex structure in perfect balance. The other works of Bach that bear the name oratorio are more properly church cantatas. The *Christmas Oratorio* was conceived not as a single work but as a series of six cantatas for performance on successive days in Christmas week. Bach's Passions, considered old-fashioned in their own day, were soon forgotten and remained so until the Bach revival in the 19th century.

The biblical narrative again succumbed to the attractions of pietist verse. The most popular German Passion oratorio of the 18th century, K. H. Graun's *Der Tod Jesu* (1755), though it preserves the form of the north German model (including chorales), lacks the spiritual stature of Bach's works; it belongs to an age of reason rather than faith. By this time German oratorios on subjects other than the Passion were common. J. C. Schiefferdecker (1679–1702), who was active in Hamburg and Lübeck, sought to combine the allegorical abstractions of the Passion commentary with Old Testament stories. The numerous Hamburg oratorios of J. Mattheson were conceived wholly as dramas and sung by opera singers in church; in 1739 Mattheson defined oratorio as "merely a sacred opera." Some works of this kind, such as J. H. Wilderer's *Esther* at Mannheim (1724), were played on the stage. G. P. Telemann, the most prolific composer of the age, wrote many oratorios as well as 44 Passions.

Handel.—Bach's Passions, partly dramatic in structure, are religious in spirit. The oratorios of Handel are essentially theatrical; they reflect his experience as an opera composer, his cosmopolitan background in Hamburg, Italy and London, and the broad humanity of his temperament. Before settling in London he had attempted the Italian *oratorio volgare* and the north German Passion oratorio with little success. His English oratorio, a largely fortuitous creation, was fed by many tributaries: Italian opera, English stage masque, German cantata and the choral tradition of all three countries. There was also a French strain: the original version (1720) of his first oratorio *Esther* was a stage masque based on Racine's drama after the model of Greek tragedy with sung choruses. This link was repeatedly confirmed later. Greek tragedy with its compound of drama, ritual and myth and its double role of the chorus as actor and commentator is the artistic ancestor of Handel's oratorios. They were performed by opera singers in the theatre, though ecclesiastical prejudice forbade stage action, and have no connection with the church, to which their often pagan spirit, not to mention their musical style, is quite unsuited.

Handel's achievement has been distorted by the almost exclusive concentration of posterity, largely for nonmusical reasons, on the two oratorios with biblical words, *Israel in Egypt* (1739) and especially *Messiah* (1742). Neither is typical; *Messiah*, well described by the compiler of the text as "a fine entertainment," reveals only one side of Handel's genius. Most of the oratorios, while varying widely in subject and design, are concerned with the sufferings of men and women, as individuals or as nations, in their conflict with life and death. Handel's mastery of characterization and every type of choral utterance is crowned by a deep

and sympathetic pondering of the issues involved, and if the librettist's proffered moral contradicts his experience, he does not hesitate to ignore or subvert it. In his last two oratorios, *Theodora* (1750) and *Jephtha* (1752), in which he explores the problems of man's enforced subjection to destiny, the music transcends the facile piety of the text. There is no difference in kind between the oratorios on Old Testament and Apocryphal stories and the classical masques (*Acis and Galatea, Semele, Hercules*), sometimes loosely known as secular oratorios. This was not Handel's title; the confusion results from the double meaning of the word oratorio: (a) a drama on a sacred subject, whether staged or not; (b) any performance—even a mixed concert—given in the theatre without action.

The Late 18th to the Early 19th Century.—Handel's oratorios had few rivals in England during his lifetime. His successors made the double error of imitating his style and misinterpreting his aim, which they took to be ethical rather than aesthetic, and they were content to turn almost any part of the Bible into three hours of music for as large a body of players and singers as they could muster. A tradition founded on such premises was bound to collapse, and although works of some merit, such as T. A. Arne's *Judith* (1761) and W. Crotch's *Palestine* (1812), appeared from time to time, the vast brood of English oratorios remained undistinguished for nearly a century and a half.

Oratorio on the continent was less subject to extraneous considerations, but it can scarcely be said to have prospered; never after the death of Bach and Handel did it represent a vital, creative tradition. Nearly every Italian composer of opera, serious or comic, from L. Leo and Porpora to G. Paisiello, D. Cimarosa, A. Salieri and F. Paer, wrote an occasional oratorio but they seldom achieved more than a parody of the operatic style. N. Jommelli's *La Passione* (1749), a setting not of the Scriptures but of a poem by P. Metastasio, treats the subject with a lyrical charm apt for sentimental comedy. C. P. E. Bach's oratorios, notably *Die Israeliten in der Wüste* (published 1775), combine something of his father's intensity of expression with the sensibility of Graun and a vigour suggesting Joseph Haydn, but this scarcely adds up to a satisfying whole. The first oratorio of Haydn himself, *Il Ritorno di Tobia* (1775), belongs to the Italian type and suffers from a feeble libretto and a surfeit of long *da capo* arias; but it contains some fine choruses. *The Creation* (*Die Schöpfung*, 1798) shows very clearly the impact made on Haydn by Handel's oratorios in London. One striking detail, the blaze of C major at the words "Let there be light," is borrowed straight from *Samson;* the massive simplicity of the whole conception, the free polyphony of the choruses and the picturesque treatment of the text bear witness to the same inspiration. The influence of Mozart's operas may also be traced in the solo music. It is the fusion of these epic and dramatic elements with Haydn's mature mastery of the symphonic style that gives the work the cohesion of a masterpiece. Haydn called *The Seasons* (*Die Jahreszeiten*, 1801) an oratorio, though its content is secular and its form a loosely articulated series of genre pieces; its vivid pictures of nature have a pantheistic quality that links it once more with Handel, as well as with the world of Beethoven and Schubert. Beethoven's single oratorio, *Christus am Ölberge* (1803), is a failure, not because it uses the language of the opera house but because it does so without discriminating between the spiritual levels of the characters.

The Late 19th Century and After.—The multiplication of large halls, choral societies and festivals during the 19th century increased the flow of oratorios, especially in Germany and England. Most German oratorios of the romantic period were produced by minor composers and have long been forgotten. Schubert's only work of this class, the religious drama *Lazarus*, remained unfinished. Spohr's three oratorios enjoyed much success in their time. Mendelssohn's *Elijah* (1846) is one of the few 19th-century oratorios still heard in modern times.

Mendelssohn's promotion of the Bach revival and his experience of Handel's music, both in Germany and England, led him to attempt in his own works a fusion of the two styles, perhaps without fully understanding the source of their strength. *Elijah* is remarkable for the vitality of the choruses. *St. Paul* (1836) suffers from Mendelssohn's inability to express religious emotion except in terms of a respectable complacency.

Elijah remained the most popular of many oratorios written by foreign composers for English choral festivals. Others include S. Neukomm's *David* (1834), Spohr's *Fall of Babylon* (1842), M. Costa's *Eli* (1855) and *Naaman* (1864), C. F. Gounod's *The Redemption* (1882) and *Mors et Vita* (1885), A. Dvorak's *St. Ludmilla* (1886) and C. Saint-Saëns' *The Promised Land* (1913). All were more or less adapted to the English taste, which was not improved when the style of Spohr, Mendelssohn and later Gounod replaced that of Handel as the favourite model. The oratorios of A. C. Mackenzie, C. V. Stanford and H. Parry, which all fall within the decade 1884–94, lack the qualities, spiritual and structural, for sustaining a large-scale work. A masterpiece of 20th-century English oratorio is Elgar's *Dream of Gerontius* (1900). Cardinal Newman's poem has unity and a sufficiently dramatic framework within which the fervent, wayward and individual character of the music could expand without becoming disorderly. In Elgar's later oratorios, *The Apostles* (1903) and *The Kingdom* (1906), the first two parts of an unfinished trilogy, the absence of a firm design forced him into a systematic and almost didactic use of the *Leitmotiv* that only emphasized their episodic nature.

Italian oratorio remained in abeyance after the 18th century. Germany produced little of consequence after Mendelssohn, unless Brahms's *Deutsches Requiem,* a setting of passages from Luther's Bible, be classed as an oratorio. Liszt's two works in this form, *St. Elizabeth* (1865) and *Christus* (1873), reflect a characteristic intention to combine the devotional and the theatrical on the grandest scale. *St. Elizabeth,* with its choruses of German and Hungarian bishops, leans toward the theatre, where it has been staged; *Christus* is more restrained, in keeping with a Latin text based partly on the liturgy. Apart from Dvorak's *St. Ludmilla,* which belongs to the same class as *St. Elizabeth,* Slavonic composers have produced few oratorios. A. Rubinstein wrote sacred operas on subjects varying from *The Tower of Babel* (1870) to *Christus* (1888), but they belong rather to the German school and left little mark.

Nor has France nourished a tradition of oratorio. Marc Antoine Charpentier in the 17th century introduced *histoires sacrées* after the manner of his master, Carissimi, and F. J. Gossec wrote several for the Concert Spirituel in the following century. There were occasional biblical operas, from M. P. de Montéclair's *Jephté* (1732) and J. P. Rameau's *Samson* (composed 1733, never performed) to Méhul's *Joseph* (1807) and J. F. Lesueur's *La Mort d'Adam* (1809). But the first (perhaps the only) French oratorio of major importance is Berlioz's sacred trilogy, *L'Enfance du Christ* (1854), a series of loosely linked tableaux with a strong theatrical flavour. Berlioz's detachment from orthodox Christianity led him to view the story almost as a classical myth; his music is reverent but wholly free from religiosity. Later French composers of oratorios include Gounod, Franck, Massenet, Saint-Saëns and D'Indy. The many oratorios of Arthur Honegger and Darius Milhaud were inspired by both religious and historical subjects.

The 20th century largely abandoned the large-scale festival oratorio. Frederick Delius in *A Mass of Life* (1905, text from Nietzsche) and Paul Hindemith in *Das Unaufhörliche* (1931, poem by Gottfried Benn) attempted a philosophical oratorio without finding a substitute for the dramatic framework. Michael Tippett in *A Child of Our Time* (1941) grafted traditional oratorio elements onto an ethical theme, employing Negro spirituals in the manner of chorales. Stravinsky's opera-oratorio *Oedipus Rex* (1927), with a Latin text translated from a French adaptation of Sophocles, was most successful in the opera house.

In England the long-delayed reaction against the past led to a preference for shorter choral works on sacred texts; but Gustav Holst's *Hymn of Jesus* (1917), Vaughan Williams' *Sancta Civitas* (1926) and William Walton's *Belshazzar's Feast* (1931) should perhaps be classed as reflective or dramatic cantatas rather than oratorios. There were also modern settings of the medieval mysteries, one of the roots of oratorio. Rutland Boughton set the Coventry play *Bethlehem* in 1915 and Benjamin Britten's *Noye's*

Fludde (1958) was designed for dramatic performance in church. Vaughan Williams' opera *The Pilgrim's Progress* (1951), based on the text of John Bunyan, which the composer described as a morality, belongs partly to the oratorio tradition.

The most active composer in this field in the mid-20th century was the Swiss Frank Martin. His works include *Le Vin Herbé* (1942), a secular oratorio on the Tristan story; the Passion oratorio *Golgotha* (1949); and *Le Mystère de la Nativité* (1959), a setting of a 15th-century French mystery play intended for stage or concert performance. The last two make a deliberate return to the early forms of the oratorio. (W. B. Dn.)

ORATORY. Oratory may be defined as the art of stirring emotion in the members of an audience by oral exhortation to produce from them an active response of a kind desired by the orator. Originally it was synonymous with rhetoric (*q.v.*), defined by Aristotle as the art of persuasion, but after the term rhetoric had been widened to include all forms of literary expression, oral exhortation was more properly described as oratory. It has been of considerable importance in political life, the dissemination of religion by preaching, and the practice of law, chiefly in countries directly influenced by western culture and the literary theory and practice of classical Greece and Rome. In the east, where religion has tended to encourage passivity and quietism, and where mass education has been slow to produce a large literate audience, oratory has not developed as a cultural or political medium, and the leaders of India, for example, have been more likely to encourage passive resistance by example than to attempt to inspire action by oral exhortation.

The importance of oratory in politics, religion and law has differed widely at different times and in different places, as have the stylistic conventions which it has followed. Its origins and development in classical times, and in medieval and Renaissance Europe, are discussed in the article Rhetoric. (*See* also Greek Literature; Latin Literature; Education, History of.) In the 18th century, for example, political and forensic oratory derived their form from the fact that they were addressed to a social class extremely limited in composition which shared a background of education in the classics. Thus, it was distinguished, in England especially, by its profusion of allusions to Greek and Latin literature; by the length and complexity of its periods; and, at its best, by strict subordination of style to sense. Its subtlety and complexity of style often obscure the meaning of a particular passage from the modern reader, who also lacks the advantage of judging from the orator's inflection, facial expression and gestures, etc., the sense intended. The classic English exemplar of 18th-century political oratory is Edmund Burke at his best; at its worst, as represented by Lord Chatham's famous grandiloquence, it was turgid and more concerned to create an impression of balance and articulation than to present an argument clearly and accurately.

The style of oratory in England was affected by the rise of Methodism and by the evangelical revival; the deliberate appeal of such great preachers as John Wesley and George Whitefield (*qq.v.*) to a wider audience gave to political and forensic oratory, as well as to preaching, a new forcefulness and emotional appeal. The 18th-century style of oratory in England was thus imperceptibly succeeded in the 19th century (especially after the widening of the franchise by the 1832 Reform bill) by a more popular style addressed to wider audiences without the common bond of a classical education. Biblical allusions and quotations replaced those drawn from the classics, although they were not so generally used as they had been in 17th-century oratory both in England and America, under the influence of Puritanism. By the end of the 19th century a Radical tradition of oratory which made much use of catch phrases was coming into vogue, and in the early 20th century this style became general, being best illustrated in England by the brilliant speeches of David Lloyd George.

The decline of oratory in the 20th century was influenced by the development of broadcasting, which led to abandonment of a grand, declamatory, style in favour of the more personal, intimate, "fireside" approach. The rise of such demagogic orators as Adolf Hitler also influenced its decline, for their frenzied, psychopathological appeal to the baser instincts of their audiences gave political oratory a bad name, and led to distrust of "fine speaking" and all forms of propaganda. Some orators, however, continued to inspire both confidence and action: the speeches of Sir Winston Churchill and Pres. Franklin D. Roosevelt, for example, widely different in style, and blending several traditions of oratory, exemplify modern political oratory at its best.

Among classical orators the two greatest were Demosthenes and Cicero (*qq.v.*). Modern orators may be divided into three main groups: political, religious and forensic (corresponding to the 18th-century division of oratory as belonging to "the senate, the pulpit and the bar"). (For religious orators, *see* the article Preaching.) Among the most famous political orators are, in Great Britain, Edmund Burke, William Pitt, earl of Chatham, and his son William Pitt the Younger, Charles James Fox, John Wilkes, George Canning, Richard Cobden, Lord Macaulay, John Bright, Disraeli, Gladstone, Lord Randolph Churchill, David Lloyd George and Sir Winston Churchill. Famous British advocates and lawyers include Lord Erskine, Lord Russell of Killowen, Lord Plunket, R. L. Sheil, Lord Birkenhead, Sir Edward Marshall Hall, Patrick Hastings, Lord Carson and Lord Birkett. The Irish have always shown a particular genius for oratory, and such Irish politicians as Charles Stewart Parnell, Henry Grattan and Daniel O'Connell were notable for their impassioned eloquence, as were many Irish-born advocates and judges. The United States has produced many great orators, notably Patrick Henry, Daniel Webster, Henry Clay, Rufus Choate, Abraham Lincoln, Wendell Phillips, William Jennings Bryan, Woodrow Wilson and Franklin D. Roosevelt. In France, the period of the Revolution produced impassioned and effective orators: Mirabeau, Danton, Camille Desmoulins, and almost all the Girondins. Their successors in the 19th century included Benjamin Constant, Lamartine, Guizot, Thiers, Montalembert, Jaurès, Alexandre Ribot, Poincaré and Briand.

See also Rhetoric; Preaching; Acting, Direction and Production; and articles on national literature and on individual orators.

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ORBIGNY, ALCIDE DESSALINES D' (1802–1857), French paleontologist who, along with Charles Darwin, initiated the study of fossil mammals in South America, is considered the father of micropaleontology (*q.v.*). He was born at Couërzon, Loire Inférieure, on Sept. 6, 1802, and was educated at La Rochelle. His first appointment was as traveling naturalist for the Museum of Natural History at Paris. The opportunities of this position strongly contributed to the value and magnitude of his contributions in later years. In 1826 he went to South America and gathered information in ethnology, natural history and geology. His studies along the barrancas of Paraná revealed the presence of fossils, both shells and bones, in the exposed strata of that region. His complex stratigraphic section of the Late Cenozoic, later shown to be in error, and his investigations of ethnology were embodied in his great work *Voyage dans l'Amérique Méridionale* (1839–42). Then in 1840 he began to publish his *Paléontologie française, ou description des fossiles de la France*, a monumental work, accompanied by figures of the species. Eight volumes were published by him dealing with Jurassic and Cretaceous invertebrates, and after his death many later volumes were issued. In 1853 he was appointed professor of paleontology at the Museum of Natural History in Paris. He died on June 30, 1857, at Pierresitte, near St. Denis.

D'Orbigny's works include *Cours élémentaire de paléontologie*

et de géologie stratigraphiques, three volumes (1849–52), and *Prodrome de paléontologie stratigraphique,* three volumes (1850–52). (E. C. O.)

ORBIT, in astronomy, is the path of a heavenly body revolving around an attracting centre (from Lat. *orbita,* "track," *orbis,* "wheel"); in particular, it denotes the path of a planet or comet around the sun, or of a satellite around its controlling planet.

Kepler's Laws.—In 1609 Johannes Kepler announced two laws of planetary motion, and by 1619 he added a third.

First Law.—Kepler's first law states that a planet moves around the sun in an elliptic orbit, the sun being situated in one focus of the ellipse. If the straight line joining any two points S and T is produced equal distances beyond S and T to A and B, and

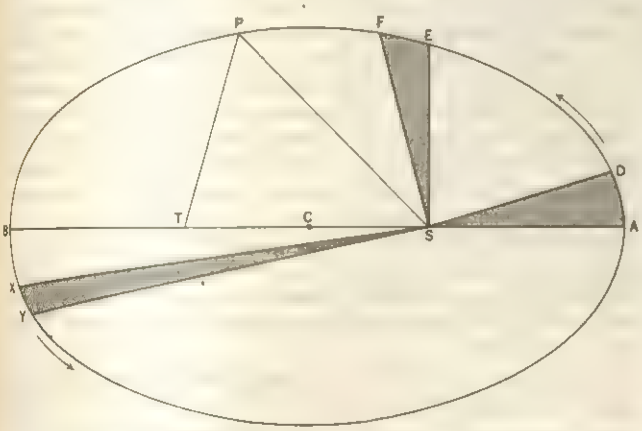

FIG. 1.—DIAGRAM ILLUSTRATING KEPLER'S LAWS OF PLANETARY MOTION

if P is any point such that the sum of the distances P S and P T is equal to the distance A B, then the aggregate of all such points as P is the curve known as the ellipse. The points S and T are the foci. The curve passes through A and B and A B is called the major axis of the ellipse. If C is the mid-point of A B, the ratio of the length of C S to the length of C A is called the eccentricity. The ellipse then is specified by means of (1) the semimajor axis and (2) the eccentricity. If the eccentricity happens to be zero, the two foci must coincide at the centre C and the resulting curve is simply a circle; if the eccentricity is precisely unity, then the curve is known as a parabola. Kepler's first law simply states that if the sun is supposed situated at the focus S, the planet's path around the sun—in other words, its orbit—is an ellipse such as is represented in the diagram above. The time required for a complete revolution in the ellipse is the planet's revolution period; for example, the earth's period of revolution is a little over 365 days; Mercury describes its orbit in 88 days, and Neptune requires 165 years. At A—the point of the ellipse nearest S—the planet is said to be in *perihelion,* and when it reaches B, the most remote point of the ellipse from S, it is said to be in *aphelion.*

Second Law.—Kepler's second law states that the straight line joining the sun to the planet (the radius vector) sweeps out equal areas in equal times. In the preceding figure let D be the position of the planet in its elliptic orbit a month after it reached perihelion (A); similarly let E F be two positions of the planet separated by an interval of a month; the pair of points X, Y are defined in the same way. The shaded area S D A, for example, is the area swept out by the radius vector in one month and by the second law the three shaded areas are equal. Now it is clear from the figure that the arc A D is greater than the arc X Y, for the areas S D A and S X Y are equal and S A and S D are less than S X and S Y; consequently, the velocity of the planet in its orbit must be greater between A and D than between X and Y. More definitely, the velocity of the planet is greatest at perihelion, decreasing gradually until aphelion is reached and thereafter increasing to a maximum again at perihelion.

The figure also shows that the angles described in equal intervals of time by the radius vector vary throughout the orbit; for example the angle D S A is clearly greater than the angle X S Y. The angular velocity is greatest at perihelion and least at aphelion. In one complete revolution around the sun, the radius vector sweeps out 360° and as the period of revolution is accurately known, the average angular velocity is easily deduced. This is known as the "mean motion" and is expressed as so many degrees (or seconds of arc) per day.

Third Law.—Kepler's third law is a relation connecting the semimajor axes of the several planets with their periods of revolution. In Kepler's time, the mean distance of any one planet from the sun was not known in miles but it was known fairly accurately in terms of the earth's mean distance from the sun regarded as the unit of the distance; in other words, the planetary system had been fairly correctly mapped out but the scale of the map was lacking. Also, the periods of the several planets were known with considerable accuracy.

The third law expressed in words is: the cube of the semimajor axis of any planetary orbit divided by the square of the period of revolution is the same, whatever planet is considered. If the year is regarded as the unit of time and the earth's mean distance from the sun as the unit of distance (this is known as the astronomical unit of distance) the quotient above for the earth is plainly unity and consequently by the third law the cube of the semimajor axis of any other planet (expressed in terms of the astronomical unit) must be equal to the square of the planet's period (expressed in years).

The Orbit in Space.—We have seen that the elliptic orbit of a planet is specified by the eccentricity and the semimajor axis. To apply Kepler's first and second laws to predict the position of the planet in its orbit at any time it is necessary to know in addition the time when it occupied any definite position in the orbit or the time when it passed through perihelion. The eccentricity, the length of the semimajor axis and the time of perihelion passage constitute three elements of the planet's orbit.

The planetary motions do not all take place in the same plane, and consequently the plane of the orbit of a particular planet must be specified with reference to some fundamental plane: the plane chosen is that of the earth's orbit and is called the plane of the ecliptic. Imagine a sphere drawn with the sun at the centre. The plane of the earth's orbit will cut the sphere in a circle (the ecliptic) and the orbital plane of any other planet will cut the sphere in another circle inclined at some definite angle to the plane of the ecliptic. The two circles intersect at two points N and M—called the Nodes. Let V denote a definite reference point on the ecliptic—the direction S V may be thought of as the direction of a particular star as seen from the sun.

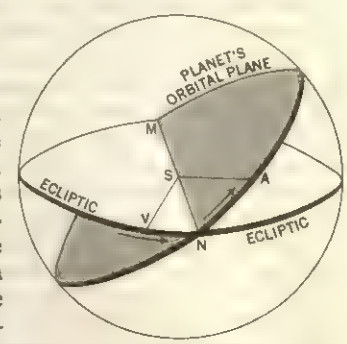

FIG. 2.—PLANET'S ORBITAL PLANE IN RELATION TO THE ECLIPTIC

The point V is known as the "vernal equinox" or "First point of Aries"; it is not necessary here to specify it more particularly. The plane of the planet's orbit is completely specified—with reference to the ecliptic and the point V—by (1) the inclination of the planet's plane to the plane of the ecliptic and (2) the position of the node N with respect to the point V. The latter is evidently given by the angle subtended at the sun by the radii S V and S N, and this angle is known as the longitude of the node. One thing more requires to be done and that is to specify the orientation of the orbital ellipse in its plane; this is accomplished by specifying the direction of perihelion—in the figure this is indicated by the direction S A. The sum of the angles subtended at S by the arcs V N and N A is called the longitude of perihelion. It should be noticed that there is an ambiguity as to the meaning of the expression "longitude of the node" for there are two nodes N and M. If the upper hemisphere in the figure contains the north pole of the heavens, the radius vector of the earth's orbit moves in the direction S V toward S N as indicated by the arrow; and if the radius vector of the

planet moves in the direction S N toward S A, as indicated by the arrow, then N is called the ascending node and M the descending node and (2) above more precisely should be "the longitude of the ascending node." The ambiguity consequently disappears.

To summarize: a planet's orbit in space is completely specified by the six elements: (1) the semimajor axis, (2) the eccentricity, (3) the time of perihelion passage, (4) the longitude of the ascending node, (5) the longitude of perihelion, (6) the inclination of the orbital plane to the plane of the ecliptic.

When the six elements of a planet's orbit are known the position of the planet (the effects of the attractions of the other planets not being taken into account) with reference to the sun and the fundamental plane (the ecliptic) can be calculated for any future date by principles essentially contained in Kepler's laws. The earth's orbit also being known, the position of the planet in the heavens, as seen from the earth, can then be deduced. (W. M. S.)

The Orbit From Observations.—The problem here is to determine the six elements which describe an orbit from observations made of the planet. The measures of position may be made visually or photographically by comparing the location of the object with the positions of the background (fixed) stars. In the case of artificial earth satellites containing radio transmitters the position may be determined by interferometric and Doppler measures. Each observation consists of determinations of the object's right ascension and declination, or some other pair of independent quantities. Since there are six unknowns, at least three observations are necessary for their complete determination. The observations should be spread evenly in time and extend over a considerable arc of the orbit for the best determination of the elements. In the case of a rapidly moving earth satellite this would mean observations spaced only a few minutes apart, whereas for a minor planet traveling about the sun they might be several months apart. The elements so determined describe an osculating ellipse at the mean epoch of the observations. Further refinements are necessary to account for the effects of any disturbing forces such as planetary attractions, or in the case of close earth satellites, the oblate figure of the earth and atmospheric drag (*see* CELESTIAL MECHANICS).

See also references under "Orbit" in the Index.

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ORCAGNA, ANDREA (ANDREA DI CIONE) (*c.* 1308–*c.* 1368), the most prominent Florentine painter, sculptor and architect of the mid-14th century, was born in or after 1308. The son of a goldsmith, Orcagna was the leading member of a family of painters which included three younger brothers: Nardo (d. 1366), Matteo and Jacopo (d. after 1398) di Cione. He matriculated in the *arte dei medici e speziali* in 1343–44, and was admitted to the guild of stonemasons in 1352. In 1354, he contracted to paint an altarpiece for the Strozzi chapel in the left transept of Sta. Maria Novella, in Florence. This polyptych (signed and dated 1357) shows Christ in a *mandorla* (an almond-shaped frame) presenting the keys to St. Peter and a book to St. Thomas Aquinas, who are represented on their knees supported by St. John the Baptist and the Virgin. In the two outer panels are SS. Michael and Catherine and SS. Paul and Lawrence. In the predella, in oblong octagonal panels, are the mass of St. Thomas, the Navicella and the death of the emperor Henry. The forceful handling of the figures is strongly individual, as is the attempt to treat the panels of the polyptych as a unitary scheme. The surviving section of a fresco of the "Triumph of Death" in Sta. Croce has also been ascribed to Orcagna. In Sept. 1367 he received the commission from the Arto del Cambio for an altarpiece of the patron of the guild, St. Matthew, with four scenes from his life. In Aug. 1368 the execution of this picture (now in the Uffizi gallery, Florence) was taken over by Jacopo di Cione on account of the illness of his brother. Orcagna is assumed to have died in this year.

ALINARI

"THE ANNUNCIATION OF DEATH TO THE VIRGIN" BY ORCAGNA, 1359. A DETAIL FROM THE MARBLE TABERNACLE OF THE CHAPEL OF OR SAN MICHELE, FLORENCE

As a sculptor, Orcagna is known through a single work, the tabernacle in the guild oratory of Or San Michele, of which he became superintending architect in 1355. This is a decorative structure of great complexity, supported on four octagonal piers and heavily encrusted with coloured inlay. Its principal sculptural features are, on the front and sides, a number of hexagonal reliefs with scenes from the life of the Virgin, and, at the back, a large relief of the Dormition and Assumption of the Virgin, signed and dated 1359. The large relief is among the most notable surviving examples of the expressive art which sprang up in Tuscany after the Black Death. There are marked differences of quality in the figurated parts of the tabernacle, and some of these may be due to Orcagna's brother Matteo.

It is known that Orcagna was employed as architect in the Duomo in Florence in 1357 and 1364–66. In 1358, he became architect of the cathedral at Orvieto, where he was engaged in 1359–60 with his brother Matteo in supervising the mosaic decoration of the façade.

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ORCHARD, WILLIAM EDWIN (1877–1955), English Free Church preacher and later Roman Catholic priest, who strove for a closer understanding between Protestants and Roman Catholics, was born in Buckinghamshire on Nov. 20, 1877. At 14 he became a clerk in the London offices of the North Western railway, where his father was employed. After his evangelical conversion he entered Westminster college, Cambridge, to prepare for the Presbyterian ministry. In 1904 he was ordained and became minister at Enfield, where he married. He took his London B.D. and D.D. degrees in 1905 and 1909 and became minister of the King's Weigh House Congregational church, London, in 1914. In 1920 his wife died.

Throughout World War I Orchard's brilliant preaching attracted large congregations. His ministry was marked by conspicuous courage, and on one occasion he braved a hostile mob in Trafalgar square when he conducted a prayer meeting aimed at ending the war. Seeking a world-wide Christianity, he introduced Roman Catholic thought and practices into his services and attempted a *rapprochement* with the Church of England, a plan which collapsed after prolonged negotiations. He became a Catholic in 1932 and was ordained priest in 1935. He preached and lectured in the United States. In 1943 he became psychological consultant at the Templewood Home of Rest, Brownshill, Gloucestershire. In 1955 appeared his book of prayers, *Sancta Sanctorum*, sequel to his popular volume, *The Temple* (1913). His numerous works also include *From Faith to Faith* (1933), an autobiography of religious development. He died at Brownshill on June 12, 1955. (HA. BU.)

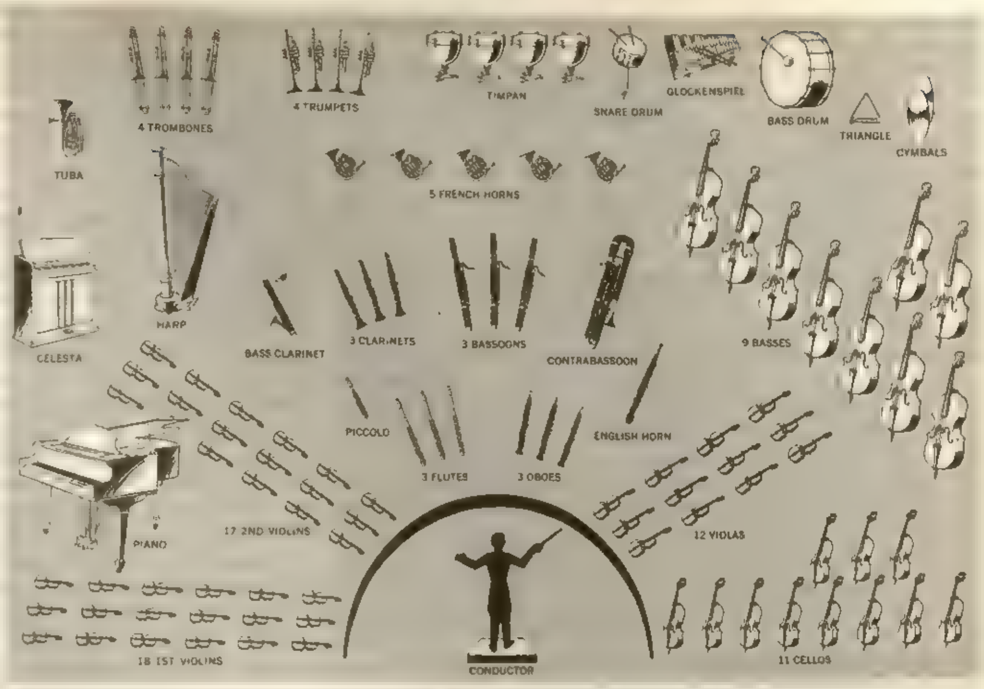
ORCHARDSON, SIR WILLIAM QUILLER (1832–1910), British painter of historical and domestic genre and portraitist, was born in Edinburgh on March 27, 1832. After studying at the Trustees' academy from 1850 to 1857, he began to do black-and-white illustrations, chiefly for *Good Words*, after the Pre-Raphaelite manner.

His early history pieces resemble R. Scott Lauder's, but he evolved a personal style characterized by thinly hatched strokes in fluid pigment, predominantly golden in tone with relieving touches of brighter colour. After exhibiting at the Royal Scottish Academy, he came to London in 1862, exhibiting at the Royal Academy from 1863. He was elected academician in 1877 and knighted in 1907. Two of his more famous paintings, "Napoleon on Board the Bellerophon" (1880) and "Her Mother's Voice"

(1888), are in the Tate gallery, London. Orchardson died in London on April 13, 1910.

See J. Stanley Little in *Art Annual* (1897); J. L. Caw, *Scottish Painting Past and Present 1620–1908* (1908). (D. L. Fr.)

ORCHESTRA, an instrumental group of varying size and composition. The term derives from the Greek *orchestra*, a place for dancing. In the ancient Greek theatre dancers and instrumentalists performed in a semicircle between the audience and the stage. When an attempt was made to revive the ancient tragedy in the form of opera at the end of the 16th century the term "orchestra" was applied to the instrumental group, which, in the early opera houses, was similarly placed between audience and stage. The 17th-century opera house orchestra consisted mainly of strings with some woodwind instruments, usually oboes and bassoons, and obbligato instruments. In the 18th century J. W. A. Stamitz and other composers of the Mannheim school laid the foundations of the symphonic orchestra in four sections, namely woodwind (two flutes, two oboes, two bassoons), brass (two horns, two trumpets), percussion (two timpani) and the quintet of strings (first and second violins, violas, cellos and double basses). Clarinets were also introduced in the 18th-century orchestra but plucked stringed continuo instruments (lutes and theorbos) disappeared. Developments in the 19th century included the introduction of triple and later quadruple woodwind and a brass section comprising three trumpets and four horns. Trombones were introduced into symphonic music about the same time, notably in the symphonies of Beethoven and Schubert. At the beginning of the 20th century the orchestra was again expanded, particularly in the works of Richard Strauss, Mahler and Stravinsky. The orchestra used by Stravinsky in *Le Sacre du printemps* consists of quintuple woodwind, eight horns, five trumpets, three trombones, tuba and several percussion instruments.



ADAPTED WITH MODIFICATIONS FROM CHICAGO SYMPHONY ORCHESTRA CHART, 1947

FULL SYMPHONY ORCHESTRA. NUMBER AND POSITION OF INSTRUMENTS IS TYPICAL BUT MAY VARY IN ACCORDANCE WITH MUSICAL REQUIREMENTS AND CONDUCTOR'S PREFERENCES

See P. Bekker, *The Story of the Orchestra* (1936); F. Howes, *Full Orchestra* (1942).

ORCHESTRATION, the art of conceiving a musical composition for a large combination of instruments, such as the orchestra. In writing out the score the composer combines, contrasts and balances sounds, using the expressive resources and qualities of timbre of each instrument. Balance is an important aspect of orchestration since the listener must be able to perceive the main strands of melody, which are likely to be obscured by the density of the accompanying instruments. Thus, the weak lower notes of the flute or clarinet would never be heard in a melody if they were accompanied by the naturally loud, cutting sounds of trumpets and trombones, even if the latter played as softly as possible. In planning the balance of a score, other natural phenomena of instruments have to be taken into account. The oboe and bassoon become louder and coarser as they descend in range, as opposed to the flute and clarinet, which become more mellow. The number of sound combinations available to the composer is almost limitless and a well-orchestrated score will contain a wealth of contrast in the use of instruments. This varying of the tonal colour scheme is an essential of true orchestral music.

During the 16th century the use of large forces of instruments of many kinds was customary. These rarely played together throughout a whole work but they were often divided into several groups of contrasting tone colour, each group including one or more continuo instruments. These groups were used, rather in the manner of organ registration, to provide sectional changes of instrumental colour and, with recorders, to provide changes of octave. The performance of the polychoral works of the early 17th-century Venetian school exploited the spatial possibilities of St. Mark's by using contrasting "choirs" of instruments (and voices) stationed in various parts of the church. In much of the instrumental music of this period, however, the instrumentation is not specified and the choice of instruments was governed by factors such as the occasion, the place of performance and the instrumentalists available. By the middle of the 17th century this profusion of wind and stringed instruments had given way to the string orchestra with continuo, with or without woodwind, that was to remain standard for 100 years.

In early 18th-century orchestral music it was usual for one set of instruments to play ceaselessly throughout a movement. The only contrast of tone colour was in the *concerto grosso* style, where a few solo instruments alternate with the whole orchestra (*e.g.*, in the concertos of J. S. Bach, Handel and Vivaldi). (*See also* Concerto: *The Concerto Grosso.*) Nevertheless, the greatest composers of this period show considerable appreciation of the characteristics of instruments. In Bach's *St. Matthew Passion* the accompaniment to the words of Jesus is perhaps the earliest use of stringed instruments to achieve a mystical, ethereal effect, such as became familiar over a century later in the works of Wagner and Verdi. Handel, too, shows a fine feeling for instrumental colour in works like the *concerti grossi*, the *Water Music* and *Fireworks Music.* It was not, however, until the latter part of the 18th century that composers learned to take full advantage of the orchestral sounds available, mixing and contrasting them in new ways; *e.g.*, an instrument might begin playing the main melody but suddenly shift to the accompaniment, and the wind instruments could be independent of the strings instead of playing in unison with them. It was discovered that wind instruments, in addition to being effective as soloists, could retire into the background and provide a discreet sustained accompaniment to melodies played on the violins. During the 18th century, composers began to write fewer parts; the first and second violins usually played in unison, while the viola and cello doubled the bass part. A harpsichord or organ provided a continuo. Examples of this kind of instrumentation are found in Handel's operas and oratorios. Gradually the wind instruments took over the function of the *basso continuo*,

and parts for oboes, horns and eventually clarinets and bassoons accompanied the main body of strings.

Haydn's symphonies provide a bird's eye view of the changes in the use of instruments during the 18th century. The early symphonies, "Le Matin," "Le Midi" and "Le Soir," are still orchestrated in the old style of the *concerto grosso*, with solo instruments pitted against the tutti. Later Haydn uses oboes, flutes and horns more imaginatively both for accompaniment and melody. But in his last Paris and London symphonies the orchestration is so rich that the harpsichord continuo ceases to be necessary.

In the orchestration of Mozart there is an even more imaginative use of wind instruments. The mixing of sounds by doubling the melody in different ways, *e.g.*, the flute and oboe or the clarinet and bassoon in octaves, is an important feature of both Mozart's and Haydn's later works. A combination of these in three octaves provides a rich variety of sounds reinforcing the main melody. A work demonstrating all these features is the first movement of Mozart's G minor Symphony, K.550 (in its second version, using clarinets). Although the main ideas are developed by the strings, the wind parts are kaleidoscopic in their variety. It should be noted that the strings still play in two- or three-part harmony, rarely in four parts.

Mozart had a keen sense of the kind of colour required in different keys. He often associated flutes and oboes with the keys of C and D, flutes and bassoons with E and clarinets and bassoons with E♭ and A. He was also the first composer to realize the expressive resources of the clarinet, which he used in conjunction with the bassoon. Haydn's and Mozart's trumpet parts are much less spectacular than those of their predecessors. The trumpet had to wait nearly a century before it came into its own again with the invention of valves, which allowed it to play any note, instead of only those few that constitute the harmonic series.

Beethoven, who needed more violent orchestral sounds, had great difficulty with his trumpet and horn parts, particularly when the music changed into a remote key. This partly explains the rather rugged, primitive quality of Beethoven's writing for these instruments in the Fifth and Seventh Symphonies. The difference between Beethoven's use of the full orchestra and that of his predecessors is chiefly one of balance between the parts and the general texture of the orchestration. He rarely uses a larger number of instruments than Mozart or Haydn, but he spaces them out more widely. Violins, flutes and oboes lie high in their compass while cellos, basses and violas play in their lowest register. A wealth of small detail in the subsidiary parts of Beethoven's orchestration also became a feature of his style, notably in the slow movements of the "Pastoral" and Ninth Symphonies.

Beethoven made it necessary to extend the technique of playing certain instruments, particularly the cellos and the double basses. He made great demands on the horn, still a natural instrument in his Third, Seventh and Ninth Symphonies. Trombones, used by Mozart and others only in operatic and church music, make their first purely orchestral appearance in Beethoven's Fifth Symphony. But the most original of all Beethoven's new instrumental conceptions was his widening of the role of the timpani. He saw possibilities of using the timpani for mysterious effects (the soft rolls in the first movement of the Fourth Symphony, or the ghostly tappings that lead from the third to the fourth movement in the Fifth Symphony) and even went so far as to begin his Violin Concerto with a soft timpani solo, the rhythm of which pervades the whole of the first movement. Despite such dramatic touches, Beethoven's innovations were on the whole an extension of the musical possibilities of instruments.

Weber, on the other hand, discovered their poetic and dramatic qualities. The horns that evoke a calm woodland atmosphere at the beginning of the overtures to *Der Freischütz* and *Oberon* can also be menacing. Weber also employed the strings to original dramatic effect. His writing for the full orchestra is clearer and better balanced than Beethoven's and poses fewer problems for performers. All Weber's instrumentation lies naturally for each orchestral group and there is none of the feeling, frequent in Beethoven, that the instruments are being strained to their limit.

In the same tradition as Weber is Mendelssohn, whose orchestration is a model of clarity. Works like the *Hebrides* overture and the music for *A Midsummer Night's Dream* show a sense of pictorial tone colouring as keen as Weber's, while in the Italian Symphony or the Violin Concerto the exquisite balance and variety of his tonal patterns is reminiscent of Mozart.

Schubert's orchestration is chiefly remarkable for its extended lyrical woodwind solos; in his later symphonies he writes impressive unison passages for trombones. Another remarkable orchestrator, though inclined to thickness of texture, is Brahms. Along with Beethoven he epitomizes the German symphonic school. Brahms, however, achieves a richer sound by means of well spaced-out strings, many moving inner parts and a full, open treatment of the tenor and bass wind instruments. Dvorak shows similar traits in orchestral style, and both he and Brahms, although they had valve horns and valve trumpets at their disposal, still tended to write for these instruments in the "natural" style mentioned above. During the 19th century the possibilities of the horn and trumpet were so extended by the invention of valves that the general texture of full orchestral sound was completely altered. Herein lies the chief difference in sound between the music of Brahms and Dvorak, on the one hand, who wrote in the old style, and that of Wagner and Strauss, who used chromatic brass.

The French and Italian composers also made use of valve trumpets (or *cornets-à-pistons*, which are nearly identical) almost as soon as they were invented. The very first published works of Berlioz (1828), for instance, make great effects with these, and throughout the 19th century French and Italian composers were greatly interested in new instruments of every kind. Berlioz was particularly original in his use of the expressive resources of instruments, and showed extraordinary imagination in inventing new combinations and textures. He not only used trombones and chromatic trumpets but he also experimented with timpani, employing them, as well as other percussion instruments, in unusual ways and often in large numbers. He used harmonics for the violins, mutes for the horns and clarinets, and instruments like the *cor anglais*, the harp, the shrill E♭ clarinet and the tuba for exotic effects. These and many other novel uses of instruments will be found in the *Symphonie Fantastique*, a model of the Berliozian instrumental technique. His *Traité de l'instrumentation* (1844) remained a standard work until the 20th century, when it was revised by R. Strauss.

It is in opera, however, that orchestral experiments were made by French and Italian composers, notably in Bizet's *Carmen*. Although, like Liszt, the French and Russians were fundamentally inspired by Berlioz, it was Richard Wagner who benefited most from Berlioz's influence. Combining the German romantic sonority of Weber's works with the Berliozian feeling for exotic colours and large-scale orchestras, Wagner evolved a style of orchestral writing of revolutionary importance. He solved the problem of balancing the naturally unequal forces of strings, woodwind and brass, so that practically no adjustment is required by conductor or players for important parts to be heard clearly against the subsidiary parts. To this perfection of balance was joined a fastidiousness for good natural part writing that is the foundation of all good orchestral sound. By clever doubling and mixing of instruments, he also created an accurately graded dynamic, so that any volume of sound could be exactly predicted by the number and disposition of the various instrumental combinations. Thus during a crescendo, instruments are subtly added to the various parts, and then are withdrawn as the music dies down. The prelude to *Tristan und Isolde* is a perfect example of this procedure. The continual changing of the texture of the main melodic strands by adding and subtracting instruments, a technique invented by Wagner, was copied and widely developed by such dissimilar composers as Elgar, Puccini, Mahler, Schoenberg and Webern. Apart from inventing new instruments, such as the so-called Wagner tuba and the bass trumpet, Wagner widened the scope of each group and also integrated instruments like the *cor anglais* and bass clarinet into the orchestra. In *Der Ring des Nibelungen* he used the largest orchestra then known, including quadruple woodwind, eight horns and six harps. With these mammoth forces he vastly enriched the vocabulary of atmospheric orchestration.

These pictorial orchestral effects were taken over by composers, such as Debussy and by the Russians, who differed in character from Wagner. Attracted to oriental and exotic subjects the Russian composers were quick to see the possibilities of Wagner's evocative combinations of sound and, although composers like Rimski-Korsakov, Borodin and Tchaikovsky lacked Wagner's genius for thematic development, they explored the possibilities of the modern orchestra to the full. Works such as Rimski-Korsakov's *Scheherezade* and Tchaikovsky's *Casse-Noisette* demonstrate the Russian style of orchestration at its most brilliant. In addition to handling the full orchestra with virtuosity the Russians were adept at inventing brilliant solo passages (as in Rimski-Korsakov's *Capriccio Espagnol*), which, although they sound very difficult, are in fact cleverly written so as to be easily played. Like Wagner, Rimski-Korsakov stressed the importance of good part writing and regarded it as almost synonymous with good orchestration. His *Principles of Orchestration* (Eng. trans., 1912) states his ideas and theories. Later Russian composers followed his example of precise part writing and balance. In fact, a unity of style in the handling of the orchestra can be traced from Tchaikovsky (whose symphonies are models in this regard) to 20th-century Soviet composers such as Shostakovich and Khatchaturian. Exceptions to this rule are Mussorgsky and Prokofiev, who, for different reasons, avoid opulence of sound in their orchestration. In his early ballets, *The Fire Bird* and *Petrouchka*, Stravinsky surpassed even his teacher, Rimski-Korsakov, in exotic and *outré* effects, but as his music became drier and less romantic his orchestration became more sombre and instruments with bite to their timbre are used at the expense of more "expressive" instruments. The *Symphony of Psalms* does not use violins, violas or clarinets at all, and in most of his later large works solos of a *cantabile* nature are generally entrusted to the oboe, bassoon, trumpet and trombone.

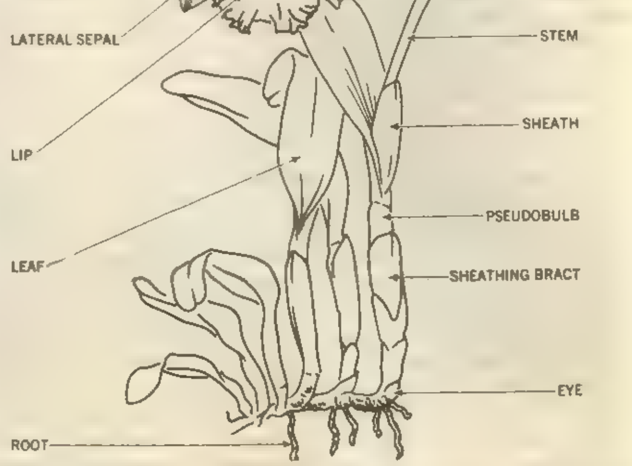
The French Impressionists shared with the Russians a taste for the exotic, but they were inspired more by a romantic view of Spain and ancient Greece than by the orient and consequently they show a predilection for instruments like the flute, harp and gentler percussion. In addition they impart to the orchestra a sensuous quality, typified in Debussy's *Nocturnes*, his *L'Après-midi d'un faune* or Ravel's *Daphnis et Chloe*. Debussy's imagination ran to unusual combinations (such as the *cor anglais* and muted trumpet at the opening of *La Mer*) and very often one note or tiny phrase will be brought into relief by the addition of a strong new colour through a muted horn, a softly struck cymbal or a harp harmonic. In this regard Debussy influenced Puccini, whose operas are masterly in their economic and telling scoring. Ravel and Manuel de Falla are more extravagant and complex in their orchestration and probably achieve the most brilliant effects of colour in all symphonic music.

In Germany Wagner was succeeded by Richard Strauss, who derived from Wagner the rich orchestration of his tone poems and large-scale operas. But it was in the creation of a new, more intimate style for small orchestra that Strauss shows his originality. *Ariadne auf Naxos* and parts of *Der Rosenkavalier* and *Capriccio* reveal the possibilities of a restricted orchestra, and, indeed, the 20th century tended to merge orchestral and chamber music, as is noticeable in the works of Schoenberg, Webern and later composers who used the serial technique. Benjamin Britten, too, showed the almost infinite possibilities of a chamber group of 13 instruments in his operas *The Rape of Lucretia*, *Albert Herring* and *The Turn of the Screw*, while his larger operas and orchestral works reveal a highly individual approach to instrumentation. Many of Britten's cleverest devices derive from Mahler, who, although a follower of Wagner in his mammoth-scale conception of the orchestra, frequently broke away from Wagner's sensuous conception of the orchestra.

Mahler's originality lies in his feeling for the grotesque and sardonic. Sometimes he makes the orchestra sound intentionally ugly, only to give way to passages of naïve and exquisite beauty. In the third movement of his First Symphony the galumphing double-bass and tuba solos shocked its first hearers and so did the whining sentimental trumpets, squealing clarinets and the saccharine quality of the violins. Mahler uses the Wagnerian principle of an ever-changing colour in the melodic line, but instead of a gradual merging of sound he produces flashes of contrasts imparting to the music a nervous, restless character. This continual changing from beauty of sound to distortion was something that kindled the imagination of the atonalists Schoenberg and Berg, while Webern's pointillistic treatment of instruments further develops the idea of a kaleidoscopic exchanging of one sound for another. The new exoticism of vibraphones, electronic effects, flutter-tonguing brass, and strings played *sul ponticello* became popular with Webern's followers. Other 20th-century masters of orchestration include Paul Hindemith, recalling the sombre colours of Brahms; Bartók, another composer who extracts nobility from the grotesque; Leos Janacek, who shows an unconventional twist in his use of every instrument; and, among others, William Walton, Aaron Copland and Jean Sibelius. (Cs. M.)

The impact of electronic music (*q.v.*) on the art of orchestration was just beginning to be felt in the mid-20th century, but promised remarkable changes. The use of magnetic tapes and computer technology increased the composer's resources immeasurably. Sounds never before heard could be synthesized and incorporated into the orchestra, completely changing its tonal "colour"; the range of sounds could be extended to the limits of human hearing—and beyond, for "subliminal" effects; and rhythmic organization of undreamed-of complexity and subtlety were possible. The very existence of the traditional orchestra and its performance hall was challenged, insofar as electronic music permitted the composer in his "laboratory" to address the listener directly, via recordings, without the need for intermediary instrumentalists led by the interpretive conductor. (X.)

ORCHID, one of the largest families of flowering plants (Orchidaceae), variously estimated as containing from 15,000 to 30,000 species in 600 to 800 genera. Distributed throughout the globe, except in the polar regions, orchids are notably abundant and diversified in the moist tropics of both hemispheres. Numerous tropical sorts are grown around the world by florists and horticulturists, professional and amateur, for their showy irregular flowers of unusual beauty and variety of colour. The name orchid comes from the Greek meaning "testicle," a term applied by Theophrastus more than 2,000 years ago to the common European *Orchis morio* because of the resemblance of its tubers to testicles. (This same resemblance led to the mistaken belief that orchids possess aphrodisiac properties.) Orchids are perennial



BY COURTESY OF THE AMERICAN ORCHID SOCIETY, INC.

STRUCTURE OF A CATTLEYA SHOWING SYMPODIAL GROWTH (CREEPING HABIT CHARACTERISTIC OF MOST ORCHIDS)

BY COURTESY OF THE AMERICAN ORCHID SOCIETY, INC.

AERIDES FIELDINGII SHOWING LATERAL PENDANT RACEMES AND MONOPODIAL GROWTH (UPRIGHT HABIT CHARACTERISTIC OF SEVERAL GENERA)

herbs, some of which may be shrublike or vinelike. Besides the terrestrial species of the temperate zone, there are the epiphytic species or "air plants" mainly of the tropics. A few species are semiaquatic, rarely subterranean (certain species in Australia) or saprophytic. In some, the rhizomes, or underground stems, are commonly horizontal and bear fibrous, fleshy roots. Epiphytic species have aerial roots that can cling to the bark of trees; these roots have a corky or spongy covering called the velamen. Erect stems are round, flat or angled in cross section, sometimes very long and often greatly swollen to form bulblike structures (pseudobulbs); rarely are stems reduced or apparently lacking. The leaves are solitary or numerous, sometimes evanescent or lacking, and vary from sheathing bracts to definite blades that are more or less fleshy and usually parallel-veined. The inflorescence may be terminal or lateral and consist of one to many flowers; a cluster may be disposed as a spike, raceme or panicle.

Orchid plants vary greatly in size: *Bulbophyllum minutissimum* does not exceed $\frac{1}{4}$ in. in height, whereas *Grammatophyllum speciosum* frequently reaches 20 ft. in height. The flowers likewise vary considerably: those of *Stelis storkii*, *Pachyphyllum schultesii* and *Octomeria pygmaea* measure $\frac{1}{16}$ in. or less across; others, such as those of *Sobralia macrantha*, may be as large as 10 in. in diameter.

USES AND IMPORTANCE

It is noteworthy that this large and diverse plant family has given so little of economic importance, excepting the ornamental and horticultural species. In some primitive societies orchids were valued for supposed therapeutic properties and other local uses. Faham tea of the Seychelles was prepared from the leaves of *Angraecum* (*Jumellea*) *fragrans*. The dried tubers of *Orchis* and *Ophrys* are still employed in the near east, and of *Eulophia* in the East Indies, to prepare salep, a nerve tonic and demulcent; these species, which contain starch and gums, are used also as food. A species of *Laelia* is the source of a mucilage in Mexico. Vanilla, the flavouring agent, is the only product of commerce still supplied to the modern world by the Orchidaceae. The cured, unripened capsules (beans or pods) of *Vanilla*, especially of the vinelike *Vanilla planifolia*, are the natural source of vanilla (*q.v.*).

The economic importance of the more striking orchids, upon which a tremendous horticultural industry valued at many millions of dollars is based, has led to the formation of numerous national and regional orchid societies and to periodic world conferences. Orchids are easily grown by the amateur under controlled conditions, and the versatility of the family has attracted the avid attention of hybridists for many years (see *Cultivation*, below).

DISTRIBUTION AND HABITAT

Tropics.—In the tropics orchids are found from near the snow line on Andean peaks to low, hot, humid forests. Some, such as *Caularthron* in Trinidad, can tolerate the salt spray of the seacoast. Orchids are practically absent, however, from the deserts of tropical areas. The great concentration of orchids does not occur (the popular misconception notwithstanding) in hot, tropical jungles, such as the Amazon and the Congo, but rather in the cooler rain forests on mountain slopes. The Andes (between 3,000 and 7,000 ft.) and the Himalayas are exceptionally rich in orchids. The world's richest areas in orchid species are Colombia in tropical America and the Indo-Malaysian region, from the Himalayas to New Guinea.

It has been calculated that the flora of Colombia, for example, comprises 50,000 species of higher plants, of which at least 2,000 are orchids. The orchid floras of some other American countries show the concentration of this family in the tropics: Costa Rica (whose national flower is the orchid *Cattleya skinneri*), 950 species; Peru, 1,200; Venezuela, 770; the islands of Trinidad and Tobago, 180 species in 62 genera. (R. E. S.)

On the other hand Africa has a comparatively poor orchid flora. Apart from several large pantropical genera, such as *Bulbophyllum* (1,000 species), *Habenaria* (600 species), *Malaxis* (300 species), *Liparis* (250 species) and *Polystachya* (200 species), most of the genera of the old world tropics are distinct from those of the new world and indeed usually belong to different subtribes.

Nontropics.—Temperate floras are much poorer in orchids than those of the tropics, but there is also a marked difference between the orchid floras of the north and south temperate regions. In the north, probably owing to the greater continuity of the land masses, many of the genera are widespread throughout the old and new worlds, good examples being *Goodyera*, *Spiranthes*, *Cypripedium* and *Platanthera* (sometimes included in *Habenaria*). The same species may be found on both sides of the Atlantic and right across Siberia; for example, *Calypso bulbosa*. The poverty of orchid species in these northern areas, however, is shown by the fact that there are only 175 species of orchids in North America, north of Mexico, and only 125 species in Europe, including about 50 native in Britain. Orchids in temperate zones usually occur in small colonies, in sparse groups or even singly; occasionally, as with the showy lady's slipper (*Cypripedium reginae*) in the Great Lakes states, colonies may contain thousands of individuals. Some orchids, as the Asiatic *Zeuxine strateumatica* introduced into Florida, or *Spathoglottis plicata* in Hawaii, may become weeds.

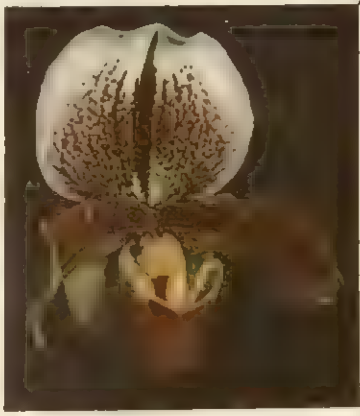
Many of the species of the United States and Canada are of wide distribution, but the greater number is found in the eastern and southeastern states. In Florida are some species belonging to the tropical genera *Epidendrum* and *Oncidium*. Many of the eastern North American orchids are well known for their attractiveness: *Arethusa bulbosa* (bog rose or dragon's mouth); *Calopogon pulchellus* (swamp or grass pink); *Cypripedium reginae* (showy lady's slipper); *Goodyera pubescens* (rattlesnake plantain or adder's violet); *Habenaria blephariglottis* (white fringed orchid), *Liparis liliifolia* (twayblade) and *Pogonia ophioglossoides* (snakemouth). The Rocky Mountain area has about four dozen orchid species, half of which occur also in the eastern states. The Pacific states have less than forty species, of which *Cypripedium californicum* (California lady's slipper) and *Epipactis gigantea* (giant helleborine) are of interest.

Great Britain's orchid flora is relatively rich, with about 48 species in about 18 genera, including especially *Aceras* (man orchids), *Epipactis* and *Cephalanthera* (helleborines), *Corallorhiza* (coralroots), *Cypripedium calceolus* (very rare), *Habenaria*, *Herminium* (musk orchid), *Liparis* (fen orchid), *Listera* (twayblades),

Laeliocattleya (*Laeliocattleya valencia*, variety DORIS)

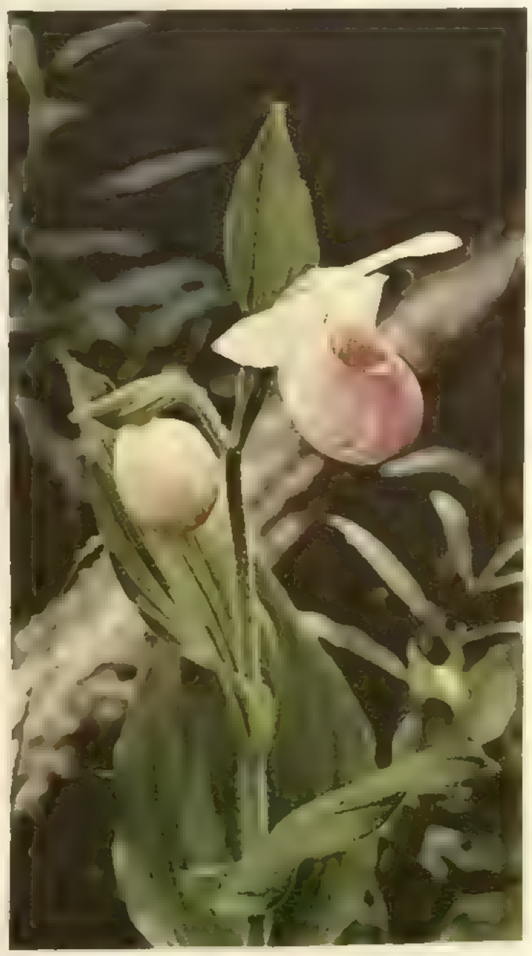
White cattleya (*Cattleya trianae*, variety A. C. BURRAGE)

Lady's-slipper (*Cypripedium maudiae*)



Lady's-slipper (*Paphiopedilum* [*Cyp.*], variety MILDRED HUNTER)

Sophronitis (*Sophronitis grandiflora*)



Showy lady's-slipper (*Cypripedium reginae*)

CULTIVATED AND WILD ORCHIDS

PHOTOGRAPHS, (TOP LEFT, TOP RIGHT, CENTRE, BOTTOM LEFT) RUTHERFORD PLATT. (CENTRE LEFT) SHERMAN, PHOTO RESEARCHERS FROM PUBLIX, (BOTTOM RIGHT) OAKES, PHOTO RESEARCHERS FROM PUBLIX

ORCHID

Epidendrum (*Epidendrum falcatum*)

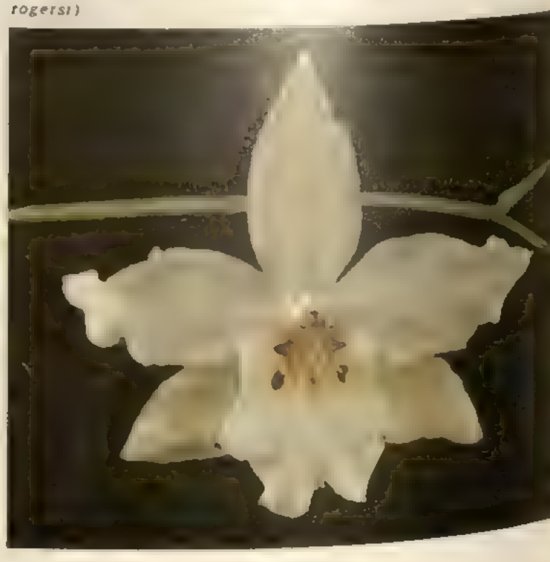
Angraecum (*Angraecum eburneum*)

Dendrob[illegible] LERIOT

Cymbidium ERICA SANDER (*C. grandiflorum* x *C. pauwelsi*)

Oncidium NONA, II (*O.* COMTESSE DE BRETON x *O. varicosum rogersi*)

Vanda (*Vanda caerulea*)



Odontonia OLGA

CULTIVATED ORCHIDS

PHOTOGRAPHS, RUTHERFORD PLATT

Malaxis (bog orchid), *Neottia nidus-avis* (bird's nest orchid), *Ophrys* (bee, spider and fly orchids) and *Orchis*.

The temperate orchid genera of South America, South Africa and Australia are all quite different from one another, belonging even to different subtribes, for example such large genera as *Chloraea* (South America), *Disa* and *Satyrium* (South Africa), and *Pterostylis*, *Caladenia* and *Prasophyllum* (Australia).

Although a large proportion of orchids grow under mesophytic conditions, which are neither very wet nor extremely dry, there are many species that exhibit more extreme habitat preferences. A small number tolerate maritime conditions; for example, spring lady's tresses (*Spiranthes vernalis*) of the tidal salt flats of Florida and species of *Bulbophyllum* and *Dendrobium*, which are characteristic epiphytes of mangrove swamps in West Africa and New Guinea respectively. Many species grow successfully in regions with a dry season of several months, during which the soil is baked dry, as in East Africa and Burma in the tropics, and parts of the United States and Australia in more temperate regions. At the opposite extreme are species that grow in quaking bogs or on floating grass-islands, examples of which are the water-spider orchid (*Habenaria repens*) of the Florida Everglades and *Disa eminii* of certain swamps of Uganda. Although many species prefer calcareous soils, especially in cooler regions, some are characteristic of acid *sphagnum* bogs, such as the grass pink in North America and the bog orchid (*Malaxis paludosa*) in Europe and North America.

A more limited number can withstand the low temperatures and exposure of arctic or high alpine conditions, such as *Platanthera hyperborea* at 70° N. in Greenland, *Disa stairsii* at 13,000 ft. on the East African mountains and *Chusua donii* at similar or higher altitudes in Tibet. Indeed with the exception of true deserts or the permanently frozen arctic tundra, there are no land habitats where some orchids do not occur. (V. S. S.)

FLORAL CHARACTERS

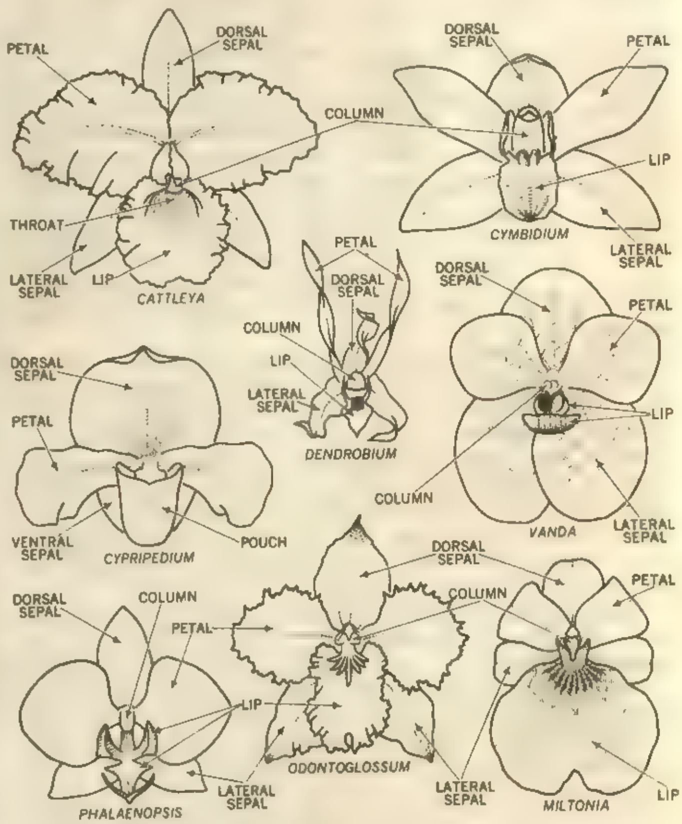
Smell and Colour.—Orchid flowers may be without any aroma, but many tropical species have characteristic, often pungent and sometimes highly offensive odours, which attract various insect pollinators. All colours are to be found, one flower often having as many as six or seven different hues. Blue is probably the rarest colour in orchids, but there are about twenty species with flowers of various blues; these include the famous Asiatic *Vanda caerulea*, one of the prizes of horticulture; the rare Amazonian *Aganisia cyanea*; and among the bluest, *Disa graminifolia*, *Thelymitra ixiodes* and *Caladenia gemmata*. Contrary to popular belief, there is no truly black orchid: the darkest are deep purple-brown; *Coelogyne pandurata*, with large green flowers, has almost pure black markings on the lip.

Structural Complexity and Pollination.—Orchid flowers, among the most complex in the plant kingdom, show an amazing degree of adaptation to insect pollination. They differ from the basic monocotyledonous type primarily in the irregularity of the perianth parts, in having most of the stamens suppressed and in the union of one of the stamens with the stigmas. The flower is usually hermaphroditic (having both stamens and pistil), but sometimes unisexual.

The perianth is six-parted, with three sepals and three petals, the petals usually being separate; the perianth arises from the top of the ovary. One of the petals is normally modified into the "lip" (labellum). Commonly larger and more striking than the other petals, the lip varies from pouch-shaped or flat to variously lobed and fringed or spurred. The lip is also often more highly coloured than the other petals.

A distinctive feature of the flower is that the stamens are united with the pistil to form what is known as the column. One group of orchids (Diandrae) has two fertile stamens and three functional lobes of the stigma; most orchids (Monandrae) have only one stamen, with two lobes of the stigma joined into a single body and a third modified to form a rostellum. The rostellum, with an important role in pollination, separates the anther from the stigmatic surface to which the sticky disc of the pollen masses (pollinia) are attached. The fruit is a dry capsule or fleshy pod containing numerous minute, dustlike seeds devoid of endosperm (stored food for the development of the embryo).

Another major peculiarity in many orchid flowers is resupination, the twisting of the inferior ovary through 180° so that the lip, normally uppermost, becomes lowermost. Resupination is frequently of value in the classification of orchids. Bizarre modifications of the lip, associated with pollination by certain insects, are likewise of taxonomic significance.

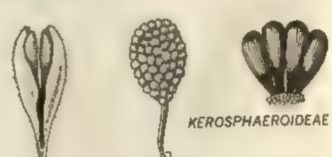


BY COURTESY OF THE AMERICAN ORCHID SOCIETY, INC.

PARTS OF VARIOUS ORCHID FLOWERS (VENTRAL SEPAL IN CYPRIPEDIUM CONSISTS OF COMBINED LATERAL SEPALS)

Most orchids are pollinated by insects, chiefly butterflies and moths; bees, wasps and ants; and flies. In a few cases, however, hummingbirds and snails may also effect pollination. The relationship between the orchid flower and insects is very highly developed, most species of orchid apparently possessing their own peculiar mechanisms that allow pollination only by a single species of insect. The column is so constructed and arranged that an insect, in extricating itself from the flower after having obtained nectar, must touch the anther, thus receiving pollinia. On entering another flower, the insect, to reach the nectary, must brush against the stigma, leaving pollinia adhering to it. (This mechanism, which ensures cross-pollination, was remarked upon by Charles Darwin in his classic book on pollination of orchids, published in 1862.)

The orchid-insect relationship in some cases has evolved to the point that the flowers of certain species are visited by insects for purposes other than the procurement of food—apparently to satisfy the sex impulse. The male insect is attracted to the flower, the lip of which has modifications simulating the female insect, and, placing his body along the column, engages in copulatory movements during which a pollinium is dislodged, becomes stuck to his body and is carried to another flower. This unusual pollinating mechanism, known for a



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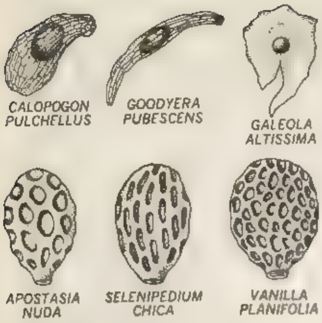
POLLINIA CHARACTERISTIC OF THREE GROUPS



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TYPES OF SEED

number of orchids, is called pseudocopulation.

CULTIVATION

The first tropical orchid cultivated in Europe was *Bletia purpurea,* introduced in 1731 from the Bahamas; by 1796, 15 or more tropical orchids were being grown at Kew gardens. The earliest book on orchid cultivation appeared in 1843. Enthusiasm for the cultivation of rare and exotic orchids spread rapidly. One result of this horticultural hobby has been the intensification of plant exploration in parts of the tropics of both hemispheres.

Most cultivated orchids are tropical species or hybrids developed from them. At least 3,500 species and many more hybrids are cultivated. Of outstanding horticultural interest are *Catasetum, Cattleya, Cymbidium, Cypripedium, Dendrobium, Epidendrum, Miltonia, Odontoglossum, Oncidium, Phalaenopsis, Stanhopea* and *Vanda.* Many bigeneric hybrids have been developed, such as *Brassocattleya* (*Brassavola* x *Cattleya*). Sometimes three or four genera have entered into the genealogy of orchid hybrids of horticultural importance: *e.g., Sophrolaeliocattleya* (*Sophronitis* x *Laelia* x *Cattleya*).

Propagation of cultivated orchids is by division, cuttings or seed. In Europe and North America, except in subtropical areas as southern Florida, most orchids are grown in greenhouses where moisture and temperature conditions may be carefully controlled. Many orchid fanciers prefer to grow "botanicals"—the truly wild and striking species—and some specialize in the miniature botanicals such as *Pleurothallis, Lepanthes* and *Stelis.*

Orchid fruits are capsules that split by three to six longitudinal sutures but remain united at the tip and the base. The minute seeds, borne in incredibly large numbers (up to 4,500,000 in one capsule), are adapted to wind dissemination. In many species the seeds are viable only a few months; they germinate slowly, those of some species requiring up to two years. Terrestrial orchids often have tuberous roots, which may form buds, thus enabling new plants to be propagated by division from the parent.

Most of the tropical orchids under cultivation are epiphytes, which grow upon trees without taking nourishment from them. Epiphytes such as orchids usually have their stems swollen into fleshy pseudobulbs that store water and mineral nutrients available in the rain, dew and dust.

Where the rather exacting conditions of culture are met, some orchids can be grown successfully as house plants. As with most plants, the conditions of their native habitat should be simulated as closely as possible. For example, the popular *Cattleyas,* native to tropical American mountain forests, where they grow on branches of trees at elevations of 3,000 to 6,000 feet, readily adapt to indoor culture when provided with fibrous material such as orchid peat (roots of *Osmunda* and other ferns) or the spongy bark of fir or redwood in which to root; a temperature of 55°–65° F. at night; a relative humidity at 60%–70%; and abundant morning and afternoon sunlight, but not direct rays during the hottest part of the day—light intensities that usually prevail at an unobstructed east or southfacing window. Since the various orchids have special cultural requirements, works on orchid cultivation should be consulted for detailed information.

Some hardy terrestrial orchids native to cool bogs or woods of the temperate zone can be grown in the wild garden or bog garden. Some of the lady's slippers and habenarias, for example, transplant well if certain care is observed. Success again depends on simulating in the garden natural conditions of shade, acidity and porosity of the soil and protection from other plants. The roots or tubers should be taken up in late summer or early autumn, with an adequate ball of soil attached: winter protection, consisting of a mulch of leaves, should be given after the soil is frozen. In many localities the collecting of native orchids and other wild flowers is restricted by law; regulations may be obtained from local departments concerned with conservation.

BY COURTESY OF THE AMERICAN ORCHID SOCIETY, INC

CATTLEYA GROWING ON A BLOCK OF TREE-FERN TRUNK FOR SUPPORT

Orchids often defy efforts of cultivation because of the grower's lack of knowledge of their need for mycorrhizal fungi in germination and growth. (Mycorrhizae are beneficial unions of fungi and higher plants; [*see* MYCORHIZA].) Since orchid seeds are devoid of endosperm, nourishment for the germinating embryo must come from an external source; indeed, the embryo cannot normally germinate without the help of a fungus. The threadlike mycelium of the fungus enters the seed and lives within the seedling, assisting in the absorption of water and nutrients through hairs that develop on the protocorm, a small tubercle produced by the embryo. The seedling may grow saprophytically, without sending out organs above ground, sometimes

BY COURTESY OF THE ROD MCLELLAN CO.

DIVIDING AND REPOTTING: (LEFT) FLAME-STERILIZED CUTTING SHEARS ARE USED TO CUT THROUGH THE RHIZOME; (CENTRE) FRESH BARK IS ADDED; (RIGHT) WIRE STAKE IS USED FOR ADDED SUPPORT

for several years, during which time the orchid is dependent on help from the fungus. The fungus does not invade all the tissues of the developing seedling. In most species of orchids the roots or, in species devoid of roots, the chlorophyll-free absorbing organs possess mycorrhizae. The balance between the fungus and the developing seedling is very delicate and easily upset. The possibilities are slight that these two types of organisms will meet in nature, which may be a significant factor in explaining why certain orchids are so rare.

CLASSIFICATION

Very little is known about the early history of orchids, since undoubted fossil orchids are not known. Representing perhaps the most advanced group of the monocotyledons, orchids are thought to have arisen from the same stock that produced the lily family. The great diversity and number of species might be interpreted as indicating extreme age of the family, but it could be evidence of a comparatively young group under extremely active evolution.

Orchids are placed in the order Microspermae (or Orchidales), which includes the Burmanniaceae, Apostasiaceae and Orchidaceae. (The Apostasiaceae, a family of several genera mainly of southeastern Asia, is sometimes included in the Orchidaceae; there is some question about combining them, since the Apostasiaceae usually have flowers without a highly modified lip, lack a column of completely fused stamens and pistils, and possess long, narrow anthers on free filaments and a long, slender free style.)

The Orchidaceae is usually divided into two subfamilies, as mentioned earlier, mainly on the basis of the number of fertile anthers: two in Diandrae (Cypripediodeae); one in Monandrae (Orchidoideae). The Cypripediodeae has one tribe, the Cypripedeae, with several genera. The most important is *Cypripedium* (lady's slipper) with about 100 species of the north temperate zone, tropical America and Asia, characterized especially by the slipper-shaped lip. The Orchidoideae is separated into two divisions: Basitonae and Acrotonae, distinguished mainly by whether the viscid disc with the cartilaginous straps connecting the pollinia arises from the base or from the tip of the anther, respectively.

Basitonae has one tribe, Ophrydeae (Orchideae), comprised mainly of north temperate, terrestrial orchids (*Aceras, Disa, Habenaria, Herminium, Ophrys, Orchis, Satyrium, Serapias*). Acrotonae is divided into two tribes, Polychondreae (Neottieae) and Kerosphaereae (Epidendreae): the former has soft, granular pollinia, the latter waxy or cartilaginous pollinia.

There are 26 subtribes recognized under Polychondreae, in which the following genera are noteworthy: *Listera, Neottia* (Listereae); *Epipactis, Cephalanthera* (Cephalanthereae); *Epistephium, Isotria, Pogonia, Vanilla* (Vanilleae); *Arethusa* (Bletilleae); *Epipogon* (Epipogoneae); *Gomphicis, Altensteinia, Cranichis, Ponthieva* (Cranichideae); *Spiranthes* (Spirantheae); *Goodyera, Erythrodes* (Physureae); *Corymborkis* (Tropidieae).

Kerosphaereae comprises two main groups, distinguished mainly on the position of the inflorescence, each with many subtribes. Genera of note are: *Pleurothallis* and *Stelis* (small tropical American epiphytes with 1,000 and 300 species, respectively); *Masdevallia* (common in cultivation); *Oberonia* and *Coelogyne* (Asiatic epiphytes, widely cultivated); *Epidendrum, Cattleya, Laelia* and *Brassavola* (tropical American genera with many choice horticultural species); *Dendrobium* (one of the outstanding horticultural groups, native to the old world tropics); *Calanthe* and *Phaius* (chiefly Asiatic); *Bulbophyllum* (an extraordinarily interesting tropical genus of both hemispheres); *Eulophia* (an important African and Asiatic genus); *Cymbidium* (an extensively cultivated tropical old world genus); *Catasetum* and *Cycnoches* (tropical American groups, with polymorphic flowers); *Odontoglossum* and *Oncidium* (genera of the warmer parts of the new world, containing some of the best-known cultivated forms); *Dichaea* (a small but complex American genus); *Vanda* and *Phalaenopsis* (Asiatic genera well known to orchid growers).

Studies in orchid cytology have, in recent years, contributed much toward clarifying some of the complexities in the classification of the family. A recently proposed classification of the Orchidaceae (including the Apostasiaceae), in some respects more meaningful from the point of view of evolution, divides the family into five subfamilies: Apostasioideae; Cypripedioideae; Neottioideae; Ophrydoideae; Kerosphaeroideae.

See also references under "Orchid" in the Index. (R. E. S.)

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ORCHOMENOS (ORCHOMENOS in literature, ERCHOMENOS on coins and in inscriptions), the name of two cities in ancient Greece.

1. A city in Boeotia (*q.v.*) between the Cephissus (Kifisos) river and its tributary the Melas (Mavropotami) on a long narrow hill projecting south from Mt. Acontium (Durduvana) near the modern village of Petromagoula, about 8 mi. from Lebadea (Levadhia). The acropolis is situated at the north end of the ridge.

The wealth of prehistoric Orchomenos was famed in legend. In Homer (*Iliad*, ix, 379–382) Achilles speaks of the gold "hoarded up" there. It was a seat of the dynastic family of the Minyae and controlled a large part of Boeotia, especially the fertile lacustrine basin of Lake Copais (Kopais), to the drainage of which the early kings gave great care. In the archaic period it was a member of the Calaurian league (*see* AMPHICTYONY). But political supremacy in Boeotia rapidly passed to Thebes. Nevertheless, Orchomenos long exercised some overlordship over northern Boeotia and an independent policy within the Boeotian league. In 447/446 it was the headquarters of the oligarchic exiles who freed Boeotia from Athenian control. In the 4th century Orchomenos was actuated throughout by an anti-Theban policy. In the Corinthian War it supported Lysander and Agesilaus in their attacks on Thebes and it again sided with Sparta in 379 (*see* GREECE: *Sparta and the Movements for Independence, 404–371*). After the battle of Leuctra (371) the Thebans, on Epaminondas' advice, at first readmitted it to the Boeotian league, but in 364 destroyed the town. By 353 it had been rebuilt, for it was taken by the Phocians and used as a bulwark against Thebes. After the subjection of the Phocians in 346 it was reduced by the Thebans, but was restored by Philip of Macedonia as a check upon Thebes (338). Its later history is obscure and its decadence is attested by the encroachments of Lake Copais.

The site was excavated in the late 19th century by H. Schliemann and in the early 20th by A. Furtwängler and H. Bulle. Excavation revealed prehistoric settlements ranging from Neolithic to Late Bronze Age. The Middle Bronze Age gray pottery known as "Minyan" is so called because it was first found at Orchomenos (*see* GREECE: *The Bronze Age;* POTTERY AND PORCELAIN). The Late Bronze Age remains excavated by Schliemann fully support the legend that Orchomenos was rich in prehistoric times. The *tholos* or "beehive" tomb known as "the treasury of Minyas" (the eponymous ancestor of the Minyae) at the foot of the ancient city is comparable with the "treasury of Atreus" at Mycenae and is almost the same size. It is constructed from blackish marble from Lebadea.

The worship of the Charites or Graces was an important cult at Orchomenos. The site of the temple is now occupied by the chapel of the Virgin. According to Pausanias they were originally worshiped in the form of rough stones which were supposed to have fallen from heaven during the reign of the legendary king Eteocles, but it was not until Pausanias' own time (2nd century A.D.) that statues of the goddesses were placed in the temple. Near this was another temple, dedicated to Dionysus. (*See* also MYCENAE.)

2. An Arcadian city about 9 mi. N.N.W. of Mantinea. Its district was mountainous but had two high-lying valleys—the northern containing a lake drained by a *katavothron* (underground

channel); the southern below the city, separated from Mantinea by the ridge Anchisia. The old city, in a strong situation, was a ruin in Pausanias' time. Till late in the 7th century the kings of Orchomenos held some sort of sovereignty over all Arcadia. In the 5th century it was overshadowed by Mantinea, and in 418 B.C. fell for a time into its power. About 370 it lost some possessions on the east to the new Arcadian capital, Megalopolis. In the 3rd century it mainly followed the fortunes of the Spartans, but belonged for a short time to the Aetolian league and, after about 235, to the Achaean league. Its history under Roman rule is obscure.

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ORCUS, in Latin, the kingdom of the dead or its ruler—the two concepts often overlap and blend. The original meaning may be "a storage vessel," passing into "a subterranean repository for the dead"; but this is hardly borne out by the earlier literary evidence, in which Orcus is always a person. As king of the underworld, he is frequently indistinguishable from Dis (*see* DIS PATER); but he can also be a demon of death who attacks and destroys living men. He is at once too menacing and too insubstantial to have a temple or cult or to be represented in the visual arts. (D. E. W. W.)

ORDEAL, in common usage means a test, physical or mental, of extreme severity; historically and in the jurisprudence of primitive societies it meant a judgment on the truth of some claim or accusation. The ordeal has taken different forms at different times and places, but the underlying idea is always the same, that it will reflect the judgment of God (*judicium Dei*), whether the ordeal be, as it often has been, essentially a practice of magic, or whether it be simply ordeal by battle, in which it is thought, or assumed, that supernatural influences will determine the issue in favour of whichever of two contestants has right and truth on his side.

There seem to be five main types of ordeal. The first, in which the magic element preponderates, is where the issue is determined wholly by the action of physical objects (*see* AUGUR; DIVINATION). The second is where the individual against whom the claim or charge is made has to undergo some physical test on the result of which the issue hangs. Whether or not it can be established that these two types of ordeal arise earlier in the development of societies than the others, they certainly appear to be linked with more primitive conceptions. The third, which seems equally primitive but which was certainly believed as late as Shakespeare's time, is connected with corpses—with the identification of the murderer by his physical proximity causing a renewed flow of blood from his victim. The fourth, the ordeal connected with an oath, in which psychological and nervous reactions may affect the behaviour of the individual submitted to the test, and the fifth, the ordeal by battle, in which a man's conscience as well as supernatural regulation of the many incalculable factors that influence combat may well determine the result, both seem to belong to a more advanced order of ideas.

Examples of ordeal by divination can be found both in Asia and Europe in historical times. In Burma suits have been determined by the parties each being furnished with a candle, equal in size and both lighted at once; and he whose candle outlasts the other is adjudged to have won his cause. In Borneo, the two parties are sometimes represented by two shellfish on a plate, which are irritated by pouring on some lime juice, and the one first moving settles the guilt or innocence (according to the arrangements made) of the owner. The uses of the sieve and the ax represent purer forms of divination, as when a suspended hatchet is believed to turn to the guilty or when, after a prayer for direction, the names of persons suspected of a theft are called over a sieve. Ordeal by divination is not without its specifically Christian forms, as when a psalter or Bible is suspended by a key tied in at Ps. l, 18 ("If you see a thief, you are a friend of his"), the bow of the key is balanced on the fingers, and the names of those suspected being called over, he or she at whose name the book turns or falls is considered the culprit.

Another form of ordeal by divination is the appeal to the corpse for discovery of its murderer. The natives of Australia will ask the dead man, carried on his bier of boughs, who bewitched him; if he has died by witchcraft he will make the bier move round, and if the sorcerer who killed him be present a bough will touch him. The ordeal of the bier in medieval Europe is founded on the belief that a sympathetic action of the blood causes it to flow at the touch or neighbourhood of the murderer. Examples are in the *Nibelungenlied*, when Siegfried's wounds bleed afresh at the approach of Hagen, and in Shakespeare's *Richard III* (Act i, scene 2), when Anne, at the approach of Richard to Henry VI's corpse, exclaims:

> O gentlemen, see, see! dead Henry's wounds
> Open their congeal'd mouths, and bleed afresh!

The submission of an individual to a physical test represents the ordeal in its purest form. The ordeal by fire is the commonest and most universal. The Old Testament has its examples in Shadrach, Meshach and Abednego, and passing through the fire is described in the Hindu codes, as when a wife so proves her fidelity to a jealous husband. This example has its counterpart in European chronicle when Richardis, wife of Charles III the Fat, proves her innocence by going into a fire clothed in a waxed shirt, and is unhurt. Alike in India and in Europe the hot iron is one of the most favoured instruments of the ordeal. The Hindu ordeal books prescribe a rite of carrying a glowing hot iron seven steps, into seven or nine circles traced on the ground, the examination of the hands to see if they show traces of burning, and the binding them up in leaves. A Scandinavian law prescribed that the red-hot iron should be carried nine steps. In Anglo-Saxon laws the iron to be carried was at first only one pound in weight, but a law of Aethelstan increased it to three pounds; this form of ordeal survived in England after the Norman Conquest. Another form of criminal procedure prescribed by the codes of the early middle ages in Germany and England was walking barefoot over glowing plowshares. Ordeals by boiling oil, hot iron and molten lead are known in modern times in Asia and Africa. The use of water for the ordeal is similar in character, one of the basic ideas being that the water rejects the guilty but accepts the innocent; hence the English usage of ducking suspected witches. In the fullest form of the ordeal by swimming, or "fleeting," the suspected witch was stripped naked and cross bound, right thumb to left toe and left thumb to right toe; in this state she was cast into a pond or river, in which it was thought impossible for her to sink. "He whom the flame does not burn, whom the water does not cast up, or whom no harm soon befalls, is to be taken as truthful in his oath" (Hindu code of Manu).

This last statement links the idea of the pure ordeal with the idea of the ordeal by oath, the idea of which is that the curse which is to fall on the oath breaker takes effect at once and becomes a sign condemning the swearer. An example from India is where an accused person drinks three handfuls of water in which a sacred image has been dipped: if guilty, sickness or misfortune will fall on him within one to three weeks. From the Mosaic law, Num. v describes the mode of administering to a woman accused of unfaithfulness holy water mixed with the dust of the tabernacle floor, after charging her with an oath, with the curse laid on it to cause her belly to swell and her thigh to rot if guilty. With the ordeal by bread and cheese, as practised in Alexandria in the 2nd century, and the virtually identical *corsnaed* of Anglo-Saxon times (where the "trial slice" of consecrated bread and cheese was administered from the altar, with the curse that if the accused were guilty God would send the archangel Gabriel to stop his throat, that he might not be able to swallow that bread and cheese) we are within sight of more modern conceptions; fear and guilt might well constrict the muscles and so inhibit the act of swallowing.

In England, legal forms of ordeal other than by combat were abolished in the reign of Henry III by a writ addressed to some of the judges on circuit in 1219, following their condemnation by the Fourth Lateran council in 1215. This last form lingered on, and a picturesque survival of it was the office of king's champion (*q.v.*), whose holder offered to defend the king's title on his accession against all comers. The claim to wager by battle made

by a man charged with murder in 1818 led to its abolition by statute in 1819.

It will be seen that the ordeal and its development in different civilizations have many features in common. There is, primarily, the religious basis as evidenced by the intervention of priests, who in the first place often took an oath themselves and later administered one to the parties. There is, throughout, a great similarity among the actual physical means employed. It seems, too, that the course by which the ordeal was gradually superseded in England is to a large extent typical of that followed in other civilizations. First the idea of the sanctity of the oath modifies the nature of the ordeal. Then as the means of enforcing order gradually prevail, the oath by the parties is extended to juries virtually as witnesses of character. Finally, as the technique of the law courts perfects itself, oral witnesses give sworn evidence as to the facts and the jury become judges of fact. With this development there is clearly no room for the ordeal.

See Sir W. S. Holdsworth, *A History of English Law*, 7th ed. (1956).
(E. B. T.; W. T. Ws.)

ORDELAFFI, the name of an Italian family which ruled the town of Forlì and neighbouring places in Romagna during most of the 14th and 15th centuries A.D. Their early history is obscure, and although their presence in Romagna may be traced back to the 12th century, they only become prominent in local politics at the end of the following century, when they appear among the Ghibelline leaders of the region and Forlì seems to have passed already under their effective control (Dante, *Inferno*, xxvii, 43–45). In 1307 Scarpetta degli Ordelaffi became *capitano del popolo* in the city. Their power was consolidated by Cecco Ordelaffi (d. 1331) and even more by Francesco Ordelaffi (d. 1374), one of the bolder figures of Romagna in his time, who shortly after his accession in 1333 added Forlimpopoli and Cesena to his dominions. As Ghibellines, bent on asserting control over towns in papal territory, the Ordelaffi came into frequent collision with the papal government in building up their despotism; even so their progress was not seriously checked before the offensive undertaken against the despots of Romagna by Cardinal Albornoz (*q.v.*). It took three years of war (1356–59) to subdue Francesco Ordelaffi and his no less resolute wife, Cia degli Ubaldini, whose vigorous defense of Cesena (1357) recalls the more famous defense of Forlì by Caterina Sforza a century later. Francesco was deprived of Forlì but retained vicarial powers over Forlimpopoli and Castrocaro. In 1376 his son, Sinibaldo, recaptured Forlì during the War of the Eight Saints. The pope eventually recognized his restoration and in 1379 made him vicar. Six years later Sinibaldo was overthrown by his nephews Pino, who ruled until 1402, and Cecco, who was killed in a popular rising in 1405. Once again a papal legate, Baldassare Cossa, governed Forlì.

The same story of periodic dispossession and despotic violence is repeated throughout the 15th century. In 1411 Forlì was retaken from the church by Giorgio Ordelaffi and his cousin Antonio, the first of whom promptly confined the other to prison and kept him there to the end of his reign. Giorgio died in 1422 and a confused period followed of intermittent government by the Church and repeated interference by the powerful states of Florence and Milan, all of which simply showed the precarious position of the smaller despotisms by this time. The final phase of Ordelaffi rule opened with the reign of Antonio (freed from prison on the death of Giorgio), who was regranted the papal vicariate in 1443. He was succeeded on his death (1448) by his sons Cecco III and Pino III. Cecco ruled until 1466 when he was imprisoned and put to death by Pino. Pino III was of a princely type considered common in 15th-century Italy, being distinguished for his patronage of art and letters and even more for his murderous violence. After Cecco, he killed his first wife, his mother and his second wife, before being killed himself by his third wife, Lucrezia Pico, in 1480. The end followed quickly. Forlì was reclaimed by Pope Sixtus IV who gave it to his nephew, Girolamo Riario; and except for a brief restoration in 1503–04, the Ordelaffi disappeared entirely from the history of Forlì and of Italy.

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(P. J. J.)

ORDER, in architecture, is a column (*q.v.*) with its base and capital (*qq.v.*), and the entablature (*q.v.*) above, considered as a single architectural feature. The entablature consists of three parts, the architrave (the beam resting directly on the columns, known also as the epistyle), frieze (*q.v.*), and cornice (*q.v.*, the chief member being the corona, a projecting block vertical on the face but hollowed or sloped up toward the back on the undersurface to shed rain). The Five orders are systematic classifications of five different types, Tuscan, Doric, Ionic, Corinthian and Composite. (*See* also ORNAMENT, ARCHITECTURAL.)

This article is divided into the following sections and subsections:

I. TYPES

1. Classic Orders.—Greek architecture developed two distinct orders, Doric and Ionic, together with a third form of capital, Corinthian, all adopted by the Romans, with modifications, by the 1st century B.C. It was natural, therefore, that Vitruvius (*q.v.*), in the last quarter of 1st century B.C. should have attempted to give rules for the construction of three orders. Moreover, as the Etruscans had developed a simple order of their own, he added a section dealing with that. With the rediscovery of Vitruvius early in the 15th century, he was at once hailed as the authority, and architectural writers of the later Italian Renaissance imitated him by giving ideal rules for the orders, attempting to reconcile his standards with the varying examples of Roman work they knew. They added as a fifth order the Composite type of capital. The three most famous Renaissance compilations, those of Sebastiano Serlio (1537), Giacomo da Vignola (1562), and Andrea Palladio (1570), exerted a tremendous influence over 17th- and 18th-century architecture throughout Europe, and gave rise to the idea that these compilations were rules to be absolutely followed, an idea contradicted by the works of the three authors themselves (as of Vitruvius before them). Since knowledge of Greek remains was lacking, the Doric and Ionic orders were described only in their Roman versions; in ignorance of Etruscan temples, the Tuscan order was described as a merely simplified Roman Doric. Their passion for

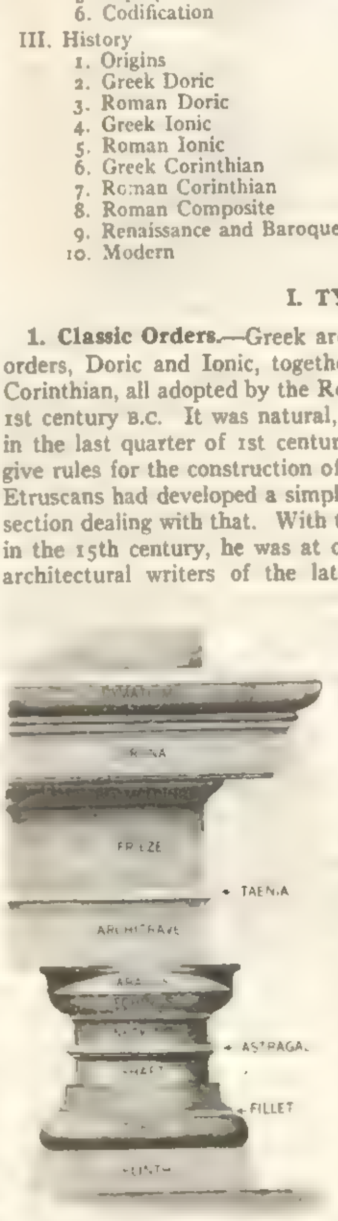

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FIG. 1.—TUSCAN ORDER

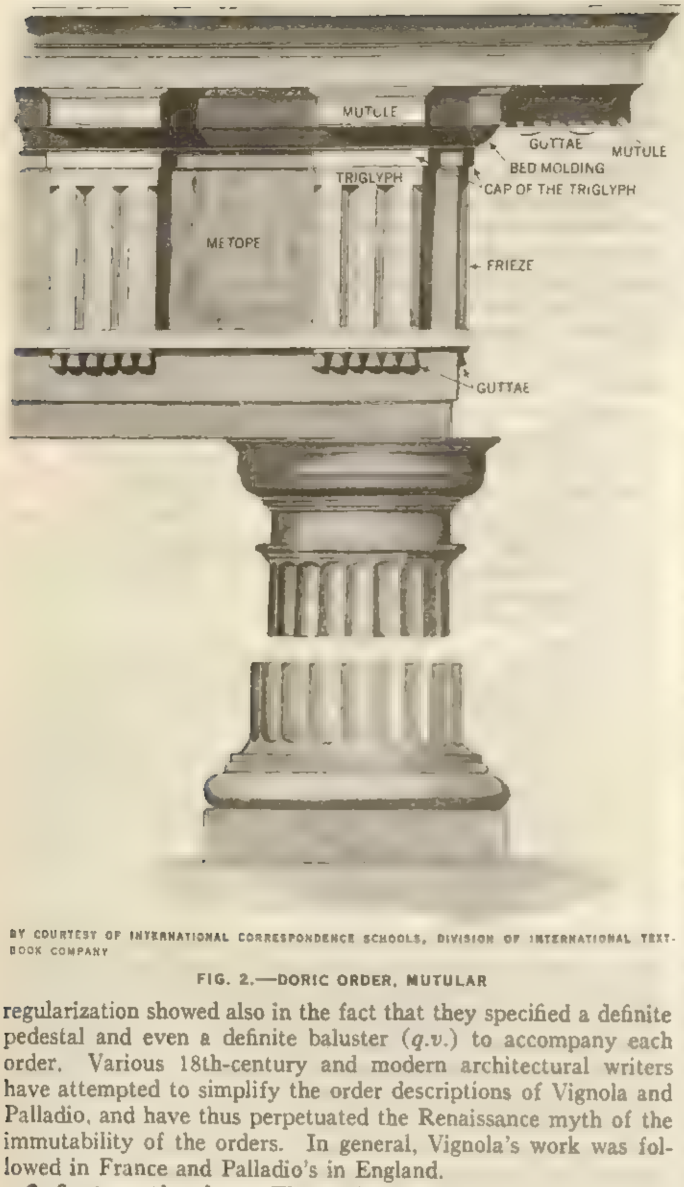

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FIG. 2.—DORIC ORDER, MUTULAR

regularization showed also in the fact that they specified a definite pedestal and even a definite baluster (*q.v.*) to accompany each order. Various 18th-century and modern architectural writers have attempted to simplify the order descriptions of Vignola and Palladio, and have thus perpetuated the Renaissance myth of the immutability of the orders. In general, Vignola's work was followed in France and Palladio's in England.

2. Systematization.—The orders as systematized by the theorists are as follows (for definitions of many of the terms pertaining to decorative details *see* MOLDING):

Tuscan.—The column is 7 lower diameters high, including 6 diameters for an unfluted shaft (tapering toward the top) and ½ diameter each for base and capital. The base is a plain square plinth with a large circular torus (a half-round profile) and a fillet above. The capital has an astragal (miniature torus) at the top of the shaft, a necking which is merely a short continuation of the shaft, and an echinus (a simple ovolo or quarter-round with a fillet below it), carrying a simple square abacus (*q.v.*). The entablature, as in all the orders, is one-quarter of the column height; the Tuscan consists of a plain architrave crowned by a simple taenia or projecting band square in cross section, a plain frieze, and a cornice with a *cyma reversa* as a bed molding, an undecorated corona, and the cymatium or gutter of ovolo profile.

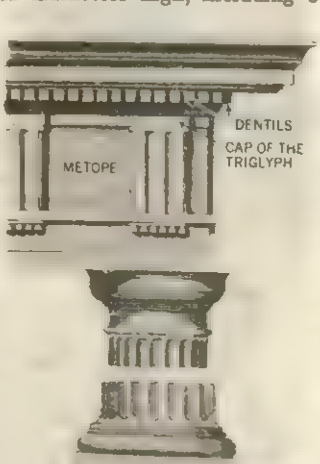

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FIG. 3.—DORIC ORDER, DENTICULAR

Doric.—The column is 8 diameters high (one more than the Tuscan), including ½ diameter each for base and capital. The shaft has 20 shallow flutes separated by sharp edges or arrises, terminating elliptically above the base and below the capital. The base differs from the Tuscan in the reduction of the height of the torus to permit the insertion of an astragal.

The capital has additional fillets or an astragal and fillet below the echinus, and a projecting molding at the top of the abacus. The echinus may be carved with the egg-and-dart, the necking decorated with rosettes. The architrave is sometimes divided into two fasciae (flat bands), the upper wider and projecting beyond the lower; the taenia may be decorated with a molding and, beneath each triglyph of the frieze, has a flat rulelike band (regula) from which hang six guttae or small conical drops. The frieze is composed of projecting triglyphs, vertical rectangles characterized by three (two whole and two half) vertical triangular grooves, alternating with receding metopes, square panels either plain or carved with sculptured reliefs. A triglyph is placed over the centre of each column, also one or more between the columns according to the variant column spacings (*see* below). Two forms of cornice are described: the mutular, in which the underside of the corona is decorated with projecting slablike blocks (mutules), one over each triglyph; and the denticular, in which the bed moldings are enlarged in order to include a row of little projecting blocks (dentils). In both cases guttae are used on the soffit or underside of the corona: in the mutular, the square undersurfaces of the mutules have six rows each of six guttae, while in the denticular (where part of the projection is taken up by the dentils) they appear in shallower panels over each triglyph, each with three rows of six guttae. The bed molding, below mutules or dentils, is an ovolo or *cyma reversa*, while the crowning cymatium is either a cavetto or a *cyma recta*.

FIG. 4.—GUTTAE ON DORIC ARCHITRAVE

Ionic.—The column is 9 diameters high, including ½ diameter each for base and capital (the latter only ⅓ diameter excluding the drooping volutes). The shaft differs from the Doric in having 24 deeper (semicircular) flutes, with flat fillets between them. The base is of the Attic type (see *Greek Ionic*, below), with a plinth carrying two tori separated by a scotia or hollow molding. The capital is characterized by volutes or spiral scrolls on its front and rear faces, where the horizontal cushion (concave in section and so called *canalis*, bordered by raised fillets) resting on the echinus winds up at either side in a volute or helix, drooping below the echinus and making the total height here ½ diameter. On the lateral faces the volutes of the front and rear are connected by a generally concave cylindrical form known as the pulvinar, bolster or baluster, which may be carved with leaves, and sometimes even takes the form of two vases, end to end. Thus the general plan of the Ionic capital is oblong rather than square, and the difference in the lateral faces causes difficulties in turning the corner of a building (see *Corner Treatments*, below). The echinus, of ovolo profile, is carved with the egg-and-dart, eggs above the flutes, darts above the fillets of the shaft; and where, as it follows the circle of the shaft, it disappears behind the volutes, a little radiating petal form hides the intersection. The abacus,

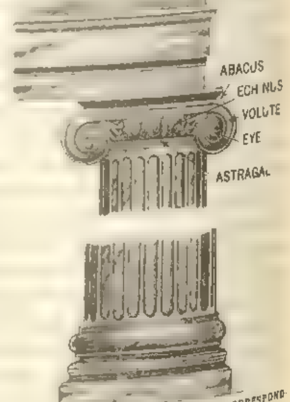

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FIG. 5.—IONIC ORDER

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FIG. 6.—CORINTHIAN ORDER

square in plan, is very low, merely a *cyma reversa* and fillet. The entablature has an architrave divided into two or three fasciae, the upper wider and projecting more than the lower, sometimes separated by moldings, with a crowning *cyma reversa* and fillet instead of a taenia. The frieze is plain, although sometimes carved with sculpture, and the cornice has bed moldings of three parts: a dentil band separating the *cyma reversa* from an ovolo above. The cymatium is a *cyma recta* with a smaller *cyma reversa* below it.

Corinthian.—The column is 10 diameters high, including the base of ½ diameter and the capital is increased to 1⅙ diameter in height. The base resembles the Ionic, but is enriched by doubling the scotia with an intervening pair of astragals with fillets (*see* BASE). The high capital consists of a bell-shaped core, supporting a molded abacus with concave sides so that the corners project, though chamfered at 45°. At the bottom of the bell of the capital is an astragal, and the surface of the bell is divided vertically into thirds, each of the two lower thirds having a row of eight acanthus (*q.v.*) leaves, each the width of three flutes of the shaft. The centres of the upper leaves coincide with the central flute on each face of the column, while the centres of the lower leaves alternate and so coincide with fillets of the shaft below. On either side of the central upper leaf on each face rise fluted stalks known as cauliculi, each with two leaves supporting scrolls or volutes, one large and one small in the upper third of the bell. The arrangement is such that the voluted ends of two larger scrolls meet and support each projecting corner of the abacus, while those of two smaller scrolls, coming together under the centre of each concave abacus face, support a flower (fleuron) carved on the abacus itself. In the entablature, the architrave and frieze resemble those of the richer Ionic examples, the frieze sometimes pulvinated with a convex or double-curved profile. The cornice also resembles that of the Ionic order with the addition of a band of modillions supporting the corona; these are small scrolled brackets, usually decorated on the sides with S-scrolls and on the bottom and front face with acanthus leaves, and crowned by a little *cyma reversa* molding. Between the modillions the soffit of the corona has panels with rosettes.

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FIG. 7.—MODILLION AND MUTULE

Composite.—The column is again 10 diameters high, the base and capital repeating the Corinthian proportions. The capital, its main distinguishing feature, shows the Corinthian two rows of acanthus leaves below; but above them, instead of scrolls growing out of cauliculi, there are large volutes somewhat like those of the Ionic order, though disconnected (without the horizontal cushion) and rising from the top of an echinus, carved with the egg-and-dart, which is placed immediately beneath the abacus. Thus they rise nearly to the top of the abacus, and are brought out (canted) at an angle to meet and support its four corners, while resting on the top of the upper row of acanthus leaves. The capital is identical on all four faces. In the bed moldings of the cornice, large brackets without scrolls take the place of the modillions.

II. PRACTICES

1. Engaged Columns and Pilasters.—When columns are not free-standing but attached to walls, they are said to be engaged. Such engaged columns should not be strictly semicolumns (with centres in the wall plane), since any projecting horizontal moldings of the wall itself would then cut into the circumference; consequently the columns are slightly stilted, the centres moved out to receive such moldings without unpleasant effect.

Pilasters are flat rectangular wall strips, normally projecting for a quarter of their width, forming responds to columns or used on wall faces instead of engaged columns, analogous to the Greek antae. They have bases and capitals like those of the corresponding orders, only, since pilasters often do not taper upward, the capitals are not reduced by the diminution and may be wider than those of columns.

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FIG. 8.—COMPOSITE ORDER

2. Corner Treatments.—In four of the orders, Tuscan, Doric, Corinthian and Composite, the capitals are alike on all four faces and thus create no difficulties in turning the corners of buildings. But the Ionic capital, different on its front and lateral faces, has to be specially designed at corners, with two "front" faces meeting at right angles, the corner volutes which would otherwise intersect being brought out back to back at 45°, as in the Composite capital. To avoid this anomaly, a variant Ionic order was codified by Vincenzo Scamozzi (1615), and hence sometimes known as Scamozzi Ionic (though it had ancient prototypes, *see* below). Its chief difference from ordinary Ionic is that the capital is alike on all four faces, the volutes occurring

on all four and brought out (canted) at an angle at the corners, the abacus above being concave-sided. Moreover, the volutes are not connected horizontally on each face, but curve up from the top of the echinus, so that the result is like the upper part of a Composite capital.

On the other hand, the Doric order encounters a special difficulty at corners of buildings with relation to the frieze: the triglyph being centred over the column and yet narrower than the width of the architrave soffit, but the face of the frieze coinciding with that of the architrave, there remains at each corner of a building an awkward quarter of a metope. This treatment, while seriously advocated by Vitruvius, was never followed either by the Romans or by the Greeks (for whose adjustments *see* below). Of the Renaissance architects who followed it, only Jacopo Sansovino adequately solved the problem in the library of St. Mark's in Venice (1536), and that at the cost of employing complicated pilasters instead of columns at the corners, permitting a half metope on each face and so a full metope folded around the corner.

FIG. 9.—CORNER OF GREEK DORIC ENTABLATURE

3. Column Spacings and Variant Proportions.—Spacings of columns, like their proportions, were subject to formulary rules. Thus Vitruvius specified five types, the unit as usual being the lower column diameter, the intervals between columns giving the names for the spacings as pycnostyle (interval $1\frac{1}{2}$ diameter), systyle (2), "metriostyle" ($2\frac{1}{2}$, the Vitruvian norm, the name coined to fill the gap left in his list of definitions), diastyle (3), and araeostyle ($3\frac{1}{2}$ or more diameters). He also cited the eustyle ($2\frac{1}{4}$, "well-columned") as the preference of the Greek codifier Hermogenes. The spacings on centres, therefore, were $2\frac{1}{2}$, 3, $3\frac{1}{2}$, 4 and $4\frac{1}{2}$ or more diameters in the graduated series, $3\frac{1}{4}$ in the eustyle. In the Doric order, restricted by the location of the column centres exactly beneath those of triglyphs (the latter spaced $1\frac{1}{4}$ diameters on centres), only multiples of this unit were possible, limiting the column spacings on centres to $2\frac{1}{2}$ (here called systyle), $3\frac{3}{4}$ (diastyle), and 5 diameters (araeostyle). The triglyph spacing being fixed, the systyle had one triglyph between the columns (monotriglyphic), the diastyle two (ditriglyphic), the araeostyle three or more (polytriglyphic). The closest spacing possible, with only $\frac{1}{2}$ diameter between the columns in order to allow for the projections of the capitals (and thus $1\frac{1}{2}$ diameter on centres), was not discussed by Vitruvius, but was used by later architects in the form of coupled columns. This practice led to a rhythmical spacing, alternately coupled and araeostyle, used in some of the Renaissance palaces in Rome (*e.g.*, the Cancelleria with pilasters and the palace of Raphael with engaged columns) and in the east front of the Louvre (with freestanding columns, $1\frac{1}{2} + 4\frac{1}{2} = 6$ diameters for the spacing of the bays).

With regard to proportions, Vitruvius, from whom much of this codification was immediately obtained, nevertheless stated that after working out the dimensions by formula the architect should obtain a proper balance by adjustment, adding or subtracting for the sake of the effect. He therefore gave rules for variations. For instance, the normal height of the Ionic column being 9 diameters, he also gave heights of 8 diameters (araeostyle), $8\frac{1}{2}$ (diastyle), 9 (the norm which we may designate as "metriostyle"), $9\frac{1}{2}$ (systyle) and 10 diameters (pycnostyle). It is evident that the height varied inversely according to the spacing, and that, added together, their sum should always be $12\frac{1}{2}$ diameters, thus: $2\frac{1}{2} + 10$ (pycnostyle), $3 + 9\frac{1}{2}$ (systyle), $3\frac{1}{2} + 9$ ("metriostyle"), $4 + 8\frac{1}{2}$ (diastyle) and $4\frac{1}{2} + 8$ (araeostyle), so that the eustyle should probably be $3\frac{1}{4} + 9\frac{1}{4}$ (though Vitruvius gave the height $9\frac{1}{2}$ as for the systyle). Reading between the lines, it is evident that these variations depend upon another element, scale or actual size; thus the plumpest and most widely spaced columns (araeostyle) were also the smallest, while the most slender and most closely spaced columns (pycnostyle) were also the largest, the reduction of spacing with increase of size being determined by the practical question of quarrying stone lintels (architraves) of adequate size. Similar consideration of scale occurs in other precepts of Vitruvius; *e.g.*, the upper diameter of a column shaft, normally $\frac{5}{6}$ of the lower, should be increased to $\frac{6}{7}$ if the height is greater than 20 ft., to $\frac{7}{8}$ if greater than 40 ft., with similar changes in the height of the architrave to allow for greater distance and foreshortening as seen from below.

4. Roman Arch Orders.—The spacing of engaged columns might be increased to 5 diameters on centres (Tabularium at Rome), $5\frac{1}{4}$ (theatre of Marcellus), $5\frac{1}{2}$ (Basilica Julia), or even $7\frac{1}{2}$ (Colosseum), by inserting arches which helped to support the architraves, these then constructed with short blocks or even as flat arches. This class of order, not discussed by Vitruvius but included by the Renaissance theorists, appeared often in superposed storys. They might involve Doric, Ionic and Corinthian, but generally Corinthian or Composite when used in triumphal arches, the latter with even greater spacings at the centre and sometimes with closer (rhythmical) spacing on either side, with considerable flexibility.

5. Superposed and Giant Orders.—When columns adorned several stories of a building, they were normally of different orders, superposed in a sequence from heaviest to most slender, Doric, Ionic and Corinthian, sometimes even Composite at the top. Since the upper diameter of the lower column properly became the lower diameter of that in the story above, giving in terms of the lowest diameter the sequence of 1, $\frac{5}{6}$, $\frac{25}{36}$, the successive heights became $8 \times 1 = 8$, $9 \times \frac{5}{6} = 7\frac{1}{2}$ and $10 \times \frac{25}{36} = 7$ of the lowest diameters, the actual heights of the stories diminishing successively from bottom to top (a rule violated in the Colosseum). These might be further varied by the interposition of pedestals. Rarely were these freestanding colonnades, as in the Septizonium at Rome; usually they were engaged columns combined with arches (Roman arch order), as around the temple of Hercules at Tivoli and in the Tabularium, theatre of Marcellus and Colosseum at Rome. When they were freestanding, the centres were naturally superposed to maintain a vertical axis; but when they were engaged the centres were successively set back as the diameters diminished, so that the wall behind might be vertical.

To avoid the complication of separate orders for each story, and to obtain more majestic scale, Renaissance architects perfected the giant or colossal order, composed of columns or pilasters running through the height of two or more stories, as on the exterior of St. Peter's at Rome (by Michelangelo and Carlo Maderna) and in the Casa del Diavolo (Palazzo Giulio Porto) at Vicenza (by Palladio).

6. Codification.—The object of such codification of the orders was to furnish exact proportionate dimensions for every feature, large or small, so that, being given the diameter of the column or any other dimension, even so trivial as the width of a dentil the entire order might be constructed mechanically. While pushed by the Renaissance theorists to such an extreme that all dimensions were predetermined in modules, parts, and minutes, down to $\frac{1}{144}$ column diameter, yet it must not be imagined that these, or the more liberal systems advocated by Vitruvius, were the earliest codifications. For even Greek architects, besides writing special monographs on their own buildings, necessarily discussing the proportional systems, also published theoretical discussions of the orders, the Doric by Philon, the Ionic by Hermogenes, and the Corinthian by Arcesius. While these books have been lost, some of their rules may be recovered from measurement of the buildings themselves. *See* also GREEK ARCHITECTURE; ROMAN ARCHITECTURE.

III. HISTORY

1. Origins.—Both the Doric and Ionic orders originated more or less simultaneously on opposite shores of the Aegean sea, so that the conventional idea that the Doric was the earlier is true only if consideration is limited to developed forms. Both originated in wooden construction, as was clearly recognized by Vitruvius.

Doric can be traced, on the Greek mainland, back to Aegean prototypes. The typical column was of wood, the shaft tapering downward to rest on a simple flat stone base; the wide-spreading wooden capital was formed by a concave necking separated from the shaft by an astragal, with a bulging echinus and a square abacus above. While only charred remains of these wooden columns have survived (with evidence for their lower diameters in sockets at Cnossus and Pylos), they are represented in wall paintings in the palace at Cnossus, and particularly important are the stone replicas (known to the Greeks of historic times) carved in the relief over the Lion Gate and the pairs flanking the doorways of the tombs of Agamemnon and Clytemnestra, all at Mycenae and dating from the 13th century B.C. The Aegean entablature, on the other hand, with its serried row of round beam-ends resting on an architrave, does not seem to have impressed the Dorian Greeks as worthy of imitation.

When these prototypes were imitated by the historic Greeks in wooden columns, to which we have literary references at Olympia (Heraeum and house of Oenomaus) and at Metapontum, and actual traces at Olympia and the Argive Heraeum, it seems evident that the taper was reversed, diminishing upward in the conventional manner. The columns were widely spaced as shown by the traces of their bottoms; but the capitals can only be restored on the analogy of Mycenaean and early archaic examples in stone, with actual pieces of bronze necking revetment at Olympia. For the entablature the evidence of archaic examples is combined with the statements of Vitruvius. The architrave represented the original wooden beam running from column to column or post to post. The taenia, a board above this, gave a bearing for the crossbeams, of which the fibrous ends were protected by terracotta slabs with the characteristic triple grooving (whence the name triglyphs), held in place by pegs through the taenia board, later translated into guttae. The metopes, literally, "between the beam-holes," were merely the panels, often of sun-dried brick faced with terra cotta, filling the intervals between the beams. The sloping undersides of the roof rafters, supported on a timber or plate above the crossbeams and projecting beneath the cornice, appeared as mutules decorated with the heads of pegs (guttae) which secured the terra-cotta corona above.

The Ionic order had manifestly an Asiatic origin. Beginning with mere wooden posts which may at first have been square, these were soon translated into stone as circular posts. They supported elongated bracket capitals, with pairs of large vertical volutes imitated from the pier and stele capitals of Phoenicia (reflected in Cyprus and Carthage), with influence also from Assyria, all these ultimately derived from Egyptian lily designs. This Proto-Ionic form, occurring at Neandria and Larissa on the Asiatic mainland and at Mytilene and Nape on the Island of Lesbos, usually lacked a formal abacus, and might have below the volutes a lofty torus decorated with interlaced ornament (another Assyrian form) and a garland of pointed leaves drooping down over the shaft.

FROM DINSMOOR, "THE ARCHITECTURE OF ANCIENT GREECE" (BATSFORD)

FIG. 10.—PROTO-IONIC CAPITAL AT NEANDRIA

From the Acropolis at Athens and from Delos come examples of the intermediate stages between the vertical volutes and the horizontal but still disconnected volutes, with the drooping leaves gradually becoming the egg-and-dart ovolo. The primitive wooden entablature is reproduced in stone copies on rock tomb fronts in southwestern Asia Minor (Lycia), showing the architrave of three fasciae, originally overlapping planks, supporting a serried row of round beam-ends (at this stage recalling the Mycenaean) which were later squared and more widely spaced, becoming large dentils. (*See* also PRE-HELLENIC ARCHITECTURE.)

2. Greek Doric.—In the Heraeum at Olympia (*c.* 600 B.C.), the columns, originally of wood, were replaced in stone one by one over nearly eight centuries; late replacements of wood by stone occurred also at Thermon. Both examples retained their old wooden entablatures with terra-cotta revetments. The evolution of the stone Doric column may be traced in Greece, Sicily and South Italy, where it was the chief order for monumental buildings (with a few intrusions in Asia Minor, as at Assus and Pergamum) during eight centuries. The Greek Doric column always lacked a base (cylindrical protrusions at the bottoms of columns at Syracuse and Agrigento were left merely for completion of the fluting) except in the Olympieum at Acragas and a few late Hellenistic examples. The shaft normally has 20 flutes, though early examples vacillated between 16 and 24, or even 32.

FROM R. KOLDEWEY AND O. PUCHSTEIN, "DIE GRIECHISCHEN TEMPEL IN UNTERITALIEN UND SIZILIEN" (JULIUS SPRINGER)

FIG. 11.—DORIC CAPITALS AT PAESTUM

Even in the Periclean period 16 flutes appeared under special conditions inside the Parthenon and at Sunium; unfluted columns resulted only from lack of completion. In secular buildings of the Hellenistic period fluting often appeared only in the upper two-thirds, the lowest third being faceted (polygonal) to avoid wear.

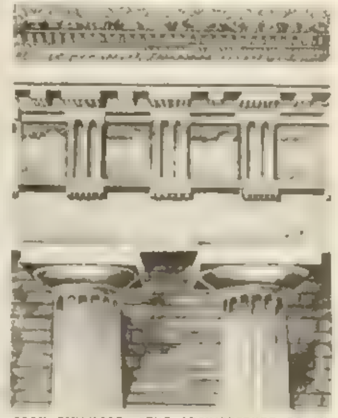
The outline of the shaft was often slightly convex as it rose from bottom to top, in a gentle curve known as entasis (*q.v.*). The capital for a long time was much heavier than that employed by the late codifiers; early examples show a tremendous width of abacus and a heavy bulging echinus; the necking might be concave, enriched with overhanging petals and separated from the shaft by an astragal (like the Mycenaean), while carved patterns might appear even on the lower part of the echinus (Paestum). With increasing strictness, the necking became no more than a continuation of the fluted shaft, separated from it by three incisions, later by one. The projection of the abacus was reduced, the echinus refined to a hyperbolic curve. Finally, the echinus was deadened to a conical, quarter-round, or *cyma recta* profile, and crowning moldings began to appear on the abacus.

The entablature, in early examples at Syracuse, had triglyphs only above the columns with horizontal oblong metopes between; as triglyphs were inserted midway between the columns (monotriglyphic), the metopes became vertical oblongs, then with increasing lightness tended to become square (though exactly square metopes were rare). The face of the triglyph was always in the architrave plane, befitting its structural derivation from a principal beam; the metope was countersunk. The latter was often enriched with relief sculpture, either on façades or all around temples; in the Peloponnesus the tendency was to confine sculptured metopes to inner porches of temples.

On the architrave, some early western colonial examples employed carved Ionic moldings of sandstone rather than the normal taenia, regulae and guttae. One example even more closely ap-

proached Asiatic Ionic in omitting the frieze (Kardaki on Corfu), and in another the triglyphs became pentaglyphs (Locri in south Italy). The mutules of the cornice (always sloping up toward the back like rafter ends) were at first of full width only above triglyphs, those above the narrow metopes being of half or two-thirds width; by 540 B.C. this restless alternation was replaced by uniform widths. At Paestum (temple of Ceres) coffered panels were substituted for mutules. The primitive terra-cotta cornice revetment survived in the earliest buildings (as at Selinus), but nailed to an upper stone member, thus doubling the height of the cornice; this was soon replaced by a stone hawks beak molding. Bed moldings made their first appearance in the Propylaea at Athens (437 B.C.). Entablatures were richly decorated in colour, blue triglyphs, red and blue on cornice soffits, and also green and gold on all moldings.

As for proportions, larger columns (after the translation into stone) were at first stumpy, but showed a general tendency to increase with the passage of time, in terms of the lower diameter, from 4 to $7\frac{1}{4}$ diameters; the proportion of 8 diameters (or more) was reached only in late house courts, as at Delos. But it must be emphasized that this variation was not solely chronological, being affected also by scale: small columns, even in the early archaic period, might be $6\frac{1}{2}$ diameters high at the same moment that large columns were no more than four. Yet a chronological sequence of large columns of about the same height (33–34 ft.), this height being about $4\frac{1}{4}$ diameters at Paestum, $4\frac{5}{8}$ at Olympia, $5\frac{1}{2}$ in the Parthenon, $6\frac{1}{3}$ at Nemea, illustrates the general tendency. The sudden change before the Parthenon is due to another factor, material; in the western colonies, where marble was not available, the height (except in two sporadic examples) did not rise above $4\frac{3}{4}$ diameters even by the end of the 5th century. The Periclean gamut ranged only from $5\frac{1}{2}$ diameters in large buildings (Parthenon) to $5\frac{3}{4}$ in small (Sunium and Rhamnus), in a fairly regular gradation according to size.



FROM DINSMOOR "THE ARCHITECTURE OF ANCIENT GREECE" (BATSFORD)

FIG. 12.—EARLY DORIC ENTABLATURE AT SELINUS

Heights of entablatures showed a corresponding tendency toward lightness, beginning with more than half the column height (temple C at Selinus), two-fifths (Olympia), one-third (Parthenon and other Periclean works), one-fourth (Nemea, there attaining the standard of the codifiers), and even one-fifth (Pergamum).

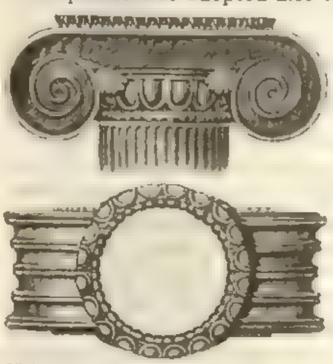
As for column spacings, the intervals were at first even less than the diameter (Syracuse), because of timidity as to the strength of stone architraves; but during most of the archaic period (except where wooden entablatures survived) they ranged from 1 to $1\frac{1}{2}$ diameters, rarely to $1\frac{3}{4}$ or $1\frac{7}{8}$; in other words, the closest pycnostyle spacing of Vitruvius was normally the maximum. Further complications resulted from the early tendency to vary the spacings on fronts (usually greater, as well as column diameters) and flanks of temples (the latter sometimes greater in the west), gradually tending toward uniformity. An additional disturbance was corner contraction, narrowing the last column interval (sometimes two intervals in the west) partially to counteract the distortion caused by the corner triglyph. In Periclean Athens the normal spacing was organized into a regular system, the intervals ranging from $1\frac{1}{4}$ diameters in the largest buildings (Parthenon) to $1\frac{2}{3}$ diameters in the smallest (Rhamnus), so that the interval exceeded the column diameter by $1\frac{1}{2}$ Greek feet ($19\frac{5}{16}$ in.), the width of a man across the shoulders, giving a scale relation. As thus co-ordinated with the height, Doric columns were heavier and more closely set together as they increased in size, emphasizing the majesty of the Doric style.

3. Roman Doric.—The Romans, adopting late Hellenistic Doric forms, with some influence from Etruscan, reserved their use for small-scale columns or secondary positions, except in the colossal column monuments of Trajan and Marcus Aurelius. Apart from small temples of the Republican period (at Cori, and that of Spes in the Forum Holitorium at Rome), Doric appeared primarily in house courtyards as at Pompeii, and as engaged columns between arches in the lowest of superposed stories (see *Roman Arch Orders* and *Superposed and Giant Orders*, above). The base was omitted (as in Greece) in early buildings in Pompeii and in the theatre of Marcellus at Rome; a simple circular disk was inserted below the shaft in Pompey's theatre, a fillet with apophyge at Albano. A simple torus formed the base at Cori, a large torus with plinth in the column of Trajan, a full Attic base with plinth in the Colosseum. Shafts were frequently unfluted (Colosseum, also the colossal columns with spiral friezes). Capitals were usually of the conventional type of the codifiers, though the quarter-round echinus was sometimes flattened conically, or replaced by a *cyma recta* (temple on the Aventine, baths of Diocletian).

In the entablature, contrasting with Greek usage (when the triglyphs were in the architrave plane, the metopes countersunk), the Romans placed the metopes in the architrave plane, with the triglyphs projecting as if they were mere applied decorative panels, misunderstanding their structural function, and sometimes even heretically breaking the epistyle taenia out around the protruding triglyphs. In many cases the architrave was Ionic with three fasciae, and in the Colosseum triglyphs were omitted. As used in rectangular buildings (as at Cori) a triglyph was placed at the corner in the Greek manner. The mutules of the cornice, while sloping up toward the back at Cori and in the theatre of Marcellus, were usually horizontal, again misunderstanding their origin as roof rafters; and there might even be Ionic dentils below the mutules.

4. Greek Ionic.—The most representative example of the archaic Greek Ionic type appears in the Croesus temple at Ephesus (*c.* 550 B.C.); but numerous other examples illustrate various phases of the development in Asia Minor, after which the scene shifts to Athens in the 5th century, back to Asia Minor for the Ionic Renaissance of the 4th century.

Bases, in the east, were usually of the form known as Asiatic Ionic, with a spool-shaped disk (trochilus) adorned with many shallow, or later, two deeper, horizontal hollow moldings (scotias) separated by fillets or astragals; above this was a torus, usually fluted horizontally. An exceptionally early appearance of a square plinth below the trochilus occurred at Ephesus. The mainland tendency was to simplify the base, first with a bell-shaped molding (*cyma recta* upside down) resting on a diminutive torus and carrying a larger torus (Athenian Stoa at Delphi), and then at Athens itself the typical Attic base with a single scotia between two tori. The upper torus might continue to be fluted horizontally or, as in the Erechtheum's north portico, decorated with a carved guilloche; the plain lower torus also became larger than the upper. A peculiar flaring type of base occurs at Bassae. Later in Asia Minor the square plinth reappeared under the Asiatic profile (the latter extremely varied on the façade at Didyma); and finally the Attic profile was adopted also in Asia Minor, now combined with the square plinth.



BY COURTESY OF JAMES CRAMER WATT

FIG. 13.—ARCHAIC IONIC CAPITAL AT EPHESUS: (ABOVE) FRONT VIEW; (BELOW) VIEW LOOKING UP

Shafts were at first adorned with shallow flutes, 18 to 36 in smaller columns, 40 to 48 in the largest, separated by sharp arises as in Doric. Exceptional were the sculptured lower drums at Didyma and in the successive temples at Ephesus. Gradually the flutes were deepened as ellipses or semicircles, and reduced in number to 20, 24 (the canonical number) or 32, with wide fillets between.

Capitals, with the volutes now united by the horizontal cushion, were at first extremely long in

proportion to their depth, befitting their bracket origin. The cushion and volutes were formed at first by convex surfaces, later concave (the true *canalis*), and they might at first wind up indefinitely (Ephesus), an awkwardness soon concealed under the decorative "eye." Some volutes were completely concealed behind rosettes (archaic front at Ephesus), or contained heads of divinities or were replaced by foreparts of winged horses and lions (corner capitals at Didyma). Unusually enriched forms of cushion and volutes appeared in the Erechtheum (*q.v.*), where also the exceptional anthemion (*q.v.*) necking, already foreshadowed in some archaic examples, reached its highest development. The total length was gradually contracted as the abacus tended to become square in plan, but did not attain an actual square until the 4th century. Volutes gradually became smaller, and in the Hellenistic period the echinus was pushed upward (as in the works of Hermogenes) to obliterate the drooping lower curve of the cushion. The Greeks never succeeded in overcoming the awkward treatment at the corner of a portico, with volutes on two adjacent faces curved out together at 45°, back to back (*see* above, *Corner Treatments*), thus causing two half volutes to meet abruptly at the opposite corner inside the portico. Not only were the outer faces unsymmetrical and lopsided as seen in direct elevation; but the interior corner problem was differently solved in every example, sometimes even to the extent of forcibly pulling out the half volutes to make them complete, albeit squeezed (Priene). Experimentally, in the half capitals at Bassae, all the volutes were canted at 45°, making the capital concave in plan (foreshadowing the Scamozzi type), the resulting optical illusion of sagging being corrected by arching the cushion upward, which in turn caused the omission of the horizontal abacus. Such canted capitals, though with an abacus, later became popular in minor structures such as the stage building at Epidaurus (2nd century B.C.) and the palace at Palatitza (Macedonia).

Entablatures, like bases, differed on opposite sides of the Aegean sea. The Asiatic form consisted of the architrave with three fasciae and a bold egg-and-dart, supporting directly a row of large dentils (the primitive beam-ends) instead of a frieze, while the cornice might be surmounted by a very high parapet carved with reliefs like a frieze (Ephesus), in later examples replaced by a cymatium. The low friezeless entablature continued in use in Asia Minor through the 4th century B.C. When the order was imported to the Greek mainland, the entablature height was increased by introducing a frieze, usually sculptured, between architrave and cornice as a substitute for the dentils, now omitted, and the parapet-sima was reduced in size. The fasciae were omitted from the architrave lest there be too many horizontal lines. Earlier Attic examples followed this scheme with a frieze but without fasciae on the architrave (temples at Sunium and on the Ilissus, interior at Bassae); the inner architrave face, however, retained the fasciae below the ceiling (Ilissus temple, Propylaea); and fasciae soon emerged again on the exterior (temple of Athena Nike, Erechtheum), thus yielding the normal Attic type. But even in Athens the Asiatic entablature was reproduced in the caryatid porch of the Erechtheum, with small dentils instead of a frieze, to give lower proportions.

In Asia Minor, the same architect who still retained the friezeless entablature at Priene (340–334 B.C.) seems already to have effected a compromise in the Mausoleum at Halicarnassus (355–350 B.C.), with a frieze inserted between architrave and dentils under the influence of mainland sculptors. This compromise type was adopted for the Ionic Philippeum at Olympia (338 B.C.), as also for the Corinthian monument of Lysicrates at Athens (334 B.C.), and thereafter also in Asia Minor (works of Hermogenes, etc.). After these many vicissitudes, the Asiatic and Greek mainland types coalesced. In minor works of the Hellenistic period, however, Doric triglyphs sometimes appeared in Ionic friezes (upper storys of Pergamene stoas, and a palace at Ptolemais in Cyrenaica).

As for proportions, there is little exact information for the archaic period as a whole. At Ephesus the columns are reported to have been 8 diameters high (Vitruvius, Pliny, quoting the original architect); also at Samos the restored height is 8 di-

FROM LETHABY, "FRAGMENTS FROM GREEK BUILDINGS" (BATSFORD)

FIG. 14.—IONIC CAPITAL OF THE ERECHTHEUM

ameters; while in the little Athenian Stoa at Delphi it is $8\frac{2}{3}$ diameters. Athens in the age of Pericles developed a graduated scale of column heights, ranging from 8 (only $7\frac{7}{8}$ in the temple of Athena Nike) diameters in the smallest to 10 in the largest, exactly like the Vitruvian. During the Ionic Renaissance in Asia Minor the proportions were more uniform, $8\frac{3}{4}$ to $9\frac{3}{4}$ diameters. The return to the Periclean system appears to have been due to the Attic tendencies of Hermogenes, perpetuated by Vitruvius. The entablature height might be only one-sixth of the column height in the friezeless type of Asia Minor, increased to more than one-third under Doric influence when the frieze was first introduced on the mainland, but finally was stabilized as about one-quarter of the column height.

In column spacings, however, there is wide variety, especially in Asia Minor because of the propensity for employing one or three wider spacings at the centres of façades (up to $28\frac{1}{4}$ ft. on centres), with other variations on the flanks. In Periclean Athens the spacings formed an organized system, the intervals ranging from 2 to $2\frac{4}{5}$ diameters, from the smallest to the largest columns, thus being exactly the opposite not only of the Doric but also of the system advocated by Vitruvius. This increase in slenderness with enlargement of size emphasized the delicacy of the Ionic, by contrast with neighbouring Doric buildings, but, because of the rapid increase in the lengths of lintels, would have been impossible to construct if there had been columns much larger than in the north portico of the Erechtheum. Consequently, for the great temples of the Ionic Renaissance in Asia Minor, a more compact system was devised, with intervals ranging only from $1\frac{5}{8}$ to $1\frac{3}{4}$ diameters. The final Vitruvian return to a graduated scale, but with the intervals diminishing from wide to narrow in accordance with the availability of lintels, seems to have been invented by Hermogenes.

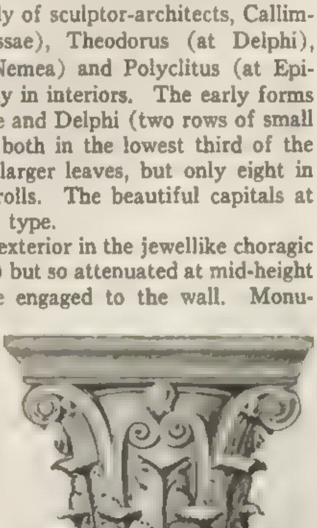
5. Roman Ionic.—Like the Doric, the Ionic order was inherited by the Romans from late Hellenistic Greek examples and employed chiefly on a small scale (as in the Republican temple in the forum *boarium* known as "Fortuna Virilis," or the Augustan rebuildings of the temples of Janus and Juno Sospita in the forum *holitorium*) or in secondary positions (as in superposed stories). Vitruvius, who belatedly advocated the use of Ionic as the primary order, copied the forms and proportions established by Hermogenes. Thus Attic bases on plinths, and capitals with small compact volutes, are characteristic of most Roman examples. Shafts were frequently unfluted, as in the theatre of Marcellus and the Colosseum, or in other cases because of the use of variegated coloured marble or granite or other hard stone (often monolithic), this applying also to Corinthian. Capitals might be enriched with foliage in the canalis, even with human heads replacing the eyes of volutes, as in capitals now in Sta. Maria Maggiore at Rome. Volutes canted at 45° occur in houses at Rome and Pompeii, in the colonnade around the temple of Apollo at Pompeii, and later in the temple of Saturn on the Roman Forum, predecessors of the Scamozzi type. The entablature, normally orthodox Ionic, sometimes in the Republican period (as in Greek Hellenistic) showed triglyphs in the frieze (colonnade around the temple of Apollo at Pompeii, the Roman tomb known as the Oratory of Phalaris at Acragas), a practice condemned by Vitruvius.

6. Greek Corinthian.—The Greeks regarded this as no more

than a special capital substituted for the Ionic. Its prototypes, however, were the bell-shaped Aeolic capitals with vertically fluted petals curling over to support a square abacus, appearing on fronts of 6th-century treasuries of Ionic type at Delphi (these later imitated on interior columns of stoas of the Pergamene school, at Pergamum itself, Aegae and Athens). The true Corinthian capital, with tiers of acanthus leaves and scrolls carved in relief on the bell, was a purely Greek invention of the second half of the 5th century B.C. (for the charming story of its creation by Callimachus *see* Vitruvius, Book IV). The modern idea that it was derived from the so-called "composite capitals" of Egypt is fallacious, since all these Egyptian examples are later, of the 30th dynasty and the Ptolemaic period after Greek contacts.

The capital was long a monopoly of sculptor-architects, Callimachus himself (possibly at Bassae), Theodorus (at Delphi), Scopas (at Tegea and perhaps Nemea) and Polyclitus (at Epidaurus), and at first was used only in interiors. The early forms were yet uncanonical, as at Bassae and Delphi (two rows of small acanthus leaves, 20 in each row, both in the lowest third of the capital). Scopas at Tegea used larger leaves, but only eight in each row, without the central scrolls. The beautiful capitals at Epidaurus foreshadow the normal type.

The capital first emerged on an exterior in the jewellike choragic monument of Lysicrates (334 B.C.) but so attenuated at mid-height as to be acceptable only because engaged to the wall. Monumental examples began to appear in the east after Alexander's conquests: at Didyma near Miletus (in the unroofed cella); externally in the temple of Zeus at Diocaesarea in Cilicia (*c.* 290 B.C.); and at Lagina. They appeared in Syria as well, and so also in a Syrian gift to Athens, the temple of Zeus Olympius (174 B.C., designed by the Roman Cossutius, working for a Syrian king long before the capital was known at Rome itself); by a coincidence, the importation of capitals from this unfinished temple to Rome by Sulla provided models for the early Roman Corinthian. A particularly rich variant, in the propylon built for Appius Claudius Pulcher at Eleusis (*c.* 50 B.C.), is hexagonal, with one row of acanthus leaves in the lower part and winged horses instead of volutes under the three most prominent corners of the abacus. A simplified but popular type was invented for the Tower of the Winds at Athens (48 B.C.), with one row of acanthus leaves around the lower half of the bell, and one row of lanceolate leaves in the upper half, the square abacus having no supporting volutes.



FROM LETHABY, "FRAGMENTS FROM GREEK BUILDINGS" (BATSFORD)

FIG. 13.—CORINTHIAN CAPITAL AT EPIDAURUS

Apart from the capitals, the columns generally had Attic bases; those of the Tower of the Winds had no bases at all. Because of the original use as an internal order, the Greeks were slow in developing a corresponding entablature. On exteriors, the combined Asiatic-Attic entablature with dentils above the frieze, which had appeared with the Ionic in the Philippeum at Olympia (338 B.C.), was adopted in the monument of Lysicrates (334 B.C.) and generally elsewhere, as in the Olympieum (174 B.C.). But such was the undefined form of the order that a Doric frieze was employed at Eleusis, with rosettes and bucrania carved on the metopes, cists and wheat-sheaves on the triglyphs. As for column proportions, the Ionic prevailed since it was a question merely of a variant capital. Thus the early Aeolic columns at Delphi were $8\frac{1}{3}$ diameters high, the Corinthian at Bassae $8\frac{3}{4}$ diameters (like the adjoining Ionic), the colossal columns of the Olympieum $8\frac{3}{4}$ diameters; only the slender engaged columns of the monument of Lysicrates attained the 10 diameters of the Renaissance codifiers.

7. Roman Corinthian.—To Vitruvius, as to the Greeks, this was not yet a separate order, merely a variant capital which might be used with either Ionic or Doric entablatures (strangely a[illegible] ting the latter despite his condemnation in the case of the I[illegible] order). So in the temple of Peace on the forum at [illegible] (as rebuilt in Sulla's time), the temple of Roma and Augustus [illegible] Philae in Egypt, and the arch of Augustus at Aosta, just as at Eleusis in Greece, it was combined with the Doric triglyph frieze. Usually, however, the entablature was denticulated Ionic with the gradual addition of modillions. The capital seems to have reached Italy by various routes. The bronze Corinthian capitals said by Pliny to have been used for the portico erected by C. Octavius (168 B.C.) after his victory in Macedonia may have been direct importations from Greece. A few rustic examples in soft stone appeared in Italy, under Alexandrian-Sicilian influence, in the 2nd century B.C. But the chief inspiration probably came from the marble capitals sent by Sulla in 86 B.C. from the Olympieum at Athens for the temple of Jupiter Capitolinus at Rome. The capitals of the temple of Magna Mater at Rome, also of temples A and B (the round temple) in the Piazza Argentina, and of the temple of Jupiter at Pompeii, executed in soft travertine or hard peperino, all show the usual two rows of large acanthus leaves, but with a horizontal joint cutting through the upper row at mid-height, a technical peculiarity occurring also in the Olympieum capitals.

In the Augustan age, and so in the very lifetime of Vitruvius, the Corinthian was organized as a distinct order and executed in marble, as in the Regia of the Roman forum (36 B.C.), the portico of the Pantheon (27 B.C.), the portico of Octavia (after 27 B.C.), the round temple of Hercules by the Tiber (*c.* 25 B.C.), the temples of Mars Ultor (3 B.C.), of Castor and Pollux (A.D. 6) and of Concord (A.D. 10), all at Rome, and the temple of Minerva at Assisi (*c.* A.D. 20); in the Maison Carrée at Nîmes (A.D. 4) it is still of limestone.

The Roman Corinthian capital is found in infinite variations. The height of the lower row of acanthus leaves is generally greater than that of the upper (despite the equality advocated by Vitruvius and the theorists). The acanthus usually has sharp lobes (*acanthus spinosus*), but in a series of the Sullan period (Tivoli, Praeneste, Pompeii and Cori) the leaves are of a more fleshy and curly variety (*acanthus mollis*). The central spirals on each face, rather than merely meeting, are sometimes interlaced (temple of Castor and Pollux, Rome). The corner volutes may be replaced by rampant foreparts of animals, winged horses (pilasters of the temple of Mars Ultor) or rams (interior columns of the temple of Concord). In some simplified varieties the corner volutes [illegible] from only one tier of leaves, and the central scrolls may be replaced by a human head, as in the forum temple at Paestum. In others, both the central and the corner volutes may be suppressed, the whole height of the bell being occupied by two tiers of a[illegible] thus leaves, eight below and four above, the latter curving [illegible] support the corners of the abacus, with a central winged chimera head or other animal or human form, usually flanked by [illegible] (West Shops at Corinth and a large series of similar capitals a[illegible] Athens [including the sunken shipload at Mahdia]. [illegible] Tarentum, Pompeii and Rome). Another simple type of capital, common in pilasters, substitutes for the cauliculi and double scrolls merely an S-scroll on either side, turned inward below and outward above to support the abacus corners (imitated in the early Renaissance).

Bases might be of the normal Attic type without plinths (at Tivoli), or the Attic type with plinths (at Assisi, and temples [illegible] Mars Ultor and Antoninus and Faustina at Rome); but [illegible] favoured was the double-scotia type with intervening astragals and fillets (Pantheon, portico of Octavio, Basilica Aemilia, temples of Castor and Pollux and of Concord). In the entablature the middle fascia of the architrave is richly carved in the temple of Castor and Pollux, the face of the corona vertically fluted [illegible] this as well as the temples of Concord, Vespasian, and Antoninus and Faustina. The cornice has neither dentils nor modillions in the portico of Octavia or the temple of Antoninus and Faustina, but usually both dentils and modillions (the latter an important creation of the imperial period) appeared together in the Maison Carrée at Nîmes, the Regia, the Portico of the

Pantheon (the dentils uncut), the temples of Castor and Pollux, Concord and Vespasian. In the temple of Venus and Roma, and that of Serapis (or the "Sun") at Rome, dentils were omitted and the modillions were replaced by great rectangular brackets, the form specified in the Renaissance for the Composite. Most exceptional are the tremendous vertical consoles occupying the whole height of the frieze, below the modillions, in the temple of Jupiter at Baalbek.

8. Roman Composite.—Vitruvius made no mention of this, since the Composite capital was apparently not invented until after his time. Even to the Romans of the later empire this was only one of many variations of the Corinthian, its elevation into a fifth order being a purely Renaissance idea. Its essential elements, an Ionic capital with volutes canted at 45° set on the lower part of a Corinthian bell with a single row of acanthus leaves occupying half of the height of the capital, are first encountered in a temple of Roma and Augustus at Mylasa near Halicarnassus in Asia Minor (12 B.C.–A.D. 14; not seen since 1740). A fully developed monumental type is that of the arch of Titus on the Roman forum, in which the exquisite Composite capitals with two rows of leaves support a normal Corinthian entablature with modillions (completed A.D. 82); the Composite pilaster capitals of the top story of the Colosseum may be slightly later. Rich examples of the Composite appear also in the arches of Septimius Severus and Constantine, and in the baths of Caracalla and of Diocletian. A splendid type in the baths of Caracalla is enriched with acanthus leaves carved in the canalis of the volutes, with human figures adorning the middle of each face, standing on the lower leaves and reaching to the top of the abacus.

9. Renaissance and Baroque.—During the 15th century in Italy, before the period of strict codification, the early Renaissance architects Brunelleschi, Michelozzo and Alberti developed modified Corinthianesque orders of extreme delicacy, not only in porticoes but also in connection with doors, tombs and the like. Similar types prevailed during the early 16th century in France. During the high and late Renaissance the orders tended to become more formal but much individuality of design is still present in the work of Bramante, Raphael, Peruzzi, Vignola and Palladio. Typically Renaissance variations are rusticated orders, like those in the gates of Verona by Sanmicheli (1533) and the banded columns developed by Philibert Delorme for the Tuileries in Paris (1564), and followed in the Grande Galerie (1578), and twisted columns like those of Bernini's baldachino in St. Peter's at Rome (1624–33). *See* also RENAISSANCE ARCHITECTURE.

During the baroque period, especially in Spain and Spanish colonies, all kinds of forms approximating the orders were employed, but they are too broken up, contorted, and varied to be classified. *See* also BAROQUE AND POST-BAROQUE ARCHITECTURE.

10. Modern.—The rediscovery of Pompeii in 1748, and the impetus toward travel in Greece from 1750 onward, diverted attention from codifications of the orders to examination of the rich variety of examples in Roman and Greek lands, and inspired two of the modern revival movements, the Roman and the Greek. Pure Roman Corinthian columns appeared at Paris (Pantheon by J. G. Soufflot, 1757 ff.; Madeleine by Pierre Vignon, 1807 ff.), Bordeaux (Grand Théâtre by Victor Louis, 1777 ff.), London (Bank of England by Sir John Soane, 1788 ff.), Liverpool (St. George's Hall by H. L. Elmes, 1838 ff.), and, to save expense, Ionic at Richmond (Virginia state capitol by Thomas Jefferson, 1785), returning to Corinthian at Charlottesville (Rotunda of the University of Virginia by Jefferson, 1821 ff.) and Washington (United States capitol by Thomas U. Walter, 1851 ff.).

On the other hand, pure Greek Doric columns appeared at Baltimore (Washington monument by R. Mills, 1815), Philadelphia (Bank of the United States by W. Strickland, 1819 ff.), Edinburgh (High School by Thomas Hamilton, 1825 ff.), Regensburg (Walhalla by Leo von Klenze, 1830 ff.), and New York (Sub-treasury by Ithiel Town and A. J. Davis, 1834 ff.); pure Greek Ionic at Philadelphia (Bank of Pennsylvania by B. Latrobe, 1798), London (St. Pancras by William and Henry Inwood, 1819; British museum by Sir Robert Smirke, 1825 ff.), and Oxford (Taylor and Randolph buildings by C. R. Cockerell, 1840 ff.); pure Greek Corinthian at London (University college by W. Wilkins and J. P. Gandy-Deering, 1827), Philadelphia (Girard college by Walter, 1833 ff.) and Nashville, Tenn. (lantern of the state capitol by Strickland, 1850). Important phases of these two revivals are the exquisite Roman details by Robert and James Adam in England, the Greek work of James "Athenian" Stuart in England, the "corn capitals" by Latrobe in the capitol at Washington, and the Neo-Greek of J. I. Hittorff and Henri Labrouste in France. After subjection to other eclectic revivals, the pure classical styles reappeared in the monument of Victor Emmanuel II at Rome (by Giuseppe Sacconi, Roman Corinthian, 1884 ff.), the library of Columbia university in New York (by C. F. McKim, Greek Ionic, 1893 ff.), and the Lincoln memorial at Washington (by Henry Bacon, Greek Doric, 1915 ff.).

The 20th century has seen a reaction against the archaeological correctness of the orders of the revival periods. Orders, where occurring, began to be treated with the utmost freedom, and those styles in which a like freedom prevailed, such as the late Georgian style and American colonial with its slimness and attenuation, began to be more popular. In so-called modernist work, the order tended to pass from use as a superfluous ornament. In exceptional cases, however, extremely free and modified orders were still used, as in the concert hall at Stockholm (by Ivar Tengbom), and in portions of the interior of the Nebraska State capitol (by B. Goodhue). An extreme example of modern functionalism is the "dendriform" column of attenuated mushroom shape used inside the Johnson Administration building at Racine, Wis. (by Frank Lloyd Wright, 1936–39), where the slender steel shafts increase slightly as they ascend and the flat conical disks serving as capitals spread almost to the full spacing of 24 ft. on centres and thus nearly touch. With this return to the Mycenaean silhouette, the cycle of evolution seemed to be complete.

See also MODERN ARCHITECTURE and references under "Order" in the Index.

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ORDERIC VITALIS (1075–c. 1142), monk of St. Evroul in Normandy, was a historian who in his *Historia ecclesiastica* has left one of the fullest and most graphic accounts of Anglo-Norman society in his own day. Born near Shrewsbury on Feb. 16, 1075, the eldest son of Odelerius of Orléans, who was chaplain to Roger de Montgomery, earl of Shrewsbury, he was baptized with the name of Orderic in Attingham church on Easter eve, 1075. He learned his letters from the priest Siward in the church of St. Peter and St. Paul, Shrewsbury; and was sent to Normandy in 1085 to become a monk at St. Évroul-en-Ouche, where he was given the name Vitalis. Here, apart from a few visits to other monasteries, including Cluny, Cambrai, Crowland and Worcester, he passed the remainder of his life. Most of his time was spent in the scriptorium, teaching calligraphy, copying books and later composing epitaphs and other occasional verses and, above all, history.

He began his historical work before 1109 by transcribing the *Gesta Normannorum ducum* of William of Jumièges with lengthy interpolations of his own, chiefly relating to the history of Norman families connected with St. Évroul. Not later than 1115, at the command of his abbot, he began a history of his own monastery and its patrons, which gradually expanded into a general history of the church and incorporated a chronological outline of events from the birth of Christ, originally intended as a separate work. He worked on his history, periodically revising the early parts, until June 1141.

Orderic took a keen interest in both English and Norman affairs. His mother was English, he always remained proud of the country of his birth and he was more ready to sympathize with the

English point of view than were the Norman court historians such as William of Poitiers. The families who had founded and endowed St. Évroul played a prominent part in the Norman wars in Maine, and later won great estates in England and southern Italy; each generation provided a number of young oblates, and war weary knights ended their days there. These men were constant travelers to their distant relatives, and might have kinsfolk as far apart as the Welsh marches and Hungary, or Apulia and Antioch. By drawing on their knowledge and memory Orderic was remarkably well-informed, both on the traditions of his own monastery from its restoration in 1050 and on feudal affairs wherever the Norman adventurers had found lands to settle.

He made critical use of all the works of contemporary historians that he was able to borrow, including the histories of William of Poitiers, William of Jumièges and Florence of Worcester for English and Norman affairs, and Baudry of Bourgueil and Fulcher of Chartres for the first crusade. His account of William the Conqueror's campaigns in 1067–71, based on William of Poitiers, has the value of a contemporary narrative, since the last books of William's *Gesta Guillelmi ducis Normannorum et regis Anglorum* have not survived in the original. Otherwise the *Historia ecclesiastica* is most valuable for Norman, English and French history in the period 1082–1141. In spite of a predilection for the founders' kin of his monastery his record is a fair one and his judgments often very shrewd. Even the chronological outline given in Books 1 and 2 and part of Book 8, which is inaccurate and unreliable, is interesting to the student of intellectual history; and his handling of the life of Christ, based partly on St. Augustine's *De consensu Evangelistarum* and partly on the universal history of Marianus Scotus, has a fullness and individuality unusual at that date.

BIBLIOGRAPHY.—The best edition of the *Historia ecclesiastica*, that undertaken by A. Le Prévost for the Société de l'histoire de France, 5 vol. (1838–55), contains an excellent critical introduction by L. Delisle. There is an Eng. trans. by T. Forester in Bohn's Antiquarian Library, 4 vol. (1853–56). The *Gesta Normannorum ducum* of William of Jumièges with Orderic's interpolations was ed. by J. Marx (1914). *See* also H. Wolter, *Ordericus Vitalis* (1955). (M. M. CH.)

ORDER IN COUNCIL, in Great Britain, an order issued by the sovereign, expressed as being made by the sovereign on the advice of the privy council; in modern practice, however, an order is only issued upon the advice of ministers, the minister in charge of the department concerned with the subject matter of the order being responsible to parliament for its contents. An order is signed by the clerk to the privy council, who is responsible for seeing that it is correct in form. In the words of *Halsbury's Laws of England* (vol. vii, 3rd ed., 1954), "Orders in council are the general medium by which the manifold statutory powers conferred upon the crown are exercised, though they may also be employed in expressing the wishes of the crown with regard to matters falling within its discretionary authority by virtue of the prerogative." Thus there are, in modern practice, two distinct types of order in council, that issued under the royal prerogative and that made under a power conferred by statute. Any order made under powers conferred by the Statutory Instruments act, 1946, or by any subsequent act is known as a "statutory instrument" and is subject to the rules as to numbering, printing, publication, citation and laying before parliament set out in the Statutory Instruments act. An order in council can be rendered null by means of an address presented by parliament unless it is an order that does not come into force until approved by an affirmative resolution of both houses.

An example of an order in council issued under the royal prerogative is the order declaring a state of war to be at an end, since the power to make war and peace is a matter of the royal prerogative. Orders appointing the commissioners who examine candidates for the civil service also fall in this category. An example of an order made under statutory authority is one made under the Emergency Powers act, 1920, declaring a state of emergency. The provisions of such an order lapse after seven days unless it has been approved by a resolution of both houses of parliament. Orders in council are used to set out the exact terms of extradition treaties with particular countries; no extradition is granted unless the presiding magistrate has seen a copy of the relevant order. The United Nations act, 1946, gave the crown power to apply by order in council any measures demanded by the Security council under article 41 of the United Nations' charter. The Ministers of the Crown (Transfer of Functions) act, 1946, arranged for the redistribution of ministerial functions and the dissolution of government departments to be effected by order in council, confirmed by a resolution of both houses of parliament. Under this statute the ministry of aircraft production and the ministry of war transport were both dissolved in 1946. Orders in council have also been used for local government regulations; *e.g.*, in the 1850s various Burial acts provided for the issue of orders in council to close overcrowded cemeteries.

Orders in council, the modern equivalent of medieval ordinances and Tudor proclamations, were first issued during the 18th century. Historically their most celebrated use was during the French Revolutionary Wars and the Napoleonic Wars when, in opposition to Napoleon's "continental system," they were a vital instrument in the economic warfare which helped to bring about his downfall. Early in the Revolutionary Wars an order (June 1793) authorized the compulsory purchase of food cargoes carried by neutral shipping to French ports; later that year (November) British ships were ordered to detain all ships carrying goods produced in a French colony. Over a decade later, by a treaty with Napoleon (Feb. 1806), Prussia agreed to close the Elbe, Weser and Ems rivers to British commerce. Britain retaliated with an order in council (April 1806) commanding the blockade of Prussian ports. This blockade was extended to the northern coasts of France, the Netherlands and Germany (May 1806), although neutral shipping was to be allowed to enter ports of the latter two countries provided they were not ultimately bound for an enemy port. In Nov. 1806 Napoleon issued the Berlin decrees, forbidding all his allies to trade with Britain. During the year 1807 Britain replied with a series of orders in council, the most important of which forbade any trading between or into ports controlled by Napoleon (Jan. 1807) and extended this blockade to the colonies of European countries in alliance with the French (Nov. 1807). Neutral trade with enemy countries and colonies was permitted only if the vessels also touched at a British port. The climax of this economic warfare came with Napoleon's Milan decrees (Dec. 1807), by which the French might seize any neutral ship that had complied with the British regulations.

From about 1805 onward annoyance to neutrals was great and particularly exacerbated relations between Britain and the United States. The blockades were one of the major causes of the War of 1812 (*q.v.*). Orders in council were also used to regulate trade during World Wars I and II, under powers conferred by statute.

An order in council should be distinguished from an order of council, which is issued by the privy council without the sovereign's concurrence.

See A. F. Fremantle, *England in the Nineteenth Century* (1929–30); H.M.S.O., *Guide to Government Orders* (1962– bi-annually). (W. T. WS.)

ORDERS AND CONGREGATIONS, RELIGIOUS. According to Roman Catholic canon law the only factor that distinguishes members of religious orders from those of religious congregations, societies of common life and secular institutes is the kind of vow taken. Fundamentally this has no connection with the kind of work performed or the manner of life, but in practice a general relationship can be seen between the kind of work and manner of life and the nature of the vow. Vows are either solemn or simple; all solemn vows are perpetual, as are most simple vows, though in some cases temporary simple vows are taken (*e.g.*, in religious orders in which three years of temporary vows must precede solemn profession). Solemn vows are taken in the religious orders (canons, monks, mendicant friars), which are older than the congregations, etc. Solemn vows can be dispensed only with very great difficulty by papal authority and, canonically, acts contrary to the vow are invalid; thus a marriage entered into by a religious in solemn vows is canonically invalid. Simple vows are generally dispensed with less difficulty, and actions contrary to them, though illicit, are canonically valid; but any simple profes-

sion in a pontifical institute can be dispensed only by the Holy See. The foregoing applies to the three religious vows of poverty, chastity and obedience. There are technical differences also between the solemn and simple vow of religious poverty, the latter allowing a certain retention of ownership.

In practice the distinction between the various orders and congregations according to their manner of life is not always easy to perceive. Members of religious orders all take solemn vows and are all bound to the choral celebration of the breviary offices (*see* BREVIARY). The canons regular lead a monastic life centred on the service of the church (choral office, administration of the sacraments). Monks, on the other hand, leading a stricter form of life, are concerned more with personal perfection and less with external church work; they may do agricultural or other work in order to live, but primarily they seek contemplation. Mendicant orders (friars) do active work or teaching and preaching, but their life is regulated by monastic rule with choir office, etc. In the 13th century, when most of the friars were founded, they practised not only personal but corporate poverty and begged for alms (hence the term mendicant; *q.v.*); nowadays none of the friars does so. All others (congregations, societies of common life, etc.), while living in community, do not usually have the obligation of the choral office but devote their lives to various forms of external ministry and charitable undertakings. Secular institutes are a modern form of religious life the members of which do not permanently dwell in community or wear a distinctive religious habit but live and work "in the world," seeking perfection in ordinary life. Members of secular institutes take private vows (which in effect are similar to simple vows).

Clerks regular, members of congregations and brothers usually take simple vows, while members of societies of common life make a promise of some kind to remain with their community. Brothers (mostly engaged in teaching and charitable work) are so called because they are not ordained priests.

Most orders and congregations have their counterpart in nuns (solemn vows) and religious sisters (simple vows), though in ordinary speech all women religious are referred to as nuns. And there are many other congregations of women religious entirely independent of the men religious (*see* below, *Roman Catholic Religious Orders of Women*).

A decree of the second Vatican Council (promulgated Oct. 28, 1965) was concerned with renewal of the religious life (*see* VATICAN COUNCILS: *Second Vatican Council: Texts Enacted by the Council*).

See also separate entries on many orders, and MONASTICISM.

(L. C. S.)

ROMAN CATHOLIC RELIGIOUS ORDERS OF MEN

The list that follows is arranged according to precedence, which is determined by the chronological sequence of the religious bodies' approval by the Holy See. The name of the order or congregation is given first, the more familiar name being sometimes preferred to the more formal; then any alternative name, whether more formal or less; then the abbreviating letters, if these are familiar, by which its members are designated; then the name of the founder, with place and date of foundation (which may be considerably earlier than papal approval); then the seat of its central government if that is not Rome, which is otherwise assumed; then its total membership, if that is available, using the figure given in the *Annuario Pontificio* for 1966. It has not been found practicable in the space available to indicate the nature of the work done by each order, save that in some cases attention is drawn to the broad distinction between active and contemplative religious; almost all active orders do pastoral work, missionary work, teaching, etc. Nor is it practicable to list the countries in which each order is to be found, save in the cases of some which are local in character, or to give details of the religious habit worn. All orders include brothers, who do not become priests. Where these are in the majority this is stated. A separate list of organizations consisting only of brothers is supplied. Diocesan congregations, as distinct from those of pontifical status, are excluded. An order or congregation that is exclusively of some other rite than the Latin is noted; there is no note when there are members of both Latin and Eastern rites.

CANONS REGULAR

1. Canons Regular of St. Augustine (Black Canons; Austin Canons): 4th-century origin; 11th-century revival; confederated 1959.
   a. Canons Regular of the Lateran (C.R.L.). 472.
   b. Austrian Canons Regular of the Lateran. 11th century, Klosterneuburg, near Vienna. 295.
   c. Canons Hospitallers of the Great St. Bernard. 11th century. On the St. Bernard and Simplon passes, and in Tibet. Grand Saint Bernard, Martigny, Valais, Switz. 92.
   d. Swiss Canons Regular of St. Maurice d'Agaune. 1128. Valais, Switz. 137.
   e. Canons Regular of the Immaculate Conception: *see* below, *Religious Congregations*, no. 38.
   f. Congregation of Windesheim. 1387, Windesheim, Holland. Extinct 1802, reconstituted 1961.
2. Premonstratensians (White Canons, Norbertines; C.R.P. or O. Praem.). St. Norbert, Prémontré, Laon, France; 1120. 1,991.
3. Order of the Holy Cross (Crosier Canons; O.S.C., O.S.Cr.). Theodore of Celles, Huy, Belg.; 1211. Amersfoort, Neth. 746.
4. Crucifers of the Red Star. Agnes of Bohemia; 1237. Prague, Czech. 42.

MONKS

A. The Benedictine tradition, stemming from the rule of St. Benedict (*q.v.*), the father of western monasticism.
1. The Benedictine Confederation (O.S.B.). 1890. 12,500 monks of the following congregations under an abbot primate residing at Sant' Anselmo, Rome (Note: [1] The dates given are those of the formation of congregations, which often include abbeys of much older foundation; [2] each congregation elects the abbot of one of its constituent abbeys as abbot president for a stated term; individual abbeys, a very few of the better-known among many, are arbitrarily named):
   a. English (1215). Downside, Ampleforth, Douai, Buckfast (1960).
   b. Olivetans (1341). Monte Oliveto, Siena. 260.
   c. Cassinese (1408). Monte Cassino; San Paolo, Rome.
   d. Hungarian (1500). Pannonhalma.
   e. Swiss (1602). Einsiedeln.
   f. Bavarian (1684; 1858).
   g. Brazilian (1827). 416.
   h. French (1837) (the only congregation that has neither schools nor foreign missions). Solesmes, Ligugé.
   i. American Cassinese (1855). St. Vincent's Archabbey, Latrobe, Pa.; St. John's Abbey, Collegeville, Minn. 2,060.
   j. Beuronese (1868). Beuron, Sigmaringen, Württemberg; Maria Laach (Rhineland); Seckau, Aus. 1,010.
   k. Subiaco (1872) (Cassinese Congregation of the Primitive Observance). Subiaco, near Rome; Montserrat, Spain.
   l. Swiss-American (1870). St. Meinrad's Archabbey, Indiana; Conception Abbey, Missouri. 1,010.
   m. Austrian (1889).
   n. St. Ottilien (1884); for foreign missions, especially in Africa. St. Ottilien, Bavaria. 1,309.
   o. Belgian (1920). Saint-André, Bruges; Maredsous.
   p. Slavonic of St. Adalbert (1945).
2. Independent Congregations of Benedictines:
   a. Camaldolese (white). St. Romuald, Camaldoli, Arezzo, Italy; 980. Hermits. 260.
   b. Vallombrosians (black). St. John Gualbert, Vallombrosa, Florence; 1015. Contemplative. 140.
   c. Sylvestrines (blue). St. Silvester Gozzolini, Montefano, Fabriano, Italy; 1231. Contemplative. 200.
3. Benedictines of Eastern Rite:
   a. Mekhitarists (Armenian rite). Mekhitar of Sebaste, Constantinople; 1701. (1) San Lazzaro, Venice; 1717. 49. (2) Vienna; 1773. 29.
4. Cistercians. St. Robert of Molesme, St. Alberic and St. Stephen Harding, Citeaux; 1098.
   a. Of the Common Observance (O.Cist.). Eleven congregations—Austrian, Swiss-German, Italian of St. Bernard, Belgian, French, Hungarian, Bohemian, Italian of Casamari, Polish, Brazilian, and South Vietnamese—with an abbot-general in Rome. 1,665.
   b. Of the Reformed or Strict Observance (Trappists; O.C.R., O.C.S.O.). From the reform at La Trappe, Normandy; 1664. Independent contemplative monasteries under an abbot-general in Rome. 4,211.

B. The Carthusian tradition (O.Cart.). St. Bruno, La Grande Chartreuse, near Grenoble, France; 1084. Contemplative hermits with the prior of La Grande Chartreuse as minister-general. The only order that has never required reform. 596.

C. The Eastern traditions.
1. Deriving from the tradition of St. Paul of Thebes (4th century). Paulites: (*a*) Eusebius of Gran (Esztergom), Hungary; 1250. Latin rite, caring for the Polish national shrine of Our Lady

of Czestochowa. Formerly much more widely diffused. Jasna Góra, Czestochowa, Pol. 231. (*b*) 1215. Rome.

2. Deriving from the tradition of St. Anthony the Abbot (4th century):
   a. Maronite Antonians. Three congregations in Lebanon; 1695–1700.
   b. Chaldean Antonians. Congregation of St. Hormisdas, Alqös, Iraq; 1808. 48.
3. Deriving from the tradition of St. Basil (4th century).
   a. Basilians of Grottaferrata, near Rome. Italo-Greek; Byzantine rite; 980, 1004, 1579. 50.
   b. Basilians of St. Josaphat. Ruthenian-Ukrainian; centralized under St. Josaphat, 1617.
   c. Melkite Basilians. Three orders in Lebanon; late 17th century.

Mendicant Friars

1. Dominicans (Order of Preachers; Black Friars; O.P.). St. Dominic, Toulouse; 1216. 10,091.
2. Franciscans. St. Francis, Assisi; 1209:
   a. Friars Minor (Grey Friars; O.F.M.). Union (1897) of the Observants (1415), Alcantarins (St. Peter of Alcántara, 1533), Reformed (1552) and Recollects (1595–1629). Second in numbers only to the Jesuits. 27,009.
   b. Franciscan Conventuals (Black Franciscans; O.F.M. Conv.). 4,650.
   c. Capuchins (O.F.M.Cap.). Reform of Matteo da Bascio, *c*. 1525, bearded. 15,838.
   d. Third Order Regular of St. Francis. 13th century. 1,592.
3. Augustinians (Austin Friars):
   a. Hermits of St. Augustine (O.S.A.). United 1256. 4,531.
   b. Recollects (O.R.S.A.). Talavera, Spain; 1588. Still predominantly Spanish. 1,615.
   c. Discalced Hermits of St. Augustine. Late 16th century. 195.
4. Carmelites (White Friars). Derived from hermits on Mt. Carmel associated with prophet Elijah. 1247 (rule approved 1226).
   a. Calced (Of the Old Observance; O.Carm.). 3,075.
   b. Discalced (O.C.D.). St. Teresa of Ávila and St. John of the Cross, 1562–68. 4,022.
5. Trinitarians. St. John of Matha and St. Felix of Valois, Cerfroid, Soissons, France; 1198. 800.
6. Mercedarians (Order of Our Lady of Ransom). St. Peter Nolasco, Aragón, Spain; 1218. 1,230.
7. Servites (Servants of Mary; O.S.M.). Seven Holy Founders, Florence; 1233. 1,750.
8. Minims. St. Francis of Paola; 1435. 305.
9. Hospitallers of St. John of God (Fate Bene Brothers; O.H. [F.B.F.]). St. John of God, Granada, Spain; 1537. Hospitals. Only a small minority are priests. 2,504.
10. Teutonic Order. Priests of the military Order of the Teutonic Knights, founded at the siege of Acre; 1190. Reorganized 1834; reformed 1929. Vienna. 97.

Clerks Regular

1. Theatines (C.R.). St. Cajetan (Gaetano) and Bishop Carafa of Chieti (Theatinus), later Pope Paul IV, Rome; 1524. 1,205.
2. Barnabites (Congregation of St. Paul; C.R.S.P.). St. Anthony Mary Zaccaria, Milan; 1530. 604.
3. Jesuits (Society of Jesus; S.J.). St. Ignatius of Loyola, Montmartre, Paris, 1534; Rome, 1540. The largest religious order in numbers. 36,038.
4. Somaschi. St. Jerome Emiliani, Somascha, Lombardy; 1528. 450.
5. Camillians (Ministers of the Sick; M.I.). St. Camillo de Lellis, Rome; 1586. Hospitals. 1,380.
6. Caracciolines (Minor Clerks Regular). St. Francis Caracciolo and Augustine Adorno, Naples; 1588. 56.
7. Clerks Regular of the Mother of God. St. John Leonardi, Lucca; 1574. (Small).
8. Piarists (Poor Clerks Regular of the Mother of God of the Pious Schools; S.P.). St. Joseph Calasanctius, Rome; 1617. Teaching. 2,540.

Religious Congregations

1. Fathers of Christian Doctrine ("Dottrinari"). César de Bus, Avignon; 1592. 106.
2. Pii Operai Catechisti Rurali. Charles Carafa, Naples; 1600. Cosenza, Italy. 50.
3. Marian Fathers (Marian Clerks Regular of the Immaculate Conception; M.I.C.). Stanislaus Papczynski, Poland; 1673. 482.
4. Passionists (Discalced Clerks of the Most Holy Cross and Passion of Our Lord Jesus Christ; C.P.). St. Paul of the Cross, Florence; 1720. 4,135.
5. Redemptorists (Congregation of the Most Holy Redeemer; C.SS.R.). St. Alfonso dei Liguori, Naples; 1732. 9,450.
6. Picpus Fathers (Congregation of the Sacred Hearts of Jesus and Mary; SS.CC.). Joseph Coudrin, rue de Picpus, Paris; 1800. 2,052.
7. Marist Fathers (Society of Mary; S.M.; distinguish from no. 16, below, which has the same name and is known by the same initials). John Claude Colin, Lyons; 1822. 2,343.
8. Congregation of the Holy Ghost (Holy Ghost Fathers C.S.Sp.). C.F. Poullart des Places, Paris; 1703. Foreign missions, especially in Africa. Paris. 5,200.
9. Montfort Fathers (Company of Mary; S.M.M.). St. Louis Grignion de Montfort, Poitiers, France; 1705. Missionaries. 2,000.
10. Oblates of Mary Immaculate (O.M.I.). C. J. E. de Mazenod, Aix-en-Provence, France; 1816. Missionaries. 7,609.
11. Oblates of the Virgin Mary (O.M.V.). G. B. Reynaudi, Carignano, Turin, Italy; 1815. 200.
12. Priests of the Charitable Schools (Istituto Cavanis). The Counts Cavanis, Venice; 1802. Venice.
13. Basilians (C.S.B.). Ammonay, Viviers, France; 1822. Transferred to Canada, 1852. Toronto. 770.
14. Missionaries of the Sacred Hearts of Jesus and Mary (M. SS. CC.). Gaetano Errico, Naples; 1833.
15. Viatorian Fathers (Clerks of St. Viator; C.S.V.). Louis Joseph Querbes, Vourles, Lyons, France; 1831. Now mainly in Canada and U.S. Coteau du Lac, Que., Can. 1,815.
16. Marianists (Society of Mary; S.M.; distinguish from no. 7, above). William Joseph Chaminade, Bordeaux; 1817. 3,490.
17. Rosminians (Institute of Charity; I.C.). Antonio Rosmini-Serbati, Domodossola, Italy; 1828.
18. Pavoniani (Sons of Mary Immaculate). Louis Pavoni, Brescia, Italy; 1821–47. Brescia. 300.
19. Missionaries of St. Francis de Sales (M.S.F.S.). Peter Mermier, Annecy, France; 1838. Annecy. 397.
20. Society of St. Peter in Chains. 1839. Marseilles. Care of delinquent boys. Barcelona. 105.
21. Stigmatine Fathers (Priests of the Holy Stigmata of Our Lord Jesus Christ; C.P.S.). Caspar Bertone, Verona; 1816. 625.
22. Congregation of Holy Cross (C.S.C.). A union of several foundations at Le Mans, France; 1837. 3,352.
23. Assumptionists (Augustinians of the Assumption; A.A.). Emmanuel d'Alzon, Nîmes, France; 1845. 1,963.
24. Sons of Mary Immaculate (F.M.I.). Louis Baudouin, Chavagnes-en-Paillers, Luçon, France; 1828. Chavagnes-en-Paillers. 220.
25. Company of Mary for the Education of Deaf Mutes. 1830. Verona. 37.
26. Congregation of the Blessed Sacrament (S.S.S.). St. Peter Julian Eymard, Paris; 1856. 1,645.
27. Resurrectionists (Congregation of the Resurrection; C.R.). Bogdan Janski, Peter Semenenko and J. Kajsiewicz, Paris; 1836. 590.
28. Claretians (Congregation of Sons of the Immaculate Heart of Mary; C.M.F.). St. Anthony Mary Claret, Vich, Spain; 1849. 3,770.
29. Congregation of the Sacred Heart of the Infant Jesus (S.C.J.). 1852. Marseilles. Teaching. 82.
30. Josephites (Sons of St. Joseph; C.J.). C. van Crombrugghe, Grammont, near Ghent, Belg.; 1817. Melle, Belg. 200.
31. Salesians (Society of St. Francis of Sales, Society of Don Bosco; S.D.B.). St. John Bosco, Turin; 1859. Turin. 22,042.
32. Lourdes Missionaries (Missionaries of the Immaculate Conception). 1848. Garaison, France. 85.
33. Missionaries of the Sacred Heart (M.S.C.). Jules Chevalier, Issoudun, France; 1854. 3,455.
34. Religious of St. Vincent de Paul. M. Le Prevost, Paris; 1845. Good works among the poor. Paris. 348.
35. Brothers of Charity ("Frati Bigi"). Louis da Casoria, Naples; 1859. 63.
36. Priests of the Sacred Heart (of Bétharram) (S.C.J.; distinguish from no. 42, below). St. Michael Garicoits, Bétharram, near Lourdes, France; 1832. Bétharram. 612.
37. Oblates of St. Francis de Sales (O.S.F.S.). Louis Brisson, Troyes, France; 1871. 1,250.
38. Canons Regular of the Immaculate Conception (C.R.I.C.). Adrian Gréa, Saint-Antoine, France; 1866. 86.
39. Fathers of St. Edmund (S.S.E.). Jean Baptiste Muard, Pontigny, France; 1843. Winooski, Vt. 136.
40. Missionaries of Our Lady of La Salette (M.S.). Filibert Bruillard, Grenoble, France; 1852. 1,179.
41. Sons of the Holy Family (S.F.). G. Mañanet y Vives, Tremp, Spain; 1864. Barcelona. 452.
42. Priests of the Sacred Heart (of Saint-Quentin) (S.C.J.; distinguish from no. 36, above). Leo Dehon, Saint-Quentin, France; 1878. 3,400.
43. Turin Society of St. Joseph ("Giuseppini del Murialdo"). Leonard Murialdo, Turin; 1873. 880.
44. Verona Fathers. (Sons of the Sacred Heart of Jesus; F.S.C.J.). Daniel Comboni, Canario, Italy; 1866. Verona. African missions. 1,710.
45. Mexican Missionaries of St. Joseph (M.J.). Joseph Villaseca, Mexico City; 1872. Mexico City. 224.
46. Priests of St. Mary of Tinchebrai. Charles Duguey, Tinchebrai, France; 1851. Tinchebrai. 35.
47. Scheut Fathers (Immaculate Heart Missioners; Congregation of the Immaculate Heart of Mary, C.I.C.M.). Theophilus Verbiest, Scheut, near Brussels, Belg.; 1862. Brussels. 2,008.
48. Society of the Divine Word (Divine Word Missionaries; S.V.D.).

Arnold Janssen, Steyl, Neth.; 1875. Foreign missions. 5,773.
49. Religious Tertiary Capuchins of Our Lady of Sorrows. Louis Amigo, Masamagrell, Valencia, Spain; 1889. Madrid. 435.
50. Sons of Mary Immaculate (F.S.M.I.). Joseph Frassinetti, Genoa; 1861. 124.
51. Salvatorians (S.D.S.). Francis Jordan, Rome; 1881. 1,538.
52. Xaverians (S. X.). G. M. Conforti, Parma, Italy; 1898. Parma. Foreign missions. 886.
53. Carmelites of Mary Immaculate (C.M.I.). South India; 1855. Contemplatives of Syro-Malabar rite. Ernakulam, India. 1,028.
54. Scalabriniani (Missionary Society of St. Charles for Italian Emigrants; P.S.S.C.). G. B. Scalabrini, Piacenza, Italy; 1887. 815.
55. Oblates of St. Joseph ("Giuseppini d'Asti"). Joseph Marello, Asti, Italy; 1878. 504.
56. Consolata Fathers (I.M.C.). Joseph Allamano, Turin; 1901. Turin. Foreign missions. 1,092.
57. Missionaries of the Holy Family (M.S.F.). John Berthier, 's Hertogenbosch, Neth.; 1895. 1,293.
58. Servants of Charity. Louis Guanella, Como, Italy; 1908. Como. 650.
59. Little Mission for Deaf Mutes. G. and C. Gualandi, Bologna, Italy; 1890. 50.
60. Mariannhill Missionaries (C.M.M.). Natal, South Africa; 1909; from the foundation (1882) of Francis Pfanner. Nördlingen, Ger. 685.
61. Missionary Sons of the Sacred Heart (M.F.S.C.). A German separation from no. 42, above; 1923. Foreign missions, especially in Africa. Ellwangen, Ger. 240.
62. Calasanctians (Congregation of the Followers of St. Joseph Calasanctius). A. M. Schwartz, Vienna; 1889. Vienna. 42.
63. Sons of Charity (distinguish from no. 72 below). J. E. Anizan, Paris; 1918. Paris. 280.
64. Institute of Missionaries of the Workers (M.O.). Theophilus Reyn, Seraing, Belg.; 1894. Brussels. 110.
65. Missionaries of the Holy Ghost (M.Sp.S.). Felix Rougier, Tepeyac, Mex.; 1914. Mexico City. 400.
66. Missionaries of the Sacred Hearts of Jesus and Mary (Majorca). G. R. Ferra, Palma, Majorca, Spain; 1890. Palma. 189.
67. Society of St. Paul (S.S.P.). James Alberione, Alba, Italy; 1914. Press, cinema, radio, television. 1,500.
68. Sons of Divine Providence (F.D.P.). L. Orione, Tortona, Italy; 1893. 1,090.
69. Vocationist Fathers (S.D.V.); 1920. Naples. 250.
70. Congregation of the Holy Family of Nazareth. G. Piamarta, Brescia; 1900. Brescia. 180.
71. Poor Servants of Divine Providence. Don Calabria, Verona; 1907. Verona. 203.
72. Canossians (Sons of Charity; distinguish from no. 63, above). The Marchioness of Canossa; 1831. Venice. 131.
73. Society of Christ for Polish Emigrants. 1932. Poznan, Pol. 430.
74. Congregation of the Priestly Brotherhood (C.F.S.). M. E. Prevost, Paris; 1901. 210.
75. Franciscan Friars of the Atonement (Graymoor Friars; S.A.). Paul James Francis, Garrison, N.Y.; 1898. Garrison. Work and prayer for Christian reunion. 280.
76. Rogationists (Rogationist Fathers of the Heart of Jesus; R.C.J.). A. M. di Francia, Messina, Italy; 1926. 320.
77. Missionary Servants of the Most Holy Trinity (M.S.SS.T.). Thomas Augustine Judge; 1929. Silver Spring, Md. 255.
78. Missionary Servants of the Poor (del Boccone del Povero). Giacomo Cusmano, Palermo, Italy; 1887. 78.
79. Legionaries of Christ (Congregatio Missionariorum S.S. Cordis Jesu et a Beata Virgine Perdolente). 1946. 245.

Societies Living in Common Without Vows

1. Oratorians (Institute of the Oratory of St. Philip Neri; Cong. Orat.). St. Philip Neri, Rome; 1564–75. A confederation (1942) of autonomous houses. 530.
2. French Oratorians. Pierre de Bérulle, Paris; 1611. Paris. 131.
3. Vincentians or Lazarists (Congregation of the Mission; C.M.). St. Vincent de Paul, Paris; 1625. Paris. 5,992.
4. Sulpicians. J. J. Olier, Paris; 1642. Issy, France. 629.
5. Paris Foreign Missionaries (M.E.P.). François Pallu, Paris; 1660. Paris. 910.
6. Priests of Mercy (S.P.M.). J. B. Rauzan, Lyons, France; 1808. Cold Spring, N.Y. 10.
7. Pallottine Fathers (Society of the Catholic Apostolate, S.A.C.). St. Vincent Pallotti, Rome; 1835. 2,400.
8. Missionaries of the Most Precious Blood (C.PP.S.). St. Caspar del Bufalo, Giano dell'Umbria, Italy; 1815. 940.
9. Eudists (Congregation of Jesus and Mary; C.J.M.). St. John Eudes, Caen, France; 1643. 710.
10. Pontifical Institute for the Foreign Missions. Union (1926) of the Milan Foreign Missionaries (1850) and the Roman Pontifical Seminary of the Holy Apostles Peter and Paul (1874). 830.
11. White Fathers (Society of Missionaries of Africa; P.A.). C. M. A. Lavigerie, Algiers; 1868. 4,013.
12. African Missionaries (Society of Missions to the Africans; Lyons Missionaries; S.M.A.). M. J. de Marion-Brésillac and J. A. Planque, Lyons, France; 1868. 1,855.
13. Mill Hill Fathers (Society of St. Joseph for the Foreign Missions). Herbert Vaughan, Mill Hill, London; 1866. London. 1,204.
14. Maryknoll Fathers (Catholic Foreign Missionary Society of America; M.M.). J. A. Walsh and T. F. Price, Maryknoll, N.Y.; 1911. Maryknoll. 1,356.
15. Spanish Institute of St. Francis Xavier for the Foreign Missions. Gerard Villota, Burgos, Spain; 1899. Burgos. 240.
16. Maynooth Mission to China (Society of St. Columban). Edward J. Galvin, Maynooth, Ire.; 1917. Navan, Ire. 1,055.
17. Paulist Fathers (Society of Missionary Priests of St. Paul the Apostle; C.S.P.). Isaac Thomas Hecker, New York, N.Y.; 1858. New York. 348.
18. Quebec Missionaries (Society for the Foreign Missions of the Province of Quebec). 1921. Montreal. 405.
19. Portuguese Society for the Catholic Missions. 1930. Cucujães, Port. 165.
20. Society of St. Joseph of the Sacred Heart (Josephite Fathers). Herbert Vaughan, London; 1866. Baltimore, Md. 289.
21. Bethlehem Missionaries (Society of Foreign Missions of Bethlehem in Switzerland). 1921. Immensee, Switz. 422.
22. Yarumal Foreign Missionaries (M.X.Y.). 1927. Yarumal, Colombia. 198.
23. Scarboro Foreign Missionaries (S.F.M.). J. M. Fraser, Scarboro Bluffs, Ont. 1918. Scarboro.
24. Institute of Our Lady of Guadelupe for the Foreign Missions (M.G.). 1949. Mexico City.
25. Society of St. Patrick for the Foreign Missions. Patrick Whitney, Kiltegan, Ire. 1932. Kiltegan. 380.
26. Home Missioners of America. 1939. Glendale, Ohio. 150.

Brothers

1. Brothers of the Christian Schools (F.S.C.). St. Jean Baptiste de la Salle, Reims; 1679–84. 17,926.
2. Christian Brothers of Ireland. Edmund Ignatius Rice, Waterford, Ire.; 1802. Dublin. 3,814.
3. Brothers of the Holy Family (of Belley) (F.S.F.). Gabriel Taborin, Belmont, France; 1835. Belley, France. 510.
4. Brothers of the Immaculate Conception of Our Lady of Maastricht. 1848. Maastricht, Neth. 994.
5. Brothers of Christian Instruction (of Ploërmel; F.I.C.P.). J. M. R. de la Mennais, Saint-Brieuc, France; 1817. Jersey, C. I., Eng. 2,215.
6. Brothers of Our Lady of Mercy (F.D.M.). V. G. B. Scheppers, Malines, Belg.; 1839. Antwerp. 350.
7. Brothers of Our Lady Mother of Mercy (of Tilburg). J. Zwijsen, Tilburg, Neth.; 1884. Tilburg. 1,000.
8. Marist Brothers (Little Brothers of Mary) (F.M.S.; P.F.M.). Marcellin Champagnat, Laval, France; 1817. 10,356.
9. Sons of the Immaculate Conception (Conceptionists). L. M. Monti, Rome; 1857. 350.
10. Alexian Brothers (of Aachen; Cellites; C.F.A.). 14th century Rhineland origin; reconstituted 1854. Signal Mt., Tenn. 401.
11. Patrician Brothers (P.B.). Daniel Delaney, Tullow, Ire.; 1888. Tullow. 316.
12. Brothers of Charity (of Ghent). Peter J. Triest, Ghent; 1807. Ghent. 1,559.
13. Brothers of Mercy. P. Loetschert, Montabaur, Ger.; 1856. Montabaur. 239.
14. Presentation Brothers. Edmund Ignatius Rice, Waterford, Ire.; 1802. Cork. 350.
15. Brothers of the Sacred Heart. André Coindre, Lyons; 1821. 3,148.
16. Brothers of Our Lady of Lourdes. M. E. Glorieux, Renoix, Ghent; 1830. Name acquired in 1880. Oostakker, Belg. 891.
17. Brothers of Mercy of Mary Auxiliatrix. P. Friedhofen, Weitsberg, Coblenz; 1850. Trier, Ger. 340.
18. Franciscan Brothers (Tertiaries) of the Holy Cross (of Trier). 1862. Linz-Rhein, Ger. 180.
19. Brothers of Christian Instruction of St. Gabriel. Derived from the Brothers of the Holy Ghost, St. Louis Grignion de Montfort, Saint-Laurent-sur-Sèvre, France; 1705. Saint-Laurent-sur-Sèvre. 1,961.
20. Poor Brothers of the Seraphic St. Francis (C.F.P.). J. Hover, Aachen, Ger.; 1861. Aachen. 240.
21. Servants of Mary of the Third Order of St. Francis of Penance. 1885. Warsaw, Pol. 84.
22. Brothers of St. Aloysius Gonzaga. W. Hellemons, Oudenbosch, Neth.; 1849. Oudenbosch. 428.
23. Dolorists (Sons of the Sorrowful Mother of God). 1880. Warsaw, Pol. 47.
24. Xaverian Brothers (Brothers of St. Francis Xavier; C.F.X.). Theodore Ryken, Bruges; 1839. 882.
25. Brothers of the Third Order Regular of St. Francis of Assisi of Mount Bellew (Irish Institute of the Franciscan Brothers). 16th century; reconstituted 1818. Mount Bellew, Ire. 218.

26. Missionary Brothers of St. Francis of Assisi. P. Moritz; 1896. Bombay, India. 161.
27. Huybergen Brothers (Brothers of the Immaculate Conception of the Blessed Mother of God). Huybergen, Neth.; 1854. Bergen Op Zoom, Neth. 322.
28. Brothers of St. Vincent de Paul (Cottolenghini). 1833. 55.

SECULAR INSTITUTES OF MEN

1. Society of St. Paul. 1920.
2. Opus Dei (Priestly Society of the Holy Cross). J. M. Escriva de Balaguer, Madrid, Spain; 1928.
3. Diocesan Priestly Workers of the Sacred Heart of Jesus. Manuel Domingo y Sol, Tortosa, Spain; 1881. Madrid.
4. Society of the Heart of Jesus. 1791; reconstituted 1918. Lyons, France.
5. Institute of Priests of the Prado. Lyons, 1856. Lyons.

(Note: The Little Brothers of Jesus, which grew [1934] out of the union of Brothers and Sisters of the Sacred Heart of Jesus founded by Charles de Foucauld, and the Missionary Brothers of the Countryside founded [1943] at La Houssaye-en-Brie, France, by Father Epagneul, are examples of well-known institutes not listed in the *Annuario Pontificio* for 1966, not yet having that pontifical status which is also the criterion for inclusion in this list.)

ROMAN CATHOLIC RELIGIOUS ORDERS OF WOMEN

The Roman Catholic religious orders and congregations of women number nearly 1,500 even when local diocesan institutes are excluded. Most of the orders and congregations of men have been associated from the first with corresponding foundations for women, and many of these have subdivided in a way that has not characterized the foundations for men. Separate orders of women, to which belong nuns in the stricter sense (*moniales*, taking solemn vows), and congregations, to which belong sisters (*sorores*, taking simple vows), not infrequently derive from the same stem, as with the Benedictines.

There are more than 70 separate congregations of Dominican nuns and sisters of the second order and the third order conventual, and there is likewise a very large number of different congregations of women in the Franciscan tradition. Some of the most important of these are of relatively recent origin, as for example the Franciscan Missionaries of Mary, founded by Mother Mary de Chappotin de Neuville in India in 1877, who number well over 10,000 sisters.

It is the number of religious foundations for women made since the Council of Trent (almost all with simple vows, with the notable exception of the Visitation order), and especially of those made during the 19th century, that makes a comprehensive list impossible in the space available. Most of these follow some form of the Augustinian rule, as also do the older orders of the Dominicans and Ursulines. A number follow rules based on that of the Jesuits. The other principal rules by which the orders and congregations of women may be classified are the Basilian, to which tradition belong the Carmelite nuns, the Benedictine, the Franciscan and the Brigittine. Some foundations have divided into active and contemplative branches; in some the active and contemplative lives are combined. Wholly contemplative or enclosed (cloistered) nuns number perhaps 80,000 throughout the world, the most numerous of these being the Carmelites and the Poor Clares. The number of active and unenclosed sisters is very much greater, amounting to at least 750,000 in all. *See* also WOMEN'S RELIGIOUS ORDERS. (M. DK.)

ORDERS OF KNIGHTHOOD: *see* KNIGHTHOOD, CHIVALRY AND ORDERS.

ORDINATION, a rite of Christian churches for the dedication and commissioning of ministers to administer the sacraments, preach and exercise pastoral care. The essential ceremony consists of the laying on of hands upon the head of the one who is ordained, with prayer for the gift of the Holy Spirit and of grace needful for the exercise of his ministry. The service usually includes also a public examination of the candidate and a sermon or charge concerning the responsibilities of the ministry.

Christianity derived the ceremony from the Jewish custom of ordaining rabbis by the laying on of hands (the *Semikhah*), the practice having biblical sanction in Moses' ordination of Joshua (Num. xxvii, 18, 23; Deut. xxxiv, 9). New Testament examples are the ordination of the 7 by the 12 apostles (Acts vi, 6), and the commissioning of Barnabas and Paul by prophets and teachers at Antioch (Acts xiii, 3). The Pastoral Epistles (I Tim. iv, 14; II Tim. i, 6) associate ordination with the conferral of a spiritual gift of grace.

The oldest ordination prayers extant are contained in the *Apostolic Tradition* of Hippolytus of Rome (*c.* A.D. 217). In medieval times, the Latin rites were elaborated by additional ceremonies such as the delivery to the ordinands of symbols pertinent to their office (*porrectio instrumentorum*), the anointing of hands, and clothing in the vestments and insignia pertaining to the rank of ministerial order conferred.

The ordaining minister in episcopal churches is always a bishop. In presbyterian churches, ordination is conferred by ministers of the presbytery; in congregational churches, by persons chosen by the local congregation. Eastern Orthodox and Roman Catholic theology accounts ordination a sacrament essential to the church and the bestowal of an unrepeatable, indelible character upon the persons ordained.

See also HOLY ORDERS; LITURGY: *Other Latin Rites: Rites Other Than Sacraments;* MINISTRY, CHRISTIAN. (M. H. SH.)

ORDINES ROMANI, certain medieval documents, written in Latin and concerned with Roman Catholic liturgy. The term itself is the plural form of the Latin *ordo romanus*, a phrase meaning literally "the Roman procedure" or "way." The word *ordo* was applied in the middle ages to directive and prescriptive documents which outlined in varying degrees of detail the procedure to be followed in complex liturgical functions (*e.g.*, the celebration of Mass; the administration of the sacraments) by the principal functionary and his assistants. Such works, however, did not ordinarily contain the wording of the prayers to be recited, which was found in sacramentaries (*q.v.*), psalters and the like. In a somewhat similar sense *ordo* is applied in modern times to the section of the missal which gives the more or less invariable functions and prayers of the Mass of the Roman rite. In a derivative sense *ordo* is still applied to the booklets, published annually for the universal church as well as for particular dioceses and religious orders, giving daily directions for the variable parts of the priest's breviary and Mass.

The Benedictine antiquarian Jean Mabillon first published in printed form in 1689 those 15 *ordines* to which the adjective *romani* was most frequently applied until modern times. They are a major font of information concerning ceremonies in churches of Roman liturgical usages from the time of Pope St. Gregory (d. 604) on. The matter of Mabillon's *ordines romani* duplicates and supplements itself in places, since these documents are by no means the work of one author or even the products of the same century. In modern times Michel Andrieu has published more critical and more complete editions of many *ordines romani*, dividing some of Mabillon's units into separate *ordines*, adding others to their number, including some which previous to Andrieu's work had not been identified.

Mabillon's *Ordines romani* may be read in J. P. Migne's *Patrologia Latina*, vol. 78, col. 937–1372. Andrieu's five volumes, *Les ordines romani du haut moyen-âge*, were published in 1931, 1948, 1951, 1956 and 1961, the last volume posthumously. (EA. A. W.)

ORDNANCE is a term that includes, in U.S. usage, nearly all combat weapons of the land, sea, and air forces. British military usage generally restricts it to guns of artillery calibre. In its broadest meaning the term includes such items as pistols, revolvers, carbines, rifles, machine guns, mortars, recoilless rifles, field guns and howitzers, rocket launchers, bombs, mines, grenades, torpedoes, guided missiles, combat vehicles, and related matériel. In this sense it is nearly equivalent to "munitions" or "matériel," encompassing virtually all fighting equipment. Chemical warfare equipment is commonly excluded from the ordnance category though it closely resembles ordnance matériel. Weapons mounted on ships, planes, or tanks are usually referred to as "armament" rather than as ordnance.

Ordnance Corps.—The Ordnance Corps was the branch of the U.S. Army formerly responsible for the design, manufacture, and procurement from industry of weapons, ammunition, and vehicles,

and for their storage, issue, and maintenance. During the early 1960s most of its functions were reassigned under a plan for reorganization of logistical services of the Army. The Ordnance Corps (formerly Ordnance Department) was one of several technical services that met the logistical needs of the Army and, for certain matters, also served the Navy and Air Force. The lapel insigne worn by ordnance officers was the flaming bomb, the oldest such insigne in the U.S. Army. (*See* INSIGNIA, MILITARY.)

In the early years of its history the U.S. Army functioned without a distinct ordnance branch. During the Revolutionary War the Continental Congress assigned certain broad responsibilities to a Board of War and Ordnance, with artillery officers being charged with ordnance activities in the field. For the first two decades under the Constitution the procurement of military stores was assigned to the Treasury Department. Not until May 14, 1812, before the outbreak of the second war with Britain, did Congress authorize establishment of an Ordnance Department. The first chief, or commissary general as he was known until 1815, was Col. Decius Wadsworth. The new department was charged with the inspection, storage, and issue of weapons and ammunition; it also operated the government-owned arsenals where munitions were manufactured or stored, and was soon given power to purchase matériel from private contractors.

Except for a brief period (1821–32) when it was merged with the artillery, the Ordnance Department continued throughout the 19th century to supply "ordnance and ordnance stores" to the Army. As years passed it gradually assumed responsibility for the design of new and improved matériel (*see* ARTILLERY and SMALL ARMS, MILITARY) and for the development at its arsenals of improved manufacturing processes. In the 20th century, keeping pace with advances in weapons, it assumed responsibility for tanks, motor vehicles, rockets, and guided missiles.

During World War II, when the United States became the "arsenal of democracy," the Ordnance Department expended some $34,000,000,000 for procurement of munitions for the U.S. armed forces and for Allied Powers. At the peak of its World War II strength the Ordnance Department had jurisdiction over 8 manufacturing arsenals, 13 procurement district offices, and scores of storage depots, proving grounds, and ammunition plants. In July 1950, shortly after the outbreak of the Korean War, the Ordnance Department was redesignated the Ordnance Corps as provided by the Army Organization Act of 1950. In the Army reorganization that took place in the early 1960s the Ordnance Corps lost most of its traditional functions to newly created army-wide commands.

Royal Army Ordnance Corps.—As constituted at mid-20th century, the Royal Army Ordnance Corps (RAOC) in the British army was by no means the exact counterpart of the U.S. Ordnance Corps. It was a fully combatant technical corps under the quartermaster general's branch of the Army Council. Her Majesty the Queen was colonel-in-chief of the corps; the active head was the director of ordnance services, a major general, with a staff in the War Office. The chief function of the RAOC was storage and issue of a wide range of military supplies and equipment, including clothing, tentage, general stores, signal and engineer equipment, weapons, ammunition, tanks, and unit transport vehicles. It had no responsibility for procurement or maintenance of this material.

The predecessor of the RAOC was the Board of Ordnance, a government agency that held responsibility over several centuries for management of the Artillery and Engineer Corps, and for supplying military matériel to the army. The Board of Ordnance appeared as a corporate body of great power and prestige as early as the Tudor period and lasted for approximately 400 years until its dissolution in 1855. It supplied guns, powder, shot, and associated stores to warships as well as to trains of artillery in the field and to fortresses; but it did not provide clothing, rations, forage, or medical stores. Partly military and partly civil, the ordnance board was headed by a master general of ordnance, a position held by Wellington from 1818 to 1827. Its principal officers were usually members of Parliament.

The Crimean War scandals (largely over items for which the board was not responsible) led to widespread army reforms in the midst of which the board was abolished. The War Office then took over the supply of war matériel, forming a Military Stores Department in 1857. After experiencing many changes of title and organization, it finally emerged in 1896 as the Army Ordnance Department (officers and civilians) and Army Ordnance Corps (military other ranks) with responsibility for clothing and general stores as well as for war matériel. Because of their outstanding service during World War I the two organizations were amalgamated in 1918 and granted the honour title "Royal." In World War II the personnel of the Royal Army Ordnance Corps expanded from 8,000 in 1939 to 140,000 by 1945.

See Constance M. Green, Harry C. Thomson, and Peter C. Roots, *The Ordnance Department: Planning Munitions for War* (1955); Harry C. Thomson and Lida Mayo, *The Ordnance Department: Procurement and Supply* (1960). (H. C. T.)

ORDOVICIAN SYSTEM, in geology a term introduced by Charles Lapworth in 1879 to include those rocks—well developed in the Welsh region formerly inhabited by the Ordovices—which had been classed by Sir Roderick Murchison as Lower Silurian and by Adam Sedgwick as Upper Cambrian. Ordovician rocks contain representatives of many classes of invertebrate organisms, as well as the oldest strata with abundant fish remains. (*See* SILURIAN SYSTEM; CAMBRIAN SYSTEM; and *Ordovician* section of PALEONTOLOGY; *see* also GEOLOGY.) The Ordovician system is composed of rocks formed in the Ordovician period of time, a span of about 75,000,000 years ending about 400,000,000–435,000,000 years ago—duration and age based on interpretations of the depositional record and on the state of disintegration of radioactive minerals in associated rocks. The Ordovician period in current classification of geologic time followed the Cambrian period and preceded the restricted Silurian or Gotlandian period in the Paleozoic era (*q.v.*), or time of ancient life. The accompanying geologic time chart indicates the position of the Ordovician in relation to other systems and periods; the dates on the chart, which have been schematized to represent all of geologic time, indicate values for the Ordovician alternative to those used in this article, which postulates the longer time span cited above. (For discussion and a more detailed time chart *see* GEOLOGY: *Historical Geology*.)

Naming the Systems.—In the early part of the 19th century all the rocks which lie beneath the Carboniferous limestone were grouped together under the general name of Transition series, and it was not till 1831 that Sedgwick and Murchison made the first serious attempt to reduce them to order. Sedgwick started to work in northwest Wales and Murchison began upon the Welsh borders. By 1835 they had advanced so that Murchison gave the name Silurian system to the sequence of rocks with which he was

Geologic Time Chart

System and Period	Series and Epoch	Distinctive Records of Life	Began Millions of Years Ago
	CENOZOIC ERA		
Quaternary	Recent (last 11,000 years)		
	Pleistocene	Early man	2+
Tertiary	Pliocene	Large carnivores	10
	Miocene	Whales, apes, grazing forms	[illegible]
	Oligocene	Large browsing mammals	35
	Eocene	Rise of flowering plants	55
	Paleocene	First placentals, mammals	65–70
	MESOZOIC ERA		
Cretaceous		Extinction of dinosaurs	130
Jurassic		[illegible]	180
Triassic		Appearance of dinosaurs	225
	PALEOZOIC ERA		
Permian		Reptiles developed, conifers abundant	260
Carboniferous			
Upper Pennsylvanian		First reptiles, coal forests	300
Lower Mississippian		[illegible]	340
Devonian		Amphibians appeared, fishes abundant	405
Silurian		Earliest land plants and animals	435
Ordovician		[illegible]	[illegible]
Cambrian		Marine invertebrates	550–570
	PRECAMBRIAN TIME		
		Few fossils	more than 3,490

might be repeated for any of many other biologic groups, though not with such world-wide prevalence.

Dictyonema, a near relative of the graptolites, is funnel-shaped with connecting bars between the rays and is particularly prevalent in the basal Ordovician of the Scandinavian classification in beds classified as uppermost Cambrian in Britain. Those with wide distribution in the earlier Ordovician are: *Dichograptus*, with eight rays radiating from a central sac; *Tetragraptus*, two rays spreading from each end of a short bar; *Phyllograptus*, leaf-shaped when compressed but originally having an X-shaped cross section as of two interlocking leaves; and *Didymograptus*, some of which are horizontally extended, others in the form of an inverted V, and other forms tuning-fork shaped with the cups toward the centre. *Nemagraptus*, having many long branches radiating from an S-shaped central rod, appears for a limited time near the middle of the system, with *Climacograptus*, like a single narrow leaf with cups on both sides, *Diplograptus*, similar but with the cups more at an angle to the stem, *Dicellograptus*, two branches diverging broadly to form a very obtuse V with exterior cups, and *Dicranograptus*, similar but Y-shaped with exterior cups. *Climacograptus* and *Diplograptus* continue into the Silurian with new forms. Graptolites abound in some sequences of the Silurian system, but are rare in younger rocks. *See* also GRAPTOLITE.

DISTRIBUTION OF ROCKS

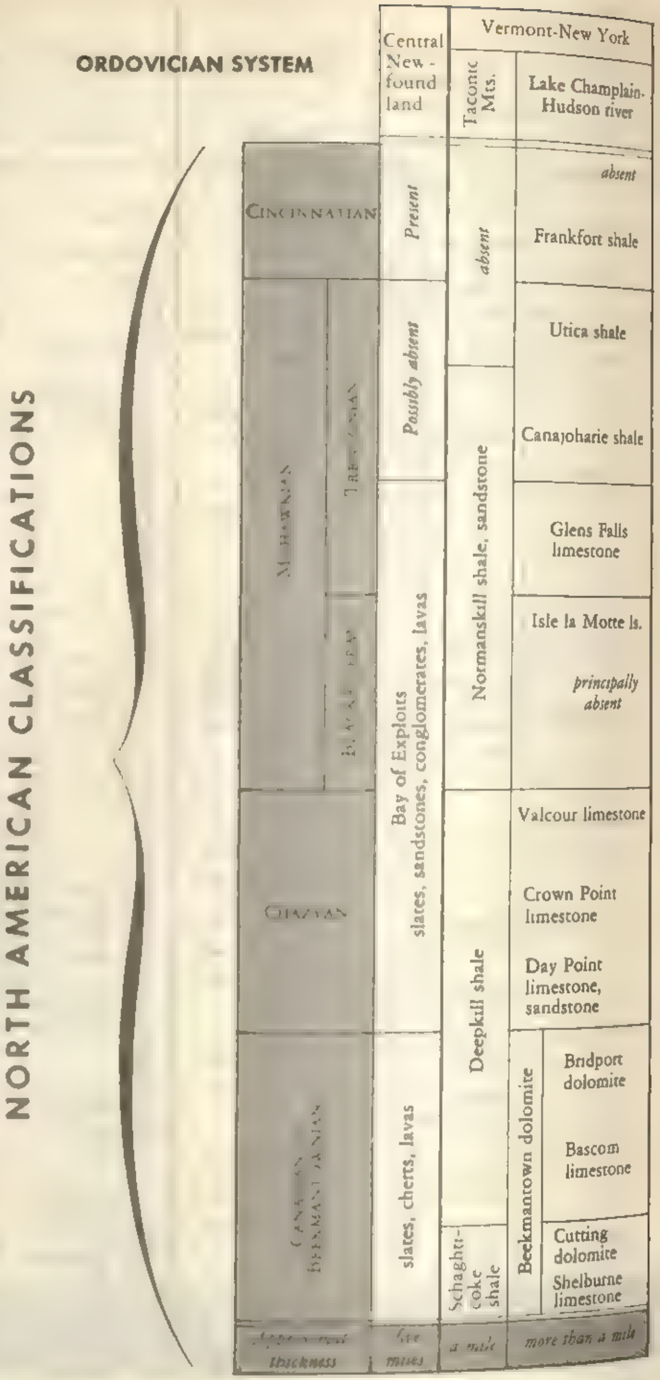
The rocks of the system are widely distributed but best known where they have been studied most intensely, in northern Europe and North America (*see* accompanying correlation chart of Ordovician system). Southern Europe has comparatively limited exposure of rocks as old as the Ordovician. In North America the system has been extensively preserved, and penetrated by wells in broad areas where the rocks are concealed deeply. Knowledge in other continents is restricted by such factors as sparse surface distribution and severe deformation of the rocks and by the limited study that they have received over broad regions of the earth.

Europe.—The system was originally described from Wales, where it is of thousands of feet of graywacke and shale having thick lava flows and volcanic fragmental rocks, and is rather widely distributed in northern Europe. The northern European shield or craton has relatively thin sections, principally of carbonates, exposed in southeastern Norway, Sweden, Bornholm (Denmark), Estonia and east to Lake Ladoga in the U.S.S.R., and in southern Poland. Geosynclines having greater thicknesses of argillites, graywackes and volcanic rocks are represented in the rocks of northwestern Norway and of Scotland and Wales, in a belt from Cornwall and Brittany to western Bohemia and probably along the east side of the Ural mountains. Along the coasts of Norway and Scotland are isolated small areas with limestone sections; beyond the geosynclinal belt south of the craton are scattered areas, principally of argillites on the Mediterranean coasts and in the southern Alps.

The section in Britain has been divided into several series having zones with graptolite assemblages named for a distinctive species. (For discussion of classification of stratified rocks into series and zones *see* PALEONTOLOGY: *Geological Paleontology; see* also FOSSIL.) Authors differ in their delimiting of series, but the geological survey in Great Britain prefers the classification shown in the table, except that the Tremadoc is excluded from the Ordovician, and retained, following the original definition, in the Cambrian system.

Some authors add *ian* and *an* suffixes to the names of the series. Doubt has been expressed whether zones 2 and 3 are correctly designated; some place the zone of *Clonograptus tenellus* above zone 1 and in the Tremadoc. Some writers prefer placing zone 6 in the Arenigian and zones 7 to 9 in the Llandeilian.

The Ordovician rocks of Britain were laid in a rapidly sinking volcanic geosyncline that passed from southern Ireland and western Cornwall through central Wales and the Lake district of northwest England into southern Scotland. Islands on the northwest furnished the principal detritus, for the Arenigian laps over Cambrian and Pre-Cambrian in Anglesey, northwest Wales; and more than 2,000 ft. of doubtful Llandeilian and Caradocian in



the Girvan district, southwest Scotland, overlaps Arenigian and has coarse sediment, whereas equivalent rocks near the English border to the east are the black shales (Glenkiln and Hartfell) with "condensed section" from the lower Caradocian through the Ashgillian totaling less than 200 ft. There are hundreds of feet of Arenigian lavas and volcanic fragmental rocks in the Girvan district. The principal flows in the Lake district, the Borrowdale volcanics, thousands of feet of andesite and rhyolite, are Llanvirnian or Llandeilian. The typical Ordovician of north Wales has similar thickness in rocks ranging from Arenigian to Caradocian; the latter, the Snowdon volcanics, resistant to erosion, form the scenic highest elevations such as Mt. Snowdon. Volcanism continued locally to the end of the Ordovician, there being volcanic tuffs and flows of felsite in the Ashgillian of southwest Scotland. The rocks thin as they enter England, and in southern Shropshire, Caradocian lies locally on pre-Ordovician. These sediments are principally shallow-water types with shelly faunas, deposited on the margin of the gently sinking platform of the midlands and southeastward.

British classifications	New York-Ontario: Eastern Lake Ontario	Pennsylvania-Virginia: Appalachian valley	Pennsylvania-Virginia: Appalachian mountains	Mississippi valley	Oklahoma: Arbuckle mountains	Oklahoma: Ouachita Mts.	Manitoba: Lake Winnipeg	Nevada: eastern	Nevada: central	Australia: South Victoria
Ashgillian	Queenston red shale Oneida sandstone Lorraine: Pulaski shale, sandstone Whetstone Gulf shale	absent	Juniata red sandstone Oneida ss. Reedsville shale	(Ohio) Richmond shale Maysville shale Eden shale (Iowa) Maquoketa shale possibly absent	Sylvan shale absent	Polk Creek shale absent	Stony Mountain limestone absent	Ely Springs limestone	graptolite-bearing slates, cherts, graywackes, quartzites, conglomerates and lavas	Bolindian slate, sandstone and volcanics
Caradocian	Trenton: Holland Patent shale Cobourg limestone Denmark limestone Shoreham limestone Kirkfield ls. Rockland ls. Black River: Chaumont limestone Lowville limestone Pamelia limestone	Martinsburg shale, sandstone Oranda limestone Mercersburg limestone absent Shippensburg ls. Edinburg limestone Bolarian	Antes shale Coburn limestone Salona limestone Nealmont limestone Benner limestone Benbolt limestone Peery limestone	Galena ls. Kimmswick ls. (Iowa) Dubuque dolomite, limestone Stewartville dolomite, limestone Prosser limestone Decorah shale, limestone (Missouri) Plattin limestone Joachim limestone Dutchtown limestone (Minnesota) Platteville limestone Glenwood shale, sandstone absent	Viola limestone Simpson: Bromide limestone, shale Tulip Creek limestone McLish limestone, sandstone	Bigfork chert Womble shale, sandstone	Red River limestone (possibly younger) Winnipeg sandstone absent	Eureka quartzite Copenhagen shale		Eastonian slate Gisbornian slate
Llandeilian	absent	Lincolnshire limestone	Ward Cove limestone Lincolnshire limestone	St. Peter sandstone	Oil Creek limestone, sandstone			sand stone		
Llanvirnian		New Market limestone Whistle Creek limestone	Five Oaks limestone Elway limestone Blackford dolomite		Joins ls.					Darriwilian slate
Arenigian		Bellefonte dolomite Axemann limestone Nittany dolomite		Black Rock Smithville ls. Powell dol. Cotter dol. Theodosia dol. Rich Fountain dol., ss. Roubidoux dol., ss. absent Shakopee dol New Richmond ss. absent Prairie du Chien dol.	Arbuckle limestone: West Spring creek Kindblade Cool Creek Strange	Blakeley shale, ss. Mazarn shale		Pogonip limestone		Yapeenian slate Castlemainian slate Bendigonian slate
Tremadocian		Stonehenge and Chepultepec limestone and dolomite		Gasconade dol. Van Buren ss., dol. Oneota dol.	McKenzie Hill					Lancefieldian slate
	a half mile	more than a mile		a half mile; 1,000 ft	more than a mile	a mile	a few hundred feet	a mile	a few miles	a few miles

England was along the southeastern border of a great volcanic belt that extended from Wales through the Caledonides (*i.e.*, mountains having structures formed during the Caledonian disturbance) of the Highlands of Scotland and the northwest coast of Norway, where areas such as Trondheim have thick sections of sediments and lavas. Northwest of this geosyncline, limestones at Durness in the north of Scotland and the island of Smölen in coastal Norway are so dissimilar in lithology and faunas from those in the geosynclinal belt to the southeast that they are more readily compared with those in North America; Bear Island and Spitsbergen also have limestone sections. The Ordovician of the geosynclinal belt was severely deformed and thrust-faulted northwestward in Scotland and southeastward in Norway in the Caledonian revolution after the Silurian period; there are some areas having granites intruded within the Ordovician period.

Southeast of this geosyncline was a large area of relatively greater stability and thinner sections, the early Paleozoic craton of Europe, occupying much of the region from the Caledonides and the Barents sea to the Urals and southward toward the Alps. The rocks have become exposed in scattered areas in southern Norway and Sweden, Bornholm, south of the Gulf of Finland, from Öland through Estonia to Lake Ladoga, and in south central Poland. The Tremadocian lies on a slightly eroded surface of Cambrian, commonly with glauconite-bearing beds at the base. Succeeding Ordovician rocks are rather constant in thickness and lithology over considerable areas and are principally limestones with abundant shell facies faunas, Estonia having particularly fine representation. The older series pass into graptolitic shales in Skåne, south Sweden, and in the Oslo district, Norway, so that the temporal relations of facies and the correlations with Wales are generally known. The Silurian lies on varying Ashgillian horizons in Scandinavia and on Caradocian in Poland. Throughout the region there were no highlands, nor did uplifts in the adjoining geosynclinal belts contribute significant thicknesses of coarse detritus to the craton.

The Baltic belt of outcrop is rather isolated by the thick younger sediments of the Low Countries and the German and Polish plains from areas of exposure extending from western France through

Classification of Series in Great Britain

Series	Zones
Ashgill	15. *Dicellograptus anceps* 14. *Dicellograptus complanatus*
Caradoc	13. *Pleurograptus linearis* 12. *Dicanograptus clingani* 11. *Climacograptus wilsoni* 10. *Climacograptus peltifer* 9. *Nemagraptus gracilis*
Llandeilo	8. *Glyptograptus teretiusculus*
Llanvirn	7. *Didymograptus murchisoni* 6. *Didymograptus bifidus*
Arenig	5. *Didymograptus hirundo* 4. *Didymograptus extensus* 3. *Dichograptus octobrachiatus*
Tremadoc	2. *Bryograptus cambriensis* 1. *Dictyonema socialis*

eastern Belgium, Bavaria and Thuringia to Bohemia. Inasmuch as wells have not penetrated the system in this great region, the character can only be induced. In Bohemia is the classic section of nearly a mile of Ordovician studied by Joachim Barrande. The older Tremadocian to Llanvirnian, mostly of graptolitic shales like those in the region along the margin of the Welsh geosyncline, has basic lavas and volcanics above the Tremadocian; coarsening graywackes and sandstones of the Caradocian and Ashgillian seem to have come from rising lands to the south. Similar sections are in southern Thuringia and Bavaria and westward through the Ardennes of Belgium into Normandy, where the Arenigian is the widely distributed Armorican sandstone lapping over pre-Ordovician rocks. To the east, Ordovician calcareous and argillaceous rocks are present sparingly in the southern Urals; the eastern Urals have younger slates, cherts and volcanic sequences thrust westward, and similar rocks may have filled a geosyncline in the Ordovician. Thus the north European craton of the early Paleozoic was margined on the northwest, south and east by more rapidly subsiding geosynclines that were filled predominantly by argillites and graywackes derived from more distant lands or islands, and by volcanic rocks of varying kinds, ages and thicknesses.

The Ordovician of southern Europe is exposed widely only in the Iberian peninsula, which in northwestern Spain and northern Portugal has overlapping Arenigian sandstone like the Armorican of France under graptolite-bearing shales and graywackes. Elsewhere north of the Mediterranean, outcrops have been so displaced by later structures that a comprehensive portrayal is not possible. Diminishing areas of land are considered to have extended in a belt from Brittany to western Bohemia; but Ordovician is present within the region, and the outline and distribution of the islands is not established. Similarly, the Iberian peninsula had land areas between a geosynclinal belt trending from the Pyrenees to the southern Alps and one through the western Mediterranean region. Shales and sandstones are prevalent in all these sequences.

North America.—The central part of North America in the Ordovician was a great shield or craton. Low-lying land of Pre-Cambrian crystalline rocks persisted in the northern half until late in the period; earlier sediments, principally carbonates with some quartz sandstones, thinned irregularly northward in the southern half. Belts of thicker carbonates (miogeosynclines) surrounded this relatively stable shield, the broadest belt being on the west. The peripheral parts of the present continent had deeply sinking geosynclines of dominantly argillaceous rocks, with interbedded lava flows and other volcanic rocks and thick graywackes and conglomerates that must have come from associated islands; these are the eugeosynclinal belts. These general relations were disturbed in the east in the middle of the period as uplifts in the peripheral areas were eroded, spreading detritus progressively over earlier carbonates, first in the miogeosynclinal belt, subsequently until they extended far into the craton, forming an exogeosyncline. Finally, the Taconian revolution severely folded and thrust-faulted the eastern geosynclines and thrust them toward the craton. The tradition has been that the early Paleozoic North American shield had persisting geosynclines along its borders—Appalachian on the east, Ouachitan, Cordilleran and Franklinian on south, west and north—with great crystalline borderlands, Appalachia, Llanoria, Cascadia and Pearya, respectively, beyond. The marginal geosynclines were of changing form, position and character, however, and the areas of the "borderlands" are known to have very thick sections of metamorphosed Paleozoic sediments; sediments that have been attributed to the borderlands seem to have come initially from within the continent and subsequently also from lands raised in the geosynclinal belts.

The Ordovician, the most widely distributed system in North America, is divided into three, four or five series by different authors; a classification of the series and stages in the typical development is as follows:

Series	*Stages*
Cincinnatian	Richmondian Maysvillian Edenian
Trentonian	Collingwoodian Cobourgian Denmarkian Shorehamian Kirkfieldian Rocklandian
Blackriveran	Chaumontian Lowvillian Pamelian
Chazyan	Valcourian Crownian Dayan
Canadian	Cassinian Jeffersonian Demingian Gasconadian

The term Mohawkian is frequently applied to the Blackriveran and Trentonian together; Champlainian has been applied to the whole system, and to the three middle series of the table. The Canadian formations of the Ozark mountains of Missouri and Arkansas are most frequently used as a basis for time correlation. The Canadian is commonly considered to be the Lower Ordovician, and the Cincinnatian, the Upper; the intervening beds are commonly called Middle Ordovician, though the Chazyan has also been classed as Lower.

The classification is based principally on shell-facies faunas, but argillitic facies are well known and their relative positions established. The Canadian has Tremadocian to early Llanvirnian faunas from the zone of *Dictyonema flabelliforme* (Shaghticoke) to that of *Didymograptus bifidus* (upper Levis-Deepkill), though the latter may be somewhat older than the European *bifidus* zone. The Chazyan seems essentially Llanvirnian and Llandeilian, for the basal Caradocian *Nemagraptus gracilis* zone (lower Normanskill) is about upper Chazyan or basal Blackriveran. Cincinnatian faunas resemble Ashgillian, though precise correlations have not been established, and the Upper Ashgillian may be included in rocks classified as Lower Silurian.

The Canadian is of two principal lithologies—carbonates in the southern part of the craton and in geosynclines along its margins, and, in areas bordering the present continent, argillites and coarser sediments gained from adjoining islands, as well as volcanic rocks on the Atlantic and Pacific coast. The limestones and dolomites are in a narrow belt east of the craton from western Newfoundland to Alabama, a great area in the southern half of the craton where they thin northward, in a broad belt along the west from eastern Yukon and British Columbia through eastern Idaho, western Utah and eastern Nevada, southeastern California and western Sonora, and north as in northwestern Greenland. Sections along Lake Champlain in New York, Vermont and Quebec, and in the Ozark mountains of Missouri and Arkansas, are representative of this facies and have many genera of cephalopods, gastropods, brachiopods and trilobites. The graptolite sequence in the argillitic shales is known from many regions all around the continent, as scattered as central Newfoundland, eastern New York, Oklahoma, Nevada, southeastern Alaska and northern Greenland. Large boulders of carbonate facies of Cambrian and

Canadian are found in the graptolite-bearing argillites south of the St. Lawrence river below the city of Quebec, and similar "exotic boulder" conglomerates are known in younger Ordovician strata in western Newfoundland. Some of the blocks being tens of feet long, their transportation has been attributed to submarine slumping in muds of rocks raised and dislodged, possibly by faulting, from the carbonate facies to the northwest. In central Nevada, Canadian and younger graptolitic slates and lavas have been thrust more than 50 mi. on a section of folded sediments including contrasting Canadian carbonates; similar thrusts are known or suggested in many regions where the two facies are in proximity, making the determination of their original relations obscure.

The Middle Ordovician Chazyan and Mohawkian series are typically exposed on the east and west sides of the Adirondack mountains in northeastern New York. The former is limited in distribution or recognition on the continent. A remarkably pure wind-transported, water-laid quartz sand formed the St. Peter sandstone in a sinking embayment from central Michigan through Illinois toward the lower Mississippi river, probably in the Chazyan. The first phase of orogeny in the east was about the end of the epoch. Rising land in the Carolina region produced sands and clays that accumulated to a few thousand feet in a geosyncline in southwestern Virginia and eastern Tennessee; the argillites (Athens) having *Nemagraptus* grade into carbonates that thin rapidly westward. The succeeding Black River limestones are principally within the craton. Uplift east of New York in medial Trentonian produced graywackes (Upper Normanskill-Schenectady) grading westward into black shales (Canajoharie and Utica) that thin rapidly along a northeast-trending axis passing through the present Adirondack mountains into shallow-laid limestones farther northwest. This narrow zone of gradation is recognized from Quebec to Virginia. Mohawkian carbonates of the interior are generally less than 1,000 ft., thinning irregularly northward so that Trentonian in central Canada lies directly on Pre-Cambrian, blanketing nearly all of the crystalline rocks so extensively exposed from the beginning of the Paleozoic.

The Cincinnatian series has typical development in calcareous and argillaceous shales in Ohio, Indiana and Kentucky; the Edenian and Maysvillian are found only in the eastern states and southeastern Canada. The earlier Cincinnatian is detrital graywacke and shale (Lorraine) laid in a geosyncline, curved like a bow toward and extending into the continental interior, an exogeosyncline. The late Cincinnatian (Richmondian) seas retreated before the advancing deltas of fluviatile sands and gravels (Juniata) and red silts and clays (Queenston) from rising lands to the east. In the rest of the continental interior Richmondian carbonates and shales formed in the most widespread sea in North American history, unless it be that of the latest Trentonian. The Cincinnatian on Anticosti Island in the Gulf of St. Lawrence has a relatively continuous succession of latest Ordovician (Gamachian) and earliest Silurian fossiliferous shales and limestones. The Taconian revolution at the close of the period folded rocks from eastern Pennsylvania to Newfoundland and may have involved thrust faults of great displacement that brought the argillaceous facies upon the carbonate facies in the east.

Australia and New Zealand.—The Ordovician is well developed in a belt, the Tasman geosyncline, extending from eastern Queensland through New South Wales and Victoria into Tasmania, and a branch spreading to the northwest into western Queensland and Western Australia, where the rock lies nearly flat in carbonate and sandy shallow-water trilobite-bearing facies up to 4,000 ft. thick. Over 12,000 feet of slate and graywacke in Victoria form one of the finest sequences of graptolite-bearing shales in the world; the order of appearances of the genera is quite like that in Britain and America, and most of the forms are found in all continents. Andesitic and rhyolitic lavas and pyroclastics are interbedded in the argillaceous rocks in a number of places, as in eastern New South Wales, southern Victoria and Tasmania; the Upper Ordovician has phosphatic beds and cherts. Intrusions of granite invaded the geosynclinal sediments during the Benambean orogeny near the close of the period. In New Zealand, graptolitic argillites are present in the Alps of the South Island.

Other Continents.—Ordovician sediments are widely distributed in Asia and have been studied considerably, particularly in China and Manchuria, where the preponderant sediments are limestones. Argillites with graptolites are known in several areas, and are associated with volcanics in a belt in western Yünnan, along the Burma frontier. The Ordovician of South America is best known in a rather continuous belt along the west of the Brazilian shield from the Mendoza region, northwestern Argentina, through Bolivia and Peru to Cordillera Oriental of eastern Colombia and southern Venezuela; there are argillites, and limy beds having faunas more similar to those of the Ordovician of Britain and Sweden than those in North America. Ordovician rocks are of limited distribution in Africa and are found principally in the north; in Morocco and northwestern Algeria are thick argillitic sequences. *See* GEOLOGY: *Bibliography*.

See also references under "Ordovician System" in the Index.

(M. KY.)

ORDU, a small port and capital of Ordu *il* (province), Turkey, situated on the Black sea near the mouth of the Melet river, 100 mi. W. of Trabzon. Pop. (1960) 20,029. It lies on the eastern slopes of the Boztepe (1,800 ft.), a mountain which affords protection against storms from the northwest. Its modern development is connected with the cultivation and export of hazelnuts. Ordu is the site of Cotyora, founded by Greek colonists (*c.* 500 B.C.) and the place where survivors of the "Ten Thousand" of Xenophon (*q.v.*) embarked for Sinope (Sinop) and Heraclea Pontica.

ORDU IL (area 2,076 sq.mi.; pop. [1960] 469,379) has a rugged landscape, well forested and entrenched by deep valleys. The climate is generally humid. Chief products are maize (corn) and hazelnuts (filberts) in the coastal areas, and wheat and livestock produce in the hinterland. (N. TU.; S. ER.; E. TU.)

ORDYN-NASHCHOKIN, AFANASI LAVRENTIEVICH (properly ORDIN-NASHCHOKIN) (d. 1680 or 1681), Russian statesman and diplomat whose foreign policy and other pioneering ventures made him a precursor of Peter the Great, was born at Pskov, the son of a petty landowner. Thanks to the presence at Pskov of a middle-class community open to cultural influences from the west, he received a comparatively good education. This led to his being appointed in 1642 to supervise the delimitation of the Russo-Swedish frontier. Virtual ruler of Livonia between 1656 and 1658, he acquired experience in dealing with Sweden which convinced him that Russia should seek to become a maritime power with a Baltic seaboard; and, since Russia could not simultaneously contend for Livonia against Sweden and for the Ukraine against Poland, he recommended peace with Poland even at the price of losing the Ukraine. His policy, which the truce—favourable to Russia—concluded by him with Sweden at Vallisaari in 1658 had begun to implement, was however not supported by the tsar Alexis and was thwarted by the peace of Kardis in 1661.

From 1664 Ordyn concentrated his attention on Poland. He formulated the policy of a Russo-Polish alliance that would nevertheless enable Russia to protect Orthodox communities outside the Russian frontiers. It was he who brought about the truce of Andrusovo in 1667, a turning point in Russo-Polish relations. In 1667 also he was promoted boyar and appointed minister of foreign affairs and head of several other departments, including the *Malorossiiski* (Ukrainian); but when he differed with Alexis over Russia's policy for the Ukraine, he was removed from the *Malorossiiski prikaz* (1669) and then from the foreign office (1671) and replaced by A. S. Matveev (*q.v.*). Though he took monastic vows, Ordyn in 1679 again participated in negotiations with the Poles. He died in the monastery of St. John the Evangelist, near Pskov.

The *Novotorgovy ustav*, or new trading ordinance, promulgated in 1667, was drafted by Ordyn to protect Russian merchants from foreign competitors and native bureaucrats alike. He also took an active interest in shipbuilding. (L. R. LR.)

ORDZHONIKIDZE, GRIGORI KONSTANTINOVICH (1886–1937), Soviet Communist leader of Georgian na-

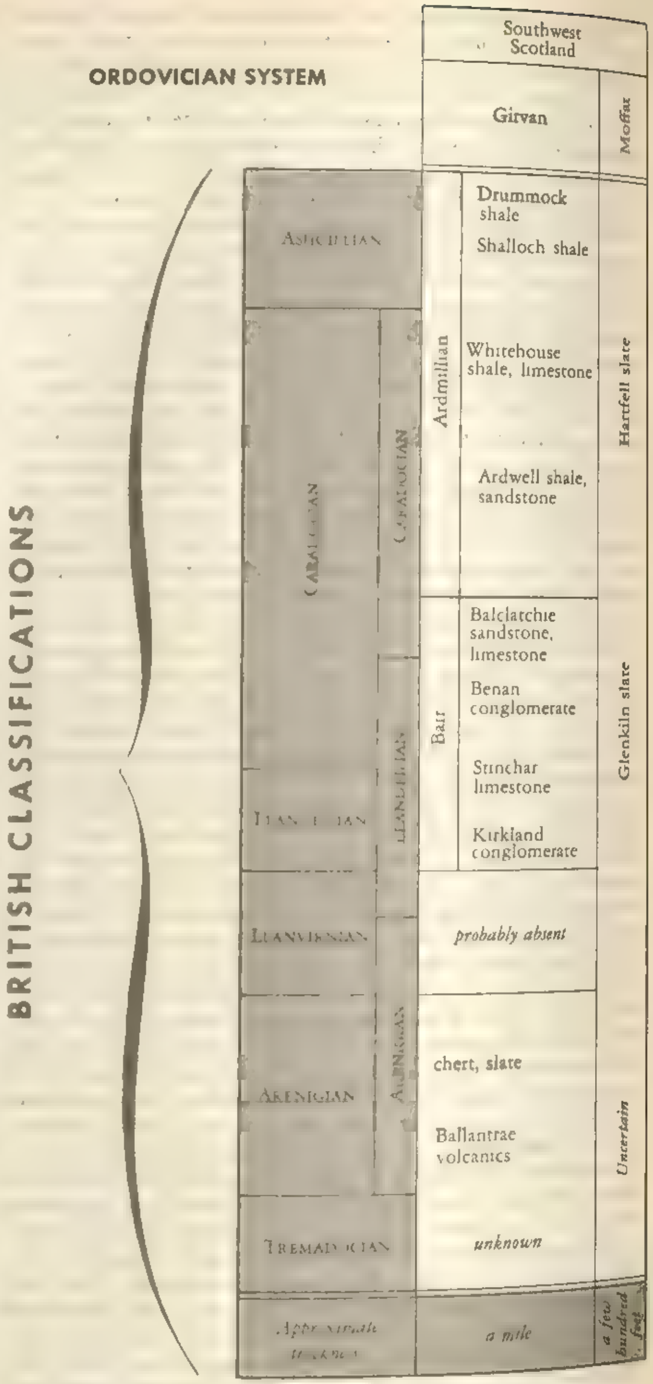
dealing, while Sedgwick called his the Cambrian series. At the time it was supposed that the Cambrian lay entirely below the Silurian. Subsequently it was shown that the upper part of Sedgwick's Cambrian was the same as the lower part of Murchison's Silurian. A prolonged controversy followed which left its effects in some confusion of nomenclature even into the second half of the 20th century. Believing that the Cambrian and Silurian of Sedgwick and Murchison included three natural divisions, Lapworth in 1879 proposed that these be called Cambrian, Ordovician and Silurian. Murchison's terminology was still used to some extent at mid-20th century, especially in Germany, the three divisions being called the Cambrian, the Lower Silurian and the Upper Silurian.

The three systems are universally recognized but there are some differences of usage with regard to their precise limits. Most British geologists adhere to a classification, based largely on original definition and structural considerations, in which the base is drawn above the Tremadoc, which includes the zone characterized by the fossil of *Dictyonema flabelliforme*, whereas in extra-British areas there is general adherence to the Scandinavian practice of placing the base below that zone. There is also some divergence of opinion as to the horizon at which the upper limit should be placed, particularly inasmuch as correlations among the several continents are not conclusive.

Stratified Rocks.—The strata composing the system can be classified in several contemporary lithologic facies (*i.e.*, lateral variations or gradations in rocks developed within a single time span) deposited under differing physical conditions, and inasmuch as these evidence differing environments, each of the lithologies has an associated distinctive fossil assemblage. The lithologies vary continuously, geographically and temporally. Their textures and depositional structures can be related to the velocities of the currents that transported and sorted them and to the depths in which they were laid; their compositions reflect the materials that were carried into their places of deposition and the minerals that were precipitated locally by inorganic or organic processes. (1) Rocks of nonmarine origin include consolidated gravels (conglomerates), sands and clays having particles of sizes that streams were incompetent to carry farther, as well as the original fluviatile structures. (2) Marine rocks ordinarily contain some significant organisms that substantiate recognition of origin from interpretation of their textures and structures. They are broadly separable into those laid in shallow water, of depth of scores of feet or less, and those laid in deeper water where currents and agitation were insufficient to prevent settling of fine particles. Each may be dominantly of inorganic detritus transported from lands, of minerals formed locally, or from the accumulation of organisms and organic detritus. Those of shallow-water origin include shelly limestones (coquinas) and calcite sandstones (calcarenites), grading into quartz sandstones, graywackes (quartz-sandy argillites), shaly and silty argillites deposited in seas receiving detritus eroded from lands and from areas having limited circulation, dense limestones (calcilutites) and dolomites, and evaporites such as gypsum and salt deposits. Rocks of deep-water origin pass through dense and nodular, somewhat cherty and argillaceous (clayey) limestones into dark laminated argillites (black shales) and dense argillaceous limestone interbeds, prevalent in deeply sinking regions in which deposition failed to keep pace with subsidence. (*See* also SEDIMENTARY ROCKS.) (3) There are additional and significant lavas and volcanic fragmental rocks, prevalent in belts of greatest mobility.

Thicknesses are a measure of the subsidence of the earth's surface, fluctuations of sea level and the rate of deposition. The Ordovician rocks of the several facies are distributed in systematic but changing patterns that reflect the structural development within the areas of deposition, as well as the uplift and erosion of adjoining lands.

The earth had several large, rather stable areas of continental proportions and varying relative elevation (cratons) separated by linear geosynclinal belts of greater mobility. The central parts of the geosynclinal belts had thick sequences of sediments, and volcanic rocks accumulated in rapidly sinking geosynclines



(eugeosynclines) that gained detritus from nearby rising narrow islands; the typical Ordovician of Wales is of this facies. Adjoining are belts of nonvolcanic rocks of relatively great thickness (miogeosynclines), commonly decreasing rather rapidly at the margins of the cratons. The North American craton in the Ordovician included the area of the Canadian shield, as well as an extensive area bordering this shield, principally to the west and south. The thicker rocks of the cratons are principally of shallow-water origin, increasing and diminishing in response to warping movements within their area; deeply sinking local regions occasionally gained deposits of geosynclinal proportions (autogeosynclines). This pattern is disturbed or destroyed where orogenies deformed and raised the rocks of the linear geosynclinal belts, and streams distributed the detritus into subsiding areas in the borders of the cratons (exogeosynclines).

ORDOVICIAN LIFE

The changing distribution and elevations of lands and the depths of the seas not only influenced the lithologies, but controlled

Northwest England Lake district	Northwest Wales	West England Shropshire	Norway Oslo district	Sweden Västergötland and Öland	Sweden Skåne	Estonia	Czechoslovakia Bohemia
Ashgill shale Keisley limestone	Conway Castle sandstone Deganwy shale Bodeidda shale	*absent*	Tretaspis limestones and shales	Dalmanina beds Staurocephalus shale Tretaspis beds Slandrom limestone	Dicellograptus shale	Harju series: Porkuni st.; Lyckholm: Pirgu st., Vormsi st., Saunja st.; Rakvere stage, Vasalemma	Zdice: Kosov quartzite; Kral uv dvur shale, sandstone
Sleddale: Applewaite beds Stockdale lavas Stile End beds	Cadnant shales Snowdon lavas Gwastadnant sandstone	Chirbury: Whittery shale, volcanics Hagley shale, volcanics Aldress shale Spy Wood sandstones	Chasmops series: Chasmops limestone and shale Ampyx limestone	Chasmops limestone: Macrourus limestone Ludibundus limestone	Dicellograptus shale	Viru series: Keila stage Jõhvi stage Idavere stage Kukruse stage	Bohdalec shale Záhořany: Lodenice shale Chrustenice shale
Roman Fell beds Borrowdale volcanics	Conway lavas Glanrafon slates, lavas	Middleton: Rorrington shale Meadowtown beds Betton shale Weston shale, sandstone	Ogygiocaris series: Ogygiocaris shale Upper Didymograptus shale	Orthoceras limestone: Crassicauda limestone Schroeteri limestone Platyurus limestone Vaginatum limestone	Dicellograptus shale Didymograptus shale	Uhaku stage Lasnamäe stage Aseri stage Kunda stage	Drabov quartzite Osek Kvaň: Sv. Dubrotiva shale, lavas Sarka shale and lavas
Skiddaw slates	Maesgwym slates, lavas volcanics and slates Garth sandstones Rhobell Fawr volcanics	Shelve: Stapeley ash Hope shale Mytton beds Stiperstone quartzite	Asaphus series: Orthoceras limestone Lower Didymograptus shale	Lepidurus limestone "Limbata" limestone Tetragraptus shale; Billingen; Hunneberg	Didymograptus shale	"Megalaspis" limestone	Komarov shale, lava
uncertain	slates	Shineton slates	Ceratopyge: Ceratopyge limestone Dictyonema shale	Ceratopyge limestone, shale Obolus conglomerate	Dictyonema shale	Iru formation Pakerort shale and sandstone	Krušná Hora: d'Olesna shale Milina shale, sandstone Trenice cgl.
a few miles	*a few miles*	*two miles*	*1,000 ft*	*a few hundred feet*		*1,000 ft*	*a mile*

physical and organic environments and restricted migration. Ordovician faunas exhibit changes with time, but also the effects of ecological factors and the isolation of geographic provinces. (See ECOLOGY.)

The fossil record of life of the system has several distinctive features; the changes from the older Cambrian and into the younger Silurian are not abrupt but are apparent to those familiar with biological classification. Similar contrasts developed within the system not only in successive strata but among varying environments represented in differing present rocks. Few classes of organisms are common to faunas both of quartz and calcite sandstones and calcareous shales deposited in relatively turbid shallow water, and of black shales and dense argillaceous limestones laid in deeper water; and such as are represented in each have distinctive families and genera. Trilobites that dominate Cambrian sediments of many lithologies continue in abundance, but become subordinate in numbers to other groups that had been absent or uncommon. Brachiopods, gastropods and cephalopods, and later bryozoans, ostracodes, cystids, tetracorals and pelecypods, became locally common in the limy and sandy lithologies, the shelly facies. The genera in each class are numbered in scores and hundreds, having smaller or greater temporal (stratigraphic) and geographic ranges; those of abundance in limited stratigraphic range are most useful in classifying and correlating the containing rocks in time. Graptolites, generally free-floating colonial marine organisms having individuals living in small cups (thecae) along raylike threads or branches (stipes) which when compressed seem like miniature deeply cut saw blades, have near relatives in Cambrian rocks, but abound in some laminated Ordovician black shales; their fragile structures were not destroyed in the quiet and rather sterile environment of the clay deposition. Being free-floating (planktonic), they are more cosmopolitan, having many of the same genera and similar or identical species over the whole earth. The appearance of these forms is in fairly consistent order whether in Britain, North America or Australia, permitting rather confident general intercontinental correlation. They are the preponderant fossils in the black-shale facies and will serve as an example of changing life forms, such as

tionality, an adherent and finally a victim of Stalin's regime, was born at Goresha, in Georgia, on Oct. 27 (new style; 15, old style), 1886, the son of a petty nobleman. After joining the Bolshevik wing of the Russian Social Democratic Workers' party in 1903, he became a professional revolutionary. During the 1905 revolution he was active in the Caucasus and was arrested, but escaped to Germany. He returned to Russia in 1907 and became a member of the Baku party committee but was soon arrested again and sent to Siberia. He escaped from Siberia and was for some time active in Persia. He attended the party school at Longjumeau near Paris in 1910 and was sent by Lenin to Russia to prepare the Prague conference (Jan. 1912). At this conference he was elected to the central committee of the party and to the committee's Russian bureau. Arrested in April 1912, he spent three years in the Schlüsselburg fortress and was then banished to Yakutsk in Siberia.

Returning to Petrograd after the revolution of March 1917, Ordzhonikidze became in June a member of the executive committee of the Petrograd soviet and of the Bolshevik party committee. He was appointed commissar extraordinary for the Ukraine area in Jan. 1918 and later for the south of Russia and the Caucasus. Having played a leading part in establishing the Soviet regime in Georgia and Armenia, he became a member of the All-Union Bolshevik party's central committee and chairman of its Transcaucasian bureau in 1921. His high-handedness was resented by the local Georgian Communist leaders, whom he accused of nationalist deviation, but he also incurred the hostility of L. P. Beria, head of the secret police in Transcaucasia, and so was transferred in 1926 to the northern Caucasus. He became a candidate member of the Politburo at the same time, but was soon elected chairman of the Central Control commission and appointed commissar for worker-peasant inspection and deputy chairman of the council of people's commissars. In 1930 he was appointed chairman of the supreme council of national economy and member of the Politburo, and in 1932 he became people's commissar for heavy industry.

Throughout the 1920s and early 1930s Ordzhonikidze supported Stalin in the struggle within the party; but in the end he seems to have tried to restrain Stalin's excesses. He was forced to commit suicide in Moscow on Feb. 18, 1937. (L. B. Sc.)

ORDZHONIKIDZE (formerly VLADIKAVKAZ and from 1944 to 1954 known by its Ossetian name DZAUDZHIKAU), the capital of the North Ossetian (Severo-Osetinskaya) Autonomous Soviet Socialist Republic of the U.S.S.R. (*see* OSSETIA), stands on the Terek river, on the northern slopes of the Caucasus, 375 mi. S.E. of Rostov-on-Don. Pop. (1959) 164,420. Vladikavkaz was founded in 1784 as the key fortress to hold the Georgian Military Highway through the Terek valley and the Ossetian Military Highway along the Ardon valley, the two main routes across the Caucasus. In 1861 it became a town and in 1877–78 the terminus of a railway from Prokhladny on the main Rostov-Baku line. The development of good communications for military purposes led to industrial development (zinc, glass, earthenware pipes, chemicals, clothing, footwear and foodstuffs). There are large rolling stock repair shops. The administrative and cultural centre of the autonomous republic, Ordzhonikidze has medical, agricultural, pedagogic and mining institutes and the North Ossetian Research institute. (R. A. F.)

ÖREBRO, a town of Sweden, capital of the *län* (county) of Örebro, lies on both banks of the Svartå river near its entrance into Lake Hjälmaren, 134 mi. W. of Stockholm. Pop. (1960) 75,379. Örebro is one of Sweden's oldest towns; it was already a commercial centre in the 13th century. Largely rebuilt since a fire in 1854, it has a modern appearance but some imposing historic buildings remain. A medieval castle (reconstructed in the 1550s in Swedish Renaissance style) stands on an island in the river and one of its four round towers is used as a museum; the castle was restored (1897–1900) and serves as the official residence of the governor of the county. Other notable buildings include St. Nicholas' church (13th century Gothic) and the 15th-century Kungsstugan (King's house), one of the best-preserved wooden buildings in Sweden.

Örebro has played a prominent part in Swedish history. It was the residence of Engelbrekt, national hero and liberator of Sweden in the 15th century. Olaus and Laurentius Petri, 16th-century church reformers, were born there; they are commemorated by an obelisk at Olaus Petri church. Several diets or important assemblies have been held at Örebro, the most notable being that of 1810 when the field marshal Jean Bernadotte was elected heir to the throne of Sweden (as Charles XIV John).

Örebro is a lively industrial town known for its shoe and biscuit manufacture. It has good rail communications and is situated at the junction of national highways. Through the Hjälmare canal and Lakes Hjälmaren and Mälaren the town can be reached by boat from Stockholm and the Baltic.

ÖREBRO LÄN (area 3,492 sq.mi.; pop. [1960] 262,239) comprises the historic province of Närke and parts of Västmanland and Värmland provinces. It has many small and medium lakes and is drained by the Svartå, Arboga, Let and Hork rivers. Mineral deposits include iron, zinc and copper; lumbering, papermaking, steel and metal smelting are important industries. Chief towns besides Örebro are Karlskoga (*q.v.*), Kumla, Lindesberg and Nora.

ORE DEPOSITS. Minerals are naturally occurring substances of fairly constant chemical composition and physical properties. They make up ore deposits and rocks. In ore deposits, the minerals that give value to the deposit are the ore minerals, and the valueless minerals are the gangue minerals, or matrix; the rock in which the ore is found is the country rock. The ore and gangue minerals are mined together—*i.e.*, taken out of the country rock in a mass—manually or mechanically. Thereafter the ore must generally be milled, the ore mineral being separated from the gangue mineral, usually mechanically. Next, the desired metal is extracted from the ore mineral by a chemical or metallurgical process; commonly this is a smelting operation. (*See* ORE DRESSING; METALLURGY.) After this, the metal may be still further purified or alloyed with other metals, as in a copper refinery or a steel mill. Exploration, mining, milling and refining are thus successive steps in the utilization of an ore deposit to yield a metal.

By general definition, ore deposits should contain metal-yielding minerals, should be of natural origin and should be economically workable. In a given instance, however, any of the three conditions included in this definition may be violated, provided the other two still hold. Thus, "ore deposits" is commonly applied to certain occurrences worked primarily for their nonmetallic elements, like the deposits of pyrite (FeS_2) mined in many industrialized countries as sources of sulfur gases and sulfuric acid. The accumulated waste, or tailings, once useless, remaining after milling some ores may subsequently become a source of metals that can be extracted with profit, or a commercial use may be found, as the use of tailings (chat) for railroad balast, concrete aggregate and road surfacing; hence, it is at times, though rarely, called an ore deposit. Finally, the disseminated, lean deposits of copper minerals in granitelike rocks, occurring notably in parts of the western U.S., northwestern Mexico and Chile, were called ore deposits even before technologic progress made it possible to work them to economic advantage.

To be economically recovered the metals must be present as elements or compounds in concentrations far higher than normal, in limited volumes in the earth's crust. For gold and silver the ratios of natural concentration required to make a workable deposit are much lower than those of the base metals. The economic ratios for any metals require material qualification if by-products are obtainable, as is commonly the case.

As almost every rock contains at least a small quantity of almost every ion, the detection of desired metals is limited virtually by the sensitivity of the analytical method available, extending even to the small quantities of copper, lead and manganese in plant ashes. The widespread occurrence, but rare concentration, of the metalliferous minerals has affected the theories for the genesis of ore deposits and the methods of searching for them.

Classification and Genesis.—Before the 20th century, a favourite classification for ore deposits stressed their composition—iron deposits, gold deposits and so on. This method lacked any

genetic significance, for iron-ore deposits can originate in several different ways. Furthermore, it ignored the fact that many ore deposits have two or more metals in abundance; the tin veins of Cornwall in Britain also yielded copper, the zinc deposits of Silesia carried noteworthy quantities of lead, and Cerro de Pasco in Peru had become by the middle of the 20th century an important source of zinc, though previously known for its copper production. In fact, the miner finds it necessary to apply such terms as "argentiferous lead deposits" to mixed ores like the silver-lead deposits in Murcia in southern Spain, or "dry gold ores" to gold-quartz ores free from base metals.

A second basis for classification, as illustrated by the comprehensive system of Bernhard von Cotta (1808–79) and others, stressed the geometrical form of the ore body. Thus, Albrecht von Groddeck, a follower of Cotta, in 1879 distinguished bedded deposits, massive deposits and clastic deposits (including placers). Classification by form serves well in the search for an extension of a known ore body or for other similar bodies in localities where deposits have been found previously. Understandably, the application of this classification led almost insensibly to a genetic grouping through the schemes presented in 1881 by A. W. Stelzner, in 1903 by Kemp and in 1909 by Richard Beck.

The most scientific mode of classification is genetic. It may be attributed to the great controversy between the "Neptunist" A. G. Werner (1750–1817) on the one hand and the "Plutonists" James Hutton (1726–97) and John Playfair (1748–1819) on the other. This controversy turned on whether most mineral deposits were to be regarded as laid down in the sea, as suggested by Werner, or as injections or fissure fillings essentially from melts or hot solutions, as the "Plutonists" maintained. Despite widely held views to the contrary, both concepts held much truth. Later scientific followers continued this discussion on more quantitative grounds, but the front shifted somewhat; F. von Sandberger (1826–98), Groddeck and others stressed the derivation of the ore ions (*e.g.*, zinc in deposits of the zinc sulfide mineral sphalerite) from the country rock and their deposition in openings of that rock, a concept usually called lateral secretion. The transportation in such a process has been variously assigned to cool surface waters, later laterally moving (as by C. E. Siebenthal for the zinc and lead ores of the Tristate, Missouri-Oklahoma-Kansas district, U.S.) or to waters of the same origin which, though originally cool, had been heated by contact with hot rocks at depth and had subsequently risen, depositing their dissolved matter as they rose and cooled, as urged by C. R. Van Hise. Since it was at first believed that all waters, even the hot ones, were merely reheated surface waters and were, in fact, notably lacking near volcanoes, where molten rock comes to the surface and can be observed, it was generally contended that few or no solutions could have come up from deep inside the earth, carrying valuable metallic or other ions. But between 1910 and 1920 came confirmation of the large quantities of water and other adequate solvents of metals (such as ions of chlorine and fluorine) in the gases given off by certain carefully observed volcanoes, notably those of Hawaii (A. L. Day and E. S. Shepherd, 1913) and Katmai, Alaska (C. N. Fenner, 1920; E. G. Zies, 1924). Thereupon the viewpoint had to be abridged that excluded completely the role of solutions and ions of deep origin, probably related to deeply buried molten lavas; *i.e.*, "magmatic." The volcanic data combined with physicochemical inferences strongly supported the "hydrothermal" school of economic geologists represented by Waldemar Lindgren, J. H. L. Vogt, W. H. Emmons, J. E. Spurr, Paul Niggli and Hans Schneiderhoehn, who derived both ores and their transporting solutions in large part from magmatic sources.

By 1950, however, there was discernible a swing of the pendulum toward a modified lateral secretion idea, advanced in England by the writings of H. H. Read (1939), in the U.S. by those of G. E. Goodspeed (1952), in Australia by those of C. J. Sullivan (1948) and in France by those of R. Perrin and M. Roubault (1939), all of whom suggested or hypothesized that some of the granitic rocks of the earth's crust may be remelted or recrystallized sediments. These or their followers inferred that during granitization, ore minerals may be generated or transferred. Even Niggli thus explained some of the "alpine" mineral deposits. This concept sought to derive the metalliferous minerals for the most part from deeper crustal or subcrustal sources, rather than from local masses of molten rock, and to attribute mainly to heat gradients and ionic diffusion the movements of the metal ions essentially to their present sites. If this process is effective, the ionic radii of the metallic elements concerned may well be a modifying factor.

Certain ore deposits were regarded by Vogt, A. P. Coleman and others as magmatic segregations. The minerals composing these were attributed to separation from the molten rock as a result of partial or complete immiscibility with the other rock constituents. Such ore minerals are generally sulfides or oxides of base metals (such as iron, chromium, copper and nickel) but they include native (elemental) metals of the platinum group and possibly also metallic iron. Many of the great nickel deposits (*e.g.*, Sudbury in Ontario, Petsamo in Finland), most of the known chromite deposits (Selukwe in Southern Rhodesia, the Stillwater deposits in Montana), probably many of the iron deposits made up of the mineral magnetite (Fe_3O_4) whether with or without titanium (as at Kiruna in Sweden, at Tahawus in New York and elsewhere) are generally regarded as of this origin. The original concentration of the platinum in the rocks of the Ural mountains of the U.S.S.R. is best explained in this manner. For some deposits of this general type the origin appears to be a separation in place of the ore from the gangue minerals, such as the feldspars, quartz, olivine, the micas biotite and muscovite or the amphiboles or pyroxenes—the major constituents of the once molten (igneous) rocks that contain the ores. For others (*e.g.*, Kiruna) studies seemed to show that a melt, unusually rich in ore minerals, was separated at depth and subsequently emplaced as a melt, injected into the containing rock after the latter had itself undergone injection and solidification.

Some ore deposits are closely related to intrusions of apparently molten rocks in the sense that they occur in or near such rocks, as a more or less continuous halo around the now solid mass. Such a melt has lost some of its more volatile constituents in the crystallization process (a theory developed by Niggli, Fenner and others), and the volatile matter moved into the adjacent, unmolten rock, usually a limestone or at least generally a rock carrying appreciable quantities of carbonates such as dolomite or calcite. The volatiles reacted with the rock surrounding the igneous intrusion, giving a halo, made of "skarn" or tactite in which the ore minerals may be concentrated. Once interpreted as the effect of mere recrystallization of the materials present in the surrounding limestone or other sediment (W. L. Uglow, 1913) but later recognized as the result of a reaction between intruding and intruded rock, such deposits have been called "contact metamorphic deposits" (the pyrometasomatic deposits of Lindgren). (*See* also GEOCHEMISTRY; METAMORPHISM; PETROLOGY.)

None of the concepts outlined above is contrary to the nonmagmatic origin of certain clearly sedimentary ore deposits, such as the iron ores of eastern Britain, those of Belgium, Lorraine and eastern France (minette ores), those of the Clinton type in the eastern U.S., and of the Wabana district in Newfoundland. The widespread banded iron ores existing in the older (Pre-Cambrian) rocks of the Crimean region (Krivoi Rog) in the U.S.S.R., and other similar ores of India, the Lake Superior region in North America, the Labrador and Ungava regions in Canada and the Pre-Cambrian terrains of Venezuela and Brazil are likewise clearly sedimentary, as are the great bedded manganese deposits of Nikopol and Chiatouri in the Ukraine and Georgia, U.S.S.R. Sedimentary ores are formed by decay of surface rocks, which contribute the necessary ions to the lakes or the sea, where they may be precipitated by evaporation, chemically or biochemically (by action of bacteria, algae or the like). Evaporation has contributed important salt and potash beds in various regions but seems to have had little part in the formation of ore deposits. Streambed or marine deposition may also take place mechanically, yielding placer deposits if the minerals concerned are sufficiently resistant to the chemical attack of the atmosphere and to impact when carried as particles by streams. Placers of world importance are the titanium-bearing beach sands of Travancore, India; the gold-

bearing stream gravels of the Sierra Nevada and Western Australia; the platinum gravels near Sverdlovsk on the eastern slope of the Ural mountains and those of Colombia; and possibly the gold-bearing conglomerate beds of the Witwatersrand, South Africa. (*See* also SEDIMENTARY ROCKS.)

Despite much discussion as to the derivation of the metallic ions in ore deposits (whether from country rock or magma) and their mode of transfer (whether in solution or by diffusion), the general grouping of the resulting deposits is fairly clearly defined and agreed upon, as a result of collective efforts through more than a century by many mineralogists, petrologists and economic geologists. The classes now generally recognized were perhaps best defined by Lindgren (1913), who separated all ore deposits into magmatic segregates, contact metamorphic deposits, pegmatites, veins and veinlike deposits of differing degrees of intensity in temperature and pressure (hypothermal, mesothermal, epithermal) and sedimentary deposits. For completeness these classes were modified, in part by subdivisions, and additional kinds of origin were recognized. Lindgren and those previously listed as sharing his views, as well as many later investigators, regarded the magma as containing the metallic ions of the ore minerals while deep down in the crust; the mass, while crystallizing there, loses its volatile constituents; these pass off, chiefly upward, depositing the ore minerals in pre-existing openings, or "fluxing" their way upward by dissolving the superincumbent rocks and finding room for ore deposition by a replacement or metasomatic process (*see* METASOMATISM). Highly concentrated solutions of volatiles, localized in the igneous rocks from which they separated, give, according to this school, the pegmatite veins or dikes that are of much importance as sources of nonmetallic minerals (mica, gems, etc.) and at times of elements useful in the metal industry (*e.g.*, beryllium).

A fundamental basis for the classification given above is the temperature of formation of the ores. By observing the behaviour of the inclusions in the ore minerals as the temperature is raised (W. H. Newhouse, 1933); by recording the temperatures at which certain minerals in the ore deposits break down when heated (the "decrepitation temperature," F. G. Smith, 1947); by a comparison of textures suggesting the unmixing of solutions at known temperatures; and by means of basic data on inversion temperatures of the minerals present, attempts have been made to set exact limits governing the origin of these deposits. Such evidence, though useful, is admittedly still inconclusive and, like the theories for the genesis of individual deposits, is constantly undergoing revision.

A very striking feature of the primary mineralization of ores is the fact that the contents of a given ore deposit may change upward or laterally. In the tin deposition of southwestern Britain (Cornwall) an ore body which at depth yields chiefly tin-ore minerals, may pass upward into a predominantly cupriferous ore, and at the surface become essentially a zinc or lead deposit (W. R. Jones, 1925). The central, copper-rich part of the Butte, Mont., mining district passes laterally into silver-bearing zinc ores and these give way to silver-bearing manganese veins and even into galena-bearing ore bodies (W. H. Weed, 1897; R. H. Sales, 1908). In fact, L. de Launay (1900), Spurr (1907) and W. H. Emmons (1924) developed in detail the sequence of mineralization from deep to shallow deposits which can be traced through the following ions: tin, tungsten, arsenic, copper, zinc, silver, lead, antimony, mercury; the position of iron and gold, among the common metallic ions, is varied and anomalous. A somewhat similar effect, extending also to certain gangue minerals, is noted with contact metamorphic deposits (V. M. Goldschmidt, 1911; Spurr, Fenner, G. H. Garrey, 1908, 1912). Such compositional changes are called zoning.

Secondary Changes in Primary Ores.—The processes described above yield the ore minerals as freshly deposited (primary), before being acted upon by atmosphere or cold surface waters, circulating downward. Most common primary ore minerals are sulfides or oxides; some are tellurides, native metals, carbonates, silicates or sulfo salts (double salts of the metal sulfides and sulfides of arsenic or antimony). Some of the minerals carry only one metal (*e.g.*, pyrite, FeS_2); others carry two or more metals (*e.g.*, stannite, Cu_2FeSnS_4).

Examples of the More Common Primary Ore Minerals

Iron		Copper		Silver	
magnetite	Fe_3O_4	native copper	Cu	native silver	Ag
hematite	Fe_2O_3	chalcopyrite	$CuFeS_2$	argentite	Ag_2S
limonite	$Fe_2O_3 \cdot nH_2O$	bornite	Cu_5FeS_4	polybasite	$Ag_{16}Sb_2S_{11}$
siderite	$FeCO_3$	chalcocite	Cu_2S	proustite	Ag_3AsS_3
		tetrahedrite	$Cu_8Sb_2S_7$		
		enargite	Cu_3AsS_4		
Aluminum				Gold	
bauxite	hydroxides	Zinc		native gold	Au
alunite	$KAl_3(OH)_6(SO_4)_2$	sphalerite	ZnS	calaverite	$AuTe_2$
				sylvanite	$(AuAg)Te_2$
cryolite	Na_3AlF_6	Lead			
		galena	PbS		
Tin					
cassiterite	SnO_2	Nickel		Mercury	
stannite	Cu_2FeSnS_4	pentlandite	$FeNiS_2$	cinnabar	HgS

After such primary ores are formed, the surface is slowly lowered by processes of weathering and erosion. At and near the surface, these processes act upon the ore minerals as upon other rock materials; in fact, even at some depth these minerals are attacked by waters, which, moving downward from contact with the air, transport oxygen, carbon dioxide and other materials in solution Under these conditions the oxides and native metals are generally stable. The other minerals, however, tend to be converted to relatively soluble compounds. This applies especially to the sulfides, which, for the most part, become highly soluble sulfates. Copper sulfides become soluble copper sulfate which generally travels farther down with the descending ground water. Below the level of saturation, however, the oxygen supply to this water is cut off, reducing conditions prevail (especially in the presence of more sulfides of the primary ore, together with the sulfuric acid in the water), and eventually the copper tends to precipitate out as sulfides, such as chalcocite and covellite (CuS). This is characteristic of the zone of secondary sulfide enrichment. As this precipitation is greatest where the descending copper-bearing solutions first come into the zone of reduction, the effects of such reprecipitation of copper taper off downward. If, however, the downward moving, acid waters, while still above the zone of saturation and reduction, encounter a reagent (*e.g.*, the calcium carbonate of a bed of limestone) that neutralizes the acid, a reaction takes place which throws down the copper (generally by replacement) as a copper carbonate, the calcium ions traveling on in sulfate solution; in siliceous rock, the copper may similarly be precipitated as a silicate; or, in the presence of a strong oxidizing agent, the copper may precipitate as copper oxides or native copper. These minerals characterize copper deposits in the near-surface zone of oxidation.

If gold or its compounds occur in the primary ore, the relatively unstable telluride compounds are broken down into metallic gold, and the insoluble gold is concentrated in the oxide zone except in the presence of manganese dioxide and chloride compounds, which together yield the strong solvent, Cl^-.

Iron sulfides on oxidation yield sulfuric acid and the unstable ferrous sulfate. The latter is oxidized to ferric sulfate which then hydrolizes to ferric hydroxide, and eventually a precipitate of limonite or a related mineral is formed. In general, zinc sulfide behaves like copper but primary sulfides are more soluble. Lead sulfide, however, oxidizes rather easily to the poorly soluble sulfate (cerussite). Silver minerals behave like copper minerals but may be stabilized in the zone of oxidation if there are halogens present. Manganese resembles iron in reactions.

A special kind of change in primary ores is summarily described as residual concentration. In this, the effect of solution (leaching) by surface waters in the zone of oxidation is to dissolve and remove the gangue minerals, and in cases to stabilize the desired metallic ions still further. Thus relatively small quantities of iron carbonate in a limestone (composed of $CaCO_3$) may be converted to limonite; meantime the limestone is dissolved, if the surface water is rich in atmospheric carbon dioxide, approximately thus:

$$CaCO_3 + H_2O + CO_2 \rightarrow Ca(HCO_3)_2.$$

If the iron content of the limestone was originally only 5%, the removal of all the limestone by solution would yield natural iron ore bearing about 48% iron. Such a process is facilitated by moisture, the presence of vegetation (yielding the solvents humic acids and carbon dioxide), a warm climate (to accelerate the reaction and to permit plant growth), good drainage (at least, periodically, as in a climate with dry and wet seasons alternating) and a topography high enough to promote drainage but not so high that most of the rainwater will run off instead of penetrating to do its important chemical work at the surface and just below it. Examples of such concentration are the secondary manganese ores of Ghana; the bauxitic aluminum ores of the Guianas; the residual iron ores of Cuba; and the gold ores of the southern Appalachians, U.S. Inimical to such a process is everything that strips the soil rapidly, such as glaciation or rapid erosion. As applied to the marked enrichment in gold, this process is called eluviation; when applied to iron, manganese and aluminum ores, it is lateritization and the resulting ore is called laterite.

A table, illustrative rather than complete, is included to show the changes in the composition of ore deposits after oxidation and secondary sulfide enrichment.

Depth Zone Below Surface

Metal	Zone of oxidation	Secondary enrichment zone	Primary ore
Iron	$Fe_2O_3 \cdot nH_2O$ (limonite) Fe_2O_3 (hematite)		$FeCO_3$ (siderite) FeS_2 (pyrite) Fe_3O_4 (magnetite) Fe_2O_3 (hematite) Iron silicates
Aluminum	$Al_2O_3 \cdot H_2O$ (diaspore) $Al_2O_3 \cdot 2H_2O$ (bauxite) $Al_2O_3 \cdot 3H_2O$ (gibbsite)		Rock-forming minerals such as clay minerals, feldspars, etc
Manganese	MnO_2 (pyrolusite) $Mn_2O_3 \cdot nH_2O$ (psilomelane) etc		$MnCO_3$ (rhodochrosite) Manganese silicates
Copper	Cu (native copper) Copper oxides Copper carbonates Copper silicates	Copper sulfides, especially Cu_2S (chalcocite), CuS (covellite)	$CuFeS_2$ (chalcopyrite) Cu_5FeS_4 (bornite) Copper sulfo salts
Zinc	$ZnCO_3$ (smithsonite) $ZnSiO_3$ $Zn(OH)_2$ (hemimorphite)	ZnS? (wurtzite?)	ZnS (sphalerite)
Lead	Residual galena $PbCO_3$ (cerussite) $PbSO_4$ (anglesite)		PbS (galena)
Silver	AgCl (cerargyrite) and other halides Ag (native silver)	Ag_2S (argentite)	Ag (native silver) Ag_2S (argentite) Silver sulfo salts Silver tellurides
Gold	Residual native gold		Ag, Au (electrum) Au (native gold) Gold tellurides

This sequence of alteration may greatly complicate the richness of the ore at changing depth Many of the disseminated copper ores (*e.g.*, Bisbee, Ariz., and Chuquicamata, Chile) are of moderate richness at the surface, where the once-exposed primary ores have had some of their copper and other components removed; at depth, however, in the zone of secondary sulfide enrichment, they become richer, the tenor (grade) rising to perhaps twice the figure for the surface zone. At still greater depths the ore values decline to perhaps half those of the oxidized zone and the metal content may decline from a useable ore to a protore, unprofitable today but perhaps workable in the future after natural enrichment takes place or cheaper working methods are developed or copper prices rise. Abrupt differences in the vertical level of these three zones may result horizontally from movement along fault planes or differences in surface conditions affecting ingress of surface waters, drainage or the like.

Forms, Structures and Textures of Ore Deposits.—In the past, ore deposits were also classified on the basis of form, or other large-scale features, collectively spoken of as structure, but it appeared later that this was not a feature fundamental to genesis and such classifications were abandoned. None the less, the form of a given ore body is of great practical importance in the search for ore extensions or for analogous bodies in near-by localities under similar geologic conditions. Thus, in the early half of the 20th century, stress came to be placed upon the geologic structures (faults and folds in the rocks or dikes [*q.v.*], sills [*q.v.*] and larger intrusions of igneous rocks) that might be the cause for localizing the ore or have exercised structural control on ore deposition. This school of investigators, among whom Canadians such as M. E. Wilson and E. L. Bruce, South Africans such as Ben Lightfoot and Americans such as B. S. Butler and G. M. Fowler merit mention as leaders, stressed the geologic structure rather than the mineralogy of the ore or the country rock—a natural outgrowth of the more intensive search for ore prevailing in a period of very abrupt rise in consumption rate.

The simplest types of ores from the structural viewpoint are the bedded or stratiform ores. In the strictest sense these consist of ore minerals deposited like any other sediment. If not too greatly deformed they may exhibit intertonguing, channeling, fading out, gradation of grain, ripple marks, fossils and other features of sedimentary rocks. They may be intensely folded, as shown by the Pre-Cambrian iron ores, or suffer thrust or normal faulting, like the minette iron ores of western Europe or those of the Clinton belt in the U.S. Among special types of sediments are the placer deposits already mentioned. The forms and other features of placers particularly resemble those that go with coarser clastic sediments, such as cross bedding and channel deposits. Concentration of the desired mineral may be in the inside of the meanders, the slipoff slope of bars or the lowest part of the bed, yielding accumulations that are locally especially rich (the "pay streak"). If deposition of ore minerals is by replacement of soluble minerals or by filling of pore space in a given stratum, the appearance of the ore may suggest a sedimentary deposit, even though ore deposition was much later than sedimentation. A special case is penecontemporaneous replacement, by which, apparently while falling to the sea bottom or shortly thereafter (during the solidification of a given sediment), such rocks as the limestones may have some or all of their constituents replaced by iron compounds.

Many ore deposits are apparently simple fissure fillings (fissure veins), transverse to pre-existing rock structures (*e.g.*, bedding) or parallel to them, as in bedded veins. If the former, they may indicate planes of shear or of tension, depending on their relation to the tectonic history of the region, which thus becomes of special interest. In closely studied districts (*e.g.*, the Erzgebirge, Saxony; the Mother Lode and Grass valley, California; and Braden, Chile), both the opening and the mineralization have proved to be repeated. This may well account, at least locally, for the wide veins of certain mining districts; other explanations for such veins include (1) a dense, essentially viscous and meltlike mineralizing solution (Spurr's "ore magma"); (2) an opening standing several feet wide, gradually filled with ore that crystallized from dilute solutions; (3) replacement (*e.g.*, solution of the country rock, with simultaneous deposition of the ore minerals) rather than open-cavity filling. Fissure fillings include such distinct types as ladder veins, small fissures between two or more bordering fractures; gash veins, several small fissure veins frequently overlapping; sheeted zones, many smaller subparallel veins making up a compound vein that is large but not simply one fracture; saddle reefs, veins in openings where beds separate at the crests and troughs of folds; zigzag veins, the direction or inclination changing as differing rock types are crossed; thinned or thickened veins, the changes taking place in a vein where it crosses from one rock type to another; breccia veins, with numerous fragments of the country rock in the plane of the vein and partially embedded in the vein material; an ore "pipe" or "chimney," a body of ore saturating and cementing a shattered rock mass and having one long dimension and two lesser dimensions. Larger fissures commonly break up into many smaller ones at their ends—upward, downward or laterally. Much attention has been given to the causes for the various forms of fissure veins.

Irregular forms include ore bodies apparently resulting from the filling of irregular caverns (though such cases are probably few); from the segregation of ore within an igneous mass in place; or from replacement, the simultaneous solution of country rock and deposition of ore, especially where ore solutions react with the country rock, as where a granitic rock is irregularly replaced by copper-iron sulfides (*e.g.*, the main ore body disseminated through the granitelike mass at Bingham, Utah) or where a lime-

stone or dolomitic (magnesian) limestone is replaced by irregular masses of zinc and lead sulfides, with diameters ranging from microscopic to tens or even hundreds of feet. Several genetically different classes are thus included among the ore deposits of irregular form. There is not uncommonly a gradation from a fissure vein to an irregular body as a fissure vein enters a rock readily attacked by the ore solution.

The textures of ore bodies are their more minute characteristics. Thus, sedimentary ores are commonly oölitic, with particles like the *Bohnenerz* (bean ore) of many sedimentary iron ores; their texture consists of small spheres, frequently concentrically banded, up to half an inch but generally much less in diameter. A similar feature, though on a larger scale, is common in oxidized ores as in the beautiful concentric (botryoidal, mammillary) banding of head-sized masses of the bright green basic copper carbonate malachite. Such features, especially if characterized by syneresis (dehydration cracks), are regarded by many as evidence of colloidal deposition, hence called colloform textures.

A mineral in a replacement ore may have the crystal form of the preceding (host) mineral and is then known as a pseudomorph of the later. Fillings in open spaces are likely to show a sequence of mineral deposition, the first minerals formed being nearest the wall rock; the centre may remain unfilled. Studies of these and other textural relations yield an idea of the sequence of mineral formation or paragenesis. From 1920 onward, the reflecting (metallurgical) microscope (*q.v.*) proved a valuable tool not only to identify opaque ore minerals but also to study and interpret their microscopic textures in terms of their paragenesis and their origin. (*See* also MINERALOGY.)

In addition to picturing the larger or smaller features of an ore, the attitude and position of an ore body must generally be described, to aid the mining engineer or miner in extracting it. In the case of irregularly shaped ore bodies, this is generally a matter of citing detailed measurements in many places. Alternatively, a series of sections across the ore body may be presented or a three-dimensional model may be prepared by mapping successively deeper levels on glass planes supported in a frame, or by making a plastic or wooden model.

For tabular ore bodies, such as bedded ores or simple fissure veins of some size, the nomenclature of description is like that applied to a stratum by the geologist. By definition, the strike of a tabular vein or ore bed is the direction in azimuth of the line marking its intersection with a horizontal plane; the dip of the plane of the vein or bed is its angle of inclination measured from the horizontal down the slope of the plane and normal to the strike. (*See* FAULT.) A fissure vein may thus be said to strike N. 20° E., with dip 50° S.E., its attitude being thus defined.

Within an otherwise barren fissure vein there may be a richer part, the shoot. If large, the ore shoot is a bonanza, if small, a pocket. If dimensions are given for such shoots, the longest measurement in the horizontal plane is the stope length ("stope" being the cavity ultimately left when the ore body has been mined out), the longest dimension directly down dip is the stope depth and the smallest in the horizontal plane is the stope width or thickness. If the ore body is chimneylike, cylindrical or relatively long for its width, the miner may refer to the dimension down dip along its longest axis as the pitch length.

Exploration for Ore Deposits.—Ore deposits are sought by means of three related methods—geological, geophysical and geochemical. Geological exploration is dependent upon a knowledge of the basic geology of the terrain in which the ore is being sought. This may be carried to varying levels of detail. For example, if exploration were contemplated in Mexico, general geologic facts and previous experience indicate that search for copper might be pursued with best hope for success in the northwestern part of the country, especially in Sonora; search for lead and zinc in the Mesa Central or the Sierra Madre Oriental; and for precious metals in the andesitic lavas of the canyon region, designated by some the Sierra Occidental. Thus are defined certain metallogenic provinces, characterized by ores rich in a specific group of metals, as though the deeper, molten part of the earth in each province had distinctive components. The ancient rocks of the Pre-Cambrian shield of eastern Canada bear little zinc or lead but have produced much gold, nickel and copper, suggesting, by this linkage of their age with certain metals, that specific ore types characterize certain periods of the earth's history, distinguishable as metallogenic periods; this concept can be applied also to sedimentary ores such as the siliceous banded iron ores which are virtually confined to the Pre-Cambrian.

The problem may, instead, be one of greater detail. When reason to expect ore in a small area or a mine exists, where shall search be especially pressed? Placer gold may be followed upstream till it stops; the outcrop of the vein from which it was derived should be on the stream bank or in the drainage basin near at hand. Principles of structural control may be used; given ore-bearing fissures, the richest and largest shoots are generally near intersections of two fissures. If present along a vein, ore is commonly found where strike or dip changes abruptly. Ore is common in smaller folds above dome-shaped intrusions. It is generally richest where a mineralized vein passes from shale to limestone, especially under capping beds of shale or other impervious or insoluble rock.

With progressive exhaustion of ore bodies that crop out, methods are continually sought by which subtler criteria can be used to find buried ore. The surface residue, especially the limonitic outcrop (gossan, "iron hat"), has been studied (Augustus Locke, Roland Blanchard, P. F. Boswell, 1926 *et seq.*) in an attempt to establish colours, textures and the like characteristic of the deeper, primary ore; also gossan is analyzed for traces of deeper elements. Alteration halos marking changes produced by solutions accompanying ore deposition have been recognized for some time as clues; these halos are distinguished by their predominant minerals—tourmalinization, albitization, epidotization, sericitization, kaolinization, sideritization and dolomitization. Special types are greisenization (bleaching and sericite development in an alkali-rich igneous rock), propylitization (the development of certain greenish minerals in intermediate to basic igneous rocks) and the widely distributed development of claylike minerals (argillization, T. S. Lovering, G. M. Schwartz and P. F. Kerr *c.* 1944) and of silica (silicification) which received particular attention after 1940.

Geophysics affords methods also increasingly useful. Many iron ores and some others are magnetic; the compass and dip needle (a vertically suspended magnetic needle) have been used for over a century in search of such ores. Modified forms of such instruments (the "flying magnetometer") are flown over promising terrain. Electric methods depend largely on the electric potential developed as ore bodies oxidize. Conductivity of ore minerals, generally higher than that of gangue, is studied with the aid of sensitive current measurements. Gravity anomalies may be a guide to ore. Uranium-rich ores give counts with a Geiger counter, and many ores, especially those of tungsten, fluoresce with characteristic colour and may thus be sought in the dark.

Tools developed by mid-20th century were geochemical ones. Careful analyses give evidences of ore by traces of the ore elements, whether the traces are in the rock outcrop, the residual soil or in growing plants rooted in that soil, or in water draining across it.

These methods have as their object narrowing down the area to be explored. Once thus narrowed, the area may be explored at depth by drilling with auger, churn drill or diamond drill, by pit-hole sinking, tunneling or shaft sinking. Diamond drilling furnishes a solid cylindrical core (if recovery is good), which can be geologically studied and provides a sample for chemical analysis as well. (*See* GEOPHYSICAL PROSPECTING; MINE PROSPECTING AND DEVELOPMENT.)

Evaluation of Ore Deposits.—Geologists and mining engineers are required at times to evaluate an ore body, quite aside from the equipment that may be on the ground. For this purpose the deposit must be sampled, usually by making a cut into a clean face of typical ore and analyzing (assaying) the material thus obtained. Systematic, large-scale sampling repeats the process at regularly spaced intervals and seeks a weighted average to obtain the grade of the ore. The total volume of the ore is then computed

using measured or inferred dimensions. The specific gravity of the ore is obtained, the weight per unit volume determined from this and the total tonnage derived by multiplication. The case is simple if the ore body is a tabular one, such as a simple vein of fairly constant thickness, or a replacement body in a stratum, or a sedimentary ore bed. For such cases E. F. Burchard recommended the formula:

$$\text{Total tonnage} = \frac{\frac{1}{2}(T+t) \times L \times D \times R}{\text{cu.ft. per ton}}$$

in which T is average thickness of ore bed (or vein) at outcrop, t is minimum workable thickness, L is length of outcrop, D is distance from outcrop at which thickness of ore becomes t and R is the percentage of recoverable ore. In complex ore bodies changing in richness and volume from place to place, the body is divided, for the purpose of computation, into geometrical units small enough to be essentially constant in width, thickness and composition; the tonnage and grade of each such unit is then separately determined to give a total for the deposit as a whole. The most comprehensive estimates require consideration of such diverse factors as future metal prices, rates of exhaustion (depletion), probable tax assessments, mining, milling and transportation costs, and even such matters as labour sources, pertinent tariff policies and political and economic stability of the country where the mining is to be carried out.

Special attention in the 20th century has been given to the role of mineral deposits in international affairs and in the economics of development, and much literature deals with this broad subject.

See also NATURAL RESOURCES: *Minerals* and articles on individual minerals. *See* also references under "Ore Deposits" in the Index.

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ORE DRESSING is the art of treating crude ores and mineral products by mechanical means to separate the valuable minerals from the worthless constituents in the crude material. The term "ore dressing" at one time referred only to processes employed in treating ores containing valuable metals such as gold and silver, but as these processes were applied more and more to the recovery of nonmetallic minerals it was also used to describe the methods for treating such materials as graphite, sulfur, mica, feldspar, asbestos and fluorspar. The term "mineral dressing" is becoming widely used instead of "ore dressing" because of its broader meaning. Usually the two terms are considered to be synonymous, but sometimes mineral dressing is intended to include other branches of metallurgy and coal preparation whereas ore dressing always refers to methods of separation of solid inorganic minerals from each other without effecting substantial chemical changes.

The need for ore dressing to produce enriched products or concentrates from low-grade ores arises from the fact that most metals and valuable minerals do not occur in nature in such a form as to be usable directly. The common base metals copper, lead and zinc seldom comprise more than a few per cent of the total rock from which they must be extracted and usually occur combined chemically with other elements. These metal-bearing compounds must eventually be subjected to a chemical treatment to break up the chemical union and liberate the metallic elements. The processes employed to accomplish the chemical separations are expensive as a rule, and the cost depends largely on the bulk of material treated. Thus it would cost as much to smelt a ton of copper ore containing 1% copper as to smelt a ton of concentrated copper ore with 30% copper, and the amount of copper produced in the first case would be only one-thirtieth as much as in the second. It is economically impossible to smelt a copper ore of 1% but, by using relatively cheap ore-dressing processes to make 30% copper concentrates for smelting, the 1% ore can be utilized economically.

Ore dressing is the first process which most ores undergo after they are dug from the ground. It may consist of very simple operations such as washing with water and hand sorting to select the richer ore pieces, or it may involve much more complicated processes using elaborate equipment to effect the separations desired. The primary operations in ore dressing are crushing and grinding (comminution) and concentration, but there are many other important operations involved in modern ore-dressing plants, such as sizing and classification, settling and filtering, drying and heat treating, and agglomerating or pelletizing.

Crushing and Grinding.—Some ores occur in nature as mixtures of separate mineral particles that are not attached to each other and require no crushing or breaking apart. Examples of this type of ore are the placer deposits found in stream and gravel beds where the ore mineral is native gold or perhaps precious stones such as diamonds or emeralds, or perhaps it is simply gravel to be utilized in concrete highways. These materials are mined and the valuable constituent concentrated directly without crushing, but, important as the minerals found in such condition may be, they represent only a small portion of the ores treated throughout the world for their mineral content. By far the greater part of the ores mined consist of hard and tough rock masses that must be crushed to free the valuable minerals. This operation sometimes includes the breaking down of the ore from huge boulders to fine powders, depending upon the fineness of dissemination of the mineral particles.

Comminution of ores is customarily done in three steps: primary or coarse crushing, secondary or fine crushing, and grinding. Primary crushing is usually accomplished with jaw or gyratory crushers. Secondary crushers are numerous, the more commonly used ones being rolls, cone crushers and rod mills. These machines customarily receive rock one to three inches in size and reduce it to about one-fourth or one-eighth inch.

There is little difference between grinding and crushing except that crushing usually refers to breaking coarse material, and grinding applies to relatively fine material. Originally grinding referred to that method of comminution which involved a heavy object being dragged or rolled over the material being ground. Mortar and pestle grinding is an example of this type of grinding, and there are still some of the early-type commercial machines in use that employ this principle. Modern ore-dressing plants almost always employ rotating cylindrical mills for fine grinding. A mill containing iron or steel balls for the grinding medium is called a ball mill; if it contains rods it is called a rod mill, and if it contains lumps of rock, ore or flint pebbles it is a pebble mill. These mills may be operated either wet or dry depending on the character of the ore or subsequent ore-dressing processes to which the ore is to be subjected.

For descriptions of the various crushing and grinding machines and their use *see* CRUSHING AND GRINDING MACHINES.

Concentration or Benefication.—The act of separating the valuable minerals of an ore from the worthless or undesirable matter (gangue) into one or more enriched or concentrated products is called concentration or benefication. In ore dressing this is possible because of the difference of certain properties of the mineral particles. The simplest form of concentration is hand picking, which is used occasionally in modern plants to remove either rich material or waste material by hand from a moving table or conveyor belt. This operation employs the difference in colour or lustre of the lumps of rock so that the picker may distinguish the wanted from the unwanted material. Differences in the density of minerals permit separation by various methods of gravity concentration; magnetic properties are the basis for separation by magnetic methods; electric properties govern the electrostatic separation of minerals, and surface properties are used to effect the almost magic separations accomplished by flotation.

The feed to a concentration process consists of ore crushed and ground to a suitable size and is called the heads. The enriched product derived from the process is known as concentrates, and the waste or unwanted material is called tailings. A third product of the concentration treatment may be produced which requires further treatment before it can be resolved into concentrates and tailings. This product is called a middlings and, theoretically at least, consists of valuable and gangue minerals which are still locked together. When such a fraction is produced it is returned to the grinding equipment for further comminution and retreatment.

In addition to the simple process of hand picking there are other seemingly crude but effective methods of concentration which are widely used throughout the mining industry. For example, many ores such as those containing nodular manganese and iron minerals occur in a matrix of clay. Often the manganese and iron nodules require only washing with water and vigorous agitation to separate them from the soft clay. This results in greatly enriched concentrates which may be utilized by the iron and steel industry. Another simple concentrating device is an ordinary screen which may be used on many ores where the valuable mineral is either finer or coarser than the size of the openings in the screen. The hardness of minerals is sometimes utilized to effect separations by screening. This may be accomplished by first grinding the ore in a ball mill so that the softer minerals are differentially ground, and the harder minerals almost retain their original size. Simple screening of the differentially ground material results in the production of concentrates of the harder mineral on the screen while the softer material goes through the screen.

Gravity concentration processes have been practised by ore dressers to obtain mineral concentrates from the earth throughout the history of mankind. Probably the first gold ever seen by man was obtained from some ancient stream bed by some form of panning that was not much different from that used by prospectors in modern times. The miner's gold pan is simply a device to concentrate heavy minerals in the bottom of the pan while the lighter, worthless minerals are washed off the top. (*See* Gold.) The mechanical jig is a development of the gold pan that utilizes the faster settling rate of heavy minerals through a semistationary bed of crushed ore in water. Essentially a jig is an open box with a perforated bottom through which pulsating water currents are forced. Crushed ore fed into the top of the box is stratified by the action of the water currents, with the heavier minerals settling to the bottom. If the heavy minerals are fine enough, they pass through the perforated bottom and are discharged intermittently through a spigot. If they are too coarse to pass through the perforations, they are removed continuously through a cup or pocket on top of the perforations.

Shaking tables are gravity concentration devices used to treat material too fine for jigging. They consist of a tablelike surface inclined slightly from the horizontal and are operated with a reciprocating action that shakes the table in the direction of the long axis. Fine ore and water are fed to the upper corner of the table and flow across the deck which has shallow riffles running the full length of the table. The reciprocating action of the table causes the heavy minerals to move to the end of the table, while the lighter minerals are washed by the water over the side of the deck. Shaking tables are called sand tables or slime tables, depending upon the size of the material that they treat.

Heavy-medium or sink-float separation processes are concentration methods that depend on the buoyant power of suspensions of fine heavy solids in water. Separating vessels are usually in the shape of a stationary cone, a revolving drum or a stationary tank with a revolving screw conveyor to remove the concentrates. The vessel is filled with a mixture of finely divided particles of some heavy material such as ferrosilicon, magnetite or galena and water. The mixture acts as a fluid with an apparent specific gravity lower than that of the mineral to be concentrated but higher than that of the gangue minerals. Crushed ore fed into the liquid-solid mixture separates into a sink or heavy product and a float or light fraction. The sink product is removed continuously from cone separators by pumps and from drum and screw separators by means of suitable conveyors. The float product overflows the top of the vessel in which the separation is made and both products are separated from the heavy medium by screening and washing with water. The treatment is applicable only to ores coarser than about one-eighth inch because of the relatively high viscosity of the heavy medium. The settling rate of fine particles in a viscous liquid or suspensoid medium is too slow to permit rapid separation, and other gravity concentration methods must be used for the finer portion of an ore.

Gravity concentration processes for treating fine sands include spiral separation which employs a spiral trough with a curved bottom. When fed with a water-sand mixture, the dilute pulp flows by gravity from the top of the spiral to the bottom. The lighter minerals, usually quartz and feldspar, are more easily suspended by the water and are washed to the outside of the spiral, while the heavier particles tend to cling to the bottom and inside of the trough. Ports or outlets are spaced along the bottom of the spiral for removal of heavy concentrates while the lighter tailings are discharged at the lower end of the spiral. Shaking tables accomplish the same separations that spirals do, but require more floor space and have more moving parts. Hydrocyclones, also known as Dreissen cones or Dutch State Mines cyclones, may be used in conjunction with a heavy-medium suspension to effect separations of heavy minerals in fine sizes. The hydrocyclone consists of a cone-shaped vessel in which a separation is made based on the principle of the vortex. A dilute ore pulp is pumped tangentially into the cone near the top with a heavy medium and the heavier ore particles find their way to the bottom of the cone while the lighter gangue minerals are removed at the top.

The foregoing processes involve concentration of ores with water, but there are equivalent processes employing air as the separating medium. Pneumatic jigs and tables operate on the same principles of gravity separation as wet jigs and tables but find use in desert regions where water is scarce and on ores that are best treated dry, such as asbestos, which depends upon the light, fluffy nature of the mineral for efficient concentration.

Magnetic separation is an efficient means for concentrating many minerals which contain iron. The mineral magnetite is both heavy and strongly attracted by a magnetic field and may be separated from its gangue minerals by either gravity concentration or magnetic methods, but magnetic separation of magnetite is so highly efficient that it is almost invariably used to concentrate the mineral rather than other, perhaps less complicated, processes (*see* Iron and Steel Industry: *Iron Ore*). Originally dry magnetic pulleys were the only separators used for concentrating magnetite, but wet separators were found to produce much richer concentrates.

Minerals such as garnet, ilmenite, wolframite and hematite are not as strongly magnetic as magnetite but are sufficiently attracted by a powerful magnetic field to permit separation from completely nonmagnetic minerals such as quartz, feldspar, rutile and zircon. A number of specially designed magnetic separators were found suitable for concentrating these weakly magnetic minerals. Among them are the induced-roll separator and the crossed-belt separator, both of which are highly efficient and widely used. They differ from each other largely in the manner of conveying the ore particles through the magnetic field. The induced-roll machine utilizes a revolving roll to carry the ore stream through the field, the magnetic particles adhering to the roll while the nonmagnetic particles are thrown by centrifugal force away from the roll. The crossed-belt separator, as the name implies, consists of a conveyor belt which carries the ore through the field and a second belt crossing under a magnet above the first belt and at right angles to it; magnetic particles are attracted upward toward the magnet and are removed to the side by the traveling belt, while the nonmagnetic particles remain on the first belt and are discharged at the end of the machine.

Electrostatic separation is a concentration method that utilizes the force of an electric field to effect separations between minerals with different electrical properties. It is based on the phenomenon of attraction between unlike electrical charges and repulsion be-

tween like charges. It is particularly applicable to the separation of some nonmetallic minerals although it may be applied to metallic minerals with equal success. It is the only process that proved successful for separating zircon from rutile, these being commonly found associated in beach sand deposits.

Flotation is perhaps the most important concentration process in the mineral industry in that more ore is treated by this method than by any other. As applied to ore dressing, the process dates back to ancient times when the Greeks reportedly used feathers dipped in pitch to recover gold from the mud of a lake, but large-scale modern use of flotation did not come about until after 1924 when the use of xanthic acids, to collect metal sulfides in a froth, was patented.

The flotation process depends upon the ability of the ore dresser to wet selectively some mineral particles while other minerals remain unwetted and adhere to air bubbles which float to the surface and are removed as a concentrate in the froth. Certain minerals, such as graphite, talc and sulfur, are called self-floating because of their natural tendency to resist wetting by water, but most minerals require coating with a water repellent to render them floatable. Coating the finely ground mineral particles is accomplished by agitating the mixture of ore, water and suitable chemicals in a conditioner for a short time, during which the chemicals react with the elements at the surface of the particles to form a new surface which is more water repellent than the original surface. Minerals that naturally tend to resist wetting may be treated so that their surfaces will be wetted and they will sink in the water and not be floated with the concentrates. Flotation is most commonly used to concentrate copper, lead and zinc minerals from their ores because of the ease with which they are floated or not floated as the case may be. These minerals often occur together and the ore dresser is called upon to separate them from each other as well as from the gangue minerals. By using suitable chemicals it is possible to float copper, lead and zinc minerals selectively from each other by preventing the flotation of all minerals, except those containing lead, then floating only the copper minerals and finally only the zinc minerals. This ability of the ore dresser to modify the floatability of minerals at will made possible many seemingly magical separations that are common practice in modern mills. In fact, it can be said that any two minerals may be separated by flotation if one contains a substantial amount of one element that is absent in the other.

Sizing and Classification.—All ore-dressing concentration processes require that the ore be sized to a certain degree. Often it is the size to which the ore must be ground before the valuable minerals are unlocked that governs the process that will be used to concentrate those minerals. Machines, used to assure grinding to at least unlocking sizes, are called sizers or classifiers. Screens are perhaps the simplest devices used to size ores, and they are widely used in a variety of forms. Fixed screens, for coarse sizing, consist of parallel bars, punched plates or coarsely woven wire. Trommel screens are cylindrical screens revolving slowly about their horizontal axes; vibrating screens are plane surfaces of woven wire cloth which are rapidly vibrated by mechanical means; and shaking screens are slightly inclined plane surfaces of wire cloth shaken endwise or sidewise. All screens may be used with or without water and some modern screens are heated either by electric current or hot air. Heated screens are less inclined to become blinded by sticky material and thus have greater capacity than unheated ones. Classifiers are made in numerous forms and may be operated either wet or dry. Hydraulic classification depends upon the different settling rates in water of grains of mixed sizes. The water in a classifier may be either in motion or substantially at rest. Air classification is equivalent to the wet operation except that air is used as the medium instead of water. Centrifugal classifiers, wet or dry, are devices that utilize centrifugal force to effect separations between coarse and fine particles.

Settling and Filtering.—Settling or thickening is a term applied by the ore dresser to the process of removing water from a dilute mixture of fine ore and water so that a relatively thick pulp results. Most ore-dressing processes require large amounts of water and the resulting concentrates, and particularly the tailings, are extremely dilute. The first operation in separating the solids from the water is usually carried out in thickeners. These are large tanks in which the fine solids are allowed to settle. Chemicals are sometimes added to increase the settling rate of the solids. Feed to thickeners usually contains from 5% to 20% solids, and the discharge, which is pumped from the bottom of the thickener, varies from about 40% to 80% solids. Thickened pulps may be further dewatered by filtering. Filters for ore-dressing plants are usually rotating cylinders covered with a porous fabric through which the water is drawn by means of a vacuum. Such machines are called vacuum filters, and there are numerous other forms and types of filtering devices.

Drying and Heat Treating.—Dryers for ores and concentrates consist of some form of container and a means to apply heat to the wet material within the container. Most commonly used dryers are rotary kilns which are slightly inclined rotating cylinders with a burner at one end or the other. Wet ore is fed continuously to the upper end of the cylinder while the dry material is discharged at the lower end. Infra-red lamps are sometimes used to dry small quantities of concentrates, and many kinds of dryers have found use on special types of ores. Roasting is sometimes used in ore-dressing plants to change the form of some mineral in the ore so that it may be more easily concentrated. Roasting of pyrite, for example, to drive off sulfur and render the mineral magnetic is carried out in roasters of various types. Roasting sometimes causes a mineral to expand or decrepitate, as in the case of vermiculite which expands and spodumene which breaks into small particles, thus making it more readily separable from unaltered minerals.

Agglomeration.—Some ores, particularly those of iron, chromium and manganese, which are smelted in blast furnaces, cannot be utilized as fine particles. They must be agglomerated in some manner so as to form tough lumps of material suitable for smelting. This process, variously called sintering, agglomerating, nodulizing, pelletizing and briquetting, may be carried out by fusing the material at high temperature, as is done in sintering and nodulizing, or by mixing a binder such as starch, molasses or bentonite with the fine ore and heating or applying pressure to the mixture. *See* also AMALGAMATION; CYANIDE PROCESS; METALLURGY: *Ores and Ore Treatment.*

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OREGON, popularly called the "Beaver state," is one of the northwestern states of the United States. Its capital is Salem. Oregon is bounded on the north partially by the Columbia river and the state of Washington, on the east by Idaho and partially by the Snake river, on the south by California and Nevada and on the west by the Pacific ocean. Its general coast line extends north and south 297 mi.; its extreme length, east and west, is 383 mi. The total area is 96,981 sq.mi. (733 sq.mi. inland water), making it the tenth state in size. The origin of the name "Oregon" is unknown; first used in 1765 to refer to a mythical river of the west, the name was later applied to the entire territory drained by the Columbia river from which the states of Oregon, Washington and Idaho were eventually formed. Oregon was admitted to the union in 1859 as the 33rd state. The state flower is the Oregon grape, the state bird the western meadow lark, the song "Oregon, My Oregon."

PHYSICAL GEOGRAPHY

Physical Features and Soils.—Oregon lies between 42° and 46° 18′ N. lat. and 116° 28′ and 124° 34′ W. long. (extreme points). Its physical features may be described generally under three headings: the coastal area, the Willamette valley and the interior plateau country.

Coastal Area.—The dominant feature of the 30-to 50-mi.-wide

coastal area is the irregular Coast range, formed by folding and volcanic intrusions. Heavily forested and deeply dissected by sharp ravines and narrow valleys, these mountains range in elevation from 1,500 to 2,000 ft. with a slight rise toward the south. The highest point is Mary's peak, 4,097 ft. In the south, the Coast range (*q.v.*) merges with the Klamath mountains (*q.v.*), generally 4,000 to 5,000 ft. high, also deeply incised and forest covered. Occasional spurs from these ranges break the otherwise regular coast line with precipitous basaltic headlands such as Neahkahnie mountain, Cape Perpetua and Cape Blanco. Between these and lesser promontories lie curved sandy beaches, some with shallow bays formed by the sunken mouths of mountain streams. Tillamook, Yaquina and Coos bays admit ocean-going vessels. The largest rivers are the Nehalem, Tillamook, Umpqua, Yaquina and Rogue.

Willamette Valley.—The Willamette valley, about 30 mi. wide, takes its name from the river that flows north about 190 mi. between the mountains of the Coast range and the Cascade range. The river meanders across the level valley floor which rises gently to the low foothills. It receives from the Coast range the slow-moving Yamhill and Tualatin rivers; from the Cascades it receives the Clackamas, Santiam and Calapooya rivers and the swift white waters of the McKenzie. Early settled and noted for its productivity in diversified farming, the valley soil is composed of residual hill, old valley filling and recent alluvium.

The Cascade range (*q.v.*) forms a north-south boundary of rough and forested mountain country 50 to 100 mi. wide along the eastern side of the Willamette valley. Its elevation ranges from 500 ft. in the western foothills to 14,410 ft. on Mt. Rainier, Wash., its highest peak. Other peaks in the chain over 10,000 ft. are Mt. Hood, Mt. Jefferson and Three Sisters. The Cascades were formed during cataclysmic periods of volcanic action and folding, and some of the snow-capped glaciered peaks are extinct volcanoes. Picturesque Crater lake occupies the crater of a great volcano active as recently as 8,000 years ago.

Interior Plateau.—The Cascades slope off on the east into a wide lava-built plateau about 5,000 ft. in elevation and occupying two-thirds of the state's area. The Deschutes river drains 9,000 sq.mi. of the north central part of the plateau, carrying a uniform flow of pure water from the Metolius, White, Warm Spring and Crooked rivers. The soil of this part of the plateau is principally residual and loess and produces hay, grains and potatoes. The rolling lands stretching east from the Deschutes to the Wallowa mountains between the Columbia river (*q.v.*) and the Umatilla range produce the bulk of the state's wheat crop. The Blue-Wallowa-Umatilla mountain complex, with elevations of 2,000 to 10,000 ft., forms a triangular wedge with its base along the Snake river, and divides the northeastern from the southeastern plateau. Cattle graze the slopes and wheat fields are found on bench lands and in rich lowland valleys. The canyoned John Day river, with many geologically important fossil beds, is tributary to the Columbia. The Powder and Grande Ronde flow into the Snake. The Snake river (*q.v.*) forms a part of the boundary between Oregon and Idaho and is one of the principal rivers entering the Columbia. It is remarkable for, among other things, its mile-deep, vertical-walled Hell's canyon.

The southeastern part of the state, bounded by the forested slopes of the Blue-Wallowa, Klamath and Cascade ranges, is high desert plateau. Its 18,500 sq.mi. are geographically part of the great basin region. Topographically it is distinguished by tilted fault-block mountains, rim escarpments and "dry" or saline lakes. Its highest mountain, Steens mountain (9,354 ft.), is a fault-block formation. Abert Rim is a great lava escarpment. The rivers are short, of intermittent flow, and except for the Malheur and Owyhee die out in the plains or dwindle to a trickle before they enter the brackish, periodically dried up, Harney lake or fresh-water Malheur. The latter may cover 125 sq.mi. with water in wet years; in dry, it shrinks to mud holes. On the other hand, the Klamath lakes, just east of the Cascade range, are Oregon's largest bodies of fresh water, covering about 64 sq.mi. The raw "young" soil, composed in part of pumiceous, sandy and alluvial loams, lake peats, silt clay, volcanic ash and diatomaceous earths, is highly productive when water is applied. Livestock is grazed on the nutritious grasses in watered areas.

Climate.—While the climate of Oregon differs from north to south, a striking contrast appears between east and west where the Cascade range divides the humid, marine climate of the coast and valley from the semiarid climate of the plateau. Water-saturated air from the ocean cools and falls in heavy rains in the Coast range. Normal annual precipitation is 75 in., but it increases to more than 130 in. at some higher elevations. The average mean temperatures of January and July vary only from about 45° F. to 60° F. (7° to 16° C.). Snow generally occurs only at the higher elevations. The average growing season is about 248 days. The interior valleys west of the Cascades have slightly shorter growing seasons because of earlier and later frosts. The temperature range, however, is greater. In the Willamette valley the average mean temperature in January is 38° F.; in July, 66°. Valleys in the Klamath range and southwestern part of the state tend to have lower absolute minimums and higher absolute maximums than does the northern Willamette valley. They also have less rainfall. The mean annual precipitation at Ashland is 20.2 in.; at Portland, 45.6 in.

The eastern slopes of the Cascades lie in a rain shadow where little precipitation falls except as snow. The mean annual rainfall in the plateau country ranges between 11 in. in the southeast and 17 in. in the Wallowa mountains; snowfall in the same areas ranges from 13 in. to 85 in. Extreme temperatures of −31° and 107° F. have occurred, and the mean maximums for July vary from 78° to 90°. Abundant sunshine compensates for relatively shorter growing seasons.

Vegetation.—The semiarid plateau has a covering of western juniper, sage and salt grasses. Forests cover 30,000,000 ac. in the mountain and coastal areas. On the eastern slopes of the Cascades occur great stands of ponderosa pine in association with ground coverings of bitter brush, green manzanita and herbaceous plants. The western slopes of the Cascade, Klamath and Coast ranges are heavily forested with stands of Douglas fir. Mature forests of Douglas fir have thick understories of vine maple, dogwood, huckleberry and other plants, and admit intrusions of other tree growths such as hemlock, spruce, cedar and varieties of pine and fir. Immature or second growth stands of Douglas fir crowd out both undercover and intrusions. In cleared areas of the damp coastal region are found stands of alder and noncommercial deciduous growth. In the alpine zones of the mountains, larch, mountain hemlock and alpine firs occur in association, and in the Blue mountains stands of mountain mahogany are found.

Animal Life.—Oregon's animal life, like its vegetation, is related to its climatic zones and hence is not peculiar to the state. Varieties of deer and elk flourish in less populated parts; antelope are found in the eastern high plateau, and bear and fox in the mountain forests. The lakes are breeding grounds for water fowl and resting places for many different kinds of migratory birds.

Parks, Forests and Recreation.—Of Oregon's total area of approximately 62,000,000 ac., the federal government holds title to about 32,600,000 ac., consisting largely of public domain used for grazing, national forests, revested forest lands and Indian reservations. The United States forest service administers nearly 15,000,000 ac. of Oregon's forest lands. There are 14 national forests, of which 10 are wholly within the limits of the state. All have camping sites or recreation parks or both. The state maintains more than 130 developed parks, many of which have improved camping facilities. More than 10,000,000 people visit these parks yearly.

HISTORY

Prehistory and Aboriginal Inhabitants.—At least 10,000 years ago an ancient people lived in caves along the shores of great lakes that occupied the southern part of interior Oregon and along the banks of the Columbia river. By the time the white man came, the villages of the native population crowded the river mouths on the coast, and native villages were found in the valleys of the western ranges and in the interior wherever roots, fowl, game, fish, insects and water supported life. The people of the southern interior were related to the Shoshone-Paiute culture of

the Great Basin peoples; the horse-raising northeastern folk had some cultural affiliations with the buffalo hunters of the plains; those who occupied the northern coast, organized in permanent villages, reflected some of the complex culture traits of the Northwest Coast canoe Indians. The peoples of the southern coast, isolated not only from each other by the broken terrain but also from the dominant cultures of their neighbours, shared some of the characteristics of the peoples of northern California.

With the exception of the Rogues who occupied the river of that name in the southern part of the coast, the Indians' first response to the white men was friendly, so much so that they quickly succumbed to the white men's diseases. The natives were not a threat to settlement until the interior peoples, finding their lands invaded first by missionaries and then by miners, rose in successive outbreaks of brief duration, in 1847 (Cayuse War), in 1852–53 (Rogue outbreaks) and 1855–58 (Yakima War).

During the 1860s the Indians preyed on immigrant trains coming in from southern Idaho, and local troops were sent to hunt them down. The last Indian uprising was the famous insurrection of Chief Joseph in 1877, when he tried to lead his people from the reservation in the Wallowas into Canada.

Exploration.—Spanish navigators may have sighted the Oregon coast as early as 1543. In 1775 Bruno Heceta and Juan Francisco Bodega y Quadra made landings near Point Grenville (Washington) and in a formal ceremony took possession of the northwest coast for Spain. Capt. James Cook of the British Royal Navy sailed along the Oregon coast in 1778–80. An incidental trade for sea otter skins between his men and the Indians to the north led to the opening of a triangular trade between these shores, China and England by 1785. The Americans entered this trade in 1789. On his second voyage to the coast in 1792, Capt. Robert Gray discovered and entered the river which he called Columbia river after his ship. Later, this discovery led the United States to claim the territory the river drained. The overland exploring expedition led by Meriwether Lewis and William Clark (1804–06) reinforced American claims to possession. Lewis and Clark's winter encampment, Ft. Clatsop near the mouth of the Columbia, was made a national monument in 1958.

Fur Trade.—Although the Canadian North West company had established fur trading posts west of the continental divide between 1807 and 1810, the first commercial post within the present boundaries of Oregon was built by Americans in 1811 when John Jacob Astor's partners in the Pacific Fur company built Astoria. During the War of 1812, Astor's field partners sold its trading goods and abandoned its posts to the Canadian company. Subsequently a British war vessel took possession of Astoria. This "act of war" brought the Oregon country into British-U.S. peace negotiations. Astoria was restored to the Americans, who, however, made no effort to occupy it for 30 years. In 1818 the two powers agreed by convention that their nationals could engage in commerce in the Oregon country without prejudice to either nation's claims. Spain surrendered its claims by the treaty of Florida in 1819, but Great Britain and the United States continued until 1846 to argue the relative strength of theirs. The British sought a boundary along the 49th parallel to the Columbia and then down that river to the sea. At no time did they push any claim to the region south of the Columbia in what is now Oregon. The United States argued for a boundary along the 49th parallel to the Pacific.

Following a merger with the North West company in 1821, the Hudson's Bay company took over the fur trade in the region, and, to all practical effect, provided the only white occupancy of the region until 1834. Under its chief factor of the Columbia department, John McLoughlin, the company's principal post, Fort Vancouver (Washington), became the wilderness metropolis of the vast Oregon country.

Several futile U.S. efforts to invade the British commercial empire revealed how firmly the Hudson's Bay company controlled the Indian trade.

Settlement.—American immigration began in 1834 with the arrival of Methodist missionaries, Jason and Daniel Lee. Reinforcements for their missions and the arrival of trappers and their families from the Rockies and others swelled the American population to about 150 persons by 1840. Oregon City, at the falls of the Willamette, was the first permanent village settlement.

Attracted by widespread reports of the fertile valley, anticipating a prosperous trade with the orient and grants of free land from the government when the boundary issue was settled, immigrants carved out the Oregon trail with the wheels of their covered wagons (*see* OREGON TRAIL). The first large immigration, occurring in 1843, increased the American population to probably 1,200 persons. Problems incident to their arrival emphasized the fact that there was no government in Oregon except the chartered powers of the Hudson's Bay company over British subjects and a rudimentary "compact" that bound the Americans together for simple purposes of law and order. By 1845 this compact was revised to conform with practices and procedures customarily found in territories of the United States. A provisional government, intended to function until the boundary was decided, it successfully, if tenuously, held the American colony together until 1849.

Oregon Question.—The "Oregon question," the boundary issue raised in the 1844 election, subsequently became a national issue summarized in the slogan "Fifty-four forty or fight." After the election of Pres. James K. Polk, the British government was notified that the United States wished to terminate the convention of joint occupancy and settle the problem of sovereignty in the Pacific northwest. Negotiations resulted in a treaty (1846) which gave the Americans the line along the 49th parallel they had originally sought. Engaged in domestic controversies over slavery and the Mexican war, congress failed to respond to Oregon's petitions for organization as a territory until the massacre of the Whitmans and inhabitants of their mission in 1847 forced it to act. In Aug. 1848 the bill to organize Oregon territory was signed by President Polk. In 1853 the area north of the Columbia was withdrawn to form Washington territory.

Territorial Period.—Oregon's territorial period was an era of population growth and economic development. Passage of the Donation Land act (1850) which guaranteed to settlers in Oregon 320 ac. of public domain if they had settled before Dec. 1, 1850, or 160 ac. if they arrived and qualified before Dec. 1, 1853, inspired immigration. The California gold rush gave Oregon's agricultural produce a market, brought its economy out of the doldrums incident to its isolation, and brought much-needed capital into the territory. Oregon had relatively few Indian disturbances. In 1855 a reservation policy was enforced by federal troops. Restless under territorial administration, Oregonians agitated for statehood. Although unauthorized by any congressional act, they adopted a constitution in 1857, and on Feb. 14, 1859, with its present boundaries and a population of 52,465, Oregon was admitted as a state to the union.

Statehood.—Statehood was ushered in with a gold rush to the northwest. Prospectors from California working their way north had discovered gold in southern Oregon, British Columbia and northern Washington in the middle 1850s. Rich placer diggings were opened up in Montana and Idaho in 1860. Demands from the mines made Oregon and its chief city, Portland, the supply centre for the interior. In 1867–68 surplus wheat was shipped to England and initiated an export trade which made Oregon one of the nation's great wheat exporting states.

The most serious drawback to Oregon's growth between 1860 and 1880 was its isolation. Agitation for railroads began almost with settlement. In the 1860s abortive attempts were made to connect with the Union Pacific, then building to California, but it was not until 1883 that the Northern Pacific gave Oregon its first transcontinental line. During the next two decades railroads were extended through most of the populated areas of the state. Railroad advertising of subsidy land grants contributed to a population increase from 174,768 to 313,716 in the decade of 1880–90.

The basic economy remained agricultural until lumbering, which previously had satisfied mainly local needs, increased at the turn of the century. In 1900 Oregon was third in the nation in lumber production and by 1950 achieved first place. During World War I, spruce from Oregon's mills was used in manufacturing aircraft, and Oregon had a brief period of large-scale wooden shipbuilding activity. Essentially a raw-resource economy, Oregon suffered

from the nationwide depression in the 1930s, but not to the degree experienced by more industrialized areas. World War II brought new industries to Portland, particularly metal shipbuilding, which, however, once again declined with the coming of peace. Diversification of the economy began with the building of power dams on the Columbia river in the 1930s, and after World War II the development of industries using hydroelectric power introduced a new era in the economy of the western part of the state.

Politics.—During the American Civil War, Oregon moved from its traditionally strong affection for the Democratic party to the Republican party. In its first 100 years of statehood, it had 18 Republican governors to 10 Democrats and 1 Independent. Between 1932 and 1944 Oregon voted for Democratic candidates for the presidency. In 1954 Richard L. Neuberger, the first Democratic senator in 39 years, was elected. Wayne L. Morse, who had been elected to the senate as a Republican in 1944 and reelected in 1950, but withdrew from the party in 1952 and two years later became a Democrat, was elected to the senate on the Democratic ticket in 1956. In that year Oregon strongly supported the Republican candidate for president, but, in addition to Morse, elected a Democratic governor—its first in 21 years—and three Democratic representatives.

In 1958 the Republicans regained the governorship and in 1960 the state again supported the Republican candidate for president, but elected another Democratic senator, Maurine B. Neuberger, to succeed her deceased husband. Senator Morse was reelected in 1962 as was Gov. Mark Hatfield. Mrs. Neuberger did not run in 1966 and Hatfield was elected to the U.S. senate.

Oregon made political history in the first decade of the 20th century when it instituted governmental reforms and pioneered legislation to bring about popular government. Advanced social legislation, such as workmen's compensation and working mother laws, and woman suffrage were adopted by 1915. Public versus private power development was the principal issue in Oregon politics after 1930.

GOVERNMENT

Oregon's constitution served the state without amendment until 1902. It provided for the usual departments of government. A two-house legislature, composed of 30 senators elected for four-year terms, and 60 representatives elected for two-year terms, meets in regular sessions beginning in January of odd-numbered years. The governor serves a four-year term; there is no lieutenant governor. A two-thirds vote of both houses is required to pass a bill over the governor's single-item and general veto. He serves as ex officio member of many departments and boards. With the growth of boards and commissions, the governor's appointive power became increasingly important.

The state's judiciary system consists of an elected supreme court of seven members which holds sessions at Salem and Pendleton; an elected circuit court serving 21 judicial districts; and district, municipal and county courts.

In 1902 the foundation for sweeping reforms in legislative practices was laid with the adoption of the initiative and referendum amendments. These two measures and a direct primary law were the principal features of the so-called Oregon system. A peculiar feature of the primary law allowed Oregonians to participate indirectly in the election of their U.S. senators, thus anticipating in practice the federal constitutional amendment permitting direct election.

Outgrowths of these fundamental reforms were such measures as the corrupt practices act, recall, presidential primary and an act requiring the free distribution of a voter's pamphlet giving information on measures and candidates.

After 1940 the state collected no real property taxes. Such taxes were the source of local government revenues, while the state depended upon the graduated income tax, excise, inheritance taxes and income from state-controlled liquor outlets. A tax on gasoline financed highway construction and maintenance.

Local taxing agencies are prohibited by the constitution from raising a greater amount of revenue from property taxes (for purposes other than meeting bonded indebtedness) than their tax base plus 6%. The tax base is the total amount lawfully levied in any one of the three preceding years. It is possible for a taxing agency to raise its base by a majority vote of its voters.

POPULATION

Oregon's population grew slowly from 13,294 reported in the first official census in 1850 to 174,768 in 1880. It experienced its largest growth in numbers in 1900–10 and 1940–50. In the latter decade the number of inhabitants increased from 1,089,684 to 1,521,341. In 1960 the population was 1,768,687. Between 1900 and 1940, a population comprising a large proportion of older persons gave Oregon one of the lowest fertility ratios in the United States. Population increase has been largely through in-migration. Of the 1960 population 94.1% was native white, 3.8% foreign-born white, and 2.1% nonwhite. Oregon in 1960 had 18.2 persons per square mile to the United States over-all 49.6 persons, indicating that Oregon is still relatively underpopulated.

The 1960 census indicated that 62.2% of the state's inhabitants live in urban areas. It has two standard metropolitan statistical

*Oregon: Places of 5,000 or More Population (1960 census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	1,768,687	1,521,341	1,089,684	783,389	413,536
Albany	12,926	10,115	5,654	4,840	3,149
Altamont	10,811	9,419	—	—	—
Ashland	9,119	7,739	4,744	4,283	2,634
Astoria	11,239	12,331	10,389	14,027	8,381
Baker	9,986	9,471	9,342	7,729	6,663
Barnes	5,076	—	—	—	—
Beaverton	5,937	2,512	1,052	580	249
Bend	11,936	11,409	10,021	5,415	—
Coos Bay†	7,084	6,223	5,259	4,034	1,391
Corvallis	20,669	16,207	8,392	5,752	1,819
Dallas	5,072	4,793	3,579	2,701	1,271
Dalles City‡	10,493	7,676	6,266	5,807	3,542
Eugene	50,977	35,879	20,838	10,593	3,236
Forest Grove	5,628	4,343	2,449	1,915	1,096
Grants Pass	10,118	8,116	6,028	3,151	2,290
Hillsboro	8,232	5,142	3,747	2,468	980
Keizer	5,288	—	—	—	—
Klamath Falls	16,949	15,875	16,497	4,801	447
La Grande	9,014	8,635	7,747	6,913	2,991
Lebanon	5,858	5,873	2,729	1,805	922
McMinnville	7,656	6,635	3,706	2,767	1,420
Medford	24,425	17,305	11,281	5,756	1,791
Milwaukie	9,099	5,253	1,871	1,172	—
Newport	5,344	3,241	2,019	580	256
North Bend	7,512	6,099	4,262	3,268	—
Ontario	5,101	4,465	3,551	2,039	445
Oregon City	7,996	7,682	6,124	5,686	3,494
Oswego	8,906	3,316	1,726	1,818	—
Pendleton	14,434	11,774	8,847	7,387	4,406
Portland	372,676	373,628	305,394	258,288	90,426
Roseburg	11,467	8,390	4,924	4,381	1,690
St Helens	5,022	4,711	4,304	2,220	258§
Salem	49,142	43,140	36,908	17,679	4,258
Salem Heights	10,770	2,351	—	—	—
Springfield	19,616	10,807	3,805	1,855	353

*Populations are reported as constituted at date of each census. †Coos Bay returned in 1940 as Marshfield. ‡Returned in 1950 as The Dalles. §St. Helens Town only. In 1910 it consolidated with Houlton.

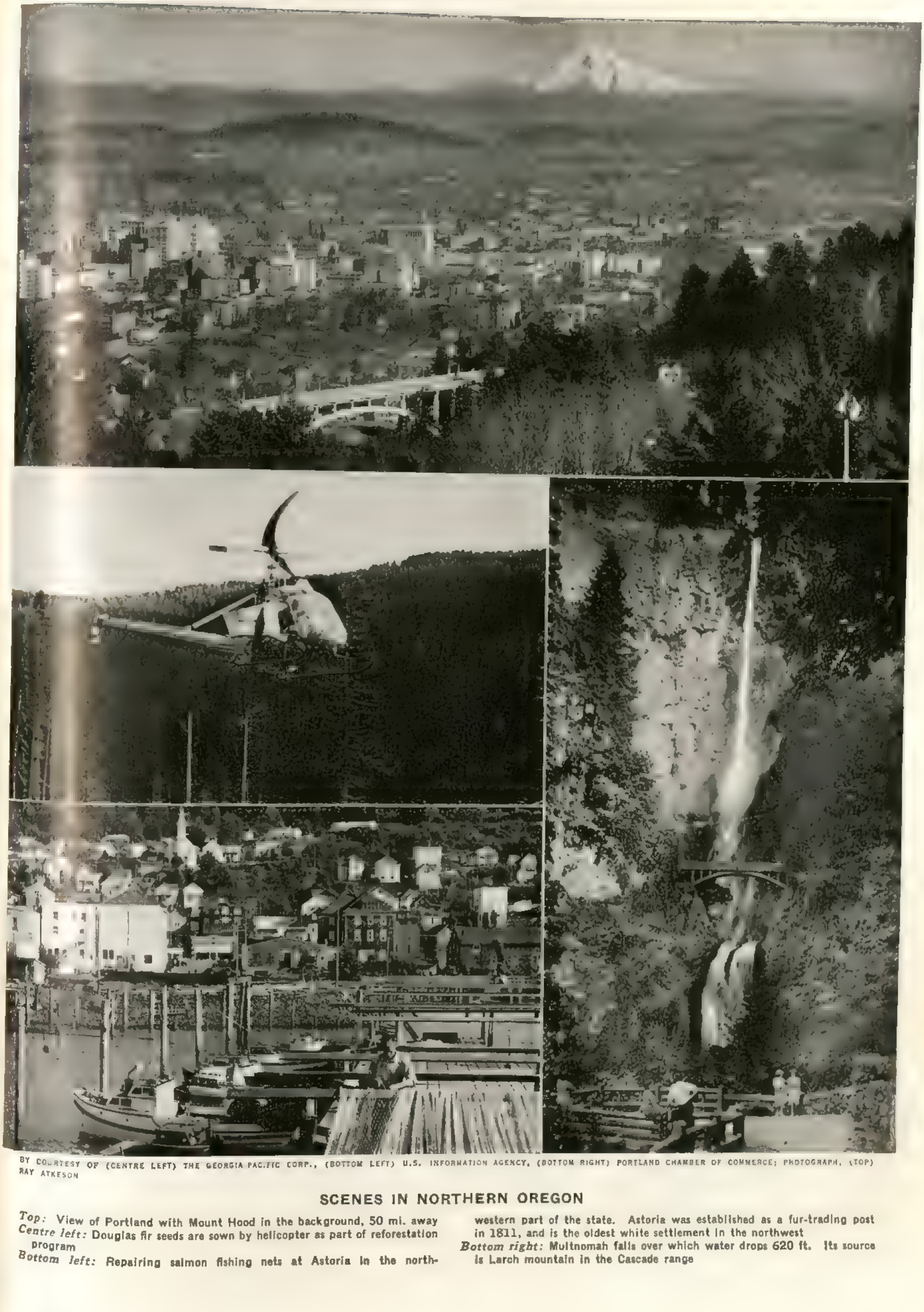
Note: Dash indicates place did not exist during reported census, or data not available.

areas, Portland (shared with Washington) and Eugene. These areas had a total population of 984,787 (including 93,809 Washington residents) according to the 1960 census.

EDUCATION

Public Schools.—Public schools of Oregon are operated by local school districts. Reorganization reduced their number from 2,200 in the 1930s to about 500 by the 1960s. An appointed state board of education has limited powers of policy making and supervision in such matters as standards, texts and teacher certification. It acts through the state department of education, headed by an elected superintendent. The board has financial and administrative jurisdiction over junior college districts. State funds contribute to local district revenues theoretically on an equalization basis.

Higher Education.—A state board of higher education operates eight institutions of higher learning: The University of Oregon at Eugene and its dental and medical schools, with teaching hospital, at Portland; Oregon State university (incorporated 1858), a land-grant college, at Corvallis; Portland State college (1955) at Portland; Oregon Technical institute, Klamath Falls (established 1946); Oregon College of Education, Monmouth (chartered



BY COURTESY OF (CENTRE LEFT) THE GEORGIA-PACIFIC CORP., (BOTTOM LEFT) U.S. INFORMATION AGENCY, (BOTTOM RIGHT) PORTLAND CHAMBER OF COMMERCE; PHOTOGRAPH, (TOP) RAY ATKESON

SCENES IN NORTHERN OREGON

Top: View of Portland with Mount Hood in the background, 50 mi. away
Centre left: Douglas fir seeds are sown by helicopter as part of reforestation program
Bottom left: Repairing salmon fishing nets at Astoria in the northwestern part of the state. Astoria was established as a fur-trading post in 1811, and is the oldest white settlement in the northwest
Bottom right: Multnomah falls over which water drops 620 ft. Its source is Larch mountain in the Cascade range

OREGON





BY COURTESY OF (TOP LEFT, CENTRE LEFT, BOTTOM RIGHT) OREGON STATE HIGHWAY COMMISSION, (TOP RIGHT) UNION PACIFIC RAILROAD PHOTOGRAPH, (BOTTOM LEFT) AL MONNER

INDUSTRIAL AND LANDSCAPE SCENES OF OREGON

Top left: State capitol at Salem, completed in 1939. A bronze statue atop the dome and two sculptural blocks at the entrance honour early pioneers of Oregon

Top right: Pacific ocean near Devil's Punch Bowl State park

Centre left. Conduit carrying water to farms from the Vale-Owyhee irrigation project in eastern Oregon

Bottom left: Paper mills along the Willamette river, Oregon City

Bottom right: Hell's canyon and the Snake river, forming a boundary between Oregon (left) and Idaho. The walls of the gorge rise about a mile above the river bed, making it one of the deepest canyons in the U.S.

1856); Southern Oregon college, Ashland (established 1926); and Eastern Oregon college, La Grande (also 1926).

The state board of higher education advises junior college districts on matters of curriculum and staffs them through the services of a general extension division that has its headquarters at Portland. The state college operates an agricultural experiment station at Corvallis and nine branch stations.

The University of Oregon, established in 1872, gave its first instruction in 1876. It comprises schools of liberal arts, architecture and allied arts, business administration, education, health and physical education, journalism, law, military and air science and music, and a graduate school, as well as the medical and dental schools.

Among the larger of the independent colleges, some with church affiliations, are. Lewis and Clark college (Presbyterian, 1867), University of Portland (Roman Catholic, 1901) and Reed college (nonsectarian, 1911) in Portland; Marylhurst college (Roman Catholic, 1893), Marylhurst; Willamette university (Methodist, 1842), Salem; Pacific university (Congregational, 1849), Forest Grove; and Linfield college (Baptist, 1849), McMinnville.

HEALTH, WELFARE AND CORRECTIONS

The state board of health by law is responsible for all matters relating to the protection of public health, but offers no treatment services. Programs include preventive medical services, sanitation and engineering, local health services and general administration. County and district health units are autonomous, but the state may assume jurisdiction if local officials neglect or refuse to comply with state laws and regulations. This has rarely happened, although the state routinely provides direct basic public health services in small counties with insufficient population to maintain adequate local health programs.

The state operates two tuberculosis hospitals, two mental hospitals, homes for the mentally deficient and for the incapacitated aged, and schools for the blind and the deaf. It also supports local school programs of rehabilitation and education for exceptional children. The public welfare commission administers expenditure for old-age and general assistance, aid to dependent children, the blind and the disabled.

The state penitentiary is located at Salem. Oregon also has an institution of correction for first offenders. Hillcrest school at Salem and MacLaren school at Woodburn are operated for underage delinquents.

ECONOMY

The economy of Oregon is based upon the resources of its agricultural and pasture lands, its forests and water power. Of its wage-earning population, roughly 30% is engaged in manufacturing, principally lumbering. Wholesale and retail trades, service and miscellaneous occupations employ an additional 35% of the population. Nonagricultural industries, including lumbering, fall into the category of highly skilled occupations. Portland (*q.v.*) is the chief industrial centre, but Eugene (*q.v.*) and the towns in the Coos Bay area are the centres of the lumbering industry.

Agriculture.—Agriculture, on which the state's economy was based until the timber resources began to be exploited in the first decade of the 20th century, remains the second most important industry in Oregon. Wheat is the staple crop, and Portland is one of the leading wheat ports of the United States. Production of fruits, nuts, nursery stock and seeds, however, approximates in value that derived from the staple grain. Dairy products account for about two-fifths of the state's farm income. In the second half of the 20th century the trend was toward a decreasing number of farms and an increasing number of acres in individual holdings; less than 10% of farms were held in tenancy. Where precipitation is not sufficient for dry farming, irrigation has made profitable otherwise unproductive lands. Approximately 1,500,000 ac. are under irrigation in the principal irrigation districts of Owyhee, Deschutes, Umatilla, Klamath and Rogue rivers and in lesser districts.

Lumbering.—Oregon contains the largest body of standing timber in the U.S., and its annual cut of lumber is the largest in the nation. Lumbering is the state's most important industry, lumber and lumber products accounting for about three-fifths of value added by all manufactures in the state. In Oregon's mills, 58% of the U.S. plywood, 30% of its fir doors, 29% of its hardboard, particle board and chip board and 28% of its shingles and shakes are produced. New processes of tree utilization in which waste was markedly reduced increased estimates of the state's usable timber to approximately 469,000,000 bd.ft., largely of softwoods such as Douglas fir and ponderosa pine. Capital attracted to investment in Oregon's forest resources has resulted in the gradual disappearance of small mill operations and the concentration of the industry in larger plants. The automobile also has contributed to revolutionizing the industry and the logger's life. Trucks haul logs to the plants from large and otherwise inaccessible areas; the labour force lives in permanent towns.

Fisheries.—One of the world's great salmon rivers is the Columbia, which bounds Oregon on the north, and during the last three decades of the 19th century fishing was a principal industry along the lower reaches of the river. After that time the catch, especially of quinnat (Chinook or king) salmon, markedly declined, but the industry survives on catches of other species of salmon, intermittent runs of albacore and increasing catches of bottom fish and shrimp. Sport fishing in mountain and coastal streams is encouraged by conservation and stocking of streams from state-owned and operated hatcheries.

Mining.—Mining was important in the 1850s when some gold mines were productive. After 1925, the principal mineral products were cinnabar (mercury), quarry stone, sand and gravel. Of a total annual value of around $50,000,000 in mineral production, various products including undisclosed quantities of semiprecious stones, diatomaceous earths, tungsten and uranium account for about $15,000,000.

Manufacturing.—Manufacturing other than lumbering is only modestly developed in Oregon. Food and food products, pulp and paper products, fabricated and primary metal products, and nonelectrical machinery, transportation equipment and chemicals and chemical products comprise the principal manufactures. Bonneville, The Dalles and McNary dams on the Columbia river and smaller installations on other rivers produce nearly 2,000,000 kw. of electric power yearly. Undeveloped hydroelectric power is estimated at close to 6,000,000 kw. The establishment of electrometallurgical industries in Oregon was associated with power development.

Transportation and Communication.—The main railway lines serving Oregon were the Southern Pacific, Union Pacific, Great Northern, Northern Pacific and Spokane, Portland & Seattle railways. Development of motorbus and truck lines reduced railroad traffic within the state. Trans-Pacific and transcontinental airline connections are made at Portland, and several airlines run scheduled flights across the state. Astoria and Portland are river ports for ocean vessels; Coos bay and Yaquina bay serve as shipping ports for the lumber trade.

Portland, Salem and Pendleton are connected with freeways and expressways. Of the state's 75,000 mi. of roads and highways, about 5,000 mi. are in the state primary system. There is a registered motor vehicle for every two persons living in the state and a telephone for every three persons. There are about 100 AM and FM radio stations and a dozen television stations. Oregon has more than 20 daily and other newspapers, the *Portland Oregonian* being one of the oldest and having the largest state-wide circulation.

See also references under "Oregon" in the Index.

BIBLIOGRAPHY.—A bibliography of general and special subjects may be found in chapters of Dorothy O. Johansen and Charles M. Gates, *Empire of the Columbia: A History of the Pacific Northwest* (1957). *See* also *Oregon Blue Book* (published biennially); Federal Writers Project, WPA, *Oregon*, in the "American Guide Series," rev. ed. (1951); Oregon State Board of Higher Education, *Physical and Economic Geography of Oregon* (1940); Lewis A. McArthur, *Oregon Geographic Names*, rev. ed. (1952); *Oregon Historical Society Quarterly* (1900 *et seq.*); Vernon Bailey, *The Mammals and Life Zones of Oregon*, U.S. Department of Agriculture Biological Survey, "North America Fauna," no. 55 (1936); Ira N. Gabrielson and S. G. Jewett, *Birds of Oregon* (1940); William J. Ghent, *The Road to Oregon* (1934); Archer B. Hulbert (ed.), *The Call of the Columbia* (1934), and D. Hulbert (eds.)

The Oregon Crusade (1935), *Where Rolls the Oregon* (1933) in "Overland to the Pacific Series." *See* also the following popular works: Murray Morgan, *The Columbia, Powerhouse of the West* (1949); Bernard DeVoto (ed.) *The Journals of Lewis and Clark* (1953); Stewart Holbrook, *Far Corner* (1952), *The Columbia* (1956); David Lavender, *Land of the Giants* (1958).

Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures are summarized annually in the *Britannica Book of the Year*, American edition. (D. O. J.)

OREGON GRAPE (*Mahonia aquifolium*), a North American evergreen shrub of the family of Berberidaceae, closely allied to the barberry (*q.v.*), and found from British Columbia to Oregon. It grows from three to ten feet high and bears large pinnate leaves composed of five to nine thick, spiny-toothed, somewhat hollylike leaflets, bright yellow flowers in erect racemes, followed by showy clusters of small blue berries. The plant is the floral emblem or state flower of Oregon, and is widely grown as an ornamental.

OREGON MYRTLE (*Umbellularia californica*), a North American tree of the laurel family (Lauraceae, *q.v.*), called also California laurel, native to Oregon and California. It occasionally attains a height of 90 ft. and a trunk diameter of 5 ft., but is usually much smaller. The tree features lance-shaped, fragrant evergreen leaves, greenish-yellow flowers, in small clusters, and a somewhat olivelike, dark purple fruit (drupe). The wood is one of the most valuable cabinet timbers of the Pacific states.

OREGON PINE: *see* DOUGLAS FIR.

OREGON TEA TREE (*Ceanothus sanguineus*), a name given to a large shrub of the buckthorn family (Rhamnaceae), called also buckbrush, native from northern California to British Columbia and eastward to Montana. It grows about ten feet high and bears reddish branchlets, thin, smooth, ovate, toothed leaves, and compound clusters, two to four inches long, of small white flowers. As in the case of the New Jersey tea (*q.v.*), its leaves have been used as tea. *See* CEANOTHUS.

OREGON TRAIL, one of the most famous emigrant routes in U.S. history, traversed about 2,000 mi. of all kinds of terrain from Independence, Mo., to the Columbia river country of Oregon. Its greatest popularity as a route to Oregon was in the 1840s when perhaps 12,000 persons traveled the full distance. The trail had been used earlier by a few hundred emigrants and as late as 1900 an occasional traveler could still be seen on it.

Wilson Price Hunt, bound for Astoria, led a party of fur trappers along the western portion of the trail in 1811–12. A year later the returning Astorians under Robert Stuart followed a much longer part of the trail. In the 1820s and 1830s hundreds of mountain men used parts of the route, and some of them, such as James Bridger and Thomas Fitzpatrick, later served as guides for emigrants and soldiers on the trail. In the 1830s missionaries, scientists and sportsmen attached themselves to the fur brigades. Then in 1841 the migration of homeseekers began with the Bidwell-Bartleson party, 32 of whom reached Oregon. More than 100 went to Oregon under the leadership of Elijah White in 1842, and in 1843 Marcus Whitman (*q.v.*) helped guide the "Great Migration" of about 1,000 persons. There were fluctuations in the volume of travel thereafter but by 1848 enough Americans had reached the northwest to warrant the organization of Oregon as a territory (*see* OREGON: *History*).

Meanwhile, beginning in 1847, the first of many thousands of Mormons began to use a trail across Wyoming. The Mormon trail began at the present site of Omaha, Nebr., and, unlike the Oregon trail, remained on the north side of the Platte river all the way to Ft. Laramie, Wyo., but from that point to western Wyoming, the Mormon trail and the Oregon trail could rarely be distinguished.

In 1849 the homeseekers moving along the eastern part of the Oregon trail were joined by a great flood of gold seekers bound for California. A few thousand California-bound emigrants had used the eastern part of the Oregon trail before 1849 but they were but a small vanguard in comparison with the gold rush hordes. At least 50,000 crowded through South pass in the summer of 1850, almost all of them on their way to the California gold fields, and heavy traffic continued for years thereafter. The eastern half of the Oregon trail might more appropriately be called the Oregon-California-Utah trail inasmuch as the people bound for California and Utah after 1847 outnumbered those who were bound for Oregon by perhaps 50 to 1.

The persistent popularity of the name Oregon trail can be attributed to Francis Parkman's classic volume of the same name. Parkman traveled over no more than the eastern third of the Oregon trail on his famous visit to Ft. Laramie and the Laramie plains in 1846. His book based on his experiences was first called *The Oregon and California Trail* but for later editions the shortened title was adopted.

The Oregon trail in its 2,000-mi. length was rarely a single track. In places it was ten miles wide as emigrants spread out for better grazing or to avoid the dust. Cutoffs and alternate routes multiplied as resourceful pioneers constantly sought for improvements. Starting from northwestern Missouri near Independence the emigrants went west into Kansas and then made almost a beeline to the Platte river in south central Nebraska. They followed the south side of the river to the junction of the South Platte and North Platte. Crossing the South Platte the travelers continued on the south side of the North Platte to Ft. Laramie. Beyond that famous way station in eastern Wyoming the travelers remained on the south side of the river until 1850 after which there was travel on the north side as well. In the vicinity of present Casper, Wyo., all who had not already done so crossed to the north side by ford, ferry or bridge, struck the Sweetwater river and followed that pleasant stream to South pass. Beyond this great natural gateway in the continental divide three main routes diverged. The "Great Migration" of 1843 turned southwest to Ft. Bridger and then northwest to the Bear river, their route forming a V. Most Oregon-bound emigrants, however, did not go to Ft. Bridger, preferring to cross the top of the V along what came to be known as Greenwood's or Sublette's cutoff. A third main route, still farther north, was opened as the Lander road in 1857. All three routes led to the Bear river and on to Fort Hall and the Snake river in the present state of Idaho. Those whose destination was Utah went mainly by way of Ft. Bridger, as did some who were headed for California. The main California trail, however, branched off from the Oregon trail beyond Fort Hall. Emigrants destined for Oregon followed the Snake river for 300 mi., crossing it twice before leaving it to take a more direct route to the Columbia through Grande Ronde valley and over the Blue mountains.

From Independence, Mo., to the Columbia took four to six months in covered wagons drawn by oxen, mules or horses. There were many sharp inclines, dangerous water crossings and long stretches of desert. Occasionally Indians ran off the livestock or attacked the emigrants. Yet many of the travelers found time to pause in Wyoming to carve their names on Register cliff and Independence rock, and their work was still visible more than a century later.

BIBLIOGRAPHY: Federal Writers' Project, *The Oregon Trail* (1939); Walter E. Meacham, *Old Oregon Trail* (1948); Paul C. Henderson, *Landmarks on the Oregon Trail* (1953). (T. A. LN.)

O'REILLY, JOHN BOYLE (1844–1890), Irish-American politician and journalist, an energetic and effective exponent of Irish national aspirations, was born at Dowth Castle, near Drogheda, on June 28, 1844, the son of a schoolmaster. He was sent to Preston, Lancashire, as a printer's apprentice, and there joined the Lancashire Rifle Volunteers. Recalled to Ireland by his parents in 1863, he enlisted as a trooper in the 10th Hussars, stationed near Dublin. Before long the Fenian leader John Devoy recruited him as a secret republican agent for enrolling Irish soldiers, who then comprised almost one-third of the British army. In 1866 his republican activities were discovered and he was sentenced to be shot. The penalty was commuted to 23 years penal servitude, which brought O'Reilly to frightful hardships in English convict prisons, especially at Dartmoor. He was deported in 1867 to Bunbury, Western Australia, and after two years there he effected a daring escape to the United States.

O'Reilly obtained employment in Boston, Mass., on the Roman Catholic weekly *Pilot*, soon becoming its editor, and later its joint proprietor with the archbishop of Boston. He reported for it the

Fenian raid into Canada in 1873, which convinced him of the incompetence of the Fenian organization, and also of the Canadian resentment at such incursions. But his passionate sympathy with the Irish republicans never wavered; though he deplored the personal feuds among the Fenian leaders, and detested the name "Fenianism," which he believed to have brought discredit on the Irish cause. In close alliance with his friend John Devoy, he successfully planned the rescue in 1876 of the remaining Irish prisoners in Western Australia, by sending out a whaling ship, the "Catalpa." O'Reilly acquired an outstanding personal influence in Boston, and among all Irish Americans, as a magnanimous Irish republican, with his romantic background of early imprisonment and daring escape. He had great gifts as a journalist and an orator, with a keen sense of Ireland's debt to America. He published several volumes of verse and a novel of convict life in Australia, *Moondyne* (1889). He died suddenly, during a political conference at Hull, Mass., on Aug. 10, 1890.

See J. J. Roche, *Life of John Boyle O'Reilly* (1891); and William D'Arcy, *The Fenian Movement in the United States* (1947). (D. G.)

OREKHOVO-ZUYEVO, a town of Moscow *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., lies 55 mi. E. of Moscow on the Klyazma river. Pop. (1959) 108,297. It is one of the chief industrial centres of the Moscow region and one of the oldest and largest textile towns of the U.S.S.R. It was formed in 1917 through the amalgamation of several industrial villages, the most important being Orekhovo, on the right bank, and Zuyevo on the left, which were known for handmade cloth even in the 17th century. Cottons dominate the present industry. Also important are chemicals (plastics) and engineering. Much peat is extracted in the vicinity. The town lies on the main Moscow-Vladimir railway, with branches to Aleksandrov and Yegoryevsk. (R. A. F.)

OREL, an *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., formed in 1937, covers an area of 9,537 sq.mi. Pop. (1959) 929,013. The *oblast* lies on the gently rolling hills of the Central Russian uplands, into which are cut the broad, shallow valleys of the many rivers. The greater part is in the basin of the upper Oka, which rises within its boundaries, and of its many tributaries, notably the Zusha, Kroma, Tson, Nugr and Vytebet. The extreme southwest and west drain by the Navlya and Nerussa to the Desna, while the east and southeast drain to the Don by way of the Sosna and its tributary, the Trudy. The climate is moderately continental, with July average temperatures about 19° C. (66° F.) and January averages about 9° C. (15° F.). Rainfall is about 20–24 in. a year with a summer maximum. Orel *oblast* is on the boundary of the mixed forest and forest-steppe zones. West of the Oka are podsolic soils, and to the east are degraded and leached chernozems. These indicate a former widespread forest cover, but this has been almost entirely cleared since the 16th century and only small groves of oak or pine remain. In the extreme southeast are limited areas of true, rich chernozems. The high degree of removal of the natural vegetation cover has caused intensive soil erosion and the hillsides and interfluves are greatly cut up by gullies and ravines.

Only 24% of the population (220,397) are urban, compared with the national average of 50%. Apart from Orel town the seven towns and six urban districts are all small centres, processing local agricultural products. The most important of these is Mtsensk, which dates back to 1147. Other industry is concentrated in Orel. Near Bolkhov a little lignite is mined. Agriculture is well developed, the main crops being rye, buckwheat, oats and maize (corn). Hemp and potatoes are the chief industrial crops, but sugar beet is increasing in importance. (R. A. F.)

OREL, a town and *oblast* administrative centre of the Russian Soviet Federated Socialist Republic, U.S.S.R., lies on the Central Russian upland, on the headwaters of the Oka at the Orlik confluence, 379 km. (235 mi.) S.S.W. of Moscow. Pop. (1959) 149,905. Orel was founded in 1564 as a fortress in a defensive line against Tatar attacks. With the intensive agricultural development of the chernozem soils of the region, Orel became an important centre of the grain trade. The processing of agricultural products (flour milling, brewing, meat packing, boot and shoe making) remain important industries of the town; but first place in industry is now taken by engineering, especially the manufacture of machine tools and machinery for linen mills, glassworks, leather and footwear factories and for food-processing factories. The automatic grader factory is the largest of its kind in the U.S.S.R. Other engineering products include spare parts for tractors and agricultural machinery, air conditioning equipment and clocks. Clothing and bricks are also made. Orel is well served by communications: the main Moscow-Kharkov-Crimea highway and railways to Moscow, Yelets, Kursk and Bryansk. There are pedagogic and engineering institutes. The house of the novelist Ivan Sergeyevitch Turgenev is preserved as a museum. Orel was occupied by the Germans during World War II and was severely damaged in the heavy fighting of 1943. (R. A. F.)

ORELLANA, FRANCISCO DE (*c.* 1511–*c.* 1546), Spanish soldier and first explorer of the Amazon river, was born in Trujillo, Spain. He sailed for Peru in 1535, settling in Guayaquil in 1537. When Gonzalo Pizarro prepared an expedition to explore the unknown regions east of Quito, Orellana was appointed his lieutenant. In April 1541 he was sent ahead of the main expedition to seek provisions, taking a brigantine with 50 soldiers. Reaching the junction of the Napo and Marañón rivers, Orellana either could not, or more probably would not, return, thereby deserting the Pizarro expedition. He followed the great river system and went down the course of the Amazon until he reached the Atlantic ocean on Aug. 26, 1542. During his voyage he heard a tale of a tribe of fighting women from the natives, and he claimed to have encountered them near the mouth of the Trombetas, a tributary of the great river. It is generally accepted that Orellana named the river the Amazon because these women resembled the Amazons of Greek mythology. He proceeded to Trinidad and from there to Spain, where he sought the right to explore and exploit the lands that he had discovered. He was granted his request and recruited an expedition which sailed in 1544. Orellana failed in this venture, however, and he died soon afterward, probably in Venezuela. (U. S. L.)

ORE MOUNTAINS (Czech KRUSNE HORY; Ger. ERZGEBIRGE) form a range of hills bounding the Bohemian massif and extending for about 100 mi. along the frontier between the German Democratic Republic and Czechoslovakia. (For rock series and structure *see* CZECHOSLOVAKIA: *Physical Geography.*) The inner, Bohemian side of the range has a scarp face; the outer slope to the northwest is gradual. The highest summits Klinovec (Keilberg), 4,081 ft., on the Czechoslovakian side, and Fichtelberg, 3,983 ft., on the German side, are in the centre of the range. Loucna (Wiselstein), 3,136 ft., is at the northeastern end and Spicak (Spitzberg), 3,650 ft., at the southwestern. The name rightly suggests the tradition of mineral wealth, worked by generations of small groups of craftsmen: gold and silver, lead and copper, tungsten and pitchblende. These attracted the medieval immigrant groups of German miners from the northwest and, until the expulsion of the Germans after World War II, the whole area was predominantly German in character and tradition. To the original mining economy the Germans added forestry, furniture making, textile industries and some farming. The main feature of settlement on both sides of the ranges was that of small-scale towns. Since 1945 the region has seen the supplanting of a population almost wholly German by one almost wholly Czech. Certain parts, *e.g.*, the western salient into German territory, have suffered large losses in population; elsewhere the replacement has been more than 100%. Uranium deposits have been developed at Jachymov and Aue.

Road communications across the Erzgebirge are good. There are also railway routes, but the sinuous and often "dead-end" tracks on the Bohemian side show the problem offered by the great scarp face. Bozi Dar (Gottesgab) on the Aue-Karlovy Vary line is the highest town in Bohemia (3,300 ft.). There are numerous mineral springs and leading spa-resorts include Teplice-Sanov, Karlovy Vary, Brambach and Oberschlema. (H. G. S.)

ORENBURG, an *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., was formed in 1934. Area 47,838 sq.mi. It lies athwart the southern end of the Ural mountains, in the basin

of the middle Ural river. Only the western end of the *oblast* drains to the Volga, by the Samara and Bolshaya Kinel. Physically the *oblast* falls into three regions: the limestone plateaus of the Obshchi Syrt in the west, the narrow "waist" in the centre, where the Ural valley cuts through the mountains, and the flat Turgai tableland in the east. The climate is markedly continental with an annual range of 20° C. (68° F.), from a January average of −16° C. (4° F.) to a July average of 22° C. (72° F.). Rainfall is low, 15 in. a year. Most of the *oblast* lies within the steppe zone, with a natural vegetation of feather grasses and fescues on chernozem soils. To the north and northwest the *oblast* passes into the forest-steppe zone and there are groves of birch and pine. The large Buzuluk pine forest in the northwest was made a natural reserve in 1932.

In 1959 the population was 1,829,481 (45% urban), living in 10 towns and 19 districts. The largest are the administrative centre, Orenburg (267,317), Orsk (176,214) (*q.v.*), Buzuluk (54,851), Novo-Troitsk (54,484), Mednogorsk and Buguruslan. The *oblast* represents the southern end of the Urals mining and industrial area. The northwest, round Buguruslan, belongs to the Second Baku oil and natural gas field. Copper is mined at Mednogorsk, iron ore at Khalilovo, nickel at Novo-Troitsk and coal at Dombarovski. Salt is obtained near Sol-Iletsk. A pipeline brings petroleum from the Emba field on the Caspian to the refineries of Orsk. These raw materials form the basis of heavy industry, iron and steel in Khalilovo and Orsk, copper smelting in Mednogorsk, petro-chemicals in Orsk, engineering in Orenburg. Agriculture is also important, with spring wheat, maize (corn), millet and sunflowers the main crops. Considerable areas, especially in the southeast, have been plowed up in the Virgin and Idle Lands campaign. (R. A. F.)

ORENBURG (known as Chkalov from 1938 to 1957), a town and administrative centre of an *oblast* in the Russian Soviet Federated Socialist Republic, U.S.S.R., stands on the right bank of the Ural at the Sakmara confluence about 750 mi. E.S.E. of Moscow. Pop. (1959) 267,317. The first Orenburg fortress was founded at the Ural-Or confluence, where Orsk now stands, in 1735. In 1743 it was moved to the present site as the key fortress at the south-eastern end of the Samara defensive line, and centre of the Ural Cossacks. It was for long the chief military and administrative town of the trans-Volga, and its importance grew as trade with central Asia developed. The 19th-century caravansary, designed by the architect A. P. Bryullov, still survives. The town's commercial significance increased after the railway from Samara (modern Kuibyshev) was built in 1871–73. Modern Orenburg has important engineering industries, producing machine tools and instruments, iron foundry equipment and hydraulic presses. There are also large locomotive and rolling stock repair shops. Other manufactures include footwear and leather goods, silk, knitwear, flour and other foodstuffs. Communications are excellent, with railways west to Kuibyshev and European Russia, east to Orsk and Siberia and south to Sol-Iletsk junction, from which lines run west to Uralsk and Saratov and southeast to Aktyubinsk and Tashkent. Orenburg has pedagogic, medical and agricultural institutes. (R. A. F.)

ORENSE, capital of Orense province in Galicia region, northwestern Spain, and the seat of a bishopric, lies on the left bank of the Miño river, 176 km. (110 mi.) S.S.E. of La Coruña by road. Pop. (1960) 64,153 (mun.). The river is there crossed by one of the most remarkable bridges in Spain, built by Bishop Lorenzo in 1230 but frequently repaired since then; it has seven arches and a central span of 150 ft. The town has three parts: the medieval, the 19th-century expansion and the modern perimeter. Family mansions include those of the Oca and the Valladares (now a casino). Capilla del Cristo Crucificado (16th century) in the Gothic cathedral (rebuilt in the 13th century on the site of an earlier one) contains a crucifix venerated throughout Galicia. The warm springs at Las Burgas (known to the Romans as Aquae Originis or Urentes) are now utilized mainly for domestic supply. It was the residence of the Suebi (Suevi) tribes in the 6th–7th centuries, destroyed by the Moors (716) and rebuilt by Alfonso III (*c.* 884).

There are sawmills, flour mills, iron foundries and some light industries. The town is on the railway from Túy to Monforte de Lemos and the new Orense-Zamora line.

Orense Province is the only landlocked province in Galicia. Area 2,810 sq.mi. The population (451,474 in 1960) is predominantly rural. The highest peak in the region, Peña Trevinca (6,706 ft.), is between Orense and Zamora. The principal river system is the Miño-Sil, the fertile valleys of which produce maize (corn) and vines. A large new hydroelectric system on the Sil had a capacity by the mid-1960s of over 400,000 kw. The Ribeiro area is famous for its white wine. There is considerable pig breeding and potato growing. Industries include chemical manufacture (El Barco de Valdeorras, pop. 7,722) and tin, wolfram and granite quarrying. Other main towns are Viana del Bollo (9,200), Ribadavia (7,576), and Monterrey (6,509). There are many religious houses, including those of Santa María de Melon, Santa Comba de Bande, Celanova, Osera and Lemos. (M. B. F.)

OREODONT, a piglike, cud-chewing mammal (ruminant) of the extinct family Merycoidodontidae. They were distantly related to pigs in their general structure and to ruminants in their dentition. Extremely abundant and varied throughout most of the age of mammals (late Eocene through Pliocene—about 40,000,000 to 1,000,000 years ago) in North America, oreodonts have not been found on other continents. (G. G. Si.; X.)

ORESME, NICOLE (*c.* 1320–1382), French royal chaplain and bishop of Lisieux, a student and translator of Aristotle and the author of a treatise on monetary policy, was born about 1320, at Allemagne, near Caen in Normandy. As a young man, he studied theology, but it is not known when he took his degree. He was a bursar in the college of Navarre in the University of Paris from 1348 to Oct. 1356, when he became master of the college, resigning in Dec. 1361. He was a canon (1362) and then dean (1364) of Rouen and preached before Pope Urban V on Christmas Eve 1363. He had been appointed a chaplain to King Charles V by 1370, and was elected bishop of Lisieux in Nov. 1377 and consecrated in Jan. 1378. He died at Lisieux on July 11, 1382.

At the request of Charles V, Oresme translated the *Ethics, Politics* and *Economics* of Aristotle from their current Latin versions, and he wrote against the claims of astrologers to predict the future. His treatise *De moneta* was probably written about 1360. The first printed edition appeared in 1484 and it was frequently reissued in the 17th century. It derived from the *Politics* and was directed against any debasement of the coinage, such as had been practised in France before 1360. Oresme regarded the coin as a definite weight of precious metal, its fineness guaranteed by the issuing authority; it belonged, in his view, to the public, not to the prince, who had no right to vary its standard, weight or bimetallic ratio. He took no account of credit nor of bills of exchange, although they were in general use by the 14th century.

See C. Johnson (ed. and trans.), *The De Moneta of Nicholas Oresme* (1956); E. Bridrey, *La Théorie de la monnaie au XIVe siècle* (1906) (C. J.)

ORESTES, in Greek mythology, son of Agamemnon (*q.v.*) and Clytemnestra. According to Homer, Orestes was absent from Mycenae when his father returned from Troy to meet his death at the hands of Aegisthus, his wife's lover. On reaching manhood Orestes avenged his father by coming back from Athens and killing Aegisthus and Clytemnestra. His conduct is regarded as exemplary in accordance with the moral code of the heroic age. In Stesichorus, as the extant fragments show, the scene shifts to Sparta. Orestes is a mere child at the time of Agamemnon's murder and is smuggled to safety by his nurse. Clytemnestra is warned of impending retribution by a dream, and Orestes is haunted by the Furies (Erinyes) after her death. In Aeschylus' trilogy the *Oresteia* (*i.e., Agamemnon, Choephori* and *Eumenides*), Orestes acts in accordance with Apollo's commands, poses as a stranger with tidings of his own death and is all but overcome with compunction when he confronts his mother. After killing her he seeks refuge from the Furies at Delphi, and, still prompted by Apollo, goes to Athens and pleads his case before the Areopagus. The jury divides equally, Athena gives her casting vote for acquittal and the Furies are placated by being given new worship as Eumenides (kindly goddesses).

In Euripides' *Iphigeneia in Tauris* some of the Furies remain unappeased, and Orestes is ordered by Apollo to go to Tauris and to bring back to Athens the statue of Artemis. Accompanied by his close friend Pylades, he reaches his goal, but they are immediately arrested since it is the local custom to sacrifice all strangers to the goddess. The priestess in charge of the sacrifice is his sister Iphigenia (*q.v.*); they recognize each other and all escape together, bringing the statue with them. Orestes inherited his father's kingdom of Mycenae and added to it Argos and Lacedaemon. He married Hermione, daughter of Helen and Menelaus; according to one version, his murder of Neoptolemus at Delphi was due to a quarrel over Hermione, who was first betrothed (or married) to Neoptolemus. Orestes is said to have died of snakebite.

Ancient artists depicted the crucial moments in Orestes' life, favourite themes being the slaying of Aegisthus and Clytemnestra, the harrying by the Furies, the judgment of the Areopagus and the recognition of Iphigenia. Aeschylus' *Oresteia* showed the dramatic potentialities of the legend, and these were further exploited by Sophocles, whose *Electra* is close to the Homeric tradition and temper, and by Euripides, whose *Orestes* and *Electra* are modernizing reinterpretations stressing the flawed characters of the principals, and whose *Iphigeneia in Tauris* is a romantic melodrama.

Aspects of Orestes' story feature in the work of many later European dramatists, such as Voltaire's *Oreste*, Goethe's *Iphigenie auf Tauris*, Eugene O'Neill's *Mourning Becomes Electra*, and Jean Paul Sartre's *Les Mouches;* and, in the history of opera, Gluck's *Iphigénie en Tauride*, and Richard Strauss's *Elektra* (with libretto by Hugo von Hofmannstahl).

See O. Höfer in W. H. Roscher, *Lexikon der griechischen und römischen Mythologie*, vol. iii, col. 955–1014 (1897–1909).
(D. E. W. W.)

ORFF, CARL (1895–), one of the principal German composers of the period following World War II. Born at Munich on July 10, 1895, he studied at the Munich Academy of Music. Later he conducted at Munich, Mannheim and Darmstadt and wrote much incidental music for the theatre. In 1921 he studied with Heinrich Kaminski and became interested in musical education. In 1924 he founded with Dorothea Günther an institute for gymnastics, dance and music, and later he edited early musical dramatic works, notably Claudio Monteverdi's opera *Orfeo*. In 1937 he produced his *Carmina Burana*, a scenic oratorio on medieval secular poems preserved in a manuscript at the monastery of Benediktbeuern, Bavaria. It achieved much success in Germany and other countries on account of its ruggedness and simplicity. Later dramatic works were inspired by the Greek theatre and by medieval mystery plays. His *Catulli carmina* (1943) were musical plays on the poetry of Catullus, and the trilogy begun with *Carmina burana* was completed by *Trionfo di Afrodite* (1953). Other dramatic works on Greek subjects were *Antigonai* (1949) and *Oedipus der Tyrann* (1959). In his operas *Der Mond* (1939) and *Die Kluge* (1943), followed by *Die Bernauerin* (1945) and *Astutuli* (1946), he was inspired by Bavarian secular poetry. Some of his later works were inspired by religious subjects. They include the Easter play *Comoedia de Christi Resurrectione* (1957) and the Christmas story *Ludus de Nato Infanti Mirificus* (1960).

See A. Liess, *Carl Orff: Idee und Werk* (1955); C. Orff, *Ein Bericht in Wort und Bild* (1955). (J. S. Wn.)

ORFORD, ROBERT WALPOLE, 1st Earl of (1676–1745), British statesman, in power from 1721 to 1742, is usually regarded as the first British prime minister. He was born on Aug. 26, 1676, at Houghton hall, Norfolk, the third son of Col. Robert Walpole by his wife Mary, the daughter of Sir Jeffery Burwell of Rougham, Suffolk. He was educated at Great Dunham, Norfolk, and afterward became a scholar of Eton (1690–96) and subsequently of King's college, Cambridge (1696–98). The death of his elder surviving brother, Edward, cut short his academic career and, instead of entering the church, he returned to Norfolk to help administer his father's estates. He married Catherine, the daughter of John Shorter of Bybrook, Kent, a Baltic timber merchant, at Knightsbridge on July 30, 1700. After his father's death in 1700, he inherited a heavily encumbered estate and also the family parliamentary seat at Castle Rising, for which he was immediately elected. In 1702 he transferred to King's Lynn, which he represented, with one short intermission, for the next 40 years.

Early Career.—Walpole rapidly made his mark in the house of commons, earning the reputation of being a clear, forceful speaker, a firm but not fanatical Whig and an active parliamentarian. He was made a member in 1705 of Prince George of Denmark's council, which controlled the affairs of the navy during the War of the Spanish Succession. His ability as an administrator brought him to the attention of both the duke of Marlborough and Lord Godolphin. On Feb. 25, 1708, he was promoted secretary at war and in 1710 treasurer of the navy, a post from which he was dismissed on Jan. 2, 1711, with the advent of the Tory party to power after the general election of 1710. During these years Walpole had established himself as one of the foremost of the younger Whig leaders: in society as well as in politics he had made his mark. He had become a leading member of the Kit-Cat club; his circle of friends was large; but his expenses were so high that he was heavily in debt. He had relied on his political offices to keep himself afloat; nevertheless he refused to compromise his principles for the sake of his salary and perquisites.

His assiduity in attending the commons and his ability in debate, made him the effective leader of the opposition, and the Tories determined to ruin him along with the duke of Marlborough. In Jan. 1712 Walpole was impeached for corruption as secretary at war, found guilty, expelled from the commons and sent to the Tower of London. Naturally he was acclaimed as a martyr by the Whigs and he himself developed a passionate hatred for Robert Harley, earl of Oxford, and Henry St. John, Viscount Bolingbroke, who brought about his fall. He enjoyed his revenge in 1714 at the accession of George I when, as well as being made paymaster general of the forces, he became chairman of the secret committee that led to the impeachment for treason of both Bolingbroke and Oxford. Bolingbroke fled to France; Oxford went to the Tower. Walpole's obvious mastery of the commons, allied to his formidable industry, brought him rapid promotion. He became first lord of the treasury and chancellor of the exchequer on Oct. 11, 1715. His abilities also aroused jealousy, which was exacerbated by a conflict over foreign policy that saw Walpole and his brother-in-law, Charles, Viscount Townshend, on one side and on the other two of the king's closest advisers, James Stanhope (*see* Stanhope, James Stanhope, 1st Earl) and Charles Spencer, earl of Sunderland. Walpole and Townshend maintained that British interests were being sacrificed to the king's Hanoverian interests in order to curry favour. The break came in 1717 and Walpole and Townshend left the ministry: shortly afterward a violent quarrel between the king and the prince of Wales split the royal family, and the opposition acquired its own court at the prince's residence, Leicester house.

During the next three years Walpole fought the government on every issue, achieving considerable success in bringing about the rejection of the peerage bill (1719), which would have limited the royal prerogative in the creation of peers. During this time, too, he became very friendly with Caroline of Ansbach, the princess of Wales, who was to help maintain him in power when her husband succeeded to the throne in 1727. Walpole used his influence with the prince to bring about a reconciliation with the king in April 1720 and his own subsequent return to the ministry as paymaster general of the forces. Townshend became president of the council; Stanhope and Sunderland, however, retained great power.

Aftermath of the South Sea Bubble.—No sooner was Walpole back in office than the country was caught up in the speculative frenzy associated with the South Sea scheme, which had been formulated to take over the national debt. (*See* South Sea Bubble.) Although Walpole had favoured letting the Bank of England take over the debt rather than the South Sea company, he was no more prudent than many others and invested heavily in South Sea stock. He was saved from financial disaster by the foresight of his banker, Robert Jacomb. Nevertheless Walpole had not been a promoter of the scheme, and he was free from the stigma of corruption that marked many other ministers as well as the king's German favourites. He used his great political skill and persuasive powers of argument in the commons to save the Whig

leaders and the court from the consequences of their folly. Some members had to be sacrificed to appease public opinion, among them John Aislabie, chancellor of the exchequer: others died under the strain, the most notable being Stanhope and the two Craggs. Walpole restored confidence, maintained the Whigs in office and greatly improved his own and Townshend's standing at court. He became first lord of the treasury and chancellor of the exchequer in April 1721, offices that he was to hold until 1742. Townshend became once more secretary of state and took over the control of foreign affairs. For some time, Walpole and Townshend were forced to share their power with Carteret (*see* GRANVILLE, JOHN CARTERET, Earl) who had succeeded to Sunderland's influence after Sunderland's sudden death in April 1722. By 1724, however, Walpole and Townshend obtained the dismissal of Carteret from his secretaryship of state and had him sent to Ireland as lord lieutenant to deal with the troubles that had arisen there over William Wood's halfpence (*see* KENDAL, EHRENGARDE MELUSINA, Duchess of). For the rest of George I's reign Walpole and Townshend remained at the head of the ministry. Their position steadily grew stronger. The hopes of the Jacobites, which the South Sea Bubble had fanned, were quashed in 1723 by the exposure and condemnation of their leader, Francis Atterbury, bishop of Rochester. The outlook for the Tory party was equally gloomy in spite of the pardon given to Bolingbroke by 1725; ministers had not enjoyed such absolute majorities in the commons and the lords since the days of Elizabeth I.

The Long Ascendancy.—The supremacy in the commons was maintained by Walpole until 1742. In 1727, at the accession of George II, he suffered a minor crisis when for a few days it seemed that he might be dismissed, but Queen Caroline prevailed on her husband to keep Walpole in office. In 1730 he quarreled with Townshend over the conduct of foreign affairs and forced Townshend's resignation; but his retirement had no effect on Walpole's position either at court or in the commons. These were the years of Walpole's greatness. His power was based on the loyal support given to him by George I and George II. This enabled him to use all royal patronage for political ends and Walpole's appointments to offices in the royal household, the church, the navy, the army and the civil service were, whenever possible, made with an eye to his voting strength in the house of commons. By these means he built up the court and treasury party that was to be the core of Whig strength for many generations after his death. These methods, however, never gave him control of the house of commons. His majorities at Westminster came about because his policy of peace abroad and low taxation at home appealed strongly to the independent country gentlemen who sat in parliament. Also Walpole possessed remarkable powers in debate: his knowledge of the detail of government, particularly of finance, was unmatched and his expression was clear, forceful and always cogent. He never underestimated the powers of the commons and no minister, before or since, has shown such skill in its management.

Walpole needed all his art, for his rule was never free from crisis. Foreign affairs gave him constant trouble. Although Townshend had secured the prospect of a general settlement by the treaty of Hanover in 1725, which helped to strengthen the alliance between England and France, the difficulties which had arisen with Spain over Gibraltar and British trading rights in the West Indies proved intractable and England hovered on the brink of war until Walpole himself intervened. By showing great willingness to compromise and negotiate, he secured the treaty of Seville in 1729. This was followed by a general settlement in 1731 at the treaty of Vienna. When war broke out in 1733 over the question of the succession to the Polish throne, Walpole had to use all his authority and influence with the king in order to maintain England's neutrality.

Many politicians, particularly those whom Walpole had driven into opposition, regarded his foreign policy as a betrayal of England's interests. They thought that he had become the dupe of France to the neglect of England's former allies (the Austrians and the Dutch), and that his desire to maintain friendship with France led inevitably to weakness toward Spain. They also strongly disapproved of his use of patronage which they stigmatized as corruption. They condemned his financial schemes as a sham, particularly the sinking fund to abolish the national debt. The prime movers in this opposition were William Pulteney (afterward 1st earl of Bath), a very able Whig whom Walpole had rejected in 1724 in favour of the duke of Newcastle as secretary of state, and Bolingbroke, the former Tory leader. They drew together a miscellaneous collection of members in opposition: Jacobites, Hanoverian Tories, dissident Whigs and urban radicals. They attempted to give unity and coherence to the party so formed, but with little success. The liveliest part of their campaign was the violent press agitation against Walpole. For this purpose they founded *The Craftsman* which denigrated Walpole and his ministry week after week. Walpole was mercilessly lampooned in pamphlets, ballads and plays, as well as in the newspapers; and this constant stream of abuse, which was not without a certain element of truth, did much to bring both parliament and politics into contempt.

The great opportunity for the opposition came in 1733 when Walpole decided to check smuggling and customs frauds by imposing an excise tax on wine and tobacco. This was extremely unpopular, particularly with the London merchants, and the opposition did all in its power to influence opinion. Walpole saved himself from defeat only by withdrawing this measure. Those politicians who had been indiscreet enough to show active opposition to Walpole's bill immediately lost their offices. The duke of Bolton was dismissed from his lord lieutenancies, the earl of Chesterfield ceased to be lord steward and Lord Cobham lost his regiment. However, these dismissals weakened Walpole's position; he lost considerable debating skill as well as votes in the house of lords, which at that time still played a most important part in government. Also, the list of able but dismissed Whig politicians grew formidably large after 1733, large enough indeed to supply an alternative Whig ministry to Walpole's own and, after the excise crisis, the opposition Whigs had far less need to rely on Tory and Jacobite elements in their battle against Walpole. Bolingbroke himself realized this; he withdrew from politics and retired to France in 1735, admitting defeat in his lifelong struggle with Walpole. The latter speeded him on his way with a particularly blistering attack on Bolingbroke's secret attachment to the French ministry from whom he had accepted money.

Walpole had successfully won the general election of 1734. This had given rise to many violent contests and a resurgence of the old bitterness about excise and Walpole's unpopularity was underlined by the loss of many seats in the large seaports and heavily populated counties. Nevertheless his majority, although diminished, remained comfortable. Without much difficulty he surmounted the troubles that arose in Edinburgh (the Porteous riots caused by the passing of the Gin act in 1736); he easily persuaded the commons to reject Sir John Barnard's scheme to reduce the interest on the national debt and showed his contempt for the literary opposition by imposing regulations on London theatres (1737). Yet from 1737 his position began to weaken. The death of Queen Caroline had less effect than many have assumed, for by then George II had developed great loyalty to his minister. More important was Walpole's increasing age which led young politicians, such as William Pitt (afterward earl of Chatham), to look elsewhere for their future advancement. The emergence as a leader of the opposition of Frederick, prince of Wales, who had quarreled violently with his parents, provided a focus and a court for the "patriot boys" as these young Whigs came to be called. The growing difficulties with Spain over trading matters in the West Indies were used by this opposition to embarrass Walpole. He did his utmost to settle these difficulties by negotiation but in 1739 he was forced to declare war. He bitterly disapproved of the war and wished to resign but the king insisted that he remain in office. These years, too, were darkened by private grief as well as public anxiety. His wife, with whom he had been on indifferent terms, died in 1737, and he was married by March 3, 1738, to his mistress of long standing, Maria Skerritt, a woman of great charm and wit. Three months later she died in childbirth.

The war with Spain did not prosper and the volume of opposition continued to mount against Walpole. He succeeded in winning the general election of 1741 but many Whig politicians, and a con-

siderable number of independents, did not consider him capable of directing the war with Spain vigorously enough, nor surviving another seven years' parliament. His resignation was forced on Feb. 2, 1742, on a minor issue. The king created him earl of Orford (he had been knighted in 1725) and gave him an annual pension of £4,000 but the commons set up a committee to investigate his ministry with a view to impeachment. They failed to secure sufficient evidence and the rancour against Orford petered out. For the rest of his life he continued to play an active and valuable part in politics. He did his utmost to secure the dismissal of Carteret, who had become secretary of state on the fall of his ministry, and to secure the promotion of Henry Pelham, his protégé and leader of the Walpole Whigs, to the position of chief minister. Orford's influence with George II remained very powerful up to his death on March 18, 1745, at his house in Arlington street, London. He was buried at Houghton, Norfolk.

Assessment of Walpole.—Although Walpole rejected the title of prime minister, which he regarded as a term of abuse, his control of the treasury, his leadership of the commons and the confidence that he enjoyed of the two sovereigns whom he served, demonstrated what was required to give stability and ordered control to 18th-century politics. He used his power to maintain the supremacy of the Whig party, as he understood it, and his prime concern was to forestall the machinations of the Jacobites, which he took very seriously, by securing the Hanoverian succession. He thought that this could best be achieved by prosperity and low taxation, which in turn depended on peace and on freedom from foreign entanglements. In order to achieve strong support for this policy he created as many obligations as possible among the politically powerful groups in the country. The Jacobite rebellion in 1745 demonstrated both the reality of his fears and the success of his policy.

The influence of Walpole's long ministry on the structure of 18th-century politics was profound. The Tory party, split as it was between Hanoverians and Jacobites, faded into insignificance, and to be a Whig became a necessity for the politically ambitious. The struggle for power ceased to be a conflict between two parties and became a battle fought between divergent groups, personalities and policies within the Whig party itself, in order to gain the support of the court on the one hand and the independent country gentlemen in parliament on the other. The frank realism which Walpole had used in all appointments to office, and the violent, prejudiced and often exaggerated criticism to which this gave rise, did much to bring the institutions of government into disrepute, and to strengthen the early growth of urban radicalism, particularly in the City of London. On the other hand Walpole's ministry had little influence on constitutional development: many generations were to pass before any minister wielded power comparable to his. Like his master, George II, he disliked cabinet government and used it as sparingly as possible. He showed what could be done within the accepted conventions of the constitution: he never attempted to change them.

One side of Walpole's life is too little noted. He possessed remarkable delight in and judgment of works of art. His house, Houghton hall, Norfolk, built and furnished under his close supervision, is a masterpiece of Palladian architecture. His collection of pictures, afterward sold by his grandson to the empress of Russia and now in the Hermitage museum, Leningrad, was one of the most remarkable in Europe. He delighted in ostentation and lived in great magnificence, spending freely the huge fortune that he made out of judicious speculation and public office. He deliberately cultivated a frank, hearty manner but his political subtlety has scarcely been equaled.

See also English History and references under "Orford, Robert Walpole, 1st Earl of" in the Index.

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ORGAN, in biology, a group of intimately associated tissues that performs certain functions in a living organism. In higher animals organs constitute organ systems; *e.g.*, the esophagus, stomach and liver are organs of the digestive system. In higher plants the leaf, stem and root are vegetative organs, while parts of cones and flowers are reproductive organs. *See* Anatomy (Articles on); Embryology and Development, Animal: *Experimental Embryology;* Histology; Plants and Plant Science: *Morphology of Plants.*

ORGAN, a keyboard instrument in which the sound is produced by pipes to which wind is supplied through the mechanism of the organ, under the control of the organist. The word derives from the Greek *organon* and Latin *organum*, an instrument.

By common usage "organ" has come to embrace any keyboard instrument capable of producing indefinitely sustained sounds, but these should be particularized as reed organ or electronic organ. Organ, alone, implies an organ with pipes and the term pipe organ is tautologous. For information about the reed organ, or harmonium, *see* Harmonium; for a discussion of the electronic organ *see* Electronic Music.

GENERAL DESCRIPTION AND MECHANISM

An organ is divided into three main parts. At one end of the instrument are the keyboards, or manuals, and other controls that collectively are called the console. At the other end are the pipes that produce the tone. Between these two is the mechanism, or action, which accounts for a large part of the bulk and cost of any organ. The simplest type of organ has one keyboard and one pipe to each note. The pipes stand in a row on a wind-tight box or chest that is supplied with wind, through a trunk, from bellows. Under each pipe is a valve, or pallet, connected by a system of cranks and levers to its respective key of the keyboard. A reservoir is interposed between the bellows and the wind chest, appropriately weighted to keep the supply of wind at a constant pressure. This reservoir has a blow-off valve that comes into operation when the reservoir is full. The bellows may resemble basically the familiar domestic type that is operated by hand or foot, but wind is normally supplied from an electrically driven rotary blower.

The pitch of each note is determined by the length of the pipe; the longest pipe makes the deepest note, the shortest pipe the highest note. If two pipes sound an octave apart, the effective length of the higher-pitched pipe is exactly half that of the lower-pitched.

Since the tone of a pipe sounding on a constant pressure of wind is immutable, both as to quality and quantity, the uses of an organ with only one pipe to each note are strictly limited. Even the smallest organs therefore have at least three pipes to each note, and organs of cathedral size commonly have as many as 100 to each note.

These sets, or ranks, of pipes are arranged in parallel rows on the wind chest. The pallet controlled from each note admits wind to all the pipes belonging to that note; but in order that the organist may be able to use at will all, none or any of the sets of pipes, an intermediate mechanism is provided, by which he may stop off any set or sets of pipes. From this function both the control at the console by whose operation the pipes are stopped off and each complete set of pipes have come to be known in English as a "stop."

The operative part of the stop mechanism lies between the pallet and the foot holes of the pipes. It normally consists of a strip of wood (or sometimes plastic) running the full length of the set of pipes, or stop. In it is drilled a series of holes. One hole registers exactly with each pipe. The strip of wood is placed in a close-fitting guide in which it may be moved; when it is moved longitudinally a short distance so that its holes no longer register with the pipes, wind will no longer reach that set of pipes, even when the organist opens the pallets. These strips are therefore called sliders, and wind chests in which the stops are operated in this way are called "slider chests." There are other ways of

working the stops, both ancient and modern, which will be referred to later, but the slider chest was in almost universal use before the 20th century and many modern organ builders consider it the best. The slider is connected to the console by a system of levers and cranks, and it terminates in a knob that the organist pulls toward him to bring the stop into play or pushes in to silence it.

It often happens that the organist needs (1) to play polyphonic music in two or more contrasted parts; (2) to give prominence to a melody against a softer accompaniment; or (3) to play loud and soft passages in rapid succession. None of these effects can be achieved on an organ with one keyboard as so far described. Loud and soft passages can be played to some extent, but to change the stops between each alternation takes time, which is not always available. For this reason organs of more than about seven or eight stops usually have two manuals, each controlling its separate wind chest and stops. Each manual department is self-contained, so that the organ is really a composite instrument. By prearranging the stops on the manuals the organist may thus perform in any of the three ways mentioned above. The organist, therefore, may vary the sounds he produces in one or both of two ways: (1) by changing the stops on the manual he is playing or (2) by leaving the stops as they are and changing from one manual to another.

Since the 18th century he has, however, yet a third way of controlling the volume of sound. The pipes of one or more manuals are usually placed in a box, one side of which consists of hinged and movable shutters that are connected to a pedal at the console. By opening and closing the shutters the sound from the stops of the manual concerned are made to sound louder or softer. These boxes are therefore called swell boxes.

Since the 14th century, one department of the organ has commonly been played from a keyboard, or more properly a pedal board, controlled by the organist's feet. The pedal department is basically like the manual departments but controls the longer pipes.

The organist sometimes wishes to combine the stops of two different manuals or to couple one or more of the manuals to the pedals. This is effected by a simple mechanism, called a coupler, that is controlled by a stop knob at the console (stops that control a set of pipes are called speaking stops).

Certain combinations of stops on each manual are more commonly needed than others; in order that these combinations may be readily available the console is provided with a number of short pedals disposed above the pedal board. Each of these pedals is connected to one commonly needed combination of stops. When a pedal is depressed, the stops connected to it are drawn on and any others that are already drawn at the time are pushed off. These pedals are therefore known as combination, or (more generally) composition, pedals.

In the simplest mechanical action the connection from key to pallet is by a series of cranks and levers. The over-all distance may be considerable and the main distance is bridged by trackers, slender strips of wood that always work in tension.

The mechanism of the organ as described so far is entirely mechanical and such organs are said to have tracker action. Tracker action is used in many modern organs, especially in Germany, the Netherlands and Scandinavia, and many organists prefer it to all other forms because it is so direct and sensitive in response. Organs may, however, have pneumatic, direct electric or electropneumatic action, although these actions result in a loss of touch and responsiveness.

In very large organs with tracker action, considerable strength may be necessary to depress the keys. Also, where the layout of the building is inconvenient and the departments of the organ have to be widely separated, tracker action is not practicable. To overcome these difficulties, especially with the object of lightening the touch, other forms of action were devised.

The first effective system was invented by Charles Spackman Barker (1804–79), an Englishman. It consisted of a series of small high-pressure pneumatic bellows, or motors, one attached to each note of the main manual at the console. When a note was depressed, compressed air was admitted to the motor, which in turn operated the tracker action. Lacking encouragement at home, Barker went to France, where the great French builder A. Cavaillé-Coll employed the Barker lever almost exclusively from 1840 onward.

Later, the trackers were supplanted by lead tubes and the connection from key to pallet was solely by compressed air traveling through these tubes. This system was called tubular pneumatic action. At its best it was remarkably effective, being reliable, long-lived, reasonably silent in action and perfectly prompt in operation. At anything but its best it was none of these things, and its worst fault usually lay in sluggish operation. Tubular pneumatic action is very seldom used in modern times.

As early as 1860 electric action was used experimentally, and in 1888 it was employed by Henry Willis (1821–1901) at Canterbury cathedral. His action remained in satisfactory use there for 50 years before it needed to be replaced. The modern type of electric action was pioneered by Robert Hope-Jones (1859–1914) at the end of the 19th century. Direct electric action may be used successfully for very small organs, but for larger instruments a combination of electric and pneumatic mechanism is universal. In this system the depression of a key completes an electrical circuit, which energizes an electromagnet, allowing wind to enter a pneumatic motor attached to the wind chest, and this motor opens the pallet.

The stops may be operated in exactly the same way but, where they are operated electrically, the sliders are often replaced by a series of valves, one to each pipe. The organ is then said to have a sliderless chest, and the most usual type is the pitman chest, so-called because it contains a type of floating valve called a pitman.

The composition pedals can also be operated electropneumatically. They are usually supplemented by a series of composition buttons, or pistons, placed in the key slips on each manual, where they are conveniently operated by the organist's thumbs. The pistons may easily be made adjustable so that the organist can quickly alter the combination of stops controlled by each one.

No electric action has yet lasted more than 50 years without needing a comprehensive rebuilding, and many have lasted for much shorter periods. But with improvements in design and standardization of parts, it may be anticipated that rebuilding will become less frequent and expensive. On the other hand, there are small tracker action organs working satisfactorily after 300 years, and even large ones have continued to operate for more than a century despite almost total neglect. Tracker action does, however, demand a vertical layout, directly above the console, and electric action possesses many mechanical conveniences.

Many organists interested in fine phrasing and articulation feel that these are only realizable through the medium of tracker action, where there is a direct connection between player and pallet. The use of tracker action was revived, particularly on the continent, during the second quarter of the 20th century.

A compromise was used successfully in France, with tracker action used for each department but with the coupler action operated electrically. This arrangement has considerable merit, since the coupling together of three or four manuals with tracker action results in a very heavy touch.

TONE PRODUCTION

The pipes are the most important part of an organ. There are two main categories: flue pipes and reed pipes.

Flue Pipes.—Flue pipes (made either of wood or metal; their construction is basically similar in principle) account for about four-fifths of the stops of an average organ. Fig. 1 shows a front view and a vertical section of the most typical sort of metal flue pipe. The pipe consists of three main parts: (1) the foot; (2) the mouth; and (3) the speaking length.

The pipe stands vertically on the wind chest and wind enters at the foot hole. The foot is divided from the speaking length by the languet (languid), a flat plate; the only airway connection between the foot and the speaking length is a narrow slit called the flue. The wind emerges through the flue and strikes the upper lip, producing an audible frequency, the pitch of which is determined

Console of the organ rebuilt by F. H. Clicquot in 1764 at St. Gervais church, Paris, France. The pedals are modern

Organ at the Grote Kerk in Haarlem, Neth., built by Christian Müller, 1738

Organ at St. Maximin, Provence, France, built by J. E. Isnard, 1773

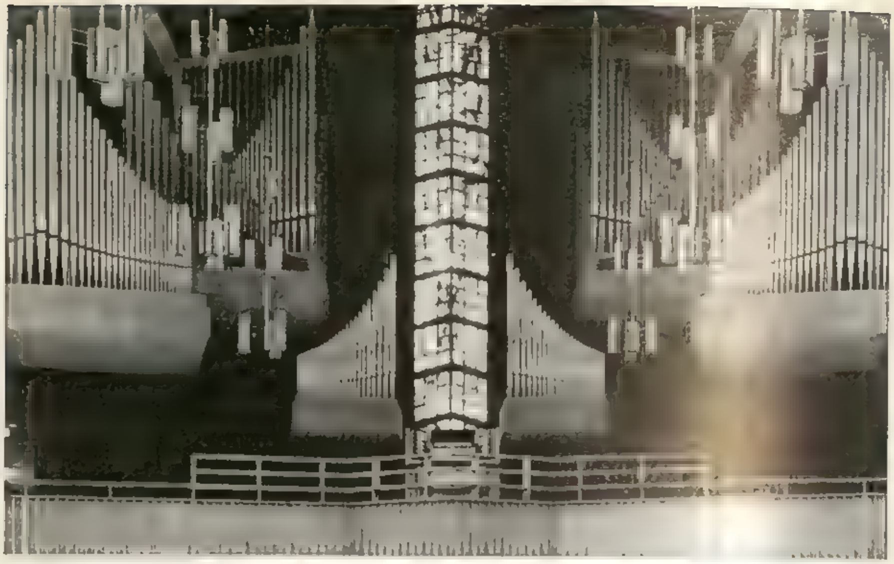
Organ at Adlington Hall, near Macclesfield, Eng., probably built by Bernard Smith, c. 1670

ORGANS OF THE 17TH AND 18TH CENTURIES

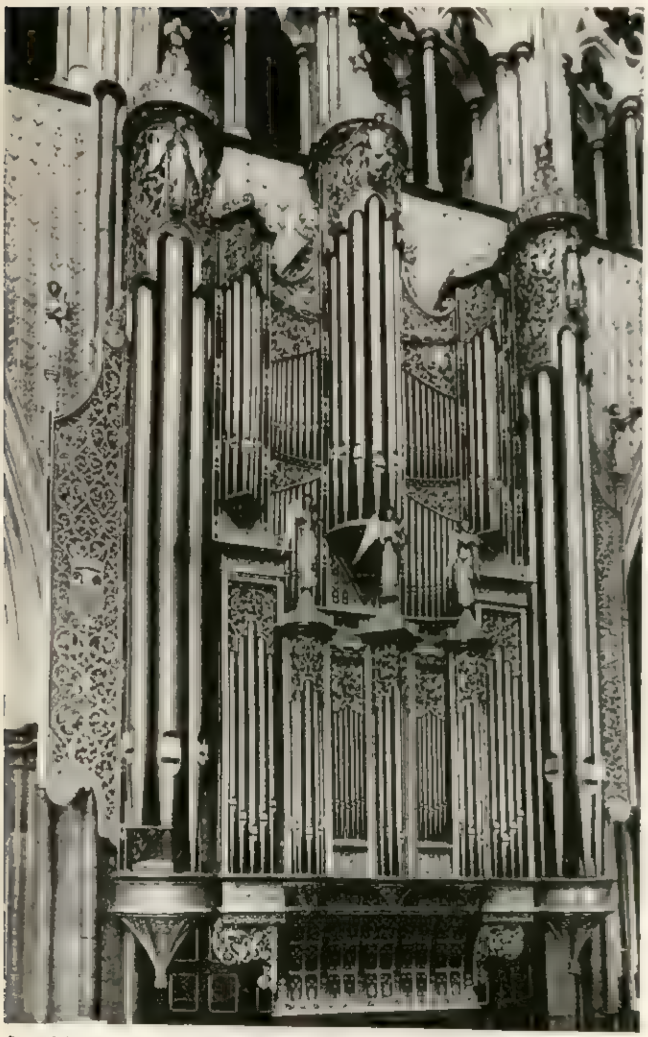
BY COURTESY OF (TOP LEFT) STUDIO STA PHOTO, (TOP RIGHT) INTERNATIONAL ORGEL IMPROVISATIE CONCOURS ZOMER ACADEMIE VOOR ORGANISTEN, (BOTTOM LEFT) A. BERTRAND, (BOTTOM RIGHT) BRITISH TRAVEL AND HOLIDAYS ASSOCIATION

ORGAN

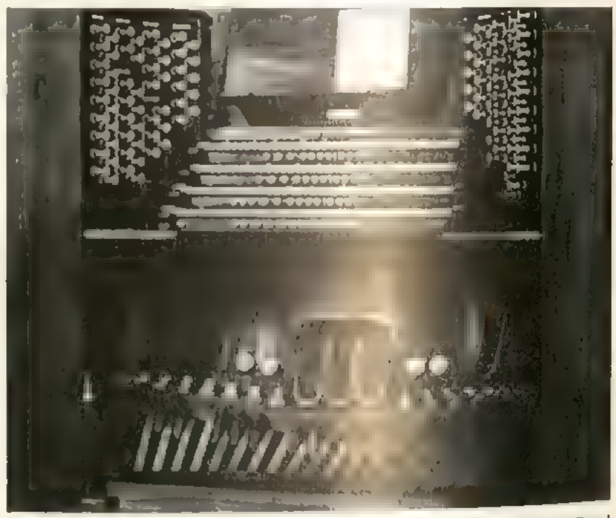
ORGANS BUILT IN THE 20TH CENTURY



Organ in Memorial chapel, Valparaiso university, Valparaiso, Ind., U.S., built by Herman L. Schlicker, 1959



One of the twin cases of organ pipes in Westminster abbey, London, Eng., designed by J. L. Pearson in 1899. They were painted, predominately in red, blue and gilt, in 1960 to the design of S. E. Dykes-Bower



Console of the organ built by Harrison & Harrison in 1954 at the Royal Festival hall, London

Organ at Doetinchem, Neth., built by D. A. Flentrop, 1952. A modern example of the "Werkprincipal" layout

by, and amplified in resonance by, the speaking length of the pipe. A pipe of this kind is, in fact, identical in principle with a recorder or a tin whistle; but whereas they have holes along the speaking length, which the player covers and uncovers with his fingers to secure the notes of the musical scale, in an organ there is a separate pipe for each note.

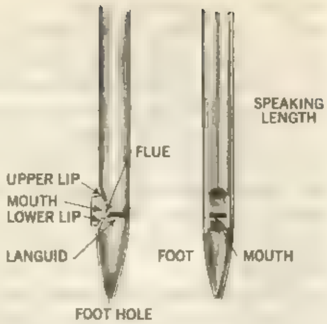


FIG. 1.—TYPICAL FLUE PIPE (OPEN DIAPASON): (LEFT) SIDE VIEW; (RIGHT) FRONT VIEW

The tone of a pipe is determined by many factors, including the pressure of the wind supply, size of foot hole, width of flue, height and width of mouth and the scale, or diameter, of the pipe relative to its speaking length. The material of which the pipe is made also exerts an influence; it may be "metal" (*i.e.,* an alloy of lead and tin), wood or, more rarely, pure tin or copper and zinc for the bass pipes. The pipes may also vary in shape, a common variant being an upward taper in which the pipe is smaller in diameter at the top than at the mouth. Or, the top of the pipe may be completely closed by a stopper. Such a pipe is said to be stopped; a stopped pipe sounds an octave lower in pitch than an open pipe of the same speaking length.

Open pipes of large diameter are said to be of "large scale" and open pipes of small diameter are said to be of "small scale." Large-scale pipes produce a dull or foundational quality of tone that is free from the higher harmonics or partials. Small-scale pipes produce a bright quality of tone that is rich in harmonics. Stopped pipes can be particularly foundational in tone, and they favour the odd-numbered at the expense of the even-numbered partials. Tapered pipes are somewhere between stopped and open pipes in tone quality.

Flue pipes are tuned by increasing or decreasing the speaking length. In the past, several methods of tuning were employed, but in modern times this is done by fitting a cylindrical slide over the free end of the speaking length and sliding it up and down as required. In stopped pipes, the stopper is pushed farther down to sharpen the pitch or is pulled upward to lower it.

The pipe maker thus broadly fixes the type of tone that a pipe will produce; but this is further controlled within fairly wide limits by the wind pressure and, finally, by the voicer, who adjusts the tone of each pipe by manipulating the foot hole, flue, and upper and lower lips. The attack of the note may also be greatly influenced by cutting a series of small nicks in the edge of the languid. Heavy nicking, as commonly practised in the early 20th century, produces a smooth and sluggish attack. Light nicking or no nicking, as used up to the 18th century and in more advanced modern organs, produces a vigorous attack with a slight effect like tonguing in a woodwind instrument. This enhances the vitality and clarity of an organ. The voicer is the artist upon whom the ultimate success of any organ depends, although the tonal designer or architect is hardly less important. It is he who decides upon the choice of stops, their disposition in the organ and the scales to be followed by the pipe maker. A completely successful organ depends upon the effective co-operation of designer and voicer.

Reed Pipes.—Reed stops have beating reeds of a kind that finds several counterparts in the orchestra, and no doubt organ reeds were originally copied from instrumental prototypes.

The shallot, seen in cross section in fig. 2, is roughly cylindrical in shape with its lower end closed and the upper end open. A section of the wall of the cylinder is cut away and finished off to a flat surface, as shown in fig. 3. The slit, or shallot opening, thus formed is covered by a thin brass tongue that is fixed to the upper end of the shallot. The tongue is curved and normally only partially covers the shallot opening. But when wind enters the boot, the pressure of the wind momentarily forces the tongue against the shallot, completely closing the opening. Immediately, the elasticity of the brass asserts itself and the tongue reverts to its curved shape, so uncovering the opening. This process is repeated rapidly. The frequency of the pulsations of air that enter the shallot is determined by the effective length of the reed and in turn determines the pitch of the note. Thence the pulsations pass out into the tube, or resonator, which further stabilizes the pitch and decides the quality of the note. Most reed tubes have a flared shape, as shown in fig. 2. As in flue pipes, a wide scale favours a fundamental tone and a narrow scale favours a bright tone. Cylindrical resonators produce an effect similar to that of stopped flue pipes, the note being an octave lower than the equivalent flared pipe and the tone favouring the odd partials. Some reed stops, such as the Vox humana, have very short resonators of quarter or eighth length. When the stops have no mathematical relationship to the pitch they are known as regals; this class of stop was very popular in the 17th century, particularly with the north German school, and its use was revived in modern times. Their short resonators have varying and peculiar shapes, which produce a highly characteristic snarling tone; they are exceedingly difficult to keep in tune.

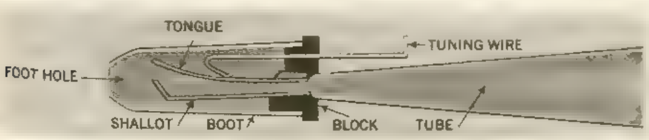


FIG. 2.—SECTION THROUGH REED PIPE (TRUMPET)

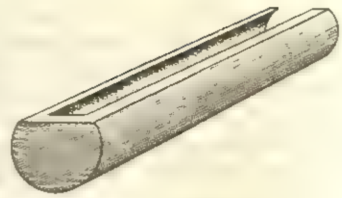


FIG. 3.—SHALLOT

Reed pipes are tuned by moving the tuning wire, thus shortening or lengthening the tongue (fig. 2). As in flue pipes, the scale and shape of the resonator largely determine the quality of tone to be produced; but the wind pressure, shape and size of shallot, and thickness and curvature of the tongue also have important influence. The tongues may also be weighted with brass or felt weights; this weighting produces a smoother quality of tone, especially in the bass notes.

Organ reeds have been referred to as "beating reeds" because the tongue is larger than the shallot opening and therefore beats against it. In a free reed, on the other hand, the tongue is smaller than the opening and so vibrates through, rather than against, it. Harmoniums and mouth organs have free reeds, which are virtually never used in organs.

Choruses.—It has already been explained that the pitch of any pipe is proportional to its length. Most modern organs have a manual compass of five octaves, from C to C; an open stop sounding at the pitch of the human voice has a longest pipe of 8-ft. speaking length (64 vibrations per second). The shortest pipe is thus 3 in. long (2,048 vibrations per second). The most characteristic tone of the organ is produced by its diapason stops. These are of medium scale (usually about 6-in. scale at the 8-ft. pipe) and moderate harmonic development; *i.e.,* neither particularly dull nor bright. Such a tone quality becomes boring if heard for a long time. Also, when greater power is required, there is a distinct limit to what can be done by adding more stops of unison pitch. From the earliest times, stops, especially the diapasons, were arranged in choruses, and the diapason chorus is the very backbone of any organ; without a complete diapason chorus, an organ is hardly worthy of the name.

A chorus consists of stops of roughly similar quality and power but at a great variety of pitches.

A unison diapason is known as "Diapason 8 ft." because of its longest (8-ft.) pipe, and the figure 8 appears on the stop knob at the console to give an indication of its pitch. The first step toward a chorus is to add a stop at octave pitch, whose largest pipe is therefore 4 ft. long. Next comes a 2-ft. stop, while in the other direction the suboctave pitch may be represented by a 16-ft. stop.

The top pipe of a 2-ft. stop has a speaking length of only $\frac{3}{4}$ in., and this is about the practical upper limit. Nevertheless, an organ with nothing higher in pitch than a 2-ft. stop would be

lacking in brilliance, especially in the lower parts of the compass. From the earliest times organs have, therefore, been supplied with what are known generically as mixture stops, which have several high-pitched pipes to each note. But since, for example, a 1-ft. rank could not be carried right up to the top note, it breaks back an octave at some convenient point in the compass. Ranks pitched even higher will break back more than once. Thus, in the bass a mixture adds definition to the slow-speaking, low-pitched pipes; in the treble, where the small pipes tend to be lacking in power, it duplicates the unison and octave ranks. A mixture therefore helps to maintain a balance of power between bass and treble, while adding harmonious power of a kind that is completely peculiar to the organ and can be produced in no other way.

Mixture stops also contain ranks sounding at pitches other than in octaves with the 8-ft. diapason. In chorus mixtures these sound at a fifth above the unison, although ranks sounding at a third above and even at a flat seventh (and their octaves, respectively) are also found; but it is recognized that the latter is artistically objectionable, and even the third-sounding rank is best restricted to mixtures intended for somewhat special effects. The theoretical justification for these quint and third sounding ranks is that they reinforce the natural upper partials of the harmonic series, but they were included in organs long before this was understood. The fact is that they were found to sound well, and any attempts to build organs without mixtures and off-unison ranks have been completely unsuccessful. The colourfulness and vitality of any organ depends largely upon copious, artistically voiced mixtures.

Off-unison ranks are also available as separate stops, mostly sounding at an interval of a twelfth ($2\frac{2}{3}$ ft.), seventeenth ($1\frac{3}{5}$ ft.) or nineteenth ($1\frac{1}{3}$ ft.) above the unison. These are used melodically to colour the unison and octave stops, and they may be wide or narrow in scale. Such stops are known as mutation stops, as opposed to the mixtures, or chorus stops. Their use is essential for the historically (and therefore artistically) correct performance of organ music written before 1800 and of much modern music as well. After a period of disuse throughout the 19th century, they are again included in all modern organs that have any pretensions to being artistically competent.

In the "classical" organ as it existed up to about 1800, each manual had its own diapason chorus, the subsidiary manuals having choruses with a preponderance of 4-ft. or 2-ft. pitch, as opposed to the 8-ft. preponderance of the principal manual. The pedal organ, whose unison pitch is 16 ft., an octave below that of the manuals, has a 16-ft. preponderance.

HISTORY OF THE ORGAN TO 1800

The earliest history of the organ is so buried in antiquity as to be mere speculation. The earliest surviving record is of the Greek engineer Ctesibius, who lived in Alexandria in the 3rd century B.C. He is credited with the invention of an organ very much on the lines of the single-manual, slider-chest organ already described, except for its wind supply, which made use of a principle that was most ingenious though applicable only to a very small instrument. A piston-type pump supplied air through an ordinary clack valve to a reservoir; at its upper end this reservoir communicated directly with the wind chest. The reservoir, conical in shape and with no bottom, was placed in a large drum-shaped container that was partly filled with water. As the reservoir became filled with air the level of the water inside it was forced downward and rose correspondingly in the container outside the reservoir. If the reservoir was completely filled with air, the air would escape round its lower edge. In this way a more or less equal pressure of air was maintained inside the reservoir. Because of this arrangement the instrument was known as a hydraulis. A clay model of a hydraulis was discovered in 1885 in the ruins of Carthage and the remains of an actual instrument were found in 1931 at Aquincum, near Budapest.

The development of the organ during the dark ages becomes obscure, but by the 8th or 9th century it was being used in Christian churches. In 950 the famous instrument in Winchester cathedral was constructed, of which the monk Wulfstan left a much quoted but manifestly garbled description ending: "the music of the pipes is heard throughout the town and the flying fame thereof is gone out over the whole country."

The artistic history of the organ begins with the development of the chromatic keyboard in the late 12th and early 13th centuries. By 1360 the cathedral organ at Halberstadt, Germany, had three chromatic keyboards and pedals; the keys, however, were much wider than those of the modern keyboard. The modern size of key was fairly generally established by the end of the 15th century.

Although the Halberstadt organ had three manuals it had no stop mechanism. The main keyboard controlled a huge mixture stop and the other keyboards controlled reduced groups of stops.

Ctesibius's slider arrangement was probably rediscovered some time in the early 15th century and it became common soon after 1450. Reed stops began to appear at the same time and by 1500 the organ had reached a stage in north Germany where all the important features of the modern organ were present. Each department had separate choruses; stopped, tapered and open flue pipes; mutation stops; and reeds. The north German organ builders continued to be pre-eminent until about 1700, when the south German builders took the lead.

During the middle ages and the Renaissance three diminutive forms of the organ were widely used. These were, first, the positive (in which category are included most chamber organs of the period), a small organ capable of being moved, usually by two men, either on carrying poles or on a cart. The second type, the portative, was smaller still with only one set of pipes and a manual of very short compass. It was carried by the player and was supported by a strap round his neck. He worked the bellows with one hand and played the keys with the other. Such instruments were used in processions and possibly in concerted instrumental ensembles. In between the last two in size was the third type, the regal (*q.v.*), which usually had only one reed stop, a regal, as previously described.

Since national styles of organ building vary widely and it is necessary to know something about them before the music of each nation can be performed intelligently, the more important styles must next be considered briefly. Of the basic medieval organ, prior to the development of national styles, little if any material survives, except in the old cathedral at Syon in Switzerland, where a large proportion of the seven-stop organ appears to date from about 1400. Although voiced on very low wind pressure, the tone of the chorus is brilliant, colourful and amazingly powerful. Not much is known about the precise uses of church organs in the middle ages. The organ hardly began to possess a literature of its own before the last of the 15th century.

Italy.—Italy is mentioned first because its organs developed to their maturity soon after 1500 and remained unaltered until about 1800. The Italian organ had one manual and usually only an octave of pedal keys, which had no pipes of their own but were coupled permanently to the manual. The manual chorus had the peculiarity that there was no collective mixture; all the ranks were drawn by separate stops. Each rank broke back an octave as it reached the $1\frac{1}{2}$-in. pipe. In addition, there were flute stops of 4-ft. and $2\frac{2}{3}$-ft. pitch and a pipe called *voce umana* that consisted of two 8-ft. diapason ranks; these were slightly out of tune with each other so as to produce an audible beat between them, usually about four to the second. The *voce umana* extended upward only from middle C and was used mainly melodically. It was the forerunner of the 19th-century "voix céleste" stop. The early Italian organ possessed no reed stops. These simple resources suffice for the performance of all the music of Andrea and Giovanni Gabrieli and G. Frescobaldi, and they are also ample for the large, highly important repertory of British organ music up to 1600 and nearly all up to 1650. There are well-preserved 16th-century instruments surviving, especially in Brescia and Bologna.

Spain.—The Spanish organ followed the Italian tradition, but later many reeds were added. Although several early specimens survive, most are not playable.

Germany.—From 1500 to 1800 Germany led the world in organ building and the composition of organ music. The organ builders reached the peak of their achievement about 1700 in the work of Arp Schnitger. His was the organ of the high baroque; but Gottfried Silbermann was equally the master of the slightly later, more sophisticated style of the mid-18th century.

Schnitger made organs with four manuals, pedals and as many as 60 speaking stops, but he made some instruments with less than 30 speaking stops that are capable of dealing with the whole classical repertory. The finest surviving examples in this size are at Steinkirchen, near Hamburg, and at Cappel, near Cuxhaven. The latter was comprehensively rebuilt by Schnitger in 1695 and became widely known in the mid-20th century when a large part of the organ music of J. S. Bach was recorded on it by Helmut Walcha. Its specification is worth quoting as epitomizing all the best and most essential of all pre-1800 organs. There are 29 speaking stops (*see* table), two manuals and pedals. There is, of course, no swell box.

On the Hauptwerk, equivalent to the British Great Organ, the Diapason, or Principal, chorus comprises the Principal, Octava,

Hauptwerk		Ruckpositiv		Pedale	
Quintade	16 ft.	Quintade	8 ft.	Untersatz	16 ft.
Principal	8 ft.	Gedact	8 ft.	Octava	8 ft.
Hohlfloit	8 ft.	Principal	4 ft.	Octava	4 ft.
Octava	4 ft.	Floit	4 ft.	Nachthorn	2 ft.
Spitzfloit	4 ft.	Octava	2 ft.	Rauschpfeife	2 ranks
Nasat	$2\frac{2}{3}$ ft.	Siffloit	$1\frac{1}{3}$ ft.	Mixtur	6 ranks
Gemshorn	2 ft.	Sesquialtera	2 ranks	Posaune	16 ft.
Rauschpfeife	2 ranks	Scharff	6 ranks	Trompet	8 ft.
Mixtur	6 ranks	Dulcian	16 ft.	Cornet	2 ft.
Zimbel	3 ranks				
Trompet	8 ft.				
Tremulant					

Rauschpfeife, Mixtur and Zimbel. The Trompet is the only reed stop on the Hauptwerk.

The flutes and mutation series are represented by the Hohlfloit, Spitzfloit, Nasat and Gemshorn, of which the first is stopped and the last three tapered.

The Quintade and Zimbel (an exceedingly high-pitched mixture) belong impartially to the Principal or flute and mutation series. The former has stopped pipes and sounds the unison and twelfth at roughly equal strengths.

On the Ruckpositiv (second manual) the Principal chorus starts with the 4 ft. and is completed by the Octava and Scharff.

The Dulcian, of 16-ft. pitch, is a regal.

The flutes and mutations consist of the Gedact, Floit, Siffloit and Sesquialtera. The latter consists of a twelfth and a seventeenth of narrow, principal scale. It is a virtual necessity in the performance of baroque music (*e.g.*, in the solo line of chorale preludes). Its uses are mainly melodic, but it can also be added to the Chorus for occasional colouristic effects.

The arrangement of the pedal organ (pedale) is obvious: the 2-ft. Nachthorn is the only flute and there are three reeds, the Posaune, Trompet and Cornet.

The lessons to be learned from this specification are numerous. Each department, including the pedals, has its own Principal Chorus, complete up to at least one mixture. They are roughly equal in power but are varied in pitch, having, respectively, a 16-ft., 8-ft. and 4-ft. preponderance. Three such balanced choruses are essential for the performance of early music as well as much modern music.

Each manual department has a set of flutes and mutations that can be combined in a variety of ways to provide accompaniment and melody or the balanced but contrasting tone qualities essential for duet and trio passages.

Although the pedal department consists mainly of its Principal Chorus, these may be coloured for solo and obbligato passages by the 2-ft. Nachthorn and 2-ft. Cornet.

The reeds are not much louder than the flue stops, and the Pedal Posaune and Trompet are frequently drawn with the Principal Chorus for improved definition. When used in this way they by no means cause the Pedal to overwhelm the Hauptwerk.

Such an instrument can deal with all the requirements of all 15th-, 16th-, 17th- and 18th-century organ music, although its limited supply of manual reeds places it at some disadvantage in French music of the 17th and 18th centuries.

Many well-preserved 17th- and 18th-century organs of the German school still survive in Germany and in the Netherlands. Many people regard the 17th-century organ at Alkmaar, Neth., as the finest in the world, and there are other fine instruments at Gouda and at the Oude Kerk, Amsterdam. All retain their tracker action.

France.—As far as the manual departments are concerned, French organs differed little from the German type, but the Principal Choruses were generally larger in scale. The separate, large-scaled tierce ($1\frac{3}{5}$ ft.) was also universal and there were many cornet stops. These consist of five pipes to each note; a stopped unison (8 ft.) and large-scale open 4 ft., $2\frac{2}{3}$ ft., 2 ft. and $1\frac{3}{5}$ ft. They extend only from middle C upward and are largely melodic in use. They were never drawn with the principal chorus (Plein Jeu) but generally were used with the reed chorus (Grand Jeu). Apart from this, the Plein Jeu, Grand Jeu and Jeux de Mutation were seldom or never intermixed in French music.

The pedal department of the French organ prior to 1700 was regarded largely as a sort of solo *cantus firmus* section that consisted usually of only an 8-ft. flute and an 8-ft. trumpet. Only in the largest 18th-century organs were 16-ft. stops included, although there were often as many as three on the Grand Orgue.

When French organs had more than two manuals (Grand Orgue and Positif), the others (Récit and Echo) were usually of short compass but if, as sometimes, there was a fifth manual it was a Clavier de Bombardes consisting of 16-, 8- and 4-ft. trumpets and a cornet.

French organs were notable for their reeds, and the highly stylized French music of the 17th and 18th centuries calls for their frequent use.

Surviving specimens in good order are rare, but unaltered, late 18th-century, four-manual organs survive at Poitiers cathedral (by Clicquot) and at St. Maximin, Provence (by Isnard).

Great Britain.—British organs before the Commonwealth seem to have been very immature. Only a very few had two manuals, and none had pedals. Mixtures and reeds seem to have been unknown and mutations were restricted to a single twelfth.

After 1660 a new school rapidly grew up and although the two principal builders had both been abroad during the Commonwealth (Bernard Smith in Germany or Holland, and Renatus Harris in France), their British work owed little to foreign influence.

Only the Great Organ had a complete diapason chorus and the Choir, or Chayre, Organ usually extended upward only to a single 2 ft. Almost every organ had a cornet, and the reeds in common use were Trumpet, Vox humana and Cremona, or Krummhorn, with half-length, cylindrical resonators. There were no pedals but the manual compass almost invariably extended to GG. If there was a third manual it consisted of a short-compass Echo department, in which all the pipes were shut up in a box to produce the echo effect. In 1712 the builder Abraham Jordan first fitted the echo box with shutters that were controlled by a pedal at the console; this arrangement produced what Jordan described as the swelling organ but it was not to reach its full development until 150 years later. No 18th-century organ music demands a swell box.

Such instruments were adequate for the music of John Lugge, John Blow, Henry Purcell, John Stanley and even early 19th-century composers such as Samuel Wesley. There are hardly any surviving examples in original condition, and the only one of any size is the 14-stop, two-manual organ at Adlington hall, near Macclesfield, dating from the last quarter of the 17th century. It is almost certainly the work of Smith. It is entirely original and was restored to perfect order in 1959.

DEVELOPMENTS AFTER 1800

Because of the increasing interest in orchestral and operatic music, the organ fell out of favour during the 18th century and by 1800 it survived only as an ecclesiastical drudge. From the middle of the 19th century, however, a revival took place under the leader-

ship of two great builders, Aristide Cavaillé-Coll of France and Henry Willis of England. In Britain during the first half of the 19th century the introduction of pedals under the influence of Henry John Gauntlett made it possible for the first time to play the organ music of J. S. Bach and the German contemporaries and predecessors.

While retaining respectable vestiges of the classical chorus, Cavaillé-Coll and Willis developed the solo stops, especially reeds, and Willis in particular provided new aids to registration (stop changing).

Organists found that they could play effective arrangements of orchestral music on the new "romantic" style of organ. Since orchestral music was popular, and respectable orchestras very rare, and other forms of public entertainment even more so, the organ suddenly regained an immense popularity hardly rivaled by that of the 17th and 18th centuries, when it was the acknowledged "king of instruments."

Organ builders naturally responded by making their instruments increasingly orchestral in character, culminating at the end of the 19th century in the work of Robert Hope-Jones, who entirely abandoned the chorus and mutation stops and relied instead upon diapasons of vast scale on heavy-pressure wind, with reeds to match, backed up by huge-scaled flutes, tiny-scaled string stops and powerful stops of his own invention called diaphones.

Hope-Jones emigrated to the U.S. and, although a semblance of classical design returned to England soon after 1900, his influence continued to be felt throughout the first half of the 20th century. This discredited the organ as a musical instrument in the eyes of all serious musicians and composers. Unfortunately, it continued to find favour among the strictly limited circle of those who had influence over organ design, so that a revival of good taste was long delayed. This revival first started in Germany in about 1925 and spread by degrees to France, the Netherlands, Scandinavia and the U.S. In England it was hardly effective until after World War II but subsequently rapidly gained ground, especially after the success of the organ in the Royal Festival hall, London (1954), with its classical specifications.

In Germany, the Netherlands and Scandinavia this renaissance of organ building was mostly in the form of a rigid return to the 17th- and 18th-century specifications, and within this self-imposed limitation its results were very successful. Such instruments, however, entirely preclude the effective performance of the relatively few works in the romantic manner by Mendelssohn, Liszt, César Franck, Brahms and the works of Charles Widor, Louis Vierne, Julius Reubke, Joseph Jongen, Max Reger and Sigfrid Karg-Elert, all of whom wrote extensively for the organ.

The revival in France, the U.S. and Britain strove to produce an instrument that could do equal justice to all legitimate organ music of whatever period. This was not easy, but it was possible. Such instruments, when of three manuals, consist usually of Great, Positive and Pedal departments, not unlike those at Cappel, and, in addition, a Swell organ comprising the essential romantic flute and string-toned stops, a small diapason chorus and a battery of chorus reeds on light or medium wind pressure. Undoubtedly the most successful exponent up to the early years after World War II was the late Donald Harrison in the U.S. In England, successful examples tending more to the classical than the romantic are the London organs of the Royal Festival hall and the Italian church, Hatton Garden (1959). A more deliberately all-around instrument is that completed in 1961 for the Mormon church, Exhibition road, London.

Such instruments, especially that in the Royal Festival hall, once more convinced the general musical public that the organ can be a worthwhile solo instrument. They have also proved themselves as eminently capable church organs. Although such organs can and must be able to play romantic music, it must be confessed that the romantic style is inherently unsuited to the organ and only such masters as Liszt, César Franck and Max Reger were able to reconcile the two successfully. The organ is essentially a polyphonic instrument, and this is recognized by successful composers for the organ in the modern idiom such as the Dutch Willem Vogel, the Danish Finn Videro and, pre-eminently, Paul Hindemith in his three organ sonatas.

The Organ Case.—From the 14th century until 1800 the organ case was nearly always an object of visual beauty, but during the 19th century the design of organ cases degenerated into the merely ugly or the bleakly utilitarian, and frequently into both. Only a few 19th-century English case designers continued to do work of the highest order.

Interest in the provision of adequate cases was revived in the mid-20th century. The richly carved cases of the 18th century would certainly be prohibitively expensive in modern times, but designers, especially in the Netherlands and Denmark, showed that simple and functional cases in a modern idiom can be artistically satisfactory. Many early cases were painted; the use of gilt and colour was being explored once more in the mid-1960s as a comparatively cheap alternative to carved decoration. The cases at Westminster abbey were so treated in 1960, with outstanding success.

Seventeenth-century German cases were usually constructed on Werkprincipal lines. Each department of the organ, or Werk (*e.g.*, Hauptwerk), in a Werkprincipal case was separately cased, the Hauptwerk behind and the Positive in front of the player, with the Pedals at each side. Britain had its counterpart to the Werkprincipal in its Great and Chair organ cases, with the organist between them. The Werkprincipal is again being widely used in the Netherlands, Germany and Scandinavia. The modern Werkprincipal case at Doetinchem, Neth. (1952), for instance, is almost classical in finish with simple embellishment and paint; other modern Werkprincipal cases are undecorated, except for colour.

Position of the Organ.—Closely connected with case design is the problem of the organ's position. In a medieval church there is frequently no satisfactory solution, since an organ in a confined space can never sound to advantage. On the continent both organ and choristers have always been housed in a west gallery, and there can be no doubt that this is the best position musically for any organ. Such placing also gives the finest opportunities to the organ-case designer.

See also references under "Organ" in the Index.

BIBLIOGRAPHY.—The number of important books currently available in English about organs is small. The classic, E. J. Hopkins and E. F. Rimbault, *The Organ: Its History and Construction* (1855, 1870 and 1887), is rarely found. It was more than adequately replaced by W. L. Sumner, *The Organ: Its Evolution, Principles of Construction and Use* (1952), covering every aspect of the subject. A further work is C. Clutton and A. Niland, *The British Organ* (1963). Works in foreign languages include M. A. Vente, *Die Brabanter Orgel* (1958), and N. Dufourcq, *Esquisse d'une histoire de l'orgue en France* (1931). For work on organ cases *see* J. E. Blanton, *The Organ in Church Design* (1957). For problems connected with organs in parish churches *see* Central Council for the Care of Churches, *Organs and Organ Cases for Parish Churches*, illustrated (1959). (Cx. C.)

ORGANICISM, the biological and philosophical doctrine that declares that an organism is a functional unity whose parts cooperate for the good of the whole and that therefore its properties are to be understood only from this viewpoint. According to this doctrine the manifestations of the whole organism cannot be understood by analyzing its chemical, physical or morphological elements. Although this view approaches vitalism it is as strongly opposed to the rigid vitalism of the late 19th and early 20th centuries as it is to the physico-chemically oriented mechanism.

See VITALISM; MECHANISM.

ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT (O.E.C.D.), an international organization created in 1960 to stimulate economic progress and world trade. The convention creating the O.E.C.D. was signed on Dec. 14, 1960, by 18 European countries, the United States and Canada. The European members included those in the European Economic Community (known as the European Common Market; *see* ECONOMIC UNION), the seven members of the European Free Trade association (E.F.T.A.), and Greece, Turkey, Spain, Iceland and Ireland. In a broad sense it represented an extension of the Organization for European Economic Cooperation (O.E.E.C.), set up in 1948 to co-ordinate efforts to restore Europe's economy under the Marshall Plan (the European Recovery program). A primary aim of the O.E.C.D. was "to achieve the

highest sustainable growth and employment and a rising standard of living in Member countries, while maintaining financial stability and thus to contribute to the development of the world economy." This was to be accomplished, in part, by efforts to "reduce or abolish obstacles to the exchange of goods and services and current payments and by the maintenance and liberalization of capital movements. . . ." A further major goal was the co-ordination of economic aid to less-developed countries.

The organizational structure of the O.E.C.D. had much in common with that of the North Atlantic Treaty organization (NATO). The main feature was a council on which all members were represented by permanent delegations. A secretary-general chosen for a five-year term headed the permanent staff. Decisions of O.E.C.D. were not binding on individual members, for the group was essentially a consultative assemblage.

At the first ministerial meeting held at the Paris headquarters on Nov. 16–17, 1961, the O.E.C.D. called for an overall increase of 50% in productivity by 1970. To attain the increase by economic co-operation and consultation would mean an average increase of productivity of approximately 4.4% per year. The U.S. government at the beginning of 1962 was advised to increase its regular government expenditures to stimulate its economy, though it was also cautioned against continuous deficits. A Development Assistance committee, composed of 11 nations (including Japan, a member of O.E.C.D. as of April 28, 1964), studied the amounts and types of foreign aid and noted that, "from the point of view of resources, there is scope for special emphasis on an increase in the aid effort of certain countries." This, presumably, meant that the western European countries would be asked to increase their share of aid to less-developed lands. Two members of the O.E.C.D., Greece and Turkey, submitted plans for development and also sought aid from O.E.C.D states. In Jan. 1962 ten of the larger countries pledged an additional \$6,000,000,000 to stabilize their currencies through the existing International Monetary fund.

(W. Sy.)

ORGANIZATION OF AMERICAN STATES: *see* AMERICAN STATES, ORGANIZATION OF; PAN-AMERICAN CONFERENCES.

ORGANIZATION OF CENTRAL AMERICAN STATES: *see* CENTRAL AMERICAN FEDERATION.

ORGANOMETALLIC COMPOUNDS are chemical substances containing a metal or metalloid in direct association with one or more hydrocarbon radicals; *i.e.*, the metal or metalloid is attached directly to a carbon atom. These compounds never arise by natural processes in nature, being produced synthetically by the chemist. They have played an important part in the development of modern chemistry, and among them are an ever-growing number of substances or classes of substances of great practical utility. Tetraethyllead (*see* below), a most effective antiknock agent (antidetonant) in gasoline, is an outstanding example of an organometallic compound of proven worth. The silicone (*q.v.*) group and the Grignard reagents (*q.v.*) are other organometallic compounds whose utility has been demonstrated.

The present article affords a general survey of organometallic compounds. The arrangement below follows the natural sequence of elements according to the periodic law (*q.v.*), with a major division being made between the transitional and nontransitional elements. Additional information about organic compounds of the various metals and metalloids will be found in the separate articles on these elements; *e.g.*, MAGNESIUM; MERCURY; TIN.

NONTRANSITIONAL ELEMENTS

In the organometallic compounds of the nontransitional elements the carbon-metal bond is usually either a classical covalent, localized two-electron bond (as in tetramethyltin) or an ionic bond (as in benzylsodium).

Group I.—Although organosodium compounds were prepared as early as 1858 (J. Wanklyn), the existence and properties of these substances remained in doubt until early in the 20th century (W. Schlenk and co-workers, 1913–17). Ethyllithium, LiC_2H_5, is prepared by the action of diethylmercury on metallic lithium; it crystallizes from benzene in colourless plates melting at 95° C. Methyllithium, $LiCH_3$, and phenyllithium, LiC_6H_5, are crystalline powders obtained by double decomposition between ethyllithium and dimethylmercury and diphenylmercury respectively (W. Schlenk and J. Holtz). Later, lithium alkyls and aryls were prepared from lithium metal and alkyl and aryl halides (K. Ziegler [illegible] H. Gilman, 1932). The simple sodium alkyls are prepared by the action of sodium metal on a mercury alkyl [illegible] (A. von Grosse, 1926). Methylsodium, $NaCH_3$, is a white powder which burns in air with explosive rapidity. Triphenylmethylsodium, $NaC(C_6H_5)_3$, a brownish-red solid, is obtained by the action of 1% sodium amalgam on a solution of triphenylchloromethane under an atmosphere of oxygen-free nitrogen. Cyclopentadienylsodium, NaC_5H_5, is conveniently prepared by the reaction of a sodium metal dispersion with cyclopentadiene in tetrahydrofuran solution, an orange solution of the [illegible] tained (G. Wilkinson and F. A. Cotton, 1954). [illegible] sium, rubidium and cesium have been similarly prepared (H. Gilman, 1940–41). Alkyl and aryl alkali metal compounds are [illegible] prepared in solution as intermediates for use in further reactions without being isolated.

Organic derivatives of IB subgroup elements are also known. Phenylcopper, CuC_6H_5, obtained by the reaction of [illegible] and phenylmagnesium bromide in ethereal solution, [illegible] powder decomposing at [illegible] C to give [illegible]. Phenylsilver, an even more unstable [illegible] phenylmagnesium bromide and silver [illegible]. It [illegible] solid, exploding on rubbing or on gentle warming. [illegible] solution of gold (III) bromide and ethylmagnesium [illegible] on evaporation colourless crystalline diethylgold bromide [illegible] at 58° C and exploding at 7[illegible] C. Bromine [illegible] converts this monobromide into the ruby-red ethylgold dibromide, $C_2H_5AuBr_2$ (W. J. Pope and C. S. Gibson, [illegible]).

Group II. The organic derivatives of [illegible] in the separate article on this metal and the [illegible] pounds are described in GRIGNARD REAGENTS. The [illegible] compounds were discovered by E. Frankland [illegible] study of organometallic compounds he was led to the [illegible] of chemical valency. Dialkylzinc compounds were [illegible] Frankland and B. F. Duppa (1863) and other [illegible] syntheses but were later supplanted by the more [illegible] less hazardous Grignard reagents. [illegible] 46° C) and diethylzinc (b.p. 118° C) are [illegible] liquids spontaneously inflammable in air. [illegible] distilling the products of the interaction of [illegible] iodides with a zinc-copper couple. [illegible] diphenylzinc have been obtained from the [illegible] magnesium bromide and anhydrous zinc [illegible] A. Job and R. Reich, 1923). The dialkyl [illegible] procurable in good yields from anhydrous [illegible] the appropriate alkylmagnesium [illegible] $(CH_3)_2Cd$ is a colourless liquid [illegible] 1917). Mercury possesses a remarkable [illegible] organic derivatives. Sodium amalgam [illegible] and bromobenzene giving respectively [illegible] (b.p. 159° C) and diphenylmercury [illegible] With certain reactive substances such as [illegible] ferrocene (see below) and certain olefins, mercury derivatives are obtained merely by boiling with mercuric acetate. In [illegible] the foregoing methods, organomercury compounds are conveniently prepared through the agency of Grignard reagents. [illegible] mercury chlorides, e.g., ethylmercuric chloride, are used as [illegible] cides. Several mercury compounds, e.g., Mercurochrome [illegible] are used as skin disinfectants.

Group III. Trialkyl- and triaryl[illegible] have been reported. The reaction of ethylmagnesium bromide and anhydrous aluminum chloride in dry ether gives [illegible] etherate, $(C_2H_5)_3Al \cdot O(C_2H_5)_2$, is a [illegible] liquid boiling at 112° C [illegible] mm. It fumes in [illegible] ously and is decomposed explosively by cold water (E. Krause and B. Wendt, 1923). Triphenylaluminum, prepared in [illegible] ner, loses the coordinated ether in vacuo at [illegible] C. Trialkylaluminum compounds are most conveniently prepared by the

reaction of an olefin, hydrogen and aluminum under pressure at 120° C. (K. Ziegler, 1955), and they find use as co-catalysts in the preparation of linear polyethylene at low pressures. Diethylaluminum iodide and ethylaluminum diiodide, both high-boiling liquids, were obtained by V. Grignard and R. L. Jenkins (1925) from the liquid product of the reaction of aluminum and ethyl iodide.

Organic derivatives of gallium, indium and thallium are obtainable through the Grignard or organolithium reagents. Thallium (III) bromide, but not thallium (I) bromide, yields both dialkyl and diaryl derivatives such as dimethylthallium bromide, $(CH_3)_2$-TlBr, in the form of silvery white leaflets (R. J. Meyer and A. Bertheim, 1904), and diphenylthallium bromide, in the form of colourless microscopic needles (D. Goddard and A. E. Goddard, 1922). The reaction of alkyllithium compounds with thallium (I) halides gives high yields of trialkylthallium compounds (H. Gilman and R. G. Jones, 1950). Trimethylindium (m.p. 88° C.) and trimethylgallium (b.p. 56° C.) can be obtained by reaction of the respective metal with dimethylmercury. Higher trialkylindium compounds are conveniently prepared via the Grignard reagent.

Group IV.—Organic derivatives are known of silicon (*q.v.*), germanium (*q.v.*), tin and lead. Organic compounds of tin have found increasing commercial utilization since 1950, first as stabilizers for polyvinyl chloride plastics, later as fungicides, bactericides, etc.

Stannous chloride and ethylmagnesium bromide give diethyltin (II) as an oxidizable, evidently polymeric water-insoluble oil (P. Pfeiffer, 1911), whereas diphenyltin (II), $(C_6H_5)_2Sn$, a bright yellow powder melting to a dark red liquid at about 130° C., is obtained from phenylmagnesium bromide and stannous chloride. When excess of phenyl Grignard reagent is added to stannous chloride, the diphenyl compound loses part of its tin and passes into hexaphenylditin, $3(C_6H_5)_2Sn \rightarrow Sn + (C_6H_5)_3SnSn(C_6H_5)_3$, obtained in colourless plates melting at 237° C.

Tetramethyltin (b.p. 78° C.) is most advantageously prepared by the Grignard method in a dibutyl ether solvent, while tetravinyltin (b.p. 161° C.), tetraethyltin and higher homologues are obtained in high yield by the Grignard method when tetrahydrofuran is used as the solvent. The disproportionation of a tetraorganotin compound with tin (IV) chloride is an excellent method for preparing organotin chlorides (K. A. Kocheshkov, 1933), while the reaction of methyl chloride with molten tin-copper alloy serves to produce dimethyltin dichloride (E. G. Rochow, 1953). Tin halides react with diazomethane in solution to give chloromethyltin compounds (A. Yakubovich, 1952; D. Seyferth, 1954), *e.g.*, $(CH_3)_2SnCl_2 + CH_2N_2 \rightarrow (CH_3)_2(CH_2Cl)SnCl + N_2$. Organotin hydrides, such as triphenyltin hydride, $(C_6H_5)_3SnH$, add to the double bond of olefins such as acrylonitrile, $CH_2{:}CHCN$, to give, in the case of the compounds cited, β-cyanoethyltriphenyltin, $(C_6H_5)_3SnCH_2$-CH_2Cn (G. J. M. van der Kerk and co-workers, 1956).

The most common and stable organolead compounds are the tetraalkyls and tetraaryls, which are obtained by interaction of lead chloride or bromide with the appropriate Grignard reagent, $4RMgBr + 2PbBr_2 \rightarrow Pb + R_4Pb + 4MgBr_2$. Tetramethyllead, $(CH_3)_4Pb$, tetraethyllead, $(C_2H_5)_4Pb$, and other tetraalkyllead compounds have been prepared in this manner, as have tetraaryls such as tetraphenyllead, $(C_6H_5)_4Pb$. Treatment of these compounds with acids or halogens converts them to alkyllead salts, such as $(C_2H_5)_3PbCl$ and $(C_6H_5)_2Pb(NO_3)_2$.

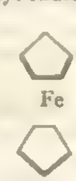
Tetraalkyllead compounds containing different alkyl groups are readily prepared by the interaction of two different tetraalkyllead compounds in the presence of aluminum chloride (G. Calingaert and co-workers, 1939). The lower tetraalkyllead compounds are relatively stable, colourless liquids, while the tetraaryls are colourless solids. Organolead compounds such as hexamethyldilead, $(CH_3)_3PbPb(CH_3)_3$, and diphenyllead (II), $(C_6H_5)_2Pb$, have also been prepared; on being heated these decompose to the corresponding R_4Pb compounds and metallic lead.

The commercially important tetraethyllead is manufactured by the action of ethyl chloride under pressure on a powdered alloy of lead and sodium contained in an autoclave. The tetraethyllead is steam-distilled from the reaction mass, leaving sodium chloride and metallic lead as by-products. It is a colourless liquid, stable in air, soluble in gasoline and quite volatile, although it decomposes at temperatures below its boiling point. For use as an antidetonant, it is added to gasoline in quantities not exceeding 3.0 c.c. per gallon; a small quantity of ethylene dibromide, and sometimes ethylene dichloride, is added to prevent formation of lead deposits in the engine.

Group V.—Certain outstanding examples of organic derivatives of arsenic and antimony are described in the articles on these metalloids. Both trialkyl and triarylbismuth compounds have long been known and were formerly prepared by the reaction of alkyl or aryl halides and sodium- or potassium-bismuth alloys. The use of the Grignard reagents has considerably enlarged the bismuth series of organic compounds. The reaction of triphenylbismuth dichloride and phenyllithium at −75° C. resulted in pentaphenylbismuth, $(C_6H_5)_5Bi$, the only bismuth compound containing five organic groups (G. Wittig and K. Clauss, 1952).

TRANSITIONAL ELEMENTS

While there are some known organic derivatives of the transitional metals in which the carbon-metal bond is a classical two-electron covalent bond, an entirely different class of compounds has been discovered involving "delocalized covalent bonds." In these compounds a metal atom is bonded jointly to several (usually five or six) carbon atoms belonging to the same highly symmetrical molecule or radical (*e.g.*, benzene or cyclopentadienyl). An outstanding example is ferrocene [bis-cyclopentadienyliron, $(C_5H_5)_2Fe$], the first-discovered member of this class (S. A. Miller, J. A. Tebboth and J. F. Tremaine; T. J. Kealy and P. L. Pauson, 1951). (See *Group VIII*, below.) Ferrocene has a molecular geometry in which the iron atom is located symmetrically between two cyclopentadienyl radicals in a sandwichlike structure.



The extreme stability which results from this structure is illustrated by the facts that (1) ferrocene itself is stable to over 400° C., while all efforts at preparing compounds containing ordinary covalent carbon-iron bonds have failed, and (2) in ferrocene and some other similar compounds the metal-carbon bonds are stable to a number of rather strong reagents; indeed ferrocene undergoes a variety of aromatic-type substitution reactions, just as benzene does. Dibenzene metal compounds similarly have a sandwich-type structure, and some, such as dibenzene chromium, $(C_6H_6)_2$-Cr, are unusually stable.

The advances in the field of cyclopentadienyl- and benzene-metal chemistry made during the 1950s were due principally to E. O. Fischer and his collaborators and G. Wilkinson and co-workers.

Group III.—The reaction of cyclopentadienylsodium with the appropriate metal chloride in tetrahydrofuran solution yields the tricyclopentadienyl derivatives of the type $(C_5H_5)_3M$ of scandium, yttrium, and of the rare-earth metals lanthanum, cerium, praseodymium, neodymium, samarium, gadolinium, dysprosium, erbium and ytterbium. These compounds are crystalline, air-sensitive ionic solids and are the only derivatives of this group that have been characterized.

Group IV.—Phenyltitanium triisopropylate, $C_6H_5Ti(OC_3H_7)_3$ (m.p. 88°–90° C.), was the first stable organic derivative of titanium to be isolated (D. F. Herman and W. K. Nelson, 1952). Similar compounds containing more than one organic group appear to be unstable.

Many cyclopentadienyl compounds have been reported. Bis-cyclopentadienyltitanium dichloride, $(C_5H_5)_2TiCl_2$ (m.p. 289° C.), results from the reaction of cyclopentadienylsodium with titanium tetrachloride. Reaction of bis-cyclopentadienyltitanium dichloride with phenyllithium yields diphenyl-bis-cyclopentadienyltitanium, $(C_5H_5)_2Ti(C_6H_5)_2$, in the form of orange-yellow crystals (m.p. 146°–148° C.) that decompose slowly at room tem-

perature (L. Summers and R. H. Uloth, 1954), while reduction with zinc dust in nonaqueous solution gives green crystals of bis-cyclopentadienyltitanium chloride, $(C_5H_5)_2TiCl$. Bis-cyclopentadienyltitanium, $(C_5H_5)_2Ti$, obtained as dark green crystals from the reaction of titanium dichloride with cyclopentadienylsodium in tetrahydrofuran, is extremely air sensitive and decomposes before its melting point is reached.

Bis-cyclopentadienylzirconium dibromide, $(C_5H_5)_2ZrBr_2$, colourless crystals melting at 260° C. with decomposition, has been prepared by the cyclopentadienylsodium method. No organic compounds of hafnium have been reported, but evidence for the existence of unstable cyclopentadienylthorium compounds has been presented.

Group V.—The reaction of an excess of cyclopentadienylmagnesium bromide with vanadium (IV) chloride in an oxygen-free system gives good yields of bis-cyclopentadienylvanadium, $(C_5H_5)_2V$, violet-black crystals (m.p. 167°–168° C.). Treatment of this compound with carbon monoxide under pressure yields orange crystalline cyclopentadienylvanadium tetracarbonyl, C_5H_5-$V(CO)_4$ (m.p. 138° C.). Bis-cyclopentadienylvanadium dichloride, pale green crystals decomposing without melting at 250° C., has been prepared by the cyclopentadienylsodium method.

Dibenzene vanadium, $(C_6H_6)_2V$, red-brown, air-sensitive crystals (m.p. 277°–278° C.) which decompose at 330° C., is obtained by the reaction of vanadium (IV) chloride, aluminum chloride, aluminum metal and benzene at atmospheric pressure, followed by hydrolytic disproportionation of the initially formed complex, $[(C_6H_6)_2V]\ AlCl_4$.

Bis-cyclopentadienylniobium tribromide, $(C_5H_5)_2NbBr_3$, reddish-brown crystals which decompose without melting at 260° C., and bis-cyclopentadienyltantalum tribromide, $(C_5H_5)_2TaBr_3$, a rust-coloured crystalline solid (m.p., with decomposition, 280° C.), have been prepared by the cyclopentadienylsodium method.

Group VI.—The products obtained by the action of phenylmagnesium bromide on chromium (III) chloride at low temperatures, thought to be polyphenyl derivatives of chromium in the IV, V and VI valence states, were investigated by F. Hein, who discovered them in 1919. It was shown by H. H. Zeiss and M. Tsutsui (1954) that previous conceptions of their structure were incorrect and that these compounds were "sandwich" compounds of chromium, the so-called triphenylchromium salts being benzene (biphenyl) chromium (I) salts and the tetraphenylchromium compounds being dibiphenylchromium (I) salts. Di-benzenechromium (readily oxidizable black-brown crystals, m.p. 284°–285° C.) is prepared by the reaction of chromium (III) chloride, aluminum chloride, aluminum metal and benzene under pressure at 150° C., followed by reduction of the $[(C_6H_6)_2Cr]\ AlCl_4$, which is formed initially. Other aromatic hydrocarbons such as toluene, mesitylene and biphenyl yield similar complexes of chromium.

The reductive Grignard procedure used for the preparation of bis-cyclopentadienylvanadium also can be applied to the preparation of bis-cyclopentadienylchromium, $(C_5H_5)_2Cr$ (red crystals, melting at 173° C.). This compound reacts with carbon monoxide under pressure to give blue-green di-(cyclopentadienylchromium tricarbonyl), $[C_5H_5Cr(CO)_3]_2$ (m.p. 163°–168° C.), and with a mixture of carbon monoxide and hydrogen under pressure to give yellow cyclopentadienylchromium tricarbonyl hydride, C_5H_5Cr-$(CO)_3H$ (m.p. 57°–58° C.). Treatment of the product of the interaction of cyclopentadienylsodium and chromium (III) chloride with nitric oxide gas produces cyclopentadienyldinitric oxide-chromium chloride, $C_5H_5Cr(NO)_2Cl$. Reaction of the latter with methylmagnesium iodide gives cyclopentadienylmethyldinitric oxide-chromium, $C_5H_5Cr(NO)_2CH_3$, while treatment of C_5H_5Cr-$(CO)_3H$ with diazomethane results in cyclopentadienylmethylchromium tricarbonyl, $C_5H_5Cr(CO)_3CH_3$.

Bis-cyclopentadienylmolybdenum dichloride is prepared from molybdenum pentachloride by the cyclopentadienylsodium method, while derivatives of the bis-cyclopentadienyldichlorotungsten ion are obtained in a similar manner. Carbonyl derivatives analogous to those described for chromium have been reported for molybdenum and tungsten. Dibenzene molybdenum and dibenzene tungsten have been reported.

One organic derivative of uranium, tricyclopentadienyluranium chloride, $(C_5H_5)_3UCl$ (dark-red crystals that are extremely air-sensitive, m.p. 260°–265° C.), has been prepared by the cyclopentadienylsodium method.

Group VII.—Bis-cyclopentadienylmanganese, an ionic compound, is best prepared by the cyclopentadienylsodium method from manganous bromide. The amber crystalline $(C_5H_5)_2Mn$, which is extremely air- and water-sensitive, reacts readily with ferrous chloride to give ferrocene. Treatment of bis-methylcyclopentadienylmanganese, $(CH_3C_5H_4)_2Mn$, with carbon monoxide gives air-stable yellow methylcyclopentadienylmanganese tricarbonyl, which is useful as an antidetonant additive in aviation gasoline. The sodium salt derived from dimanganese decacarbonyl, $NaMn(CO)_5$, reacts with methyl iodide to give methylmanganese pentacarbonyl, $CH_3Mn(CO)_5$, and with acetyl chloride to yield acetylmanganese pentacarbonyl, $CH_3COMn(CO)_5$ (R. D. Closson and co-workers, 1957).

Bis-cyclopentadienylrhenium hydride, $(C_5H_5)_2ReH$, results from the action of cyclopentadienylsodium on rhenium pentachloride. This compound (yellow crystals, m.p. 161°–163° C.) forms a unipositive cation, $[(C_5H_5)_2ReH_2]^+$, in aqueous solution.

Group VIII.—Bis-cyclopentadienyliron (ferrocene) (orange-yellow crystals, m.p. 173°–174° C.) is conveniently prepared either by the Grignard or cyclopentadienylsodium methods, as well as by the amine method. In the latter method, ferrous or ferric chloride and cyclopentadiene are heated in the presence of a strongly basic amine which functions as a hydrogen chloride acceptor (J. Birmingham, D. Seyferth and G. Wilkinson, 1954). Oxidizing agents convert ferrocene to the blue ferricinium cation, $[(C_5H_5)_2Fe]^+$, many salts of which are known.

Ferrocene behaves like an aromatic compound toward many reagents and undergoes a variety of aromatic substitution reactions such as Friedel-Crafts acylation (introduction of an organic acid radical) and alkylation (introduction of an alkane [paraffin hydrocarbon] radical), arylation (introduction of an aromatic radical), mercuration (introduction of mercury) and metalation (introduction of a metal) to yield substituted ferrocenes. These substituted ferrocenes are then capable of taking part in a large number of organic reactions without disruption of the ferrocene structure.

Cyclopentadiene reacts with iron pentacarbonyl at 135° C. to give di-(cyclopentadienyliron dicarbonyl), $[C_5H_5Fe(CO)_2]_2$ (m.p. 192° C.), decomposition of which at 220° C. yields ferrocene. Oxidation in hydrochloric acid gives cyclopentadienyliron dicarbonyl chloride (red crystals decomposing at 87° C.) which reacts with methylmagnesium bromide to yield cyclopentadienylmethyliron dicarbonyl, $C_5H_5Fe(CO)_2CH_3$.

Bis-cyclopentadienylcobalt (almost black crystals melting at 171°–173° C.) is readily oxidized to the $[C_5H_5)_2Co]^+$ cation, which is extremely stable, being unaffected by fuming nitric acid or aqua regia. It also reacts with carbon monoxide to give a red liquid carbonyl derivative, $C_5H_5Co(CO)_2$ (b.p. 75° C./22 mm.). Green bis-cyclopentadienylnickel reacts with nitric oxide to yield C_5H_5NiNO (red liquid, b.p. 49° C./27 mm.).

Of the other Group VIII elements the following cyclopentadienyl derivatives, prepared by standard methods, can be mentioned: bis-cyclopentadienylruthenium (light yellow, m.p. 195.5° C.) readily oxidizable to the ion, $[(C_5H_5)_2Ru]^+$; bis-cyclopentadienylosmium (m.p. 218°–219° C.); bis-cyclopentadienylrhodium bromide, $(C_5H_5)_2RhBr$; the corresponding iridium derivative, $(C_5H_5)_2$-$IrBr$; cyclopentadienylrhodium-1:5-cyclo-octadiene, C_5H_5Rh-C_8H_{12} (m.p. 108° C.).

Trimethylplatinum iodide, $(CH_3)_3PtI$, has been obtained by interaction of platinum chloride and methylmagnesium iodide. The corresponding chloride is tetrameric, indicating that bonds of fractional order are involved in the electronic structure of the molecule. Tetramethylplatinum, $(CH_3)_4Pt$, has been prepared from trimethylplatinum iodide and methylsodium, and hexamethyldiplatinum, $(CH_3)_3PtPt(CH_3)_3$, has been obtained by heating trimethylplatinum iodide with potassium in benzene (H. Gilman and M. Lichtenwalter, 1936).

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ORGANON, the collective name of the six logical treatises of Aristotle (*q.v.*), namely the *Categories*, the *De interpretatione*, the *Topics*, the *Sophistici Elenchi* and the *Prior* and *Posterior Analytics*, given to them because logic is an aid or "instrument" (Gr. *organon*) for scientific thought of any kind. Francis Bacon called his treatise *Novum Organum* in the belief that he had discovered a new inductive logic.

ORGANUM, the name given in the 10th and 11th centuries to a style of polyphonic singing and in the 12th and 13th centuries to a musical form. In the organa found in the manuscripts from the monastery of St. Martial at Limoges (11th century) the drawn-out plain chant melody has a richly melismatic upper part in free rhythm. The later flowering of organa in Paris coincided with the building of Notre Dame (1163–1235). The 12th-century composer Léonin was the first master to write two-part organa for the cathedral. He was followed *c.* 1200 by Pérotin whose historically important three- and four-part organa are of the highest musical quality.

See A. Hughes (ed.), "Early Medieval Music," vol. ii of *The New Oxford History of Music* (1954). (E. J. Wz.)

ORGY. This is a modern philological blunder, for the Greek *orgia*, adopted by the Romans, existed only in the neuter plural. Properly it was the post-Homeric word for religious rites, probably meaning "operations," "performances." It is chiefly used of those rites which involve an initiation; *e.g.*, the Eleusinian mysteries (*see* MYSTERY), the worship of the Cabeiri and especially of Dionysus (*qq.v.*), hence presumably its modern connotation of wildness and lawlessness. Metaphorically, it meant studies which involved training, such as philosophy. (H. J. R.)

ORHAN VELI KANIK (1914–1950), Turkish poet, exercised an important influence on Turkish literature. Born at Beykoz on the Bosporus in 1914, the son of an orchestra conductor, he was educated in Ankara and studied philosophy at Istanbul university. His slight volume of poems *Garip* (1941), published in collaboration with two other poets, Oktay Rifat and Melih Cevdet, revolutionized Turkish literature. It created a break with everything hitherto associated with Turkish poetry, conventional metre, rhyme, language and themes being all discarded. He encountered violent opposition from conservative circles, but by the time he died, he was firmly established. He introduced everyday spoken Turkish, with its rich idiom, into poetry and made use of folk poems and popular song motifs. Influenced by contemporary French literature, he made translations, and a verse adaptation of La Fontaine's fables. Other works included *Yenisi* (1947) and *Karshi* (1949). He died at Istanbul, Nov. 14, 1950. (F. I.)

ORHON GOL (RIVER): *see* SELENGA-ORHON RIVER SYSTEM.

ORIBI (OUREBI), *Ourebia ourebi*, a pygmy antelope (*q.v.*) of South Africa, standing about 24 in. at the shoulder, and characterized by a bare glandular spot below the ear; the upright horns of the bucks, ringed for a short distance above the face; and the tufted bushy tail. The name is extended to include other members of the genus. The steinbok and grysbok are closely related.

ORIEL, in architecture, is a projecting bay window carried by corbels or moldings. It is usually polygonal or semicircular in plan, but at Oxford, in some of the colleges, there are examples which are rectangular and rise through two or three stories. In Germany it forms a favourite feature, and is sometimes placed at the angle of a building, carried up through two or three floors and covered with a lofty roof. The oriel is also said to have been provided as a recess for an altar in an oratory or small chapel.

In the 15th century, oriels came into general use and are frequently found over entrance gateways. The earliest meaning of the word seems to be a gallery, portico or corridor, and the application of the term to a particular form of window apparently arose from such a window being in an "oriel." *See* BAY; WINDOW.

ORIENT, THE: *see* FAR EAST.

ORIENTAL JEWS are the descendants of those Jews who, following their exile from Palestine in the 1st century A.D., or even prior to that date, settled in the Middle East and North Africa. *See* SEPHARDIM, ASHKENAZIM, AND ORIENTAL JEWS.

ORIENTAL MUSIC. It has been widely held that the music of the west differs fundamentally from that of the orient in its harmonic, polyphonic texture; and that, in decisive contrast, the music of the orient is primarily melodic, nonharmonic, essentially linear in texture. While some such generalization may apply if certain art musics of the orient are compared with the art music of the west, it ceases to be true if the range of oriental music also includes folk musics. The increased availability of folk and art music recordings from all parts of the world has shown that the isolated position of European art music is relative rather than absolute.

With experience it is possible for the trained listener to attribute any music to its region of origin, but this attribution depends on a number of points of detail recognizable by the specialist rather than on a single difference in principle. For the uninstructed western listener, the first impression obtained from non-European music is not that it is "oriental" but that it is "foreign." This impression depends in the first instance on unfamiliar qualities of instruments or voices. The foreignness may be further qualified as "oriental" if certain other characteristics are displayed: if notes are approached and quitted by glides, instead of being attacked and released sharply and distinctly with an abrupt change of pitch; if the melody includes unusual steps, such as the notorious "augmented second" of middle eastern and Indian musics—phrases such as A B♭ C♯ D, for example; or if a single, fully pitched melody is accompanied by percussion in a two- or multivoice counterpoint of indeterminate pitch. The sum of these components is perceived as a form that cannot be matched with any familiar pattern of music in western culture; without further analysis, this form is judged to be "not our music" and may be further qualified as "oriental."

Where some of these elements are lacking, however, the judgment of the untrained listener will be less sharply qualified. A folk singer from Sikkim using "natural" voice (by western standards); mouth organs from Laos or China in diatonic harmony; a Syrian lute in simple two-part diatonic harmony; flute folk tunes from Iran; a Jew's harp from Afghanistan playing a broken triad; a fiddler from the Black sea coast playing in three parts—parallel fourths moving against upper or lower drones; any of these may well evoke the reaction of "not our music" but will probably not evoke the judgment "oriental," though they are all, geographically speaking, from the east.

Only recently has it been realized that the development of the strictly linear, melodic art musics of the orient does not represent, as once was thought, a primitive stage in the evolution of music as it is known in the west but, rather, the end result of an independent, highly intellectualized, evolutionary development, a development that the west seems to have known only for a brief period and as a cultural borrowing from the middle east. That such an art music is recognized as a cultural achievement is demonstrated by its dominance over rudimentary polyphony where the two impinge on each other. In Turkey, for example, parallel fourth and fifth diaphony is prevalent in folk music in rural areas but is replaced by linear music in the towns. The view that this suppression of rudimentary polyphony in urban circles is a refinement in the interests of an ideal, pure melody is further supported by the observed differences in timbre between art and folk musical instruments in this area. The folk instruments yield rough sounds, rich in overtones; the art instruments are smooth and pure in quality—compare, for example, the sounds of the two flutes *kaval* and *ney*. The reason for this purification is, presumably, that it is only possible to savour to the full the refined pleasure of perfect intonation if instrumental sounds are pure; that is, if the fundamental is conspicuous, the overtones weak.

To suppose that oriental art musics have no harmonic interest, however, is to misconceive their nature; they are harmonic in the

sense in which ancient Greek music was harmonic. That is to say, a song or an instrumental piece exists in time as a continuous static harmony. Every note of the piece is harmoniously related to every other note and to the final note. In theory—and often in practice as well—this final note sounds continuously, and every sound is heard as a simultaneous harmony with the final. The exposition of a northern Indian *raga* (*see* below) on the sitar (a long-necked lute with sympathetic strings and two gourd resonators), for example, is not merely a melodic but inevitably a harmonic experience. It offers a kind of harmonic satisfaction different from that of western art music in that tension and relaxation arise from the movement of the melody relative to a static harmony of the final note with its fifth and octave. The harmony is that of bagpipe music or of medieval dance music in Europe.

Over much of the orient the concept of art music is inseparable from that of mode, a word originally meaning manner or fashion. This presents great difficulties of comprehension, for present-day understanding of what is meant by mode is vestigial; generally speaking, modern listeners do no more than recognize the change in mood associated with a change from a minor third to a major third (or conversely) in a piece of music based on a seven-note, equal-tempered, diatonic scale. To understand what mode meant to the Greeks and to the musicians of the medieval Church it is necessary to look today to the meaning of the terms *raga* and *maqam* in Indian and middle eastern musics respectively.

The mere definition of a scale, a note series, whether it be a major or a minor scale, or a seven-note or five-note scale, does not suffice to define either *raga* or *maqam*. The definition of a Turkish or Arabic *maqam*, for example, requires in addition the specification of where to begin and where to end; of how to approach points of rest; of characteristic turns of phrase. For a northern Indian *raga*, the characteristic turns of phrase are often numerous and are all codified (*cf.* the medieval *tonarium* in the west) so that a specimen melody, a pattern (*rupa*), can be prepared to enable the beginner to grasp the essence of any particular *raga*. Any movement of the melody outside the bounds of these many specifications at once destroys the characteristic atmosphere or ethos of the *raga* or *maqam*.

The system of permissions and prohibitions that determines the character of an individual *maqam* or *raga* presents an immediate parallel with those governing the course of contrapuntal melody in classical counterpoint; it also presents analogies with the selection and exclusion practised unconsciously in the construction of any language. Modes, like languages, are distributed discontinuously in space. It can be no accident that the names of the ancient Greek modes—Dorian, Phrygian, Lydian, Aeolian—are place names and tribal names, as are the names of a high proportion of the Persian, Arabic, and Turkish *maqam*—Nihavent, Isfahan, Iraq, Ajem, Nishapur, Hijaz, Kurdi, Shehnaz—and as were certain medieval Chinese modes—Ch'u, Wu, Yüeh, Shu—all names of ancient provinces. Indeed, it would seem that modes arise from the formation of local musical dialects.

The parallels between the organization of middle eastern and Indian music are far-reaching as are the parallels between these and what is known of the music of ancient Greece. The source of this similarity is perhaps to be sought in the ancient community of Indo-European and Indo-Iranian descent rather than in cultural borrowings in more recent historical times. On the other hand, there is good reason to suppose that cultural borrowing from central and western Asia played an important role in historical times in the development of the musics of eastern Asia. The classification of the modes current in China during the T'ang and Sung dynasties (618–1279), for example, followed Indian precedent and even made use of transliterations of technical terms from the Sanskrit.

One striking difference between the musics of China or Japan and those of India or the middle east is that improvisation is relatively unimportant in the first two. Even when Chinese zither tunes of the 15th century were prefaced with an introductory prelude called the *tiao i* ("meaning of the mode"), this was not an improvisation but a short standard melody suitable for all pieces in that mode and comparable with the standard lute preludes in the earliest printed lute books of the west. The idea of an improvised exposition of a mode is foreign to both Chinese and Japanese music. On the other hand, both these countries, unlike India and the middle east, developed accurate tablatures in which lute and zither compositions have been printed continuously from medieval times. Improvisation occurs only as the technique of decorating a melody, as in accompanying the voice, for example. But if improvisation is of lesser importance, the traditional art-music ideal of China or Japan, a solo for lute or zither, surely owes much to central Asian models. By way of contrast, Chinese folk music offers many examples of rudimentary harmony and polyphony.

A further profound difference is that Chinese music, whether classical, popular or folk, tends to be programmatic, deliberately evocative of nonmusical ideas; to this extent it differs markedly from the "musicians' music" of India and the middle east, where extramusical associations are minimal.

The most ancient cultured music of China probably resembled that of the ritual orchestras of Indonesia today. This latter music often makes an immediate appeal to western listeners because of its harmonic-polyphonic qualities. In China it seems to have failed to withstand the pressure of new music coming from central Asia in the train of Buddhism and other cultural borrowings. In the west the rise of harmony and polyphony may perhaps have been due to a resurgence of ancient polyphonic tendencies when the dominance of the linear tradition of the early Church—derived from the Syrian tradition—waned. The total picture suggests the radiation of rationalized melody structure from a central area and its subsequent modification in peripheral areas, both east and west, by persistent elements of more ancient musical cultures. The new musics of the middle east, India, the People's Republic of China, and of Japan provide still more recent examples of the effects of cultural contact. *See* also INDIAN MUSIC; CHINESE MUSIC; JAPANESE MUSIC; GREEK MUSIC (ANCIENT).

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(L. E. R. P.)

ORIENTATION is a term expressing the position of any object relative to the points of the compass; in architecture, it is used to express the main dimensions of a building, with reference to the compass points. The word orientation derives from orient, meaning the east. In Mesopotamia and Egypt, as well as in primitive Central America, the important features of the buildings, such as entrances and passages, were pointed east, in the direction of the rising sun. Early Jews and Muslims turned in their prayers toward Jerusalem and Mecca respectively. Mosques are oriented so that the mihrab or prayer niche faces toward Mecca. Christian churches are usually oriented, with the apse or altar placed at the east end. Orientation has come to express relationships to any compass point. In architecture, the word is used in reference to the positioning of buildings relative to environment.

Orientation for sun takes into consideration the daily and seasonal variations of the sun's radiation. In the northern temperate zone the south side receives the largest amount of the sun's radiation in winter. The north side gets the least all year round, while the east and west sides receive the most in summer. Living areas usually are arranged to face south. Solar houses, which utilize solar rays for heating in winter, have large glazed surfaces oriented south. Skylights for factories or studios, where steady illumination without direct sunlight is preferable, face north. Sol-air orientation includes the factor of air temperature as well as solar radiation. This factor shifts the orientation from the south toward southeast in proportion to regional temperature differences. Orientation also may be affected by prevailing winds. Optimum wind orientation may not necessarily coincide with the solar orientation. The final orientation of a building is a compromise of the above factors. (A. OY.)

ORIENTE, the easternmost and largest province of Cuba. Area 14,132 sq.mi. Pop. (1962 est.) 2,172,839. It has the most vigorous relief of Cuba in the Sierra Maestra (to 6,578 ft.) but

also contains large plains in the northwest. Both the northern and southern coasts have excellent bays. Sugar cane is grown on the plains. Manganese is mined in the south and chromite, nickel and iron ore in the north. The capital is Santiago de Cuba, pop. (1962 est.) 215,616 (*see* SANTIAGO DE CUBA). Other major cities are Guantánamo, Holguín and Manzanillo.

The province was established in 1879 and was called Santiago until 1905. Population growth has been very rapid, especially after 1900 with the development of transportation and the large-scale utilization of the eastern plains of Cuba. Oriente has been the scene of major Cuban revolts, and it was from there that Fidel Castro launched his revolutionary movement which overthrew the regime of Fulgencio Batista in 1959. (D. R. D.)

ORIENTE, Ecuador: *see* EL ORIENTE.

ORIGEN (ORIGENES ADAMANTIUS) (*c.* 185–*c.* 254), the most influential theologian of the early Greek church, was an Egyptian who wrote in Greek. He was born *c.* 185 probably in Alexandria, of pagan parents according to the Neoplatonist philosopher Porphyry but of Christian parents according to the ecclesiastical historian Eusebius of Caesarea, whose account is probably right in this. Eusebius says that Origen's father, Leonides, was martyred in the persecution of 202, so that Origen had to provide for his mother and six younger brothers. At first he lived in the house of an opulent lady, where there was also a heretic named Paul; he then earned money by teaching grammar, and lived a life of strenuous asceticism. Eusebius adds that he was a pupil of Clement of Alexandria, whom he succeeded as head of a catechetical school under the bishop of Alexandria's authority, but the documents he quotes suggest rather that both Clement and Origen were independent lay teachers of grammar and philosophy. Eusebius also alleges, without supporting documents, that Origen castrated himself so as to work freely in instructing female catechumens; but this was not the only story told by the malicious about his extraordinary chastity, and it may all be mere hostile gossip. Writing in 248 Origen deplored the fanaticism of literal exegetes of Matt. xix, 12 ("there are eunuchs who have made themselves eunuchs for the sake of the kingdom of heaven"). Eusebius' account of Origen's life bears the marks of hagiographical legend and needs cautious treatment except where it is dependent on documents rather than hearsay.

According to Porphyry, Origen attended the lectures of Ammonius Saccas (*q.v.*), an esoteric Alexandrian Platonist whose parents had been Christians though he had abandoned his childhood faith. Concerning Ammonius Porphyry has more to say in his life of Plotinus where he mentions Plotinus and Origen as fellow-pupils of Ammonius; but it is so difficult to reconcile what Porphyry there says about Origen with what Eusebius says, that most scholars recognize the existence of two Origens, the one mentioned in the life of Plotinus being a pagan Neoplatonist. Origen ("son of Horus") was a common Egyptian name and there is no need to suppose that Ammonius could not have had two pupils named Origen. A letter of the Christian Origen mentions his "teacher of philosophy," at whose lectures he met Heraclas who was to become his junior colleague, then his rival, and ended as bishop of Alexandria refusing to hold communion with him. That Origen possessed a masterly knowledge of philosophical debate is evident from his writings.

Origen invited Heraclas to assist him with the elementary teaching, leaving himself free for advanced teaching and study; it was during this period (from *c.* 212) that he learned Hebrew and compiled his *Hexapla*.

A wealthy Christian named Ambrose, whom Origen converted from Valentinian Gnosticism and to whom he dedicated many of his works, provided shorthand writers, and a stream of treatises and commentaries began to pour from Origen's pen. At Alexandria he wrote his lost "Miscellanies" (*Stromateis*), "On the Resurrection" (*Peri anastaseos*) and, above all, "On First Principles" (*De principiis*). He also began his immense commentary on St. John, written to refute the Valentinian commentary of Heracleon. His studies were interrupted by visits to Rome (where he met Hippolytus), Arabia, Antioch and Palestine. Because of his reputation he was much in demand, and this provoked the disapproval of Demetrius, bishop of Alexandria, who was anxious to control this free lay teacher and especially angry when Origen was allowed to preach at Caesarea Palestinae. In about 229–230 Origen went to Greece to dispute with a Valentinian, Candidus. On the way he was ordained presbyter at Caesarea. The Valentinian doctrine that salvation and damnation are predestinate, independent of volition, was defended by Candidus on the ground that Satan is beyond repentance; Origen replied that if Satan fell by will even he can repent. Demetrius of Alexandria, incensed at Origen's ordination, was appalled by such doctrine, and instigated a synodical condemnation. This, however, was not accepted in Greece and Palestine. Thenceforth Origen lived at Caesarea, where he attracted many pupils. One of the most notable of these, Gregory Thaumaturgus, vividly describes his teaching in his extant panegyric, an oration praising his master after the contemporary fashion and designed to claim for Origen a position equal to that of pagan teachers.

From Caesarea Origen continued his travels. In 235 the persecution of Maximin found him in Cappadocia, whence he addressed to Ambrose his "Exhortation to Martyrdom" (*Eis martyrion protreptikos*). During this Caesarean period falls the "Discussion with Heracleides," a papyrus partially transcribing a debate at a church council probably in Arabia where a local bishop was suspected of denying the preexistence of the divine Word, and where obscure controversies raged over Christological issues and whether the soul is blood. When in 250 persecution came under the emperor Decius, Origen was imprisoned and tortured but survived to die in about 254 at Tyre. His tomb there was held in honour, and its long survival is attested by historians of the crusading period.

Writings.—Origen's main lifework was on the text of the Greek Old Testament and on the exposition of the whole Bible. The *Hexapla* was a synopsis of the Old Testament versions: the Hebrew and a transliteration were followed by the Septuagint, the versions of Aquila, Symmachus and Theodotion and, for the Psalms, two further translations (one being discovered by him in a jar in the Jordan valley, like the Dead sea scrolls). The purpose was to provide a secure basis for debate with rabbis to whom the Hebrew alone was authoritative. The Greek churches generally accepted the Septuagint text and canon. Concerning Septuagintal authority Origen is not consistent, but the unspoken implication of his work (made explicit by Jerome) was that the Hebrew text and canon possess more certain authority and that one cannot safely appeal to the Greek version to establish a point of doctrine. It is a consequence of this view that in English Bibles the overplus of the Septuagint canon is separately printed under the misleading title Apocrypha. Origen frequently mentions textual variants among New Testament manuscripts, but undertook no study of them comparable to the *Hexapla*, which is extant only in parts.

His exegetical writings consist of commentaries (scholarly expositions for instructed Christians), homilies for mixed congregations, and scholia (detached comments on particular passages or books, almost entirely lost). None of his commentaries survives complete; quite apart from doubt about his orthodoxy, it militated against preservation that they were too long to copy. All extant manuscripts of the commentary on St. John, which extended to 32 books, depend on a Munich codex containing books 1, 2, 6, 10, 13, 19–20, 28, 32. This (the Venice manuscript Marc. gr. 43 is a copy of the Munich codex and only important where dampness has made the latter unreadable) and a related manuscript at Trinity college, Cambridge, are the sole witnesses for the Greek original of books 10–17 (on Matt. xiii, 36–xx, 33) of the commentary on St. Matthew; for part of this work (Matt. xvi, 13–xxvii, 63), which extended to 25 books, there is an anonymous Latin translation (perhaps 5th century). Greek fragments of this, as of most of Origen's exegetical works, survive in *catenae* ("chains"; *i.e.*, anthologies of patristic comments on biblical books). The commentaries on the Song of Solomon and on Romans survive in a drastically abbreviated Latin paraphrase by Tyrannius Rufinus. Parts of the original commentary on Romans iii, 5–v, 7 have been recovered on papyrus. The homilies on the Hexateuch (except Deuteronomy), Judges and Ps. xxxvi–xxxviii survive in translation

by Rufinus, to whom also the homilies on I Samuel may be due. Jerome translated homilies on the Song of Solomon, Isaiah, Jeremiah, Ezekiel and Luke. These Latin homilies were widely read in medieval monasteries and have a rich manuscript tradition. The Greek original of homilies on Jeremiah survives in a single Escorial manuscript, that of a homily on the witch of Endor (which provoked early criticism for its thesis that Samuel really was conjured up) in a Munich manuscript and on papyrus.

Before 231 Origen wrote *De principiis*, an ordered statement of Christian doctrine on an ambitious scale, based on the presupposition that every Christian is committed to the rule of faith laid down by the apostles (the Creator as God of both Old and New Testaments, the incarnation of the preexistent Lord, the Holy Spirit as one of the divine Triad, the freedom of rational souls, discarnate spirits, the noneternity of the world, judgment to come) but that outside this the educated believer is free to speculate. Origen was writing long before the conciliar definitions concerning the Trinity and the Person of Christ and at a period when a far larger area of doctrine could be regarded as open for discussion and argument than was the case by 400. Unhappily the treatise was only too ordered and clear, and the divergence of its speculations from later standards of orthodoxy could not be concealed. The original is consequently lost and can only be reconstructed from the *Philocalia*, an anthology compiled by Basil the Great and Gregory of Nazianzus chiefly illustrating Origen's biblical interpretation, from Rufinus' Latin paraphrase, which avowedly rewrites heterodox-sounding passages, and from later writers, notably Jerome and Justinian I, who quote especially compromising passages to prove Origen a heretic. The polemical anti-Origenists, however, need to be read with care since they are demonstrably not above quoting as Origen's personal opinion his statement of the view he rejects and fathering upon him the words of later Origenists such as Evagrius Ponticus. Only Rufinus gives the whole and, although he requires alert caution, his unreliability can be exaggerated.

Origen's great vindication of Christianity against pagan attack, *Contra Celsum*, written probably in 248 at Ambrose's request, survives entire in one Vatican manuscript, with fragments in the *Philocalia* and on papyrus. Paragraph by paragraph it answers the anti-Christian *Alethes Logos* ("The True Doctrine" or "Discourse") of Celsus (*q.v.*), and is therefore a principal source for the intelligentsia's view of 2nd-century Christianity as well as a classic formulation of the early Christian reply. Admittedly the initial impression of a modern reader may be that, since both protagonists agree in their basic Platonic presuppositions, the controversy hardly rises beyond debating points that merely provide Origen with scope for his rare knowledge of philosophical debate and scarcely reach the root of the matter. Besides the trivialities and advocacy, however, serious questions are argued: on Celsus' side the validity of appeals to the supernatural guarantees of miracle and prophecy and especially the doctrine of God implied by the Bible as a whole and the incarnation in particular; on Origen's side, the weighing of the pagan tradition by an intelligent critic, negative toward paganism's moral weakness and easy receptivity to gross superstitions, cold toward philosophical rationalizations and compromise with pagan cult, but often positive in his appreciation both of the intellectual achievement of Greek philosophers and of the political significance of the Roman empire. Celsus' brusque dismissal of Christianity as a crude and bucolic onslaught on the religious traditions and intellectual values of classical culture provokes Origen to a sustained rejoinder, claiming that a philosophic mind has an unqualified right to think within a Christian framework and that Christian faith is neither unreasoning prejudice nor a mere social eccentricity of dissident nonconformists.

The tract "On Prayer" (*Peri euches*), preserved by one Cambridge manuscript, was written about 233; it expounds the Lord's Prayer and discusses some of the philosophical problems of petition, arguing that petition can only be excluded by a determinism false to the experience of personality, while the highest prayer is an elevation of the soul beyond material things to a passive inward union with Christ, mediator between men and the Father.

System.—Origen's experience as a teacher is reflected in his continual emphasis upon a scale of spiritual apprehension. Christianity to him is a ladder of divine ascent, and the beginner must learn to mount it with the saints in a never-ceasing advance. Uneducated and elementary Christians may entertain strange misunderstandings, and may even believe things of God that would not be believed of the most savage and cruel men. But the truth at the higher level is plain: that God's nature is essentially goodness and that he desires of his creatures a love which is free. Everything in Origen's theology ultimately turns upon the goodness of God and the freedom of the creature. The transcendent God is the source of all existence and is good, just and omnipotent. This omnipotence is never mere power evacuated of moral quality; one cannot appeal to it to rationalize absurdity or the merely prodigious. In overflowing love God created through the Logos rational, spiritual beings; this creative act involves a degree of self-limitation on God's part.

In relation to the created order God is both conditioned and unconditioned, free and under necessity. In one sense the cosmos is eternally necessary to God, since one cannot conceive such goodness and power at any time inactive. Yet in another sense the cosmos is not necessary to God but is dependent on his will, to which also it owes its continued existence. Origen is aware that there is no solution of this dilemma. The rational beings, however, neglected to adore God and fell. The material world was created by God as means of discipline (and its natural catastrophes such as earthquakes and plagues remind man that this world is not his ultimate destiny). Origen speculates that souls fell varying distances, some to be angels, some descending into human bodies, and the most wicked becoming devils. (Origen believes in the preexistence of souls, but not in transmigration nor in incorporation of rational souls in animal bodies.) Redemption is a grand education by providence, restoring all souls to their original blessedness. For none, not even Satan, is so depraved and has so lost rationality and freedom as to be beyond redemption. God never coerces, though with reformative intention he may punish. His punishments are remedial; even if simple believers may need to think of them as retributive, this is pedagogic accommodation to inferior capacity, not the truth.

The climax of redemption is the incarnation of the preexistent Son. One soul had not fallen but had remained in adoring union with the Father. Uniting himself with this soul, the divine Logos, who is second *hypostasis* of the Triad of Father, Son and Spirit, subordinate to the Father but on the divine side of the gulf between infinite Creator and finite creation, became incarnate in a body derived from the Virgin Mary. So intense was the union between Christ's soul and the Logos that it is like the union of body and soul, of white-hot iron and fire. Like all souls Christ's had free will, but the intensity of union destroyed all inclination for change, and the Logos united to himself not only soul but body, as was apparent when Jesus was transfigured. Origen, influenced by the semi-Gnostic Acts of John, thought that Jesus' body appeared differently to different observers according to their spiritual capacities. Some saw nothing remarkable in him; others recognized in him their Lord and God. In his commentary on St. John Origen collects titles of Christ, such as Lamb, Redeemer, Wisdom, Truth, Light, Life. Though the Father is One, the Son is many and has many grades, like rungs in a ladder of mystical ascent, steps up to the Holy of Holies, the beatific vision.

The union of God and man in Christ is pattern for that of Christ and the believer. The individual soul, as well as the church, is the bride of the Logos, and the mystery of that union is portrayed in the Song of Solomon, Origen's commentary on which was regarded by Jerome (in the period of his enthusiasm for Origen) as his masterpiece. So redemption restores fallen souls from matter to spirit, from image to reality, a principle directly exemplified both in the sacraments and in the inspired biblical writings where the inward spirit is veiled under the letter of law, history, myth and parable. The commentator's task is to penetrate the allegory, to perceive within the material body of scripture its soul and spirit, to discover its existential reference for the individual Christian. Correct exegesis is the gift of grace to those spiritually worthy.

Both the biblical revelation and the spiritual life of the believer are a progress. The church is the great "school of souls" in which erring pupils are disciplined: elementary education in this life, higher education in the world to come where the atoning and sanctifying process will continue in a purging baptism of fire, burning up the wood, hay and stubble. Hell cannot be an absolute since God cannot abandon any creature; because of his respect for freedom, it may take time but God's love will ultimately triumph. Christ's work remains unfinished until he has subdued all to himself. (It is noteworthy that for the final restoration of all to original blessedness Origen normally avoids the technical Stoic term *apocatastasis* which he uses rather in the quite general sense of "salvation" or "conversion.") Heaven is not necessarily absolute because freedom is an inalienable characteristic of the rational creature. "If you remove free will from virtue, you destroy its essence." Because the redeemed remain free, when all souls have been restored the whole drama may begin again. The Stoics believed in world cycles determined by fate. Origen thought them possible for the opposite reason, because freedom means that there is no ultimate finality.

Influence.—If orthodoxy were a matter of intention, no theologian could be more orthodox than Origen, none more devoted to the cause of Christian faith. His natural temper is world-denying and even illiberal. The saintliness of his life is reflected in the insight of his commentaries and the sometimes quite passionate devotion of his homilies. The influence of his biblical exegesis and ascetic ideals is hard to overestimate; his commentaries were freely plagiarized by later exegetes, both eastern and western, and he is a seminal mind for the beginnings of monasticism. Through Evagrius Ponticus his ideas passed not only into the Greek ascetic tradition but also to Cassianus and the west. Yet he has been charged with many heresies. In his lifetime he was often attacked, suspected of adulterating the gospel with pagan philosophy. After his death opposition steadily mounted, respectful in Methodius' criticism of his spiritualizing doctrine of the resurrection (*c.* 300), offensive in Epiphanius' (375), violent in Jerome's quarrel with Rufinus (*c.* 393–402). Origen had his defenders, especially in the east (Eusebius of Caesarea, Didymus of Alexandria, Athanasius to some degree and especially the Cappadocian Fathers); but in the west Rufinus' translation of *De principiis* (398) caused scandal, and in the east the Origenist cause suffered by the permanent influence of Epiphanius' attack. In the 6th century the "New Laura" in Palestine became a centre for an Origenist movement among the monastic intelligentsia, hospitable to speculations about preexistent souls, universal salvation and spherical resurrection bodies (a belief not countenanced by Origen himself). The resultant controversy led Justinian I to issue a long edict denouncing Origen (543); the condemnation was extended also to Didymus and Evagrius by the fifth ecumenical council at Constantinople (553). Nevertheless, Origen's influence persisted (*e.g.*, in Maximus the Confessor and Johannes Scotus Erigena), and since Renaissance times controversy has continued concerning his orthodoxy, western writers being generally more favourable than Eastern Orthodox.

The chief accusations against Origen's teaching are the following: making the Son inferior to the Father and so being precursor of Arianism; spiritualizing away the resurrection of the body; denying hell, a morally enervating universalism; speculating about preexistent souls and world cycles; dissolving redemptive history into timeless myth by using allegorical interpretation, thus turning Christianity into a kind of Gnosticism. None of these charges is altogether groundless. At the same time there is plenty to justify Jerome's first judgment that Origen was the greatest teacher of the early church after the apostles.

See also references under "Origen" in the Index.

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ORIHUELA, a town and episcopal see of southeastern Spain in Alicante province, Valencia region, lies in the fertile Vega (flat lowland) del Segura, 23 km. (14 mi.) N.E. of Murcia by road. Pop. (1960) 44,830 (mun.). The old part of the town is north of the Segura river, the new on the south. Old buildings include the 14th-century cathedral, the church of Santiago (once a mosque and rebuilt by the 18th century); the 14th-century church of Santas Justa y Rufina with an 18th-century facade, and the Colegio de Santo Domingo (1516–1701, the former university). There is a diocesan museum of sacred art. Orihuela is on the railway from Murcia to Alicante. Local agriculture is very important and is assisted by a remarkable irrigation system left by the Moors. Oranges, lemons, potatoes, pepper, hemp, cotton, maize (corn), oats, wheat, almonds and dates are the chief products. The town dates back to 1500 B.C. and was the Roman Orcelis. Captured by the Moors in 713 it was finally liberated in 1264. It was sacked during the disturbances at the beginning of Charles V's reign (1520) and again in the War of Succession (1706). It suffered several epidemics of plague, was partly destroyed by an earthquake in 1829 and has often been flooded by the Segura. (P. D. Y.)

ORINOCO, the third largest river system in South America, rises in the Parima mountains in southern Venezuela and empties into the Atlantic ocean south of Trinidad island. Several expeditions have attempted to determine the exact source of the Orinoco. The 1951 Venezuelan expedition, led by Maj. Rísquez Iribarren, located the source at lat. 2° 19′ N., long. 63° 22′ W., almost on the Brazilian border.

The main river flows westward from its source, skirting the Parima mountains. Upon turning north, it forms the boundary of Venezuela and Colombia for nearly 200 mi. The river then swings eastward along the edge of the Guiana highlands and forms the southern edge of the llanos (*q.v.*). It finally enters the ocean through a great delta, covering approximately 5,000 sq.mi. of islands formed by the many distributaries.

The Orinoco is 1,281 mi. long. Approximately 100 mi. from its source, the main river is about 170 ft. wide and widens to nearly ½ mi. at the junction of the Casiquiare in the upper basin. The width of the main stream as it turns north upon receiving the waters of the Atabapo and Guaviare tributaries is about a mile. The river divides and braids itself throughout its course, and islands are particularly numerous in the middle course. The river widens considerably upon receiving the waters of the Meta, and islands are large and long. Just below Ciudad Bolívar, the chief city on the Orinoco, the river widens to about 5 mi.

The flow of the Orinoco shows marked seasonal variations. The greatest flow occurs from May to October, the rainy season, with the maximum usually reached in July and August. The long dry season from November to April causes considerable reduction in the flow. At Ciudad Bolívar the difference between high and low water averages 50 ft. and has been known to reach 60.

The drainage basin of the Orinoco system covers more than 350,000 sq.mi., encompassing about four-fifths of Venezuela and one-fourth of Colombia. Seven large tributaries enter the Orinoco in its middle and lower courses. Three of these rise in the highlands of Venezuelan Guiana close to the Brazilian border. The Caroní river, the farthest downstream, has the largest basin of the three, covering much of southeastern Venezuela. The Caura and Ventuari basins are separated by a high massif that forms the boundary between Bolívar state and the federal territory of Amazonas.

The major left bank tributaries of the Orinoco are the Apure, Arauca, Meta and Guaviare. All four are long streams following somewhat sluggish but relatively straight courses from the base of the Andes across the gently sloping llanos to the Orinoco. The Apure has several long, parallel affluents; its numerous northern tributaries, chief of which is the Portuguesa, drain the southern slopes of the Venezuelan Andes. The Arauca parallels and is close to the Apure; their waters commonly mingle by means of lateral channels during the rainy reason. The Meta rises high in the Colombian Andes south of Bogotá. The Guaviare, southernmost of the great western tributaries, marks the dividing line between the savannas of the western part of the llanos and the higher and more varied topography of the south.

From its source at 3,523 ft. elevation the Orinoco rushes downward across numerous rapids and little falls. In its first 30 mi. it descends to 1,000 ft. elevation and in the next 50 mi. cascades to 500 ft. elevation; then the gradient lessens and the river descends only 100 ft. in the next 100 mi. to Esmeraldas. In the middle course the rate of descent is about six inches per mile, but rapids are still common.

About 50 mi. above the junction of the Meta, about 700 mi. from the ocean, are the Atures rapids, which limit the navigation of large river steamers. The lower Orinoco has been dredged to a minimum depth of 26 ft. for a distance of 178 mi. from the mouth of Puerto Ordaz on the Caroní.

The value of the Orinoco for navigation lies in the transport of iron ore from the tremendous deposits south of the river. Ore is transported by railways from the iron mountain of Cerro Bolívar and El Pao, west and east of the Caroní, respectively, to the mouth of the Caroní for loading on barges and ships. A large hydroelectric plant was completed at the lower falls of the Caroní in 1958. Most of the power was destined for steelmaking at a large steel mill near Puerto Ordaz and the remainder for the region's future industrial growth. (D. R. D.)

History.—Europeans have had an interest in the Orinoco ever since Columbus wrote Queen Isabella that the river's mouth was the gateway to the Celestial Paradise. In 1531–32 Diego de Ordaz went upstream far enough to find that that was not true, but many Spanish adventurers continued to believe that in the valley would eventually be found Eldorado (*q.v.*). Sir Walter Raleigh paid with his life when the Orinoco failed to yield what the English adventurer had assured his sovereigns it would. During the 17th century Jesuits established missions along the banks of the river, but by the mid-18th century their hold was still tenuous, as the Indians periodically laid waste buildings and fields. In 1744 Jesuit missionaries discovered the unusual Casiquiare connection between the Orinoco and Amazon (*q.v.*) systems. Alexander von Humboldt (*q.v.*) took an expedition up the river in 1800. Simón Bolívar envisioned a city on the banks of the Orinoco as one day being the chief port of entry for all of South America. Tradition has it that the first steamship was on the river as early as 1812, but it was not until the late 1860s and after many efforts and much expense that steamship navigation became a continuous part of the river's history.

Herbert Spencer Dickey in 1931 headed an expedition that claimed to have established the exact source of the river; a Brazilian boundary-settling expedition claimed a slightly different location of the source in 1943; the Venezuelan expedition of 1951 (*see* above) claimed the final settlement. Meanwhile, as for nearly four centuries, gold seekers combed the valleys of the river's tributaries in search of wealth. (J. J. J.)

ORIOLE, the name applied in America to several birds of the genus *Icterus*, grouped with blackbirds and troupials in the family Icteridae. They were called orioles by the early American settlers because the black and yellow patterns of these birds was reminiscent of the true orioles (family Oriolidae) of Europe. (*See* ICTERUS.)

The true orioles, of which there are about 26 species, chiefly in Asia, Africa and northern Australia, are represented in Europe by the golden oriole (*Oriolus oriolus*). The golden oriole is an occasional spring visitor to the British Isles, but rarely breeds there. In Europe it is a well-known bird; its range in summer extends east to Irkutsk, U.S.S.R., while in winter it is found as far south as the Union of South Africa. In India it is replaced by an allied form, *O. kundoo*, the mango bird, and both in Asia and Africa are several other species, some of which have a black head, or even a glowing crimson, instead of the ordinary yellow colouring, while others exhibit the dingy type of plumage seen in the female of the more usual form.

ERIC HOSKING

GOLDEN ORIOLE (ORIOLUS ORIOLUS)

Mimeta and *Sphecotheres* species are orioles peculiar to the Australian region; the former are drab in colour and mimic friarbirds (*q.v.*), the latter are distinguished by a bare space round the eyes.

Orioles are shy and restless birds, frequenting gardens and woods, and living on insects and fruit. Most of the species have loud, clear, flutelike melodious songs. *Oriolus* species are not gregarious, but some of the Australian forms tend to keep in loose but sizable flocks. The nest is pocket-shaped, composed of bark, grass and fibres, and the eggs are white or salmon-coloured with dark spots in most species, greenish in *Sphecotheres*. *See* also BIRD. (HT. FN.)

ORION, a major constellation named for the Greek mythological son of Hyrieus or Poseidon, a mighty hunter of great beauty and gigantic strength. He is also sometimes represented as sprung from the earth. He was beloved of Eos, the dawn-goddess, who carried him off to Delos; but Artemis slew him with her arrows (*Odyssey*, v, 121). According to other accounts which attribute Orion's death to Artemis, the goddess herself loved him and was deceived by the angry Apollo into shooting him by mistake; or he paid the penalty of offering violence to her, or of challenging her to a contest of quoit-throwing. In the lower world his shade is seen by Odysseus driving the wild beasts before him as he had done on earth (*Odyssey*, xi, 572).

After his death he was changed into the constellation called by his name. It took the form of a warrior wearing a girdle of three stars and a lion's skin and carrying a club and a sword. When it rose early it was a sign of summer; when late, of winter and stormy weather; when it rose about midnight it heralded the season of vintage.

Orion is one of the most conspicuous constellations, contain-

ing many bright stars. Of these Betelgeuse is easily distinguished by its yellowish-red colour in contrast to all the other important stars of the constellation, which are white B-type stars. Betelgeuse is an irregular variable sometimes above and sometimes below the first magnitude. It was the first star for which the apparent diameter was measured by Michelson's interferometer method (1920). Rigel at the opposite corner of the quadrilateral is rather brighter; and the third brightest star is Bellatrix. The Orion nebula can be seen with the naked eye just below the belt; faint extensions of it have been photographed filling practically the whole constellation. The multiple star Theta Orionis is near the centre of the nebula.

There is no doubt that the principal stars of the constellation form a single system and are involved in the nebulosity whose luminescence is stimulated by their intense radiation rich in light of short wave length. The distance of the nebula from the solar system is estimated at 1,500 light-years.

See also references under "Orion" in the Index.

ORISKANY, a village of Oneida county, N.Y., U.S., is located about midway between Utica and Rome, on the State Barge canal. It was founded in 1802 by Col. Garrett Lansing near the site where, on Aug. 6, 1777, Gen. Nicholas Herkimer stopped the advance of Col. Barry St. Leger and contributed to the failure of the British northern campaign. Marching from Ft. Dayton (now Herkimer) with 800 militiamen to relieve Ft. Schuyler (also called Ft. Stanwix, now Rome), Herkimer was ambushed in a ravine by British and Indians under Joseph Brant. Though wounded, he continued to direct his forces in what developed into one of the bloodiest hand-to-hand battles of the American Revolution. Victory came when part of the British forces were drawn off by a sortie from Ft. Schuyler led by Lieut. Col. Marinus Willet. Herkimer died on Aug. 16, seven days before St. Leger, hearing exaggerated reports of American reinforcements, withdrew permanently. The site of the battleground is a state park marked by a memorial shaft erected in 1883. The state's first woolen cloth factory was founded in Oriskany in 1811 and an iron foundry in 1856.

Oriskany, whose population has always been less than 2,000, was incorporated in 1914. The name comes from an Indian village, Oriska, which once occupied the site. (V. C. C.)

ORISSA, a constituent state of the Republic of India. It lies along the shores of the Bay of Bengal between the states of West Bengal and Andhra Pradesh, and extends inland on to the plateau to the borders of Madhya Pradesh and Bihar. Thus constituted it has an area of 60,164 sq.mi. Orissa proper, the coastal area, long formed part of Bengal presidency. In 1912 the province of Bihar and Orissa was separated from Bengal and the two parts, Bihar and Orissa, were later created separate provinces in 1936. When India became independent in 1947 changes followed; before the end of the year the rulers of 25 states surrendered their authority to the government of India, and by 1949 their domains had been transferred to the province of Orissa and, with other boundary adjustments, the present limits of the state were fixed. The province of Orissa became a state under the constitution of 1950. The old capital and still the largest city, Cuttack (*q.v.*), was replaced by a new state capital, Bhubaneswar (*q.v.*) in 1958.

Physical Characteristics.—Orissa comprises a number of contrasted parts. The old core of the province is the long-settled, densely populated alluvial delta of the great Mahanadi (*q.v.*), connected by a narrow coastal plain with the Ganges delta in West Bengal to the northeast, and by a narrow coastal plain, past the extensive Chilka lake, with Srikakulam district of Andhra Pradesh. Behind the coastal plain is the edge of the great Indian plateau through which the Mahanadi river cuts in great gorges. Southward the plateau edge constitutes the Eastern Ghats and the surrounding country is mountainous, thickly forested and so difficult of access that its few tribal inhabitants were always left very much to themselves. North of the Mahanadi lies the Chota Nagpur plateau mostly in Bihar and largely forested. In the northwest of the state the Mahanadi flows in a broad course through the midst of extensive valley basins on the plateau surface.

Broadly the whole state enjoys a good and reliable rainfall from the monsoon, varying between 40 and 60 in. annually, decreasing from the east (adjoining the hot, humid and very wet Calcutta area) to the west. Though modified by elevation in the mountainous areas, in the settled tracts mean January temperatures range between 18° and 24° C. (65° and 75° F.), and hot season temperatures are rarely excessive. These conditions favour the growth of monsoon forests in which the sal (*Shorea robusta*) is a chief timber tree, and, on the plains, the conditions favour rice cultivation especially if protected by supplemental irrigation.

The ancient rocks of the plateau are highly mineralized in places, and Orissa shares with Bihar the riches of the Chota Nagpur plateau—notably in iron ore. (L. D. S.)

History.—Orissa was known in ancient times as the land of the Kalingas and comprised the entire coastal strip of eastern India, stretching from the Ganges river to the Godavari, with an extensive belt of uplands in the west. The culture of this land is often referred to in the early Buddhist and Brahmanic literatures. Srutayuh, the king of Kalinga, is believed to have sided with the Kauravas in the Mahabharata (*q.v.*) war (*c.* 900 B.C.). After him up to the reign of Mahapadma Nanda (350 B.C.), as many as 32 Kshattriya kings ruled over Kalinga. In 261 B.C. Kalinga was conquered by Asoka (*q.v.*), the Mauryan king. (*See* also INDIA-PAKISTAN, SUBCONTINENT OF: *History*.) At the fall of the Mauryan empire Kalinga regained its independence and rose to prominence under the emperor Kharavela, whose military exploits extended from sea to sea, and from Mathura to the Tamil lands in the South. At this time Jainism flourished in Kalinga.

After Kharavela a long period of darkness descended on Orissa which lasted until the conquests of Samudragupta (*c.* A.D. 350). Kalinga then appears to have enjoyed a period of prosperity under the Mathara kings (4th–6th century A.D.). By the 6th–7th century, however, a group of regional states seems to have sprung up, famous among which were the Kongoda kingdom of the Sailodbhavas and the Toshala kingdom of the Manas. Taking advantage of this disintegration, Sasanka, the king of Karnasuvarna (West Bengal and part of Bihar) occupied the entire coastal tract of Kalinga up to Ganjam, but he was soon supplanted by his adversary, Harshavardhana of Kannauj.

By about the 8th century the Bhaumas became powerful in the Toshala region. The Somavamsis also rose to power at the same time. After the death of Queen Dharma Mahadevi, the last Bhauma monarch in the late 10th century, the coastal territories came under the Somavamsi king Yajati II. Early in the 12th century the Ganga king, Choda Ganga Deva occupied Orissa. He constructed the world famous temple of Jagannath (*see* JUGGERNAUT) at Puri (*q.v.*). Narasimha Deva I (1238–64), of the Ganga dynasty, is well known for his victories against the Muslims and as the builder of the Sun temple at Konarak (*q.v.*). The Ganga dynasty came to an end in 1435 and was succeeded by the Solar (Surya Vamsa) dynasty under Kapilendra Deva. Orissa reached the peak of its political glory under him, its territory covering the entire eastern coast up to the Cauvery (Kaveri) river in the south. Kapilendra Devas' son Purushottam Deva (1467–97) was able to maintain the imperial legacy of his father, but Purushottam Deva's son Prataprudra Deva (1497–1540) suffered great reverses at the hands of Krishna Deva Raya of Vijayanagar, after which Orissa passed through four centuries of Muslim, Maratha and British rule.

The Muslims of Bengal occupied Orissa in 1568 after defeating its last independent Hindu king, Mukunda Deva. The Moguls conquered Bengal and Orissa in 1576 and Alivardi Khan ceded Orissa to the Marathas in 1751. Maratha rule ended in 1803 when the British occupied Orissa after the 2nd Maratha War.

In 1823 Orissa was divided into three regulation districts of Cuttack, Balasore and Puri, and a number of non-regulation tributary states. The districts formed part of the Bengal presidency. In 1866 Orissa suffered from famine followed by destructive floods and the latter part of the 19th century witnessed various irrigation projects. Agitation for the unification of the Oriya-speaking peoples in a separate province of Orissa began at the outset of the 20th century and in 1903 the first meeting was held of the Utkal Union conference which was organized to achieve this

end. In 1912 the area of modern Orissa was separated from Bengal and united with Bihar to form the province of Bihar and Orissa. But the agitation continued and in April 1936 Orissa was constituted as a separate province. It became a state in 1950. No territorial changes were made with the provisions of the States Reorganization act of 1956. (N. K. S.)

Population, Administration and Social Conditions.—Orissa had a population (1961) of 17,548,846 of which more than 97% were Hindus. Most of the people speak Oriya (*see* ORIYA LANGUAGE), which is the language of the state. The state has only one city, Cuttack, and 38 towns and 50,984 villages. The city and the chief towns with their population according to the 1961 census are: Cuttack 146,308; Berhampur 76,931; Bhubaneswar 38,211; Sambalpur 38,915; Balasore 33,931; Parlakimedi 22,708; Jeypore 25,291.

The state, which has a unicameral legislature, is divided into 17 districts but for administrative purposes some districts are grouped together, so that there are only 13 administrative districts. These, with their headquarters, are: Balasore (Balasore); Bolangir (Bolangir-Patna); Cuttack and Narsinghpur (Cuttack); Dhenkanal and Angul (Dhenkanal); Ganjam (Chatrapur); Kalahandi (Bhawanipatna); Keonjhar (Keonjhargarh); Koraput (Koraput); Mayurbhanj (Baripada), Boudh and Khondmals (Phulbani); Puri and Nayagarh (Puri); Sambalpur (Sambalpur) and Sundergarh (Sundergarh).

At the 1961 census, 35% of the male and 9% of the female population were given as literate. In the early 1960s primary education was imparted to more than 40%, and secondary education to about 10% of the children forming the respective school-going age groups. Of the total 22,597 educational institutions—including Utkal university at Cuttack, 42 colleges, 20,000 primary and secondary schools—37% are managed by the government, 4% by the local boards and 59% by private bodies. Free compulsory education is provided to about 2,400 children in the age-group of 6 to 11 in ten towns and villages.

The general standard of health is low, common diseases being cholera, smallpox and malaria. Through about 60 primary health centres the government provides free institutional and domiciliary health services to rural people and school children. A contributory social insurance plan protects more than 18,000 factory workers against the risks of sickness (including free medical care), maternity and employment injury. Besides various welfare plans for tribal and backward people, the government runs multi-purpose welfare centres providing educational and recreational facilities to industrial workers and their children. Welfare plans, undertaken by the state social welfare board, include state homes and district shelters for discharged convicts and destitute women, welfare institutions for widows, orphans and neglected children, and vacation homes with free board and lodging and free train fares to poor children. (S. CH.; S. B. L. N.)

The Economy.—As elsewhere in India, agriculture occupies more than three-quarters of the population, and by far the most important crop is rice. The eastern margins of the state come just within the India-Pakistan jute belt, but acreage and production are small. A specialist crop of some interest is turmeric from which is extracted a yellow substance that forms the basis of most curry powders. The forests of the plateau, apart from an important output of timber and firewood, are a leading source of the resinous secretion caused by an insect (*Laccifer lacca*) and known as lac, of which India has a virtual world monopoly. Fishing is important along the coasts and there is a considerable trade also of fish from Chilka lake sent notably to Calcutta.

Although the rice lands of the Mahanadi delta have long been protected by irrigation, the Naraj dam on the Mahanadi above Cuttack (*q.v.*) and the Tikarpara dam where the river cuts through the Eastern Ghats are modern large-scale works. But these pale into insignificance when compared with the Hirakud dam, one of the world's largest earth dams, up on the plateau—stage 1 was completed in 1957. A site, some 75 mi. N.E. of the Hirakud dam, at Rourkela near the Bihar border, was chosen for one of the three great iron and steel plants, built under the second five-year plan with the aid of foreign capital. About 80 mi. farther northwest is the old established Jamshedpur, in Bihar, but Rourkela is designed to use other rich sources of iron ore. Power from Hirakud (projected capacity 147,000 kw.) can be sent to almost any part of the state. In consequence, the old handloom industry is giving place to modern textile and weaving mills. Other industries include the manufacture of cement, paper, glass, sugar and aluminum, and the first tube mill in India. The Machkund hydroelectric project (begun 1946 with an ultimate capacity of 115,500 kw.) in Koraput district is financed jointly with the Andhra Pradesh government.

Urbanization is in progress. In 1951 Cuttack was the only city with over 100,000 people (102,505). On the coast south of Cuttack, Puri (*q.v.*) has long been a great centre of pilgrimage for the devotees of Jagannath. Orissa has no significant port because of the shallow shelving shore and monsoon storms, but Paradip was being developed in the 1960s; other small ports are Chandbali and Gopalpur. In the early days of the British period a canal was dug parallel to the shore connecting the Hooghly river with the Mahanadi delta, and on this Balasore was developed both as a port and factory town. The main railway from Howrah (Calcutta) to Madras serves the coastlands and crosses the Mahanadi by a magnificent bridge at Cuttack. Bhubaneswar and Cuttack, 15 mi. N., share an international airport. (L. D. S.)

See R. D. Banerji, *A History of Orissa*, 2 vol. (1930–31); W. W. Hunter, *Orissa*, 2 vol. (1827).

ORIYA LANGUAGE, the language of the Indian state of Orissa, is one of the 14 major languages of the Republic of India accepted by the Indian constitution and is spoken by about 20,000,000 people of whom many hundreds of thousands live outside Orissa. It belongs to the northeastern group of the Indo-Aryan family and is descended, as are its closest relatives, Maithili (north Bihar), Assamese (Assam) and Bengali (Bengal), from Prakrit, or spoken form of Sanskrit, as used in ancient Magadha (mod. Bihar) from about 1000 B.C. Oriya is thus directly descended from the language named Ardha Magadhi (dialect spoken in the eastern region of the ancient kingdom of Magadha); and is the closest of all modern Indian languages to Sanskrit in vocabulary and phonetics. Its vocabulary it shares with Maithili, Assamese and Bengali, but differs from them in morphology, syntax and pronunciation. It has been much less affected than they by the foreign elements consequent upon Muslim and British rule, because the state of Orissa was among the last to be conquered. Unlike Bengali or Hindi, it is pronounced as it is written; for example, the word *rama* is so pronounced in both Sanskrit and Oriya, while in Bengali and Hindi it loses the final *a*. Oriya's grammatical structure is simple and its correspondence between pronunciation and spelling makes it much easier for a foreigner to learn than, for example, Bengali. Its script, however, is better suited to manuscript than to print and a reform was under consideration in the 1960s.

See INDIAN LANGUAGES. (MA. M.)

ORIZABA, a city in the Mexican state of Veracruz. Pop. (1960) 69,706. Orizaba lies 82 mi. W.S.W. of the port of Veracruz and 203 mi. S.E. of Mexico City, on main roads and the two railways connecting those points. Founded by Spaniards in the 16th century to guard these critical routes, Orizaba's strategic importance made it a centre of Mexican history, to which was added its economic development in a favourable habitat. It stands at 4,211 ft. in a fertile, well-watered and temperate valley of the Sierra Madre Oriental, over which towers the Pico de Orizaba, a famous snowcapped extinct volcano (18,701 ft.) 18 mi. N. Midway between the tropical lowlands on one side and the semiarid plateau on the other, Orizaba's sufficiency of water and temperate conditions make its district an important agricultural and industrial area. Crops include tobacco, maize, sugar, cereals and rum. The Rio Blanco furnishes hydroelectric power for numerous textile mills, tobacco factories and light industry, among which is one of the principal breweries of Mexico. Tourists are attracted by the picturesque vegetation and pleasant climate.

Though a garrison post of Aztecs, called by them Ahuaializapan ("Pleasant Waters"), Orizaba had a negligible native population. Its public buildings recall a long colonial past. It was chartered

as a city in 1774 and was licensed under crown monopoly to produce tobacco. It was one of the first textile centres of Mexico. (Hd. C.)

ORKHAN (d. 1362), son of Osman I (*q.v.*), was beg (prince) of the Ottomans from 1326 to 1362. In 1326 the Byzantine town of Bursa had just fallen to the Ottomans; a similar fate was soon to overtake Nicaea (Iznik) and Nicomedia (Izmit). As in the case of Bursa, which became the Ottoman capital, so now, a process of military and economic blockade was to bring about the eventual capitulation of these two important cities—Nicaea in 1331 and Nicomedia in 1337. The continued success of the Ottomans attracted into their service numerous Muslim warriors from the neighbouring Turkish amirates in western Asia Minor. This development gave the Ottoman state a military potential out of all proportion to its geographical size, and, in addition, led to the appearance, within the other amirates, of parties favourable to the Ottoman cause. Orkhan, during *c.* 1335–*c.* 1345, was able to absorb into his own territories the little state of Karasi, weakened by dynastic rivalries in its ruling house and by the presence within its borders of strong pro-Ottoman elements. Most of the extreme northwestern corner of Asia Minor was by then under Ottoman control. The warriors of Orkhan crossed over into the Balkans in 1345 to aid the future Byzantine emperor John VI Cantacuzenus against his rival John V Palaeologus. This and other similar campaigns in the following years gave them an intimate knowledge of the Balkan scene. In 1354 the Ottomans seized Gallipoli as a permanent military base in Europe. When Orkhan died in 1362 a great tide of Ottoman conquest was just beginning to gather momentum in the Balkans. (V. J. P.)

ORKNEY, EARLS OF, a Scottish title derived from the earls or jarls who ruled the Orkney Islands under the suzerainty of the kings of Norway from the 9th to the 14th centuries. Many of these jarls also held the earldom of Caithness. Among the most prominent of these were THORFINN II (1009–*c.* 1065), who built up an empire based on the Orkneys, of which he had full possession by 1046, and MAGNUS I ERLENDSSOHN (d. *c.* 1117) who was later canonized and to whom the cathedral at Kirkwall was dedicated in 1137.

In its more modern sense the earldom dates from 1379 when SIR HENRY SINCLAIR (d. *c.* 1400) was made earl. His mother was Isabella, daughter of MALISE (d. between 1344 and 1358), the last of the ancient line of earls. He ruled the islands virtually as a king, built Kirkwall castle and met Nicolo and Antonio Zeno, the Venetian travelers, during his conquest of the Faeroe Islands, and employed them in his own service. He also went on a voyage of exploration to Greenland. His grandson WILLIAM, 3rd earl, took a prominent part in Scottish affairs, was chancellor of Scotland and after gaining the earldom of Caithness in 1455 resigned his Orkney title in 1470 to James III of Scotland who had acquired sovereignty over the Orkneys by his marriage with Margaret, daughter of Christian I, king of Denmark and Norway.

The title of duke of Orkney was created in 1567 for James Hepburn, earl of Bothwell (*q.v.*), on his marriage to Mary Stuart, but the old title of earl of Orkney was granted in 1581 to ROBERT (1533–1593), an illegitimate son of James V and half brother of Mary Stuart. He was abbot of Holyrood, but joined the Reformers after 1560 and was one of the principal opponents of the regent Morton. His son PATRICK (*c.* 1569–1615), 2nd earl, acted in such an autocratic and arbitrary manner in the Orkneys that he was imprisoned by the king in 1609 and after his son Robert had been executed for stirring up a rebellion, suffered the same fate himself in Feb. 1615, when his titles and estates were forfeit.

LORD GEORGE HAMILTON (1666–1737) was created earl of Orkney in 1696. He was a soldier who fought for William III in most of the king's more important campaigns in Ireland and the Netherlands. His granddaughter, MARY (*c.* 1721–1791), and her daughter MARY (1755–1831) were countesses of Orkney in their own right. The latter married Thomas Fitzmaurice (1742–1793), the brother of the earl of Shelburne (afterward marquess of Lansdowne), the prime minister. She was succeeded by her grandson THOMAS (1803–1877), 5th earl. CECIL (1919–) succeeded as 8th earl in 1951.

ORKNEY ISLANDS, a group of islands forming an insular county of Scotland, lie off the north coast of Caithness. The Orkneys are separated from the mainland by the Pentland firth which is 6½ mi. wide at the narrowest point between Caithness and South Ronaldsay in Orkney.

Physical Geography.—Massive red sandstones and gray lime-rich flagstones of the Old Red Sandstone formation, including northeast-southwest igneous instrusions, have been dissected into low rolling hills that reach 1,565 ft. in Ward hill in Hoy. The post-glacial rise in sea level has produced the present intricate pattern of sea-lochs and more than 70 islands of which 24 are inhabited, if only by the occupants of a single farm. Quaternary glaciers from the Scottish mainland dredged lime-rich marine muds and added them to local drift of lime-rich flagstones, and locally sandstones, producing the material for soil both fertile and tillable in the climate and latitude of Orkney. Waves driven by westerly winds and gales have produced the spectacular cliffs of Hoy and the narrow 450-ft. stack of the Old Man of Hoy. The climate is windy but mild (August mean 12° C. [54° F.], with 18½ hr. of daylight; March 3° C. [38° F.]). There are few trees. Seals and many species of seabirds abound, and the Orkneys are the most southerly breeding place of the great skua.

The largest island of the group is Mainland, divided into East and West Mainland which are joined by a neck about a mile wide between Scapa on Scapa Flow and Kirkwall. Mainland is sometimes called Pomona (*q.v.*), apparently through a mistranslation of Solinus who wrote a geographical book in the 3rd century. The island is comparatively low, undulating country, mostly cultivated but with much moorland and several lochs. Two lochs, Harray and Stenness, occupy more than 10 sq.mi. in West Mainland. The streams are very short; brown and sea trout fishing is good. Skara Brae and Maeshowe are two outstanding prehistoric monuments.

Among the islands to the south, Burray and South Ronaldsay, lying south of East Mainland, are now joined to Mainland by causeways built on the "Churchill barriers" which were constructed during World War II to prevent submarines entering Scapa Flow through the sounds. In Scapa Flow the only island now inhabited is Graemsay where crofting, in the strict sense, is still carried on. On Hoy (*q.v.*), the second largest island, is the Dwarfie stone, an enormous block of sandstone with rooms hollowed out in it that lies in a valley near Ward hill. Lyness, a naval base, lies on the eastern side of the island. Burray is notable for the *broch*, or fortified tower, from which the island takes its name (Borgarry, Norse; "island of the broch"). The remaining islands are low-lying and, where inhabited, thoroughly tilled.

To the north of Mainland lie the North Isles, also on the whole flat, though varied and colourful, as the soil is good and the land is heavily cultivated. North Ronaldsay, most northerly of the islands, is almost the last home of a fine-wooled breed of sheep once native to all Orkney. Westray has a considerable village at Pierowall and, a little inland, ruins of Noltland castle dating from the 16th century. Sanday, longest of the islands is, like the others, split into bays and headlands by the action of the sea; on it is a Neolithic chambered cairn. Stronsay has a considerable pier and harbour at Whitehall.

History.—The Orkney Islands were the Orcades of classical literature and the word may be derived from the Norse for a seal. Reindeer hunting is mentioned in the *Orkneyinga Saga*, one of the great Viking sagas, and elk were known until about 1300. There is much evidence of prehistoric occupation of various periods: underground houses, circles, tombs, standing stones and earth houses, the earliest of which date from the Stone and Bronze Ages. Skara Brae (*q.v.*), an underground village in West Mainland excavated (1928–31) by V. Gordon Childe, is one of the most complete relics of the late Neolithic age. A Roman fleet which reached the Orkneys shortly before Agricola, the Roman general who had attempted to subdue the east coast of Scotland, was recalled in A.D. 85. Norse raiders arrived in the late 8th century and settled in the 9th century. Thereafter the Orkneys were ruled by Norse earls or jarls under the kings of Norway and Denmark. Celtic missionaries had arrived in the 7th century but the inhabitants were probably not finally converted until much later.

From Orkney, over which he wished to strengthen his hold, Haakon IV Haakonsson of Norway went south to the battle of Largs (1263). The Norsemen were defeated and Haakon afterward died in Orkney. Kirkwall cathedral, dedicated to St. Magnus, a claimant to the Norse earldom in the early 12th century, was mainly built under the Norse earls.

Orkney (1468) and Shetland (1469) were pledged by Christian I of Denmark in payment of the dowry of his daughter, Margaret, queen of James III of Scotland. The dowry was never paid and the islands were annexed to Scotland in 1472, although the Danes continued to make claims until the mid-18th century. Subsequently the Orkneys played little part in Scottish history although some of its earls (*see* ORKNEY, EARLS OF) were prominent. In World Wars I and II the waters, particularly Scapa Flow (*q.v.*), were important to the Royal Navy and the Royal Air Force.

Population and Administration.—The population of the county in 1961 was 18,743; that of Kirkwall (*q.v.*), the county town and a royal burgh, was 4,315. The only other town is Stromness (*q.v.*), which is a small burgh with a population (1961) of 1,477. Both towns, on Mainland, are picturesque. Their main streets are extremely narrow. St. Magnus cathedral in Kirkwall, though small, is one of the finest and most complete examples of Norman architecture in Scotland. Built of red and gray sandstone, it was begun in 1137 and finished in the 15th century except for the steeple which is modern, the original having been struck by lightning. In Kirkwall, too, there are several fine old houses and the ruins of the Bishop's palace and the palace of the Scottish earls. The population of the inhabited islands in 1961 was as follows: Auskerry (3); Burray (262); Copinsay (3); Eday (198); Egilsay (54); Fara or Pharay (5); Flotta (123); Graemsay (51); Hellyar Holm (5); Holm of Grimbister (5); Hoy (511); Mainland (13,495); North Ronaldsay (161); Papa Stronsay (4); Papa Westray (139); Pentland Skerries (3); Rousay (237); Sanday (670); Shapinsay (416); South Ronaldsay (980); Stronsay (497); Sule Skerry (3); Swona (3); Westray (872); Wyre (47).

Orkney with Shetland sends one member to parliament. Together with Caithness and Shetland it forms a sheriffdom. The system of udal tenure still obtains to some extent on the islands.

The Economy.—As in Caithness, the Old Red Sandstone is easily worked for building. Much moor and peat remain but most of the glacial till is intensively farmed. World War I brought prosperity to Orkney, and improved strains of "wild white clover" were introduced then. Orkney has remained a technically advanced ley farming county, even through the depression of the 1930s. Every year more land is claimed for agriculture. The main products are beef cattle and eggs, though pigs and milk production have greatly increased. The county produces more beef cattle than any other Highland county and is among the first three counties in Scotland in the production of eggs. The holdings are for the most part owner-occupied and small. Oats are grown for food as well as turnips and potatoes but the county imports feeding stuffs for its own large production of livestock. Agriculture is by far the most important industry in the island.

There used to be a herring station at Stronsay and a certain amount of fishing, but this had almost ceased by the mid-20th century, though efforts were being made to revive seine netting from the town of Stromness. Lobsters are caught in considerable quantities, particularly round the northern islands and Scapa Flow. There are two distilleries and a plant for processing seaweed.

The northern islands are served by regular steamer services from Kirkwall and there is, in addition, a daily service to Shapinsay. There are air services from the Orkneys to Inverness and Aberdeen from Grimsetter aerodrome (near Kirkwall), and by steamer from Kirkwall or Stromness to Scrabster, Aberdeen and Leith. There are also regular steamer and air services to Shetland.

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ORLANDO, VITTORIO EMANUELE (1860–1952), Italian statesman who headed his country's delegation to the Conference of Paris at the end of World War I, was born at Palermo on May 19, 1860. He was first elected to the chamber of deputies for Partinico in Sicily in 1897. He was minister of education in the Giolitti cabinet of 1903–05, and of justice in the Giolitti cabinet of 1907–09, and again under Salandra in Nov. 1914. He was in favour of Italian intervention in World War I. On the resignation of the Salandra cabinet in June 1916 he remained in office under Boselli as minister of the interior, and when the latter resigned he was entrusted with the formation of a new cabinet.

After the armistice of Nov. 11, 1918, he went to Paris as leader of the Italian peace delegation. When Pres. Woodrow Wilson challenged Orlando's stand on Fiume and launched his appeal to the Italian people over the heads of their delegates, Orlando returned to Rome. He was triumphantly received, but after his return to Paris without obtaining any satisfactory solution of the Adriatic problem the chamber of deputies voted against him, and he resigned on June 19, 1919. On Dec. 2, 1919, he was elected president of the chamber. He at first supported Mussolini, but after the Matteotti affair he withdrew his support, without, however, abandoning the chamber. At the municipal elections of Palermo in Aug. 1925 he mobilized all his adherents in favour of the antifascist list. He resigned from parliament in protest against the fraudulent fascist victory.

After the Allies' entry into Rome in World War II, Orlando resumed public life, was a member of the consultative assembly and president of the constituent assembly elected in June 1946. In 1947 he resigned from the assembly in protest against the Italian peace treaty. He was a member of the Italian senate elected in April 1948 and in May was candidate for the presidency of the republic but was defeated by Luigi Einaudi by 518 votes to 320. He died in Rome on Dec. 1, 1952. *See* also ITALY: *History*.

ORLANDO, a city of central Florida, U.S., is located 145 mi. S. of Jacksonville and 97 mi. N.E. of Tampa; the seat of Orange county. Topographical features include low, rolling hills, with over 50 fresh-water lakes, many of them spring fed and surrounded by parks, located wholly or partly within the city limits.

Settlement of Orlando began about 1844 in the vicinity of Ft. Gatlin, a U.S. army post from 1837 to 1848. The first post office, established in 1850, was called Jernigan after Aaron Jernigan, an early settler from Georgia, but was changed to Orlando in 1857, in honour of Orlando Reeves, a soldier who was killed in the vicinity by Indians in 1835. Orlando became the county seat in 1856 and was incorporated as a city in 1875. The South Florida railroad, later part of the Atlantic Coast Line system, reached Orlando from Sanford, a distance of 20 mi., in 1880 and was extended to Tampa in 1883.

Most of the business life of the city centres around the distribution of products throughout the fertile citrus-growing and truck-gardening regions which surround the city. Major industries include citrus processing and packing, boatbuilding and the manufacture of electronic and guided-missile components, clothing, furniture and machinery. Two U.S. air force installations, Orlando air force base (military air transport service) and McCoy air force base (strategic air command), and a navy underwater sound reference laboratory are located in or near the city.

Educational facilities include Rollins college (1885), located in suburban Winter Park, and municipally owned Orlando junior college (1941).

Pop. (1960) 88,135; standard metropolitan statistical area (Orange and Seminole counties) 318,487. For comparative population figures *see* table in FLORIDA: *Population*. (J. E. Jo.)

ORLÉANAIS, a province or military government of France under the *ancien régime*, comprising not only the territory of the original countship and the later duchy of Orléans (*see* ORLÉANS, DUCS D') but also Blésois (the country round Blois, with its dependencies in Sologne), Vendômois, Dunois (round Châteaudun), the Pays Chartrain (round Chartres), Dreux, Étampes, half of Gâtinais (with Montargis) and Gien. In terms of modern *départements* it included most of Loiret, Loir-et-Cher and Eure-et-Loir, with parts of Seine-et-Oise and Sarthe. The *généralité* of

Orléans (under an intendant) was not conterminous with the military government: for instance, it did not include Dreux or Étampes, but included Rambouillet and, in the southeast and south, several areas in the governments of Burgundy, Nivernais and Berry.

During the feudal period, Orléans and Étampes were in the royal domain from the beginning of the Capetian monarchy, while the counts of Blois (*q.v.*), with the countship of Chartres also in their hands, long constituted a major threat to the king's power. The military government began to take the form described above from the beginning of the 17th century.

See R. Crozet, *Histoire de l'Orléanais* (1936).

ORLEANISTS, in French history of the 19th century, those who supported the claim of the head of the house of Orléans, a junior branch of the house of Bourbon (*q.v.*), to be "king of the French by the grace of God and the will of the people," in accordance with the principles of the July monarchy of 1830–48 (*see* FRANCE: *History*). As monarchists, they were opposed to republicans; as royalists, they were opposed to the Bonapartists, who wanted an emperor; but they split the royalist camp by ousting the senior line of the Bourbons, whose cause was that of the Legitimists (*q.v.*). Louis Philippe's July monarchy appealed most strongly to the prosperous *bourgeoisie* (financiers, tradesmen and industrialists), who had envied the landed nobility's virtual monopoly of high office under Charles X and who were afraid that a Jacobin republic might endanger stability; to academics and intellectuals like the Doctrinaires (*q.v.*); and to the Protestants, who had naturally resented the reactionary Catholicism of the Restoration.

The foremost representatives of Orleanism in power were Casimir Périer, Jacques Laffitte, Louis Adolphe Thiers, the duc Albert de Broglie, François Guizot and Louis Mathieu Molé (*qq.v.*), with Victor Cousin (*q.v.*), and Charles de Rémusat in lesser posts. These men, however, often diverged widely from one another on political as well as personal matters. Primarily, there was the cleavage between the Parti de la Résistance (Périer, Guizot) and the Parti du Mouvement (Laffitte). The Parti de la Résistance was conservative, standing for the consolidation of the dynasty and insisting on the limitation of the franchise. The Parti du Mouvement wanted an active foreign policy to spread liberalism abroad and envisaged the progressive extension of the franchise; it was in opposition to the ministry from 1831 and, under the leadership of Odilon Barrot (*q.v.*), became the "dynastic left" in the chamber of deputies.

The July monarchy fell in 1848. During the second republic and the second empire, Orleanists upheld the cause of Louis Philippe's grandson and heir, Louis Philippe Albert, comte de Paris, though his uncle the duc de Nemours (*q.v.*) tried to prepare a royalist restoration by negotiating with the Legitimists. After the fall of the second empire (1870) the kingdom might well have been restored; but Thiers was no longer working for the Orleanists, and while the latter were still arguing with the Legitimists the third republic came into being. The reconciliation of Aug. 1873 between Legitimists and Orleanists did not last long. Thereafter the Orleanists represented a minority of the royalists till 1883, when the direct male line of the elder Bourbons died out. Most of the Legitimists then accepted the comte de Paris.

ORLÉANS, DUCS D', princes of the royal house of France. The countship of Orléans, comprising the *châtellenies* of Orléans, Beaugency, Châteauneuf-sur-Loire, Vitry-aux-Loges, Lorris, Châteaurenard, Boiscommun, Neuville-aux-Bois, Janville and Yèvre-le-Châtel, was part of the royal domain under the first Capetian kings. It was erected into a peerage duchy by Philip VI of France in 1344 for his younger son PHILIPPE (July 1, 1336–Sept. 1, 1375), to compensate him for losing his expectation of Dauphiné, which had been reserved for him in 1343 but was subsequently assigned to his elder brother John. Philippe caused alarm by expanding his possessions, but left no children by his wife, Charles IV's daughter Blanche de France, though he had some natural children (including Louis d'Orléans, bishop of Poitiers from 1391 to 1395 and of Beauvais from 1395 to 1397). On his death, therefore, the duchy was reunited to the French crown by Charles V. Charles VI's brother LOUIS, duc d'Orléans from 1392 to 1407, and his successor CHARLES (d. 1465) are treated in separate articles, as also is the latter's successor, who became king of France as Louis XII in 1498. Francis I of France (a great-grandson of the second duc) granted the duchy in 1518 to the future Henry II of France, who on becoming dauphin in 1536 transmitted it to his brother CHARLES (Jan. 22, 1522–Sept. 9, 1545), previously known as duc d'Angoulême. This Charles, Francis I's favourite son, twice took Luxembourg from the Holy Roman emperor Charles V's forces (1542 and 1543), and there were plans for marrying him to a Habsburg princess who would bring him either Milan or part of the Netherlands as dowry; but he died suddenly, after rashly exposing himself to infection from the plague, at Forêtmoutiers, near Boulogne.

Henry II's son LOUIS (1548–1550) was duc d'Orléans for a few months only; then the title passed to the future Charles IX of France. Under Henry III, the duchy was an appanage for Catherine de Médicis. The second son of Henry IV and Marie de Médicis was duc d'Orléans during his short life (1607–11); and only in 1626 did Louis XIII grant the title to his surviving brother GASTON (1608–1660), who is treated in a separate article.

Louis XIV's brother PHILIPPE DE FRANCE (1640–1701), duc d'Orléans from 1660, founded the house which survived as a major branch of the house of Bourbon (*q.v.*). He and his successor, the regent PHILIPPE D'ORLÉANS (1674–1723) are discussed in separate articles, as also is the latter's great-grandson LOUIS PHILIPPE JOSEPH (1747–1793), the Philippe Égalité of the Revolution, whose son and successor became king of the French as Louis Philippe (*q.v.*) in 1830. The regent's son LOUIS (Aug. 4, 1703–Feb. 4, 1752), austerely pious and learned, spent the last decades of his life mainly in the abbey of Ste. Geneviève, devoting himself to charity and producing works of Christian apologetic and translations of Holy Writ (the Psalms from the original Hebrew; also St. Paul's epistles). His successor LOUIS PHILIPPE (May 12, 1725–Nov. 18, 1785) fought in the War of the Austrian Succession and in the Seven Years' War and, after his first wife's death, made a secret marriage with his mistress Mme de Montesson. King Louis Philippe's eldest son FERDINAND (Sept. 3, 1810–July 13, 1842), who in 1830 became duc d'Orléans and heir apparent to the new kingdom, served with the army in Belgium (1832) and in Algeria (1835, 1839, 1840) but was killed in an accident at Neuilly, when his carriage overturned.

From 1674 to 1838 the heir apparent to the duchy of Orléans was styled duc de Chartres. Ferdinand's eldest son Louis Philippe Albert, however, was comte de Paris instead. For his eldest son, LOUIS PHILIPPE ROBERT, duc d'Orléans (1869–1926), there is a separate article.

ORLÉANS, CHARLES, DUC D' (usually called CHARLES D'ORLÉANS) (1394–1465), French poet, the last, and one of the greatest, of the courtly poets of France, who during exile in England also earned a reputation for his poems in English. The son of Louis, duc d'Orléans (brother of Charles VI of France), and of Valentina Visconti, daughter of Gian Galeazzo, duke of Milan, he was born at Paris on Nov. 24, 1394 (some documents erroneously assign his birth to 1391 or 1396). On June 29, 1406, he was married to his cousin Isabella, widow of Richard II of England; she died in 1409.

Charles succeeded to the title in 1407, when his father was assassinated by the Burgundians in the struggle for power which followed the king's insanity. Aged 13, he sought vengeance with the help of the party led by Bernard VII, count d'Armagnac, whose daughter, Bonne, he married, or formally espoused, in 1410. Six years of negotiations, truces and civil war ended in 1414 with the public condemnation of Louis's murder and the temporary eclipse of Burgundian influence. Henry V of England invaded France in 1415 and in the advance of the French army to Agincourt, Charles held high command. Defeated and captured, he spent 25 years in England as a prisoner. He was treated as befitted his station, enjoying society fully, but his importance made his release difficult and his ransom great.

Charles's release was agreed to on July 2, 1440, and on Nov. 3 he returned to France, where he married Mary of Cleves, whose

dowry greatly assisted the payment of his ransom. After fruitless attempts to regain influence in France and to reclaim his maternal inheritance in Italy he withdrew from public life to Blois, receiving there many important literary figures: François Villon, Georges Chastellain, Jean Meschinot and many others visited him or were his correspondents. His son, who became Louis XII, was born in 1462. Charles died at Amboise on Jan. 4, 1465.

His enforced idleness while in England gave him leisure to pursue his literary interests; he had written some verse before his capture, and he now composed a complete love-history, mainly in *ballades*, besides other poems. While in England he also wrote more than 6,000 lines in English, arranged in two love-histories linked by a miscellany. These are now generally accepted as having been written by Charles, although previously thought to be the work of an Englishman. The collection of English poems is much more of a literary unit than are the French poems, to which Charles continually added after his return to France. Like much English verse of the times, these poems are more natural and vigorous than his restrained and carefully polished French verses. In later life, he wrote mainly rondels (*see* RONDEAU).

Charles d'Orléans is the last representative of medieval poetry, in which the free expression of the poet's personality was limited by emphasis on technique and the widespread use of allegory and personification. His skill in using these figures, and the music and grace of his metres and rhymes, have led to his being recognized as one of the greatest of courtly poets.

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ORLÉANS, GASTON DE FRANCE, DUC D' (1608–1660), French prince, a tragically inadequate opponent of ministerial absolutism, was born at Fontainebleau on April 25, 1608, the third son of Henry IV and Marie de Médicis. Known at first as the duc d'Anjou, he was called Monsieur from 1611, when he became Louis XIII's only brother on their intermediate brother's death. Intelligent, high-spirited and humane, he wished to play a role in public affairs and to alleviate the hardships which France's wars imposed on the common people. When his mother, seconded by the cardinal de Richelieu (*q.v.*), wanted Monsieur to marry Marie de Bourbon-Montpensier, the government arrested his mentor J. B. d'Ornano for dissuading him; the marquis de Chalais (H. de Talleyrand) was arrested for inciting more resistance; the marriage took place at Nantes (Aug. 6, 1626), Monseiur being created duc d'Orléans; Chalais was beheaded and Ornano died in prison. Within a year the bride was dead (having borne a daughter).

After disappointments over military commands, Monsieur was on his way to the king's army in the south in Feb. 1629 when he turned back to defend a personal interest. Alarmed at the king's displeasure, he fled to Charles IV, duke of Lorraine, in September, but returned to France in Feb. 1630. On the downfall of Marie de Médicis, he declared himself against Richelieu in Jan. 1631, began raising troops at Orléans, but fled to Lorraine again in April. On Jan. 3, 1632, at Nancy, he was secretly married to Marguerite de Lorraine (1613–72), the duke's sister; but a few days later he had to move to the Spanish Netherlands. His entry into France with a feeble little army was the signal for the revolt of Henry de Montmorency (*q.v.*), whom he joined in Languedoc in July 1632. On the defeat of the revolt he was pardoned; but when his plea for Montmorency was ignored he withdrew to the Netherlands again (Nov. 1632). His confidant, Antoine de Laage, marquis de Puylaurens, negotiated with Richelieu, and Monsieur returned to France in Oct. 1634; but Puylaurens, arrested in Feb. 1635, died in prison in July. Interrupting a life of ease at Blois, Monsieur campaigned against the Spaniards in Picardy in 1636. Louis XIII persistently deferred recognizing Monsieur's marriage; the birth of a dauphin (1638) quashed his hopes of the crown; and exposure of his complicity with Cinq-Mars (*q.v.*) brought further humiliation (1642).

When Anne of Austria became regent for Louis XIV, Monsieur became lieutenant general of the kingdom (1643). He commanded in Flanders in 1644 and 1645. During the Fronde (*q.v.*) his popularity with the Parisians was useful to the government in 1650, but he declared himself against Mazarin in Feb. 1651 and was thereafter drawn, step by anguished step, into the princely rebellion. Exiled from Paris on the king's return (Oct. 1652), he was formally reconciled with the king in Aug. 1656. He died at Blois on Feb. 2, 1660. *See* also MONTPENSIER, ANNE MARIE LOUISE D'ORLÉANS, DUCHESSE DE.

See G. Dethan, *Gaston d'Orléans . . .* (1959). (J. G. R.-S.)

ORLÉANS, HENRIETTA (ANNE) OF ENGLAND, DUCHESSE D' (1644–1670), the brilliant and unfortunate sister of Charles II of England, was born at Exeter on June 16, 1644, during the English Civil War, the youngest child of Charles I of England and Henrietta Maria. When Exeter fell to the parliamentarians in April 1646, her governess Lady Dalkeith (later countess of Morton) took her to Oatlands in Surrey and then smuggled her to France in July. Joining her mother in Paris, Henrietta was brought up as a Catholic. After the restoration of Charles II to the English throne (1660), she was married, on March 30, 1661, to the effeminate Philippe de France, duc d'Orléans (*q.v.*), who soon neglected her. As he was Monsieur, she was designated as Madame at the court of her brother-in-law Louis XIV. Beautiful and frivolous, she lent herself to amorous intrigues. Louis XIV himself showed a lively interest in her; and when Louis transferred his attentions to Louise de La Vallière (*q.v.*), Madame began a liaison with a young rake, the comte de Guiche (Armand de Gramont). At the same time her discernment made her an early patroness of Racine and Molière. Meanwhile she was in regular correspondence with her brother, Charles II, who loved her dearly and knew her affectionately as Minette; and in 1670, with Louis XIV's consent but without her husband's, she went to England to play an active part in the secret negotiations preceding the treaty of Dover (*q.v.*). Shortly after her return to France, she died at St. Cloud on June 30, 1670. It was widely rumoured that she had been poisoned by a cup of chicory; and her husband and his favourite, the chevalier de Lorraine, were suspected of connivance at the crime. From the official report of the autopsy, modern historians are inclined to conclude that she died a natural death, but the affair has never been entirely cleared up. Bossuet's funeral oration for Madame was one of his most celebrated. She left two daughters, Maria Luisa, later the wife of Charles II of Spain, and Anne, later the wife of Victor Amadeus of Savoy, king of Sardinia.

See Madame de La Fayette, *Histoire de Madame*, ed. by E. Henriot (1925); C. H. Hartmann, *Charles II and Madame* (1934) and *The King My Brother* (1954). (G. Mo.)

ORLÉANS, LOUIS DE FRANCE, DUC D' (1372–1407), French prince whose quarrel with the dukes of Burgundy gave rise to the war between Burgundians and Armagnacs, was born in Paris on March 13, 1372, the second son of Charles V of France and Jeanne de Bourbon. Created comte de Valois in 1375 and duc de Touraine in 1386, he exchanged the latter dignity for the duchy of Orléans in 1392. His brief life was marked by the pursuit of pleasure and by overweening ambition. His marriage in 1389 with his cousin Valentina Visconti, daughter of the duke of Milan, brought him the county of Asti (between Turin and Genoa) and encouraged him to dream of founding a French dynasty in northern Italy. In 1396, however, on the failure of his plans to annex Genoa, he turned his attention to setting himself up as the rival of his uncle, Philip the Bold, duke of Burgundy, for effective power in France during the insanity of the king his brother, Charles VI (*q.v.*).

When Philip was temporarily absent, Orléans in 1401 had himself appointed custodian of the Avignon pope Benedict XIII (Pedro de Luna) and also commander of the French king's force at Toul, on the border of the Holy Roman empire and on the line of communication between Burgundy proper and the Burgundian Netherlands. Furious at this, Philip appeared before Paris with

an army. A reconciliation took place on Jan. 14, 1402, but thereafter the relationship between the two men was one of mute hostility alternating with open conflict.

On Philip's death in 1404, Orléans aimed at political supremacy. Appointed lieutenant general in Picardy and Normandy, he ordered in March 1405 the levy of an aid for a renewal of the war with England. The new duke of Burgundy, John (*q.v.*) the Fearless, took this chance of coming out in opposition. Relations between the cousins became progressively embittered; and when Orléans and the queen, Isabella of Bavaria, carried the dauphin off from Paris (Aug. 1405) the rivals began issuing manifestos and raising troops against one another. Their reconciliation of Oct. 16, 1405, proved shortlived, and fresh agreement was reached only on Nov. 20, 1407. Three days later, on Nov. 23, 1407, Orléans was assassinated in Paris by men in John's pay. There ensued the long feud between the Armagnacs, as the partisans of his heir were called, and the Burgundians (*see* FRANCE: *History*).

Intelligent, shrewd and charming (he was reputed to be the queen's lover), Orléans owed his downfall to his readiness to act on impulse. His ostentatious luxury lent weight to the charge that he enriched himself at his country's expense. By Valentina Visconti he was the father of the poet Charles d'Orléans (*q.v.*) and of Jean, comte d'Angoulême (grandfather of Francis I of France); and by his liaison with Mariette d'Enghien he was father of Jean, comte de Dunois.

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ORLÉANS, LOUIS PHILIPPE JOSEPH, DUC D' (1747–1793), French prince, the PHILIPPE ÉGALITÉ of the Revolutionary period, was born at St. Cloud on April 13, 1747, the son of Louis Philippe, duc d'Orléans from 1752, and of Louise Henriette de Bourbon-Conti. At first he was titled duc de Montpensier; then, from 1752, he was duc de Chartres till he became duc d'Orléans on his father's death (1785). Married in 1769 to the heiress Adélaïde de Bourbon-Penthièvre (by whom he had four children who survived infancy; *see* BOURBON: *Table II*), he yet ran into debt and, to increase his income, built the shops that still surround the Palais Royal in Paris. Quick to take offense and very hostile to Marie Antoinette, he lived away from the court of Versailles and traveled abroad (England, Holland, Switzerland and Italy). He also became grand master of the Freemasons. In Nov. 1787, when Louis XVI came to impose certain edicts on the *parlement* of Paris, the duc d'Orléans made his opposition clear and was promptly exiled to Villers-Cotterêts.

Shortly before the elections for the estates-general of 1789, the duc published some *Instructions* issued by himself to his representatives in the *bailliages*. Elected deputy by the nobility of several *bailliages*, he chose to sit for that of Crépy-en-Valois. On May 28, 1789, when the nobles voted that each of the three orders should debate separately, Orléans protested against this decision; on June 25 he joined the third estate with a minority of the nobles. His popularity was so great that his effigy, together with Necker's, was carried through the streets of Paris before the storming of the Bastille.

After returning from a mission to England, Orléans sat on the extreme left in the Constituent Assembly. About the time of the king's flight to Varennes (June 1791) he was admitted to the Jacobin club. There is no proof, however, for the allegation that he was then seeking to be nominated lieutenant general of the kingdom; the Legislative Assembly paid no heed to a deputy's attack on the "Orleanist faction." Nevertheless, Orléans was careful of his own popularity; on June 21, 1791, when the king had fled, he showed himself walking about Paris. After the fall of the monarchy (Aug. 1792), he asked the commune of Paris to give him a new family name. The commune chose the name Égalité for him (Sept. 1792).

Égalité was elected to the Convention on Sept. 19, 1792, the last of the deputies for Paris. Sitting with the Mountain, he was attacked by the Girondins (*q.v.*). In Dec. 1792, F. L. Buzot demanded the banishment of all the Bourbons, alleging that those who wished to do away with Louis XVI intended to put the former duc d'Orléans in his place. Forced to defend Égalité, the Mountain thus incurred a charge of royalism. During the king's trial, Égalité voted with the Mountain—against an appeal to the people, for the death sentence and against suspension of the sentence.

The treason of General Dumouriez (*q.v.*) put Égalité in a delicate position: friends and relatives of his belonged to the general's circle; and his own son, the duc de Chartres (Louis Philippe, the future king of the French), was one of the general's lieutenants and had followed him in his flight. This enabled the Girondins to revive the charge of "Orleanism" against the Mountain. On April 4, 1793, their spokesman C. J. M. Barbaroux declared that Dumouriez intended to restore the monarchy for the former duc d'Orléans. On April 6, when the Convention learned of the treason and flight of the duc de Chartres, the Girondins obtained a warrant for the arrest of Égalité.

Transferred to Marseilles (in accordance with a decree of April 8, 1793), Égalité was interrogated in May: he denied all designs on the crown and all knowledge of Dumouriez' plans. The matter seemed to be forgotten until, on Oct. 3, when the act of accusation against Égalité's mortal enemies, the Girondins, was being read, the Montagnard J. N. Billaud-Varenne perfidiously asked why Égalité's name did not appear on the list. Brought back to Paris, Égalité behaved with dignity and assurance before the Revolutionary tribunal and died bravely under the guillotine on Nov. 6, 1793.

See A. Britsch, *La Jeunesse de Philippe Égalité, 1747–1785* (1926); E. S. Scudder, *Prince of the Blood* (1938). (A. So.)

ORLÉANS, LOUIS PHILIPPE ROBERT, DUC D' (1869–1926), French pretender and explorer, was born in England, at York house, Twickenham, on Feb. 6, 1869, the eldest son of Louis Philippe Albert, comte de Paris (*see* BOURBON: *Table IV*). Taken to France when other princes of the house of Orléans had secured the abrogation (1871) of the law proscribing them, he was educated at Eu and at the Collège Stanislas in Paris; but in 1886 a new law was passed exiling from France the heads and the heirs of all formerly sovereign families. Returning to England, the duc d'Orléans passed through the Royal Military college at Sandhurst and received a commission in a British regiment then stationed in India, with which he served for a few months from Jan. 1888. On attaining his majority (Feb. 1890), he went to Paris and offered himself for military service, but was promptly arrested. Tried and sentenced to two years' imprisonment, he was incarcerated at Clairvaux till June 1890 and then conducted to the Swiss frontier. He subsequently traveled in Europe and the middle east.

After his father's death (Sept. 1894), the duc d'Orléans was recognized by most French royalists as their rightful king. He undertook voyages to the Arctic in 1905, 1907 and 1919 and traveled in British East Africa in 1922–23, bringing back zoological specimens which he bequeathed to France. During World War I he had vainly sought permission to serve in either the French or an Allied army.

The duc d'Orléans had no children by his marriage (Nov. 5, 1896) to the Austrian archduchess Maria Dorothea Amalia (a granddaughter of the archduke Joseph, palatine of Hungary; *see* HABSBURG: *Table IV*), so that when he died, at Palermo in Sicily on March 28, 1926, his pretensions passed to his cousin Jean, duc de Guise.

ORLÉANS, PHILIPPE DE FRANCE, DUC D' (1640–1701), French prince remembered for his unedifying role at the court of his brother Louis XIV, was born at St. Germain-en-Laye on Sept. 21, 1640, the younger son of Louis XIII and his consort Anne of Austria. At first known as the duc d'Anjou, he became duc d'Orléans in 1660, when that title fell vacant on the death of his uncle Gaston; but from his brother's accession to the crown (1643) he was generally designated as Monsieur. On March 30, 1661, he was married to his cousin Henrietta, sister of Charles II of England. This marriage proved unhappy, and when Henrietta died suddenly in 1670 Monsieur was suspected of having had a hand in poisoning her. Next, on Nov. 16, 1671, he was married to Elizabeth Charlotte (Liselotte) of the Palatinate, daughter of the

elector Charles Louis, a plain woman who commented mordantly on her surroundings in her letters.

Monsieur was a man of great culture and a patron of the arts and of literature, but his morals were deplorable: he was extremely effeminate, and the life that he led in his magnificent palace at St. Cloud with his handsome favourite, the chevalier de Lorraine (Philippe de Lorraine-Armagnac; 1643–1708), was so scandalous that the king sent the chevalier to prison in 1670, then to exile till 1672. Monsieur, however, was not lacking in courage: he distinguished himself in the Flanders campaign of 1667 and at the capture of Zutphen in 1672 and won a great victory over William III of Orange at Kassel on April 11, 1677, after which he took St. Omer. Louis XIV, allegedly jealous of his brother's military success, gave him no further command and studiously excluded him from affairs of state. Monsieur died at St. Cloud on June 9, 1701. For his descendants *see* BOURBON: *Table II*.

See Guy de la Batut, *La Cour de Monsieur* (1927); Philippe Erlanger, *Monsieur, frère de Louis XIV* (1953). (G. Mo.)

ORLÉANS, PHILIPPE D'ORLÉANS, DUC D' (1674–1723), regent of France from 1715 to 1723, was born at St. Cloud on Aug. 2, 1674, the son of Philippe de France, duc d'Orléans (*q.v.*), and his second wife, Elizabeth Charlotte of the Palatinate. Known as the duc de Chartres during his father's lifetime, he was married in Feb. 1692, against his mother's wishes, to Françoise Marie de Bourbon (previously known as the second Mademoiselle de Blois), the favourite legitimized daughter of his uncle Louis XIV and Madame de Montespan. Though the duc served with the army at Mons (1691), at Steenkerque (1692), at Neerwinden (1693) and at Namur (1695) during the War of the Grand Alliance, the king excluded him from the high military commands to which he considered himself entitled. Resenting this, he studiously neglected his wife as a way of spiting the king. Himself a minor poet of some distinction, he gave his enlightened patronage to both music and painting. He was also interested in chemical experiments and acquired a somewhat sinister reputation as an alchemist and concocter of perfumes and poisons. A cynical freethinker and a habitual drunkard, he was utterly depraved and licentious in his private life. Generosity, a certain integrity in financial matters and intellectual distinction were his only virtues. On his father's death (June 1701), he became duc d'Orléans. He held military commands in Italy (1706) and in Spain (1707–08) during the War of the Spanish Succession.

As a matter of right, the duc d'Orléans, premier prince of the blood royal, should have become regent without restriction, on the death of Louis XIV. Under the terms of Louis XIV's will, however, the control of the education of the infant Louis XV and the command of the household troops were vested in the duc du Maine (*q.v.*), the elder of the legitimized sons of Louis XIV and Madame de Montespan. Though Orléans was to preside over the council of regency, it was packed with loyal servants of the old court, and its decisions were to be taken by majority vote. It was certain that, if the sickly Louis XV were to die, the legitimized princes would champion the claims, not of Orléans, but of Louis XIV's grandson Philip V of Spain to the French crown, despite Philip V's renunciation of his French rights.

Immediately after the death of Louis XIV (Sept. 1, 1715), Orléans was encouraged to contest this will by the aristocracy, which was anxious to resume the political powers it had lost. On Sept. 12, 1715, at a *lit de justice* to ratify a vote of Sept. 2 in the *parlement* of Paris, Louis XIV's will was annulled and Orléans given full authority to appoint the members of the council of regency and command of the king's bodyguard. This was the beginning of a political revolution designed to destroy the authority of the secretaries of state and to reestablish the aristocratic control of the central government. This experiment in conciliar government, known as *la polysynodie*, did not, however, outlast the year 1718.

The dynastic ambitions of Orléans were also responsible for the new direction given under the regency to French foreign policy by the *abbé* (future cardinal) Guillaume Dubois (*q.v.*). This took the form of an alliance concluded with Great Britain in Nov. 1716 and expanded into the triple alliance by the adhesion of the United Provinces of the Netherlands in Jan. 1717. By the alliance of 1716, George I of Great Britain was assured of French support against Jacobite claims, and Orléans of British support against the claims of Philip of Spain. When, in 1718, the duc du Maine was involved in a conspiracy organized by the Spanish ambassador to ruin Orléans' chances of succession, Dubois seized the occasion to make war on Spain. Philip V was forced to recognize the dynastic claims of Orléans.

The most pressing problem confronting the regent on his assumption of power was financial for, as a result of the aggressive wars of Louis XIV, France was on the verge of bankruptcy. Between 1717 and 1720 Orléans entrusted the reform of French finances to the Scottish banker John Law (*q.v.*), who established a central bank, unified the control of French commerce and industry in his company and experimented with a managed system of paper currency. The failure and collapse of these experiments did much to discredit the regent. (*See* also FRANCE: *History*.)

Meanwhile, the quarrel between the Jansenists and their opponents (Jesuits and others) on the question of the acceptance of the papal bull *Unigenitus* (1713) was dividing the church and encouraging the growth of skepticism in France. The regent had at first been inclined to sympathize politically with the Jansenists, but finally, after twice trying to silence both parties (Oct. 1717 and June 1719), he proceeded in July 1722 to a more firmly anti-Jansenist line.

The regency ended when Louis XV came of age in Feb. 1723. When Dubois died, in August, Orléans took his place as prime minister, but before the year ended he died at Versailles, on Dec. 2.

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ORLÉANS, a city of north-central France, capital of the *département* of Loiret and of the old province of Orléanais (*q.v.*), 70 mi. (113 km.) S.S.W. of Paris. Pop. (1962) 82,812. Orléans lies on the banks of the Loire, in a valley rich in market gardens, fruit and flowers. It lies also on the edge of the great Beauce plain and is close to the Sologne, a poor, humid and wooded region covering the greater part of the south of the *département* of Loiret. It is crossed from north to south and from east to west by national roads. Les Aubrais station is one of the principal French railway junctions, through which several main lines pass from Paris. The city is also an important road traffic centre for passengers and freight.

Orléans is divided by the Loire into two very unequal parts. The southern portion, the St. Marceau quarter, is rural in appearance and is the scene of the principal horticultural and market-gardening activities of the town. It also preserves memories of Joan of Arc's battles against the English in 1429; it was in fact from this side of the river that Joan led her attack and delivered the city by capturing the most important of the fortifications held by the English, the Fort des Tourelles. Nothing of that period remains except the site of the fort, marked by an inscription. A statue of St. Joan (19th century) stands facing the Tourelles. In this quarter also is found the botanical garden, with a rich variety of flowers, and the municipal rose garden.

The northern part of the town, by far the more important, has grown round the Place du Martroi (*martroi*, from Latin *martyretum*, applied to the cemetery in the days of the early Christians). Wide boulevards planted with trees have replaced the fortifications that stood there till the 16th century. The configuration of the centre of Orléans preserves the look of the old town. Parallel to the banks of the Loire, the rue de Bourgogne crosses the central half of the city from east to west; this was the route followed by Joan of Arc when she entered Orléans, coming from Chinon, on April 29, 1429. Between this street and the river are several old quarters. In the rue de Bourgogne stands the prefecture, a handsome 17th-century edifice, converted in the 19th century from a Benedictine convent. Farther north is the rue Jeanne d'Arc with 18th-century buildings, which leads into the Place Ste. Croix, where stands the cathedral of Ste. Croix. This cathedral, the same size as Notre Dame in Paris, was built between the 13th and 16th centuries, but that Gothic building was largely destroyed

(1568) by the Protestants. The present building dates from the 17th–19th centuries, with portions of the original. The interior contains important artistic and archaeological treasures. Among other religious buildings of Orléans are the church of St. Aignan, of which several fine portions of the 14th century still remain, though it also had to be rebuilt after being destroyed by the Protestants; the church of St. Euverte, originally of the 12th century, with alterations up to the 16th; and the church of Notre Dame de Recouvrance, a harmonious and homogeneous 16th-century building in one of the oldest streets of Orléans.

Among the civil monuments is the Hôtel de Ville, located in one of the oldest squares, near the cathedral, in a 16th-century Renaissance mansion; the young king Francis II, husband of Mary Queen of Scots, died there (1560). The building was restored and reconstructed, adhering to its style, in the 19th century. Also near the cathedral are the bishop's palace (built in the 17th century and now the municipal library), with its public garden facing the east of the cathedral; and the Lycée Jeanne d'Arc (for girls). In the town centre are also the boys' *lycée* in the rue Jeanne d'Arc; the fine arts museum, one of the finest in the province, housed, with the natural history museum, in the Hôtel des Créneaux, a 15th–16th-century building with a belfry dating from 1453; the Hôtel Cabu (16th century), heavily damaged in 1940, attached to the Musée Historique de l'Orléanais et de Jeanne d'Arc; and the Musée-Centre d'Études Charles Péguy. In 1962 a university was established in Orléans.

The most important locality in Orléans is the Place du Martroi, west of the cathedral. Of vast dimensions, overlooked by two 18th-century buildings housing the chamber of commerce and the chancellery, it has at its centre an equestrian statue of Joan of Arc by Denis Foyatier, erected in 1855. The arcaded Rue Royale runs south from the Place du Martroi over the Pont George V. Southwest of the Place du Martroi is the old quarter of Orléans, the St. Paul quarter, where, before World War II, stood Jacques Boucher's house, which sheltered St. Joan during the siege of Orléans, hence was called Maison de Jeanne d'Arc.

Outside the centre and the part enclosed by the wide boulevards the town spreads into the suburbs. Some of these have preserved much of their old and almost rustic appearance: Bourgogne, made famous by the writer Charles Péguy, who was born there; St. Vincent; and St. Jean. More contemporary in look are Bannier, which carries traffic toward Paris; and Madeleine, which serves as the exit from Orléans to the west. In the early 1960s the town acquired a large area south of the Loiret river, including its springs.

The chief activities of Orléans originate in agriculture, the essential resource of Orléanais; one-third of the working population of the *département* is employed in agriculture, and the area of Orléans itself has some important trade in market gardening, horticulture, fruit and wine. Its nurseries are well known for their fruit and ornamental young trees. Floral horticulture is equally developed, and the region's rose gardens have a reputation of long standing. The industries of Orléans also have sprung, naturally, first from agriculture: its weaving of the Beauce wool, preserves, vinegar (Orléans leads in world production) and cheese have all been known since the middle ages. The town and its suburbs have profited by the industrial decentralization of the Paris region, and a large number of industrial workers are engaged principally in such manufacturing enterprises as clothing and linen goods, electric heating material and plant, agricultural machinery, car bodies and spare parts, glass, pharmaceutical products and rubber.

Orléanais was an inhabited region from prehistoric times, and Orléans was a thoroughfare. Orléans (Gallic Cenabum; Roman Aurelianum) was part of the territory of the Carnutes, who rebelled against the Romans; Julius Caesar conquered it in 52 B.C. Many Roman roads crossed the region, serving as routes for commerce and later for barbarian invasions: Attila occupied the city in 451, in spite of courageous resistance by the bishop, St. Aignan (Anianus). In the reign of Charlemagne, Orléans became an intellectual capital, thanks to Bishop Theodulf (*q.v.*), abbot of the famous nearby abbey of Fleury (at the village of St. Benoît-sur-Loire, 20 mi. from Orléans). In the schools established by Theodulf originated the University of Orléans, founded in 1305 by Pope Clement V, which continued in existence till the Revolution. (*See* SAINT BENOÎT-SUR-LOIRE.) The first Capetians were greatly attached to Orléans, which in the 10th and 11th centuries became the real capital of France: the kings Robert the Good, Henry I and Louis the Fat were anointed there.

The chief episode in the history of Orléans in the middle ages was its deliverance, after a seven-month siege by the English, by Joan of Arc (for these events, *see* JOAN, SAINT, of Arc). The English left the city on May 8, 1429, and Orléans has celebrated the anniversary with great festivities ever since. As the seat of a duchy tied in appanage to the royal domain, Orléans continued to play an important role in the history of France (*see* also ORLÉANS, DUCS D'). During the Wars of Religion it was at one time the Protestant centre, in control of the prince de Condé (1567). About a thousand Huguenots were massacred there in the St. Bartholomew's day outbreak, and Orléans then remained in the hands of the Catholic party until the Edict of Nantes (1598). In the 17th and 18th centuries the town was very prosperous. Factories were created, trade flourished (thanks to navigation on the Loire and the canals), and the university was famous for its faculty of law.

During the Revolution, Orléans remained relatively peaceful. It was raised to a prefecture by Napoleon in 1800, and its population regularly increased during the 19th century with the development of industry. The French defeat at Sedan in 1870 brought the Prussians as far as the gates of Orléans, where a vigorous resistance held them in check for several weeks, though in the end they occupied the town. It was in 1940 that Orléans had to endure the severest trial of its history since the middle ages. On June 16 it suffered severe aerial bombardment, which destroyed or damaged thousands of buildings. Fresh bombardments in 1944 increased the ruin and killed several hundred persons. Irreplaceable buildings of historical and artistic value were destroyed, such as the Maison de Jeanne d'Arc, the museum of Jeanne d'Arc, the church of St. Paul and entire streets. A great effort was made after the liberation (Aug. 1944) to rebuild and enlarge the town, and Orléans, as a result, has put on, alongside many old features which it has preserved, the aspect of a new town.

See also references under "Orléans" in the Index. (LL. M.)

ORLEY, BERNAERT (BERNARD, BAREND) **VAN** (*c.* 1492–1542), Flemish painter of religious subjects and portraits, son of the painter Valentyn van Orley, was born at Brussels about 1490. The date of his birth is estimated from his portrait painted by Dürer in 1521, which represents an attractive and intelligent man of about 30. In 1515 he was employed by Margaret of Austria, then regent of the Netherlands, and three years later he was appointed her court painter. He died in 1542.

Orley's earliest important work is the altarpiece of SS. Thomas and Matthew, of which the centrepiece is at Vienna and the wings at Brussels, painted about 1512. The style of the picture seems to be inspired by the school of Autrey. From 1516 to 1522 Orley imitated Mabuse, but by the latter year the influence of Mabuse had given way to that of Raphael. In the altarpiece representing the "Patience of Job" (1521), now in the Brussels gallery, the two influences are combined. The artist had many opportunities to see designs by Raphael, whose tapestry cartoons were in Brussels for many years. Orley also painted several portraits; the one of Georg Zelle in the Brussels gallery is the only one that is signed and dated (1519). Orley was a designer of tapestries, among them being the "Hunts of Maximilian" in the Louvre and the "Victory of Pavia" at Naples. He is represented in the United States at the Metropolitan Museum of Art, New York city (including the well-known "Virgin and Child With Angels"), and at the National Gallery of Art, Washington, D.C.

ORLON, the trade-mark name registered by E. I. du Pont de Nemours & Company for a group of synthetic fibres used primarily for making clothing and other textiles.

Orlon, introduced by du Pont in 1948 after 20 years of research, was the first acrylic fibre to be made available in commercial quantities. It is produced from acrylonitrile (CH_2CHCN), a chemical formed by reacting ethylene oxide and hydrocyanic acid.

Single molecules of acrylonitrile are reacted with water and a catalyst until the molecules connect in long-chain polymers. After the water is removed, the polymer is solidified and then dissolved into a spinning solution. This solution is forced through the minute holes of a spinneret into filaments of Orlon, which are stretched three to eight times their original length to impart strength by orienting the chains in a parallel arrangement.

Known for its durable wearing qualities and its soft, silklike "hand" or feel, Orlon is used extensively in sweaters, furlike fabrics, socks, jersey fabrics and suiting fabrics such as shetlands, tweeds and flannels. Because of its resistance to acids and alkalis, it is employed in many industrial fabrics and work uniforms. Its resistance to weathering makes it suitable for outdoor use, especially in sailcloths. (C. H. Ru.)

ORLOV, ALEKSEI FEDOROVICH, Prince (1786–1861), Russian army officer and statesman, one of the most trusted advisers of the emperors Nicholas I and Alexander II, was born in Moscow on Oct. 19 (new style; 8, old style), 1786, the natural son of Count F. G. Orlov (*q.v.*); Catherine the Great interested herself in his education. Joining the army in 1804, Orlov took part in all the Russian campaigns of the Napoleonic Wars from 1805.

For his services as commander of the cavalry regiment of the life guards on the occasion of the December rising of 1825 (*see* Dekabrists), Orlov was created a count by the emperor Nicholas I; and in the Turkish War of 1828–29 he rose to the rank of lieutenant general. He next went as the Russian plenipotentiary to conclude the peace of Adrianople (1829). Russian ambassador to Turkey in 1833 and at the same time commander in chief of the Black sea fleet, he signed the treaty of Unkiar Skelessi (July 8, 1833), which provided for a Russo-Turkish alliance. He accompanied Nicholas on his foreign tour in 1837. In 1844 he succeeded Count A. K. Benckendorff as director of the third section of the imperial chancellery, a position which embraced the general direction of the police corps and gave him great power. Sent to Vienna in 1854 to bring Austria over to Russia's side (*see* Crimean War), he failed in his mission; but in 1856 he was one of the plenipotentiaries who concluded the peace of Paris. The emperor Alexander II rewarded him with the dignity of prince and "the presidency" of the imperial council of state and of the council of ministers. In 1858 Orlov presided over the commission formed to consider the question of the emancipation of the serfs, to which he was altogether hostile. He died in St. Petersburg on May 21 (N.S.; 9, O.S.), 1861. (G. A. Ln.)

ORLOV, ALEKSEI GRIGORIEVICH, Count (1737–1808), Russian nobleman, army officer and naval commander who rendered important services to Catherine the Great, was born at Lyutkino, in Tver province, on Oct. 5 (new style; Sept. 24, old style), 1737, as brother to Grigori Grigorievich Orlov (*q.v.*). Having entered the cadet corps in 1749, he witnessed Grigori's rise to favour with Catherine. Grigori always relied on his advice; and in the *coup d'état* of July 1762, whereby Catherine became sole ruler, it was Aleksei who transported her husband the emperor Peter III to Ropsha, where Peter was murdered (*see* Catherine II the Great; Peter III, emperor of Russia). Appointed major general after the *coup*, he was in 1769 made commander in chief of the Russian fleet sent to the Mediterranean against the Turks. On July 6 (N.S.), 1770, the Russian squadrons annihilated the superior Turkish fleet near Cheshme (Cesme; on the Aegean coast of Anatolia); and though Orlov contributed very little to this victory he was welcomed as a hero in St. Petersburg on his return in March 1771 and given the title Count Cheshmenski.

In 1775, when the beautiful Elizabeth Alekseevna Tarakanova (1752?–1775) was being put forward by two Polish *émigrés* in Italy as the daughter of the Russian empress Elizabeth (*q.v.*), Catherine, regarding her as a potential pretender to the throne, sent Orlov to bring her to St. Petersburg. By making love to Tarakanova he lured her onto his ship at Livorno, and she died a prisoner in the Schlüsselburg fortress.

Orlov resigned from the army in 1775 and retired to his land at Lyutkino, where he devoted himself to horse breeding. After Catherine's death, when Peter III's body was transferred to the cathedral of Peter and Paul in St. Petersburg, the emperor Paul I forced Orlov to carry his victim's crown in the procession. Orlov died in Moscow on Jan. 5, 1808 (N.S.; Dec. 24, 1807 O.S.).

ORLOV, FEDOR GRIGORIEVICH, Count (1741–1796), Russian army officer and statesman, the younger brother of Grigori and Aleksei Grigorievich Orlov (*qq.v.*), was born at Lyutkino, in Tver province, on Feb. 19 (new style; 8, old style), 1741 He participated in the *coup d'état* of 1762, after which he was appointed chief procurator of the senate. He took part in the Russo-Turkish War of 1770 as commander of a naval squadron in the Mediterranean and was made count for his exploits there. He retired from service in 1774 and died in Moscow on May 28 (N.S.; 17, O.S.), 1796.

ORLOV, GRIGORI GRIGORIEVICH, Count (1734–1783), Russian nobleman and army officer who rose to prominence as the lover of the empress Catherine II the Great. He was born at Lyutkino in Tver province on Oct. 17 (new style; 6, old style), 1734, the son of Gen. Grigori Ivanovich Orlov, governor of Novgorod. He entered the cadet corps in 1749 and became an artillery officer. Wounded three times at the battle of Zorndorf (1758; in the Seven Years' War), he was detailed to escort a Prussian officer as prisoner-of-war to St. Petersburg, where in 1759 he was introduced to the grand duke Peter and his wife Catherine. Leading a riotous life in the capital, he caught Catherine's fancy and became her lover; and after her husband's accession to the throne as Peter III, Orlov and his brother Aleksei organized the *coup* of July 1762 whereby Peter was dethroned in favour of Catherine (and subsequently murdered). Catherine created her lover a count and made him adjutant general, director-general of engineers and general-in-chief, but Catherine's political mentor, Nikita Panin (*q.v.*), frustrated her intention of marrying him.

In order to serve Catherine well, Orlov was anxious to remedy the defects of his own education. He took an interest in natural science and was one of the founders of the Imperial Free Economic society (1765). He sought to improve the condition of the serfs, whose advocate he was on the grand commission of 1767; and he earned high praise for his conduct when Catherine sent him to Moscow in 1771 to deal with the disturbances arising from an outbreak of plague there. An early exponent of the Slavophil idea of liberating the Christian subjects of Turkey, he was premier plenipotentiary at the abortive Russo-Turkish peace conference of Focsani (1771). Deeply resentful when Catherine took Aleksandr Vasilchikov and then G. A. Potemkin as her lovers in his place, Orlov left Russia in 1775. He married his cousin E. N. Zinovieva in 1777. On her death at Lausanne in 1782 his mind became deranged, and he returned to Russia completely insane, to die on his estate at Neskuchnoye, near Moscow, on April 24 (N.S.; 13, O.S.), 1783.

ORLOV, NIKOLAI ALEKSEEVICH, Prince (1827–1885), Russian diplomat notable for his humanitarian interest in his country's internal affairs, was born in St. Petersburg on May 9 (new style; April 27, old style), 1827, the son of Prince A. F. Orlov. He entered the army in 1845, fought in Hungary in 1849 and lost an eye on the Walachian front during the Crimean War, in 1854. Prince A. M. Gorchakov, the chancellor, took him into the diplomatic service and sent him to be ambassador in Brussels (1859–69). After short periods in Vienna and in London, Orlov was appointed ambassador to Paris in Dec. 1871. He was thus Gorchakov's spokesman in Paris during the years of tension after the Franco-German War and during the crisis that led to the congress of Berlin (1878). Recalled in 1882, Orlov was posted for a time to Berlin. He died in France, at Fontainebleau, on March 29 (N.S.; 17, O.S.), 1885. As a political writer, Orlov criticized corporal punishment in articles published in the monthly *Russkaya Starina* in 1881 and advocated tolerance for religious dissenters. He also published, in 1856, a sketch of Napoleon's three-week campaign of 1806 against Prussia.

ORM (Ormin), an Augustinian canon, author of an English book to which he gave the title *Ormulum*, "because Orm made it," consisting of metrical homilies on the Gospels as arranged in the missal. The unique manuscript, Junius 1 in the Bodleian library, Oxford, is his autograph, and contains abundant corrections and

additions in his own hand or by his direction. It is usually held that paleographical and linguistic evidence point to a date *c.* 1200, and that the dialect is east midland, though neither fact has been established beyond doubt. Henry Bradley, on admittedly slender evidence, suggested that Orm and his brother and fellow canon Walter, to whom he dedicated the work, were inmates of the Augustinian priory of Elsham, Lincolnshire. Another suggestion would identify him with Orm, grandson of Earl Gospatric, whose brother Walter was prior of the Augustinian canons of St. Mary's, Carlisle (1150–70), though it cannot be shown that this Orm was a canon. Many scholars would oppose this localization of the text, but there is little material for comparison. There is also an Orm *Skalt* "the skald," (?) mentioned in Yorkshire in a pipe roll of the reign of Henry II.

The *Ormulum* is written without rhyme or alliteration in a monotonous metre based on the Latin *septenarius.* The extant portion, of about 20,000 lines, is probably not more than one-eighth of the work, for only 31 of the 242 homilies referred to in the table of contents survive. A portion has been lost since the 17th century. The work is of little literary interest but is of great value to the linguist, for Orm, who clearly wished to spread sound teaching, derived, perhaps through an intermediate source, mainly from the works of Gregory I, Bede and Ælfric, invented an individual and remarkably consistent orthography to help preachers when reading his work aloud. For example, it shows the quantity of the vowels by doubling a consonant after a short vowel in a closed syllable, and it distinguishes by three symbols sounds which in Old English were all represented by the insular form of *g.*

Bibliography.—The *Ormulum* was first ed. by R. M. White (1852) and rev. by R. Holt (1878). Corrections were made by E. Kölbing, *Englische Studien*, i (1877), S. Holm, *Corrections and Additions in the Ormulum MS* (1922) and R. W. Burchfield, "The Language and Orthography of the Ormulum MS.," in *Transactions of the Philological Society* (1956). The last claimed that further correction was necessary. *See* also N. R. Ker, "Unpublished Parts of the Ormulum," in *Medium Aevum*, ix (1940); H. M. Flasdieck, "Die sprachliche Einheitlichkeit des Orrmulums," in *Anglia*, xlvii (1923); H. C. Matthes, *Die Einheitlichkeit des Orrmulum* (1933); J. E. Turville-Petre, "Studies on the Ormulum MS.," in *Journal of English and Germanic Philology*, xlvi (1947); M. Lehnert, *Sprachform und Sprachfunktion im Orrmulum (um 1200)* (1953). On the author, *see* H. Bradley, in the *Athenaeum* (May 19, 1906) and J. Wilson (July 14, 1906); H. B. Hinckley, "The Riddle of the Ormulum," *Philological Quarterly*, xiv (1925). The purpose of his spelling is best discussed by K. Sisam, *Review of English Studies*, ix, pp. 1–10 (1933). (D. Wk.)

ORMIZD (Ormazd; also Hormizd), Middle Persian forms of the divine name Ahura Mazda (*q.v.*); commonly used as a personal name, especially of five kings of the Sasanian dynasty of Iran.

Ormizd I the Brave (reigned A.D. 272–273 or 273–274) was son and successor of Shapur I. Known as Hormizd-Ardashir before his accession, he acted as viceroy of the Iranian province of Armenia (according to al-Tabari, previously of Khurasan; however, coins once thought to confirm this statement are best attributed to a later governor). During the capture of Antioch by Shapur I from the Romans in 256 he exercised important command, presumably then earning his surname. When prince, the city of Hormizd-Ardashir (later Ahvaz) was named after him. When ruler, he gave his name to the nearby town of Ram Hormizd. Apparently tolerant of the activities of Mani, founder of Manichaeism (*q.v.*), Ormizd's reign was brief. The account of his descent in a Pahlavi text, *Karnamak-i Ardashir-i Papakan*, is regarded as legendary.

Ormizd II (reigned 302–309), son of Narses, may be the ruler reported by al-Biruni to have executed some of the Manichaeans. In an equestrian rock sculpture near Persepolis he is recognizable by his crown, shaped as an eagle which holds a pearl. At Ormizd's death the nobles killed his son Adhur-Narses, who had assumed power. The throne was reserved for the unborn Shapur II, and another son, Ormizdas, was imprisoned. The latter's escape in 324 to the court of Constantine the Great is related by Zosimus, Zonaras and others. He served in Julian's army against Iran in 363. A son, also named Ormizd, achieved proconsular rank in 366 and later served under the emperor Theodosius.

Ormizd III succeeded to the throne in 457. Son of Yazdegerd II and Queen Denak, he was opposed by his brother Firuz and two years later was defeated and put to death.

Ormizd IV (reigned 578 or 579–590) was son of Khosrau I. Some characteristic stories are told of him by al-Tabari. Ormizd protected the common people, while maintaining severe discipline in his army and court. When the priests demanded a persecution of the Christians, he declined on the ground that the throne and government could only be safe with the good will of both concurring religions. His policies raised strong opposition in the ruling classes. From his father he inherited wars against the Byzantine empire and against the Turks in the east. Though negotiations for peace had begun with the emperor Maurice Tiberius, Ormizd haughtily declined to cede any of his father's conquests. The accounts given of him by such Byzantine authors as Theophylact Simocattes, Menander Protector and John of Asia are therefore far from favourable. In 588 his general Bahram Chobin (*q.v.*) defeated the Turks, but in the next year was beaten by the Romans. When Bahram was dismissed by the king he rebelled with his army, a general insurrection following. Ormizd was deposed and his son proclaimed king as Khosrau II. Fighting followed between Khosrau and Bahram, while the deposed Ormizd was done to death by partisans of his son in 590.

Ormizd V was one of the many pretenders who arose after the murder of Khosrau II in 628 (or 627). He maintained himself for about two years (631–632) in the district of Nusaybin (Nisibin).

See A. Christensen, *L'Iran sous les Sassanides* (1936); T. Nöldeke, *Geschichte der Perser und Araber* (1879, but largely unsuperseded). (A. D. H. B.)

ORMOLU, an alloy of copper and zinc, sometimes with an addition of tin. The name is also used to describe gilded brass or copper. The tint of ormolu approximates closely to that of gold; it is heightened by a wash of gold lacquer, by immersion in dilute sulfuric acid or by burnishing.

The principal use of ormolu is for the mountings of furniture. With it the great French *ébénistes* of the 18th century obtained results which, in the most finished examples, are almost as fine as jewelers' work. The mounts were usually cast and then chiseled with extraordinary skill and delicacy. *See* also Silver and Gold Work.

ORMONDE, EARLS AND MARQUESSES OF: *see* Butler; Ormonde, James Butler, 1st duke of; Ormonde, James Butler, 2nd duke of.

ORMONDE, SIR JAMES (d. 1497), lord treasurer of Ireland who upheld the Tudor cause there against Lambert Simnel and Perkin Warbeck. He was the illegitimate son of James Butler, 5th earl of Ormonde, and was known as "Black James" and was also sometimes erroneously called the earl of Ormonde. He was brought up in England by his uncle Thomas, 7th earl, and became a staunch supporter of the Tudor dynasty. His actions against Lambert Simnel and his patron, the earl of Kildare, gained Ormonde a knighthood and he was appointed lord treasurer of Ireland in June 1492.

Because the earl was in England, Ormonde assumed the leadership of the Butler family and was soon in conflict with the Fitzgeralds, with Sir Piers Butler (heir-at-law to the earldom of Ormonde) and Kildare. He denounced Kildare in 1494 and secured his imprisonment; in the same year Ormonde supported the government against Perkin Warbeck. Kildare returned to Ireland as deputy in 1496. In 1497, probably on July 17, in a chance meeting near Kilkenny, Ormonde was killed by Sir Piers Butler.

ORMONDE, JAMES BUTLER, 1st Duke of (1610–1688), Irish statesman and soldier who dominated Anglo-Irish politics from the English Civil War until the revolution of 1688 and may be regarded as the real founder of the Protestant ascendancy in Ireland. He was born in London on Oct. 19, 1610, the eldest son of Thomas Butler, Viscount Thurles, and of Elizabeth, daughter of Sir John Poyntz, and grandson of Walter, 11th earl of Ormonde. On the death of his father by drowning in 1619, the boy was made a royal ward by James I, removed from his Roman Catholic tutor and placed in the household of George Abbot, archbishop of Canterbury, with whom he stayed until 1626, and later lived in Ireland with his grandfather. By his marriage in 1629 to his cousin, the Lady Elizabeth Preston, daughter and heiress of Richard, earl of Desmond, he put an end to the long-

standing quarrel between the families and united their estates. He succeeded as 12th earl in 1633.

His active career began in 1633 with the arrival of Lord Wentworth (afterward earl of Strafford) whom he supported consistently. In 1640 during Strafford's absence he was made commander in chief of the forces, and in August he was appointed lieutenant general. On the outbreak of the rebellion in 1641 he rendered great service in the expedition to Naas and in the march into the Pale in 1642. His religious sympathies brought him into conflict with the lords justices, especially Sir William Parsons, and he was recalled after he had succeeded in relieving Drogheda. On April 15, 1642, he won the battle of Kilrush against Lord Mountgarret. He was created a marquess, made lieutenant general with a commission direct from Charles I, and defeated Thomas Preston at the battle of Ross (March 18, 1643). In view of the successes of the confederates and the uncertain loyalty of the Scots in Ulster, Ormonde concluded with the former, in opposition to the lords justices, the "cessation" (Sept. 15) by which the greater part of Ireland was surrendered to the Catholic confederation. By the king's orders he subsequently dispatched a body of troops to England which were routed by Sir Thomas Fairfax at Nantwich (Jan. 1644). Agents were dispatched from Dublin and Kilkenny to the royal court at Oxford in the hope of reaching a settlement. But the negotiations broke down over religion and were referred back to Ormonde. He concluded a treaty with the Irish on March 28, 1646, which granted religious concessions and removed various grievances. Meanwhile the difficulties of his position had been greatly increased by the arrival of Glamorgan, a secret emissary of Charles I, armed with special concessions, and by the appearance of the papal nuncio Archbishop Giovanni Battista Rinuccini. After an Irish victory in June 1646 at Benburb, Rinuccini denounced the Ormonde peace and soon made clear that the cessation was over. An attack was launched on Dublin whereupon Ormonde applied to the English parliament, signed a treaty on June 19, 1647, surrendered Dublin conditionally and sailed for England in early August. He attended Charles at Hampton Court, but subsequently, in order to avoid arrest by parliament, he joined the queen and prince of Wales in Paris (March 1648). Ormonde returned to Ireland in September to try to unite all parties for the king and he concluded "the second Ormonde peace" with the confederates (Jan. 17, 1649), on the basis of the free exercise of religion; this was again denounced by Rinuccini. On the execution of the king Ormonde proclaimed Charles II and was created a knight of the Garter in Sept. 1649 but returned to France in Dec. 1650 after Oliver Cromwell's invasion of Ireland.

Ormonde accompanied Charles when he was expelled from France by Cardinal Jules Mazarin's treaty with Cromwell in 1655, and he went disguised, and at great risk, upon a secret mission into England in 1658. He attended the king at Fuenterrabia in 1659, had an interview with Mazarin and was actively engaged in the negotiations immediately preceding the Restoration. After the Restoration Ormonde became commissioner for the treasury and the navy, and received other important places, together with an English peerage, the dukedom of Ormonde (1661) in the Irish peerage, and became lord lieutenant of Ireland again in Nov. 1662. The Act of Explanation which largely approved the Cromwellian land confiscations was passed through the Irish parliament by Ormonde in 1665. His heart was in his government and he vehemently opposed the bill prohibiting the importation of Irish cattle which struck so fatal a blow at Irish trade, and retaliated by prohibiting the import into Ireland of Scottish commodities and obtained leave to trade with foreign countries. He encouraged Irish manufactures and learning to the utmost, and the Irish College of Physicians owes its incorporation to Ormonde.

Ormonde was dismissed in March 1669 after threatened impeachment by the duke of Buckingham in 1667–68. His irresponsible government was no doubt open to criticism. He had billeted soldiers on civilians and had employed martial law. He was, however, elected chancellor of Oxford university in 1669 and successfully opposed Richard Talbot's attempt to upset the Act of Settlement in 1671. Restored to favour in 1677 he was reappointed lord lieutenant. Charles II summoned Ormonde to court in 1682; an English dukedom was conferred upon him on Nov. 9, 1682, and in June 1684 he returned to Ireland but was recalled in October in consequence of fresh intrigues. However, before he could give up his government to the earl of Clarendon, Charles died and Ormonde's last act as lord lieutenant was to proclaim James II in Dublin. Subsequently he lived at Cornbury in Oxfordshire. He refused the king his support over the Declarations of Indulgence but James held him in respect. He died at Kingston Lacy, in Dorset, on July 21, 1688, and was buried in Westminster abbey.

There is no general unanimity over Ormonde's character; to some he appears as the noblest and loyalist member of Charles I's retinue; to others, however, he has seemed Machiavellian, serving his own interest, and incapable of trust.

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ORMONDE, JAMES BUTLER, 2nd Duke of (1665–1745), Irish soldier who, as a Tory, played a decisive part in English politics under Queen Anne. He was born in Dublin castle, the son of Thomas, earl of Ossory, on April 29, 1665, and was educated at Christ Church, Oxford. He inherited his father's title in 1680, and served against the duke of Monmouth in 1685. He inherited the dukedom from his grandfather in July 1688 and, since he was regarded as a pillar of the Protestant constitution in that year of crisis, he was elected chancellor of the university of Oxford in order to keep out the notorious judge, Lord Jeffreys. Ormonde was given the Garter by James II but joined William III and was lord high constable at his coronation.

He served in William's army in Ireland and on the continent, where he was taken prisoner by the French in 1693; he was always loyal to the king, despite some differences in their later years. Upon Anne's accession Ormonde was among the most popular magnates in the country and was given command of the land forces accompanying the Cadiz expedition in 1702. Disagreements between him and Sir George Rooke marred the expedition, and led to an inquiry after their return, but a naval victory was won at Vigo bay (Oct. 1702). Ormonde was appointed privy councilor in 1703, and also lord lieutenant of Ireland. He was dismissed from the latter place in 1707 but regained it from the Tories in 1710 and then resigned in 1713. Upon the dismissal of the duke of Marlborough in 1711, Ormonde was made captain general and was placed in command of the campaign in Flanders. After his landing he received the notorious secret restraining orders which forbade him to join in any siege or action without further commands, and which were communicated to the French. The humiliating position in which Ormonde was placed did not, however, appear to have reduced his popularity. As warden of the Cinque ports he was in touch with the Jacobite duke of Berwick, and was on the point of taking office under Viscount Bolingbroke when Anne died.

Ormonde signed the proclamation of George I's accession and insisted that civil war must be avoided. He was nevertheless deprived of the captain generalship and was soon holding a Jacobite court at Richmond. James (afterward Earl) Stanhope moved his impeachment in June 1715 and on Aug. 8 Ormonde fled to France. During the Jacobite rebellion in 1715 Ormonde made an ineffectual effort to land in Devon and was given command of the Jacobite attempt of 1719, but never sailed. He settled in Spain, where he received a pension from the crown, and later spent much time at Avignon where he died on Nov. 16 (new style; Nov. 5, old style), 1745. His estates were confiscated by act of attainder after he had fled in 1715, but under an act of 1721 were repurchased by his brother, the earl of Arran. (W. R. Wd.)

ORMUZ: *see* Hormuz.

ORNAMENT, ARCHITECTURAL. Although it would be difficult to cover in any single definition all conceptions, past and present, of what constitutes ornament in architecture, three basic and fairly distinct categories may be recognized: mimetic or imitative ornament, the forms of which have certain definite meanings or symbolic significance; applied ornament, intended to add beauty to a structure but extrinsic to it; and organic ornament, inherent in the building's function or materials.

Mimetic Ornament.—This is by far the commonest type of architectural ornament in primitive cultures, in eastern civilizations and generally throughout antiquity. It is still found. It grows out of what seems to be a universal human reaction to technological change: the tendency to use new materials and techniques to reproduce shapes and qualities familiar from past usage, regardless of appropriateness. We may call this tendency the principle of mimesis. Its operation may be traced in thousands of instances, from the decoration of prehistoric pottery in imitation of clay-covered baskets down to the preservation of the buggy form in early 20th-century automobiles (on which even whipsockets for nonexistent horses were often reproduced). Perhaps the most remarkable of all examples of mimesis occur in architecture. Most common building types in antiquity, both east and west (*e.g.*, tombs, pyramids, temples, towers) began as imitations of primeval house and shrine forms. An obvious example is the dome (*q.v.*), which developed as a permanent wooden or stone reproduction of a revered form originally built of pliable materials. In the mature stages of early civilizations, building types tended to evolve past primitive prototypes; their ornament, however, usually remained based on such models. Decorative motifs derived from earlier structural and symbolic forms are innumerable and universal. In developed Indian and Chinese architecture, domical and other originally structural forms occur often and lavishly as ornament. In ancient Egypt, architectural details continued throughout history to preserve faithfully the appearance of bundled papyrus shafts and similar early building forms. In Mesopotamia, brick walls long imitated the effect of primitive mud-and-reed construction. In the carved stone details of Greco-Roman orders, (*e.g.*, capitals, entablatures, moldings) the precedent of archaic construction in wood was always clearly discernible.

The prevalence of mimetic ornament in architecture may be explained in two ways. Some (perhaps most in primitive cultures) is religious in origin. Certain forms and shapes, through long association with religious rites, became sacred and were preserved and reproduced for their symbolic value. These forms continued to be understood even though they were often stylized into abstract or geometric patterns, unrecognizably removed from their naturalistic models. Much mimetic ornament, however, even in early times, can be ascribed simply to inertia or conservatism. People generally tend to resist change; they find it reassuring to be surrounded by known and familiar forms. Reproducing them as ornament on newly introduced forms is a common reaction to the vague feeling of uneasiness that rapid social and technological change induces; it provides a satisfying sense of continuity between the past and the present. This resistance was a factor in the 19th-century practice of disguising new techniques of construction in metal and glass by an overload of ornament imitating earlier styles.

Applied Ornament.—Architectural ornament in the 19th century exemplified the common tendency for mimetic ornament, in all times and places, to turn into mere applied decoration, lacking either symbolic meaning or reference to the structure on which it is placed. By the 5th century B.C. in Greece, the details of the orders (*q.v.*) had largely lost whatever conscious symbolic or structural significance they may have had; they became simply decorative elements extrinsic to the structure. The Doric frieze is a good case: its origin (*i.e.*, an imitation of the effect of alternating beam ends and shuttered openings in archaic wood construction) remained evident, but it came to be treated as a decorative sheath without reference to the actual structural forms behind. In losing their mimetic character, the details of the Greek orders acquired a new function, however; they served to articulate the building visually, organizing it into a series of co-ordinated visual units that could be comprehended as an integrated whole, rather than a collection of isolated units. This is the concept of applied decoration which was passed on through the Greco-Roman period. The triumphal arch (*q.v.*) of Rome, with its system of decorative columns and entablature articulating what is essentially one massive shape, is a particularly good illustration; the Colosseum is another. Most of the great architecture of the Renaissance and baroque periods depends on it; to a large extent, the difference between these styles is the difference in decoration. The characteristic serenity and balance of Brunelleschi's architecture, for example, is very largely effected by his treatment of applied pilasters and entablatures, whereas in designs like Michelangelo's Medici chapel or the dome of St. Peter's, the same elements are used in different combinations to create a quite opposite effect of tension and release.

Judicious and intelligent use of applied ornament remained characteristic of most western architecture until the 19th century. During the Victorian period, however, the rationale of applied ornament broke down, and an indiscriminate and inappropriate use of decoration became one of the most characteristic and obnoxious features of 19th-century architecture. The reasons for this development are complex. In part it was a reaction to an overly rapid pace of social change during the period; partly, also, it was a logical outgrowth of the increasingly lavish decoration of late baroque and rococo architecture in the 18th century. Also there was an overemphasis on the purely literary and associative values attached to the ornament characteristic of historical architectural styles. But compounding all these factors was the development of machinery, such as multiple lathes and jigs, which provided builders with cheap prefabricated ornament to give their often shoddy and ill-proportioned structures an illusion of elegance. Architectural ornament and architectural forms proper tended to part company, to be designed quite independently of each other. Since it became obvious that ornament so conceived served no good purpose at all, a reaction was inevitable; it began to appear in force by the 1870s.

Organic Ornament.—By the early 20th century a preoccupation with the proper function of architectural ornament was characteristic of all advanced architectural thinkers; by the mid-20th century a concept of architectural ornament had been formulated which we may call organic ornament. This concept, however, is by no means peculiar to the 20th century. Its essential principle is that ornament in architecture should derive naturally from, and be a function of, the nature of the building and the materials used. This principle is characteristic of both Christian and Islamic religious architecture of the medieval period. In the architectural ornament of Muslim India or Persia, as in early Christian and Byzantine work, there is a strong mimetic element. The proscription of representational forms in the Koran, and the tendency of both Muslim and early Christian artists to borrow and adapt their formal vocabulary from preceding cultures, led inevitably to their transforming what had been meaningful forms into systems of abstract ornament. But basically, this ornament was neither mimetic nor applied. Throughout the middle ages, church buildings were conceived primarily as tangible symbols of heaven. Their architectural ornament, no matter how various or lavish, was consistently designed to promote this symbolism; whether by gilt, intricacy or multiplicity, it all contributed to an overall effect of glory, and so was integral to the architectural form.

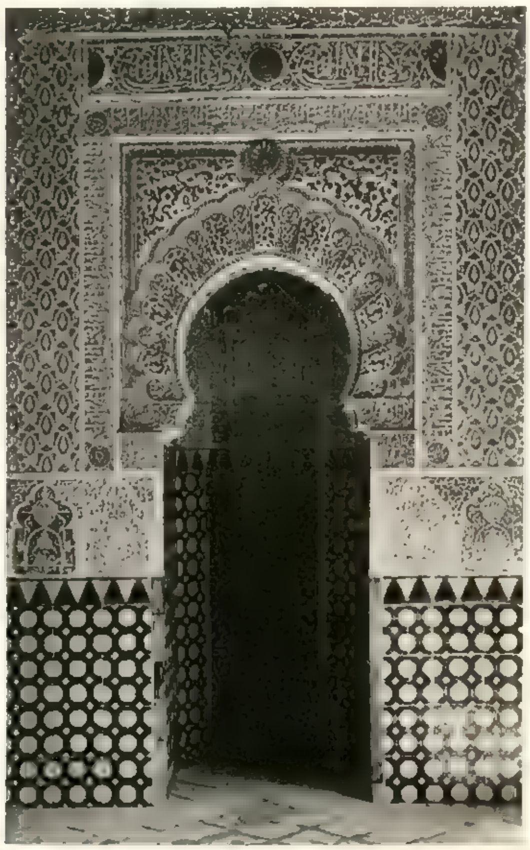
Twentieth-century concepts of the function of architectural ornament, generally speaking, began with an understanding of this medieval usage. Certainly the first movements toward reform of Victorian practice grew out of the Gothic revival writings of John Ruskin and Viollet-le-Duc, as interpreted and applied by William Morris (*q.v.*). The immediate influence of these men proved rather unfortunate. The first result of Viollet-le-Duc's disciplined and scholarly investigations into the principles of medieval architecture was a school of slick archaeological architects, capable of decorating all manner of collegiate, civic and domestic buildings with frigidly correct reproductions of the details of medieval cathedrals and châteaus. Out of Ruskin's demonstration of the origins of medieval decoration in natural forms there grew the so-called *art nouveau* movement toward exaggerated floral and curvilinear ornament; and out of Morris' insistence on handicrafts, inspired by infatuation with the medieval guild system, developed the Arts and Crafts movement (*q.v.*).

As early as the 1870s H. H Richardson adopted the Romanesque style less for its historical associations than for the opportunities it afforded him to express the nature and texture of stone. In mature examples of his architecture from the mid-1880s, ornament in the older, applied, sense has virtually disappeared, and buildings

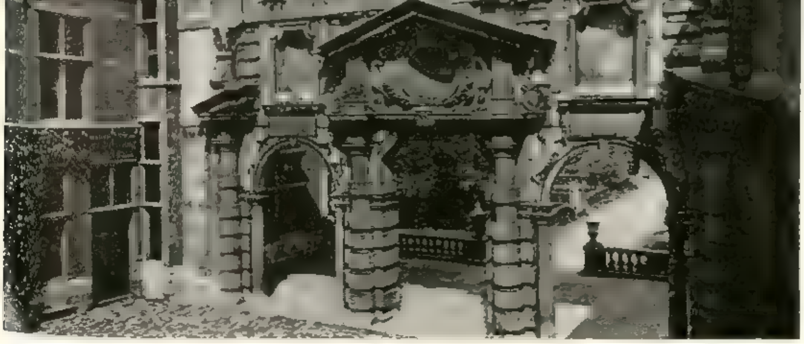
Chichén-Itzá, Yucatán. Characteristic Mayan façade using mimetic ornament—forms derived from earlier structural or symbolic shapes

Pillars of the Confucian temple at Chu Fu, Shantung province; Yüan dynasty (1280–1368). Mimetic ornament: Chinese dragon and other forms in high relief

Detail of molding, Erechtheum, Athens. Typical classical ornament of the 5th century B.C.; originally mimetic forms, imitating structural and symbolic features of archaic Greek architecture, later—as in this example—providing visual articulation for the building as a whole



Prayer niche in the Alhambra, Granada, Spain; 13th and 14th centuries. Typical of Moorish art in Spain, the ornamentation chiefly serves a symbolic function



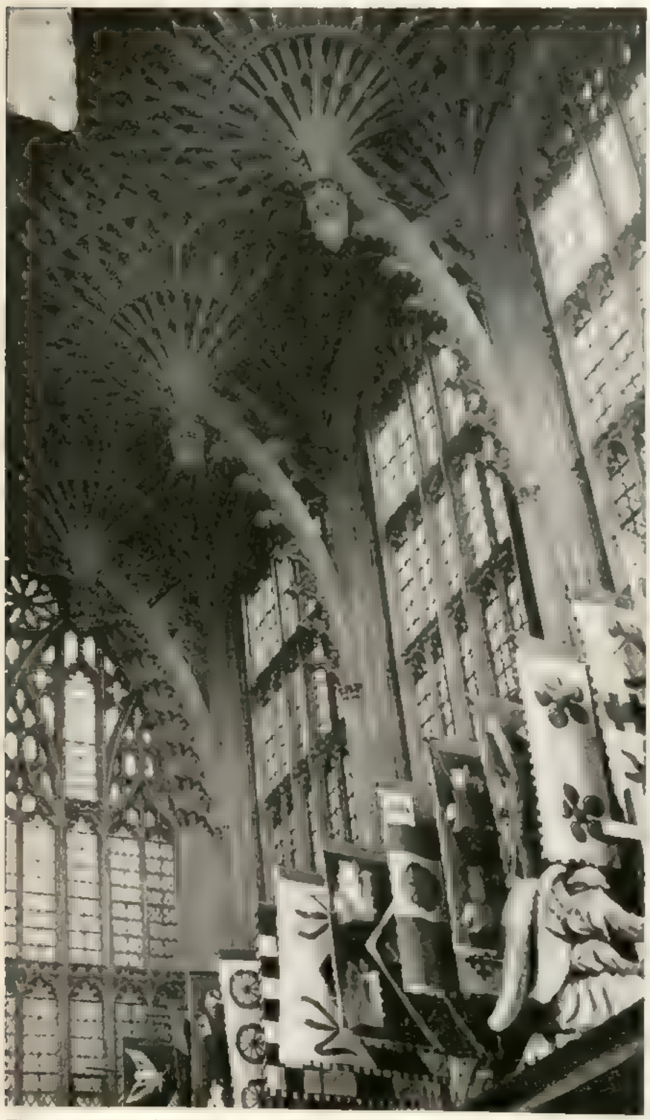
The elegant private home of Peter Paul Rubens at Antwerp, a model of the returning interest in architectural innovation in the early 17th century. Its architectural decoration was articulated in both the internal and external setting

PHOTOGRAPHS, (TOP LEFT) HAROLD GROSSMAN FROM BLACK STAR, (TOP RIGHT) ORIENT AND OCCIDENT, (CENTRE LEFT) ALISON FRANTZ, (CENTRE RIGHT) EWING GALLOWAY, (BOTTOM LEFT) LOUIS L. FROHMAN

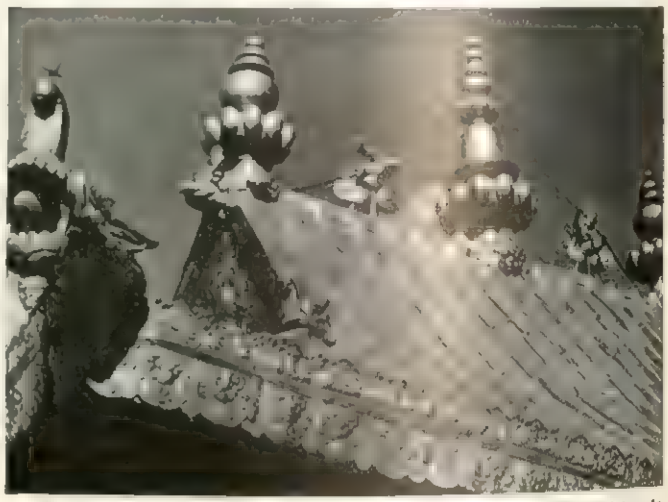
ORNAMENT, ARCHITECTURAL

Entrance to the Transportation building, World's Columbian exhibition, Chicago, 1893; Louis Sullivan, architect. Lush areas of applied decoration in studied contrast to the plain surrounding wall surfaces characterized Sullivan's work

Millard house, Pasadena, Calif., 1923; Frank Lloyd Wright, architect. Ornamental qualities are derived from patterns inherent in the nature of the material



The early Tudor chapel of Henry VII (1502) in Westminster abbey, showing the highly ornamented supporting arches



Roof of the great temple of Lord Buddha, Lhasa, Tibet, ornamented with elaborate gilt images. The temple is believed to have been founded c. 640

"Wedding Cake house," Kennebunkport, Maine. A mid-19th-century example of ornamentation entirely distinct from the older building to which it has been added; typical of indiscriminate Victorian usage

BY COURTESY OF (TOP RIGHT) FRANK LLOYD WRIGHT; PHOTOGRAPHS, (TOP LEFT) EWING GALLOWAY, (BOTTOM LEFT) LOUIS H. FROHMAN, (CENTRE RIGHT) CAMERA PRESS—PIX FROM PUBLIX, (BOTTOM RIGHT) WAYNE ANDREWS

depend for their aesthetic effect mainly on the inherent qualities of their materials. The generation following Richardson saw a further development of this principle everywhere.

In England Edwin Lutyens and C. R. Mackintosh, in the Netherlands H. P. Berlage and in the United States Louis Sullivan were among many contributors to the new architectural expression. It was largely based on intrinsic texture and pattern, but with interspersed bands and patches of naturalistic ornament, applied with studied discipline. With the general reaction against Victorian principles after World War I, however, leading designers rejected even this kind of applied ornament, and relied for ornamental effect on building materials alone. The so-called international style, in which Walter Gropius and Le Corbusier were the chief figures, dominated advanced design during the late 1920s and 1930s. However, the barrenness that resulted from their reliance on such materials as concrete and glass, along with other factors, resulted in a reaction by the 1940s in favour of the neglected precedent set by Frank Lloyd Wright in his early 20th-century work. It emphasized more visually interesting materials, intricate textural patterns and natural settings as the proper basis of architectural ornament.

It is in Wright's work of the 1940s and 1950s that the 20th-century concept of organic ornament was most characteristically embodied, as in such notable examples as Taliesin West, his home and studio near Phoenix, Ariz.; the campus of Florida Southern college at Lakeland, Fla.; and the Guggenheim museum in New York city. Impressive evidence of the renewed interest in architectural ornament generally, and organic ornament in particular, was provided by the buildings of the 1958 Universal and International exhibition in Brussels. The U.S. pavilion was designed by Edward D. Stone and made extensive use of ornamental screens characteristic of his work. Further articles on the several architects and architectural styles and periods mentioned in this article are listed in ARCHITECTURE (ARTICLES ON). *See* also ANTHEMION; CEILING; GARGOYLE; MOLDING; and references under "Ornament, Architectural" in the Index.

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ORNAMENTATION, in music, the embellishment of a melodic line, either by elaboration or by rhythmic modification. In European music, ornamentation is ideally something added to the music in order to make it more pleasing (early writers called it "spice," "salt," etc.). In music, as in the other arts, badly conceived or badly executed ornaments may have the effect of causing confusion and a disintegration of the basic structure.

From at least the middle ages until the end of the 18th century the practice of improvised ornamentation was part of a singer's or an instrumentalist's traditional technique. The composer provided the composition and the performer used all his technical skill—the singer his vocal agility, the instrumentalist the technical potentialities of his instrument—to heighten the expressive power of the music by florid embellishment and sensitive articulation. That ornamentation was sometimes debased by a tasteless display of technical virtuosity is attested by writers of many periods.

In instrumental music some styles of ornamentation are the direct result of the technical limitations of the instrument; *e.g.*, repeated notes of the same pitch are impossible to play on most bagpipes and must be simulated by means of ornamentation.

Ex. 1

Ornamentation was also the result of a natural desire to add variety to the repetition of a section of a work or of a short piece, such as a dance, that was repeated many times. This practice led logically to the variation form.

The apparatus of ornamentation varies greatly from age to age and from country to country. It is a traditional vocabulary that reflects and often influences the development of musical style. In its most creative sense ornamentation is closely linked with improvisation and, therefore, with composition itself.

When a musical work is transferred from one medium to another, as in a keyboard transcription of a vocal composition, the instrumental style and ornamentation appropriate to the new medium may alter entirely the character of the music.

A decorated arrangement is often a creative reworking of the original material and may reflect not only the instrumental style of the new medium but also the personal style of the arranger. This is found in the harpsichord transcriptions by J. S. Bach of violin works by Vivaldi and later in the elaborate arrangements and fantasias for piano made by Liszt of operatic excerpts and orchestral works.

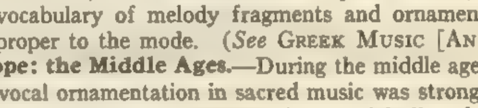
Ancient Civilizations and the Orient.—The European concept of ornamentation as an addition to an already musically complete composition is something foreign to the music of ancient civilizations and to the classical music of many modern oriental countries. In this primarily melodic music the boundaries between ornamentation, improvisation and composition are impossible to define. Composition is improvisation, and improvisation is the organization, within the limits of a specific mode, of a traditional vocabulary of melody fragments and ornamentation formulas proper to the mode. (*See* GREEK MUSIC [ANCIENT].)

Europe: the Middle Ages.—During the middle ages the practice of vocal ornamentation in sacred music was strongly opposed by the church and was prohibited by papal bull and denounced by bishops as being detrimental to the purity of the Gregorian chant. Precise details of early medieval ornamentation were not recorded.

All that is known is that some notational signs signified an ornament and that in vocal music the trill was known from at least the 3rd century. Guido of Arezzo wrote that Italian singers were best fitted to perform the ornaments notated in the plain chant, and that foreigners who were unable to perform these ornaments adequately should rather sing the music undecorated.

Both the monophonic and the polyphonic music of the 13th century contain what appears to be written vocal ornamentation. The first notated dance tunes date from this time and these show certain features of a purely instrumental style of ornamentation:

Ex. 2



Although no particular instrument is specified, this is typical writing for bowed stringed instruments tuned in fifths and, in fact, was later to become a commonplace of violin figuration.

Italian secular music of the 14th century contains much notated vocal and instrumental ornamentation. In this music one of the fundamental techniques of ornamentation was established: that of "diminution" (the 16th-century English word was "division"); *i.e.*, the dividing of the basic notes of the melodic line into groups of notes of a shorter duration.

Ex. 3

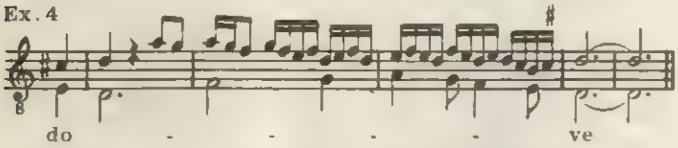
Example 3*a* shows the melody undecorated; ex. 3*b*, 3*c* and 3*d* show three possible methods of ornamentation.

In the 14th century this technique became codified and the performer could choose one of several diminution patterns to

ornament a given melodic phrase. These diminutions were generally performed at certain foreseen developments in the composition, such as at cadences.

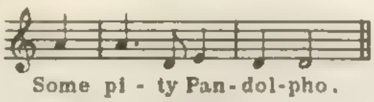
The most elaborate diminution was often reserved for the end of a section, as in this florid example from "De'l non fugir" by Francesco Landini (d. 1397):

Ex. 4



This practice of cadential embellishment became a feature of vocal and, later, instrumental ornamentation. Example *5a* is the unornamented form of the last two bars of "Pandolpho" by Robert Parsons (d. 1570); ex. *5b* is a contemporary decorated version in which the first bar is significantly extended to three bars in order to give the singer full scope for virtuosity.

Ex. 5a



Ex. 5b

It thus came about that the 18th-century cadenza (*q.v.*), from which the cadenzas of the great 19th-century instrumental virtuosos developed, had its origin, as its name implies, in the earlier cadential ornamentation.

The Renaissance.—Despite the codification of diminution in the 14th century, it was not until the following century that the first theoretical works on the subject appeared. One of these, the Buxheim organ book (*c.* 1460), contains, besides many ornamented keyboard settings of French, German and English vocal music, an additional section of musical examples showing 15th-century methods of improvisation in which appears the sometimes inflexible and stereotyped style of diminution that was typical of German lute and keyboard ornamentation until the mid-16th century.

In the Renaissance, vocal ornamentation was one of several subjects co-ordinated in a musician's training. Jean Petit Coclico records that Josquin Després taught his pupils singing, vocal ornamentation, improvised counterpoint and composition.

During the 16th century many printed books appeared containing instructions on diminution. These books, mostly by Italian authors, were directed to the amateur musician though they were not necessarily of a popular nature. Among these, *Fontegara* (1535) by Sylvestro Ganassi is one of the most comprehensive ever published on the subject. In common with all writers on ornamentation from the 16th to the 18th century, Ganassi deals first with the ornamentation of intervals, that is to say, a systematic survey of the intervals of the second, third, fourth and fifth in various ornamented forms, and secondly with the ornamentation of conventional cadences. All the treatises on ornamentation from Ganassi to J. J. Quantz in the 18th century follow this principle. A copy of *Fontegara* contained, in Ganassi's own hand, 300 different ways to ornament a single cadence.

Sixteenth-century vocal ornamentation was conceived as an abstract musical expression rather than as an expression of literary ideas. It was primarily concerned not with underlining the words but with reflecting the mood of the text. Therefore, the singer's approach to diminution was basically the same as that of the instrumentalist. In fact, the title page of Ganassi's work describes it as "teaching . . . diminution suitable to wind and stringed instruments as well as to those who delight in singing."

The Baroque: Italian and French Styles.—The early years of the 17th century saw, in Italy and France, a decisive change in vocal and instrumental styles of composition, and also the founding of two distinct national styles of ornamentation. With the revival of interest in the literature of classical Greece and with the founding of the literary academies, poets and musicians began to collaborate in an attempt to re-create the musico-poetic art of the classical world. Music was to be the servant of poetry and vocal ornamentation was used expressly to heighten the emotional content of the words. To achieve this, a new emotionally expressive style of melodic writing was developed, together with a rhythmically mannered vocabulary of vocal ornamentation.

In Italy diminution was still practised in vocal as well as in instrumental music, but the new style of ornamentation was reserved for solo vocal music. The following example, from the opera *Orfeo* (1607) by Claudio Monteverdi, shows the intense dramatic passion conveyed by the early 17th-century Italian vocal ornamentation, with its jerky rhythms and groups of rapidly repeated notes (called *trilli;* trills were known as *gruppi*).

Ex. 6

The principles of diminution were preserved in the 17th-century French style of vocal ornamentation associated with the performance of the *airs de cour.* They also survived in a relatively simple form in the "doubles" or varied repeats found in the harpsichord works of François Couperin. In early 17th-century French lute music, a tradition was current using a large number of small ornaments for the purpose of articulation and accentuation as well as rhythmic modifications of the written notes. These ornaments became an important stylistic feature of French harpsichord music, while the rhythmic modifications used by the lutenists were incorporated in the later French instrumental style, notably in that of the French overture with its characteristic double-dotted rhythms.

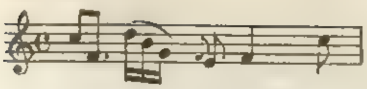
Small ornaments such as mordents and turns, deriving from the lute compositions of the École de Paris, in which Denis Gaultier was a prominent figure, were transformed and codified for use in the harpsichord music of Couperin and are set out in his *L'Art de toucher le clavecin* (1717). The following examples are typical of this style of ornamentation:

Ex. 7

Following the ornamented vocal styles of Monteverdi and his contemporaries, the Italian instrumental style remained elaborately florid. The performance of solo works in the mid-18th century required great creative skill in improvisation on the part of the performer as it was customary for the composer to write only the main structural notes of the melody. This led eventually to the debasement of the Italian style with the vocal and instrumental gymnastics practised by virtuosos of the late 18th and early 19th centuries.

Example 8 shows the first bar of an adagio from a violin sonata by Guiseppe Tartini (d. 1770), first in its simple form and secondly in a typically elaborate version published about 1788.

Ex. 8a



Ex. 8b

The French and the Italian styles of ornamentation remained distinct throughout the greater part of the 18th century. Thus a composer such as J. S. Bach not born to one or other of these styles could use either of them dispassionately.

In the works of Haydn and Mozart variations of themes incorporated written ornaments in a manner that announces the absorption of ornaments in the accepted musical language. In the 19th century many of the features of ornamentation, such as turns and accented grace notes (which take the form of appoggiaturas or anticipations), became an integral part of the musical language but without being left to the discretion of the performer. Improvisation ceased to form part of the performer's equipment, except in vocal ornamentation (deplored by contemporary critics) in Italian opera, but its spirit persisted in a crystallized form, so to speak, in established harmonic and contrapuntal procedures. Many examples of florid turns, anticipations and suspensions in the works of Chopin and Wagner can be traced back to earlier forms of ornamentation (*see* HARMONY).

In essence the art of ornamentation is dependent on a certain distribution of responsibility between composer and performer. This concept was foreign to 20th-century music, though the ancient tradition reappears in spontaneously conceived examples of ornamentation in jazz music. Here, however, as in the series of stereotyped ornamented cadenzas provided by the composer Quantz in the 18th century, the uninitiated jazz trumpeter is provided with a series of "hot breaks" in the form of cadenzas that have their origin in practices reaching back to the beginnings of music.

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(M. Mw.)

ORNE, a *département* of northern France, formed in 1790 from districts of ancient Normandy, with adjacent portions of Alençon and Perche. Pop. (1962) 280,549. Area 2,372 sq.mi. It is bounded north by Calvados, east by Eure and Eure-et-Loir, south by Sarthe and Mayenne and west by Manche.

The *département* lies astride the watershed (Collines de Normandie and Collines du Perche) between the Loire tributaries flowing south (Mayenne and Sarthe) and the streams (the chief among which is the Orne) draining into the English channel. Most of the *département* lies above 600 ft. and is hilly country, reaching 1,368 ft. in the Forêt d'Écouves and Les Avaloirs. The western half, lying within the Armorican massif, is built of ancient rocks that yield only poor soils, but the eastern part, consisting of Jurassic and Cretaceous rocks, provides richer country and contains the plains of Alençon and Argentan. These *campagnes*, open tracts of old-established cornland, present a contrasting landscape to the *bocage* in the west, which is broken hilly country with woodlands and much waste, among which farmland presents a discontinuous patchwork of small, hedge-bounded enclosures. The countryside is mainly pastoral, young cattle and dairy produce being the chief products. In the northeast, near Vimoutiers, Camembert cheese has been a noteworthy product since the 18th century, and elsewhere much butter is produced. The district of Perche, in the east of the *département*, is famous for its breed of draft horses. Orne lies outside the northern limit of the vine, but cider-apple orchards are widespread. Iron ore is worked in the southwest and there are scattered stone quarries. Bagnoles is a well-known spa, with a picturesque lake. Old textile, tanning and metal-working industries survive in some of the market towns, notably at Flers, which has cotton and linen mills, and at Laigle, which manufactures pins and needles and hardware. The largest town and *préfecture* of the *département* is Alençon, famous for its lace, but little of this is now made. Sées, near the source of the Orne, is the seat of the bishopric, and its cathedral is one of the finest examples of the Norman style of Gothic churches. The *département* comes under Caen for the administration both of education and of justice. It is divided into three *arrondissements*, centred upon Alençon, Argentan, and Mortagne. Among other towns, Domfront in the southwest is noteworthy for the magnificent panorama that can be viewed from the castle terrace which overlooks the precipitous Varenne pass. Most of the towns suffered considerable damage during the Allied advance in 1944.

(AR. E. S.)

ORNE RIVER, of northern France, 94 mi. long, flowing through the *départements* of Orne and Calvados to its mouth in the Baie de la Seine, 8 mi. N. of Caen.

The Orne rises near the little cathedral city of Sées in the Forêt d'Écouves, the highest part of the Collines de Normandie, and flows northwest past Argentan and then north across the Campagne de Caen to the sea. Its basin is chiefly devoted to pastoral farming, especially concerned with cattle rearing and dairy farming, but grain growing is important on the plain of Argentan and especially on the extensive arable tracts of the limestone platforms that flank its lower course. The limestone provides an excellent building stone, long famous and widely distributed by sea from Caen for use in many historic buildings in south and east England, including the Tower of London and Norwich cathedral. Iron ore deposits which occur on the margin of the Armorican massif in the south of Calvados are more important now. The short canal which connects Caen with the sea, alongside the estuary of the Orne, serves as outlet, and considerable industrial development has taken place along it, with blast furnaces, engineering establishments and cement works. (AR. E. S.)

ORNITHOLOGY is the science of birds. This article will deal with the development of the study of birds from early historic to modern times; for a detailed account of bird anatomy, physiology, natural history and classification, *see* BIRD. The historical record begins with the representations of birds made by Stone Age man during the last glacial epoch of the Ice Age in France and Spain—paintings on the walls of caves, or figures or incisions carved on bits of horn, bone or stone. The birds that have been identified thus far from this remote Paleolithic art include the stork, swan, capercaillie and what appears to be the great auk. From the more recent Neolithic period, outlines of birds are more common. To these, archaeologists assign an antiquity of 6,000–8,000 years. The Paleolithic designs are much older.

A structure of the Sumerians of about 3100 B.C., near Ur in Mesopotamia, was decorated with a large copper relief that included an eagle. On the tomb of Nefermaat, of about 3000 B.C., at Medum, in Egypt, is a fresco showing red-breasted, bean and white-fronted geese whose painted colours are said to be like those seen in these species today. Bird designs in following centuries in Egypt were many and varied, depicting at least 90 species, while numerous birds were preserved entire as mummies. Designs of numerous species are also found in the early art of Greece.

Early Writings.—There are many incidental references to birds in the Bible, those in the Old Testament being of considerable antiquity. The writings of Aristotle (384–322 B.C.), though they do not attempt to give a connected account, include statements that concern about 170 species of birds, which he divided into eight groups, an early attempt at classification. He obtained part of his information from still earlier writers whose works are lost. Pliny the Elder (d. A.D. 79), in his *Historia Naturalis*, devoted book x to birds, taking much from Aristotle. The books of Aelian, of the 3rd century, written in Greek, have much on birds, largely in the form of anecdote, folklore or fable, a pattern that continued in the bestiaries and medical treatises through the dark ages. Early Persian, Arabic and Hindustani manuscripts of the Muslim

period of learning have references to birds. Avicenna (A.D. 980–1037), writing in Arabic, expanded the accounts of Aristotle with additional material. Averroës (A.D. 1126–98) of Spain was an equally celebrated naturalist whose manuscript writings have been preserved in print.

Early Saxon poets mention the gannet and several other birds of uncertain identity in songs current during the 6th and 7th centuries, and during the latter there came early records of falconry, apparently introduced by the Saxons into Britain. The *Epistolae Sancti Bonifacie*, written about the middle of the 8th century, recorded that Boniface, archbishop of Mons in Belgium, presented to Aethelberht, king of Kent, a hawk and two falcons. In the laws of Howel, king of Cambria, supposedly in the 10th century, there is statement of the hunting of the pheasant and an allusion to hawking. Aelfric's *Vocabulary*, prepared in the 10th century, and a similar later work contain names of more than 100 birds, while in the *Colloquy of Aelfric*, a series of dialogues between a master and his pupils, are references to hunting with and training of hawks. In the writings and manuscripts of the 12th and 13th centuries are many references to hawking, descriptions of decoys in which ducks were captured alive, records of heronries and an account of a great flight of crossbills into England in the year 1251.

The earliest printed account of birds is found in the *Sermonum Proprietate* of Rabanus Maurus (A.D. 776–856), archbishop of Mainz; this work, printed in Strasbourg in 1467, contains a chapter entitled *De Avibus*. About 1500 Leonardo da Vinci studied, in sketches and models, the aerodynamics of bird flight as a basis for a flying machine (*see* FLIGHT [NATURAL]). William Turner published in 1544 the earliest printed book devoted solely to birds, entitled *Avium praecipuarum*, a commentary on the birds of Aristotle and Pliny, prepared in accordance with treatment that was the forerunner of modern methods. This was followed in 1555 by Konrad von Gesner's *Icones Avium*, which contained many original observations, as the author traveled extensively and recorded his impressions first-hand. Pierre Belon, whose *Histoire de la nature des oyseaux* appeared also in 1555, had considerable knowledge of the anatomy of birds, and seems to have been the first to compare the various parts of the avian skeleton with those of man.

In the joint observations of Francis Willughby and John Ray, published by the latter in 1676 and 1678 after the death of Willughby, there is a division of known birds into two great groups of land fowl and waterfowl, an arbitrary classification that was current to the end of the 19th century, when it was superseded by a more modern grouping based on structural characters.

Linnaeus, the founder of the modern system of scientific names, began publication of his *Systema Naturae* in 1735, in the first edition of which he included a list of the birds known to him. In 1758, in the 10th edition of his work, Linnaeus proposed that each species of animal, including birds, be designated by two names: the first of generic significance, applying in most cases to a number of somewhat similar allied forms; and the second specific in nature, used in connection with the genus name to designate a particular species. In later years, a category of subspecies, or geographic races, designated by a third Latin term or subspecific name, was added where required.

Natural history collections made in connection with the many explorations of the late 18th and early 19th centuries brought to Europe, particularly to England and France, many specimens of birds that greatly broadened knowledge of the birds of the world. In early explorations, paintings or drawings were made of birds, and specimens were preserved in spirits or sometimes dried as mummies. After the middle of the 18th century, as travelers increased and interest in natural objects expanded, methods of preparing skins of birds were evolved that led finally to the making of what are known as scientific specimens. Such specimens were, and still are, prepared as follows: the skin, with the feathers intact, was removed from the body, leaving only the bones of the skull, wings, feet and base of the tail. After the inner surface was poisoned, usually with arsenic, the skin was then stuffed with cotton, tow or other light vegetable substance and dried so that the finished object resembled a dead bird. By means of such preparations it became possible to assemble collections of birds, preserved indefinitely, for continued study and examination.

The growth of bird collections and their expansion into museums, where birds were mounted in natural positions, changed completely the style and method of published treatises dealing with ornithology. To this time these had been mainly accounts and descriptions written from hearsay or memory, and involving constant repetition of the writings of previous authors. Such accounts began to be supplanted in large measure by detailed statements regarding specimens secured during voyages, or by monographs that brought together all available knowledge concerning genera, families or larger groups of birds. Many works contained series of coloured illustrations that delineated the bird under discussion more definitely than words. Among earlier writers of such illustrated works or monographs may be mentioned L. Daubenton, whose *Planches enluminées* contained 1,008 plates, most of them of birds; F. Levaillant, who published on hornbills, cotingas, birds of paradise and many others; L. J. P. Vieillot, who produced an array of volumes that dealt with the majority of the known birds of the world; and C. J. Temminck, who wrote on the pigeons, gallinaceous birds and others.

John James Audubon's *Birds of America*, in four volumes of large folio size, containing 435 plates, was published in London between 1827 and 1838 and was followed by his *Ornithological Biography*, in which, with the aid of William MacGillivray, he gave accounts of the habits of North American birds. The writings of John Gould, which began in 1832, included descriptions and beautiful paintings in colour of birds of all parts of the world; they comprised more than 40 folio volumes illustrated by more than 3,000 plates.

After the middle of the 19th century ornithological publications increased greatly in number. In America increase of knowledge in ornithology subsequent to Audubon and Alexander Wilson (who was a contemporary of Audubon in the study of American birds and published an excellent and painstaking account of them) came rapidly with the appointment in 1850 of Spencer Fullerton Baird as assistant secretary of the Smithsonian institution. Baird's early years in this new position were coincident with the initiation of the great exploratory surveys, including the Hayden surveys and the survey of the 40th parallel of latitude, undertaken by the government to develop the western part of the United States. Baird developed the U.S. National museum as a depository for specimens of all kinds belonging to the U.S. government, and arranged to send naturalists with the different survey parties, with the result that large collections, particularly of birds and mammals, came to Washington, furnishing the material for many important reports.

Modern Studies.—Throughout the 19th century and the early years of the 20th, emphasis was directed to the search for unknown and unusual birds, by exploration of little-known regions.

Until about 1930 the technical aspects of bird study were the interests of relatively few scholars. More recently, as scientific investigations have diversified, popular interest has increased, until now birds are a concern, casual or important as the case may be, of hundreds of thousands of persons. Most of the species of existing birds have been discovered, except for possibly a limited number in a few regions that have not yet been completely explored. While studies of geographical variation and taxonomic relationships continue to be important fields for investigators, steadily increasing numbers of students are occupied with studies of the living bird in field and laboratory.

Extended programs, through which many thousands of living birds are banded with numbered, lightweight rings and then released, give much information on longevity, distribution and migration (*see* MIGRATION, BIRD). Studies of anatomy lead to increasing understanding of the relationships of birds; discoveries of fossils add to the knowledge of birds that are now extinct and help to clarify the evolution of the group; and research in physiology and behaviour increases understanding in many directions. Added to these are the data provided by the steadily growing number of bird watchers, who are afield with binoculars, spotting scopes, cameras and notebooks to record the occurrences of birds that they may encounter and to note anything of interest about them.

Ornithological Societies.—As ornithologists increased in number, desire for discussion of their problems grew, to take shape finally in serial publications devoted to birds alone. Among the early periodicals that continue today may be mentioned especially the *Journal für Ornithologie*, begun in 1853; the *Ibis*, founded by the British Ornithologists' union in 1859; and the *Auk*, originated by the American Ornithologists' union in 1883. The last-mentioned periodical is a direct continuation of the *Bulletin* of the Nuttall Ornithological club, established by that organization in April 1876. The Zoological Society of London, especially in its earlier years, had a profound influence on the development of ornithology, particularly through the labours of A. H. Garrod, W. A. Forbes and Frank E. Beddard and through its publications, especially the *Proceedings of the Zoological Society of London* and its precursor, the *Proceedings of the Committee of Science and Correspondence of the Zoological Society* (1830, *et seq.*).

In North America there are numerous local amateur societies devoted to birds, in addition to the older ones of wider geographic scope, a part of whose membership is engaged in technical investigations. Similar organizations are found in the countries of Europe, in Australia and in many other parts of the world. Several dozen periodicals are devoted to ornithology alone, and articles on the subject appear in numerous other serial publications, so that an expanding amount of popular and technical literature steadily increases the fund of knowledge of birds. One serial publication alone—the *Zoological Record*, published annually since 1864 by the Zoological Society of London to list the technical papers in this field—has included in recent years over 2,000 titles in the section on birds, "Aves." (A. Wt.)

ORNITHOPTER, a flying machine with flapping wings operated either mechanically or manually. The type is of historic interest only, and represents man's attempt to imitate the flight of birds. *See* Airplane; Flight (Natural).

OROBANCHACEAE, the broomrape family of parasitic flowering plants, containing 14 genera and about 160 species, easily recognized by their nongreen colour, irregularly shaped flowers, scales for leaves and one-celled capsules with numerous, usually minute seeds. These succulent plants are commonly yellowish, brownish, purplish or almost white. Orobanchaceae obtain their nourishment from other plants (angiosperms or rarely gymnosperms) to whose roots they attach themselves, usually by means of haustoria (absorbing organs). Some members are confined to a few or even just one host species; *e.g.*, beechdrops (*q.v.; Epifagus virginiana*) parasitizes only beech trees. Others, especially some species of broomrape (*q.v.; Orobanche*), parasitize a wide range of hosts.

The family is confined largely to the northern hemisphere and is especially well represented in temperate Eurasia. In the United States its representatives, in four genera, include beechdrops, squawroot (*Conopholis americana*), ground-cone (*Boschniakia hookeri*) and broomrape. In Britain are found broomrape and toothwort (*Lathraea squamaria*). Some broomrapes are troublesome parasites on crop plants such as hemp, tobacco, tomato, cotton and clover. *Aeginetia indica* injures sugar cane in the Philippines. Flowers of Orobanchaceae, which are either variously grouped or rarely solitary, have two to five united sepals, five petals united to form a two-lipped corolla, four stamens and a one-celled ovary. Orobanchaceae, closely related to the figwort family (Scrophulariaceae), are sometimes included therein.

See C. R. Metcalfe and L. Chalk, *Anatomy of the Dicotyledons*, vol. ii, pp. 988–991 (1950). (J. W. Tt.)

ORODES (Parthian Wrwd; Pahlavi Wyrwd, Wyrwy), Iranian personal name, especially of three Parthian kings of Iran.

Orodes I ruled (80–76 b.c.) in Babylonia, according to cuneiform tablets.

Orodes II (57–37/36 b.c.) helped Mithradates III to murder their father Phraates III, then supplanted him. When Mithradates reoccupied Seleucia and Babylon, Orodes stormed these towns, immediately executing his brother. In 53 b.c. the Romans under Crassus were crushed at Carrhae (*see* Carrhae, Battle of) by Orodes' cavalry; yet the king put to death his victorious general, Surenas. Raids into Roman Syria were checked by the death of the Parthian leader Pacorus, the favourite prince and perhaps joint king. The king was stunned at his loss. He was murdered in turn by another son, Phraates IV.

Orodes III (a.d. 4–6), unpopular for his brutality, soon perished by assassination.

There were also five local kings of Elymais in southern Iran of this name, known from coins and inscriptions. (A. D. H. B.)

OROGENY, in geology, is the development of mountain structure by folding and fracturing of the earth's crust, the term coming from the Greek *oros*, "mountain," and *genesis*, "birth." In general, orogeny has followed a long period of deposition of sediments in the form of a broad trough, or geosyncline, resulting from slow subsidence as the deposits accumulated. A complex history of deformation has ended the geosynclinal stage and introduced the mountain-building stage, generally accompanied by earthquakes, volcanic activity and the intrusion of massive bodies of granitic rock. For discussion of these processes *see* Geology: *Structural Geology*. *See* also Fault; Fold; Isostasy.

ORONTES (Arabic Al'Asi "rebel"), the ancient name of a river of western Syria, also called Draco, Typhon, Axius. It rises north of Baalbek in the Bekaa (Al Biqa') valley fed by springs in the limestone of the eastern side of Mt. Lebanon. Flowing northward through the lake of Homs (an irrigation reservoir formed by damming the Orontes) and the swampy depression of Al Ghab, it turns west at Jisr al Hadid on the Turkish border and enters the sea near the small Mediterranean port of Samandag (Seleucia Pieriae). North of Homs it receives numerous small wadies (seasonal rivers). Within Turkey it is joined by the Afrin Suyu and Kara Su upstream from Antakya (Antioch). The mean annual discharge is 2,500,000,000 cu.m., and the seasonal variation is from 10 to 16 cu.m. per second near its source and 35 to 230 cu.m. per second at its mouth. It is mainly unnavigable throughout its 355-mi. course. Between Homs and Hamah its waters irrigate about 85,000 ac. of land, and there is projected drainage of Al Ghab. Its valley served as an ancient military and trade route between Egypt and Asia Minor and from Mesopotamia to the Mediterranean.

See J. Weulersse, *L'Oronte: Étude de fleuve* (1940). (C. G. Sm.)

OROPUS (modern Skala Oropou), an ancient Greek seaport on the Gulf of Euboea opposite Eretria, on the border between Attica and Boeotia. It was probably acquired by Athens in the 6th century b.c., but in and after the 4th century it was for long periods controlled by Boeotia or Eretria, being finally restored to Athens by the Romans. It was celebrated for the oracle of Amphiaraus (*q.v.*).

OROSHÁZA, a town of southeast Hungary in Békés *megye* (county), lies 32 mi. N.E. of Szeged on the main railway from Szeged to Békéscsaba. Pop. (1960) 32,033 (mun.). The surrounding countryside is one of the most fertile in Hungary and was for long well known for its lively, picturesque weekly markets and annual fairs. After World War II the land around Orosháza was noted for experiments in new crops, especially cotton and oil-bearing plants. Orosháza is the intersection point of a number of secondary roads. (H. G. S.)

OROSIUS, PAULUS (fl. 414–417), theologian and author of a world history which was immensely popular in the middle ages, was born in Spain (probably at Braga in Galicia). He entered the priesthood, and after the invasion of the Suebi and Vandals went *c.* 414 to Hippo, attracted by the reputation of Augustine. There he wrote his earliest work, *Commonitorium ad Augustinum de errore Priscillianistarum et Origenistarum*. In 415 Augustine sent him to Palestine where he immediately became involved in the Pelagian controversy. At a synod summoned in July 415 by Bishop John of Jerusalem, Orosius engaged in a public debate with Pelagius himself, without getting the better of him. Soon afterward he wrote *Liber Apologeticus contra Pelagianos*. Early in 416 he returned to Augustine, at whose request he composed a historical apology of Christianity, *Historiarum adversus paganos libri vii*. In this world history, he draws particular attention to the catastrophes befalling mankind before the coming of Christianity, thus arguing against the accusation, common among the pagans, that the contemporary evils and perils of the Roman empire were a sequel of its conversion to Christianity.

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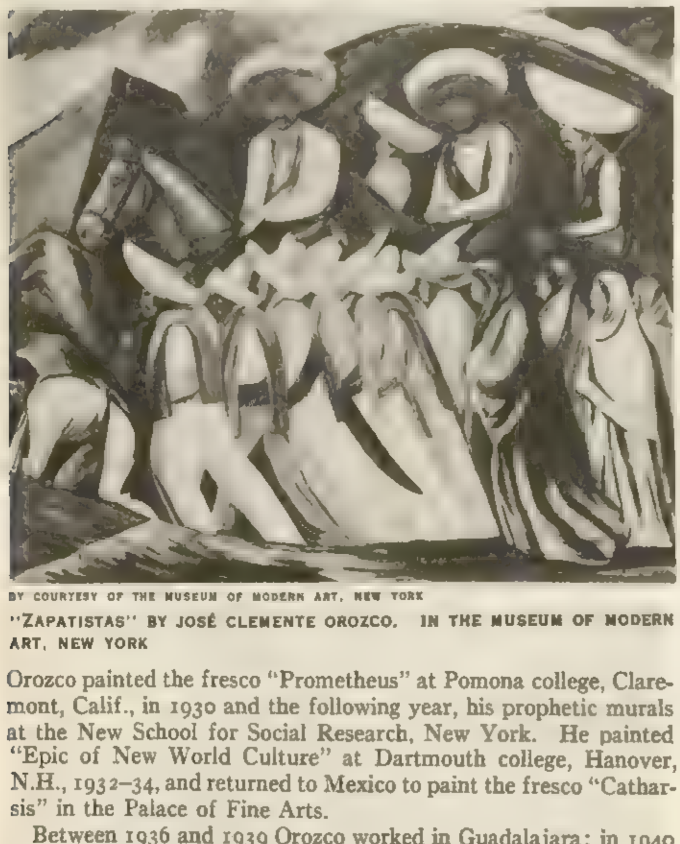
(V. C. de C.)

OROZCO, JOSÉ CLEMENTE (1883–1949), Mexican painter, whose original style was expressive of his strong social convictions, was born on Nov. 23, 1883, at Ciudad Guzman, Jalisco. The family moved to Mexico City where the child often watched José Guadalupe Posada at work. After completing a course in scientific agriculture at the College of Chapingo, he entered the National university with the intention of becoming an architect. Losing his hand in a chemical explosion he abandoned that career and, in 1909, devoted himself to creative art, for which several years of intensive study at San Carlos academy prepared him. The water colours of his first one-man show in Mexico City in 1915 revealed his social consciousness.

When the revolutionary government invited outstanding artists to decorate the walls of public buildings, Orozco worked in the medium of true fresco in the patio of the National Preparatory school, 1922–27, also decorating the Industrial school at Orizaba and, as a private commission, the main stairway of the House of Tiles in Mexico City. Rejecting Cubism as well as the imitation of pre-Hispanic art forms, Orozco developed his own powerful style.



BY COURTESY OF THE MUSEUM OF MODERN ART, NEW YORK

"ZAPATISTAS" BY JOSÉ CLEMENTE OROZCO. IN THE MUSEUM OF MODERN ART, NEW YORK

Orozco painted the fresco "Prometheus" at Pomona college, Claremont, Calif., in 1930 and the following year, his prophetic murals at the New School for Social Research, New York. He painted "Epic of New World Culture" at Dartmouth college, Hanover, N.H., 1932–34, and returned to Mexico to paint the fresco "Catharsis" in the Palace of Fine Arts.

Between 1936 and 1939 Orozco worked in Guadalajara; in 1940 he completed fresco murals in the library at Jiquilpan and six movable panels, "The Dive Bomber," for the Museum of Modern Art in New York. In 1941, in Mexico, he decorated the main floor of the supreme court and in 1942 began the murals of the Jesus Nazareno hospital. For the next four years Orozco painted numerous portraits and held several exhibitions. In 1946 he was awarded the national prize of the Institute of Arts and Sciences. Orozco's final works included a large-scale mural in plastic medium in the open-air theatre of the National School for Teachers (1947), completion of the Jesus Nazareno hospital frescoes (1947–48), "Juarez and Reform," Museum of History, Chapultepec (1948), and "The Great Legislation," Chamber of Deputies, Guadalajara (1947–48). He died on Sept. 7, 1949.

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(A. M. Rd.)

ORPEN, SIR WILLIAM NEWENHAM MONTAGUE (1878–1931), British painter, was born at Stillorgan, County Dublin, on Nov. 27, 1878, and studied at the Dublin Metropolitan School of Art and at the Slade school, London. He was elected an associate of the Royal Academy in 1910 and academician in 1919. He first exhibited at the New English Art club, of which he became a member in 1900, his early work being marked by preoccupation with spacing and silhouette and the use of quiet harmonies of gray and brown, with a note of vivid red or blue. He soon turned to the use of bright colour and the study of light, seen in a series of brilliant portrait interiors such as the "Hon. Percy Wyndham" (1907) and "Myself and Venus" (1910; Pittsburgh, Pa., gallery). About this time he became well known for his vigorously characterized portraits. During World War I Orpen received an appointment as official artist, and in 1918 an exhibition of his war pictures was held in London. Many of these are now in the Imperial War museum.

Orpen was created knight commander of the order of the British Empire in 1918. He wrote *An Onlooker in France* (1921) and *Stories of Old Ireland and Myself* (1924). Orpen was a friend of Augustus John. He died Sept. 29, 1931.

ORPHEUS, in the ancient Greek world a legendary hero of the generation of the Argonauts (*q.v.*), earlier than the warriors of the Trojan War, with a particular gift of superhuman skill in music and song; he became as well the patron of a religious movement dependent on a body of sacred writings said to be his own ("of Orpheus" or "Orphic"). This movement can hardly have antedated the 6th century B.C., and its adherence to a sacred literature sets it apart from the type of religion most commonly practised in Greece and favoured by the authorities of the city-states. Whether there is any connection between the two sides of his character may emerge from an examination of the legend.

Orpheus in Legend.—He was the son of a Muse (Calliope in most sources) and Oeagrus, a Thracian river-god, or alternatively Apollo, and his home was Thrace. He joined the expedition of the Argonauts, where his bewitching music was of use in various ways; he also performed certain religious functions connected especially with initiation and purification. These are naturally most prominent in the late Orphic version but appear also in Apollonius of Rhodes and elsewhere. His descent to Hades to restore his dead wife to the upper world is referred to by Plato and Euripides, who however do not mention her name. This occurs in a Hellenistic poet as Agriope, and from the 1st century B.C. as Eurydice. The common story was that his music charmed the nether deities into consenting to her return on condition that he should precede her and not look back, and that he lost her again through breaking this condition. Orpheus himself was later killed by the women of Thrace. The motive and manner of his death vary in different accounts, but the earliest known, that of Aeschylus, says that they were Maenads urged by Dionysus to tear him to pieces in a Bacchic orgy because he preferred the worship of the rival god Apollo. His head with his lyre, still singing, floated to Lesbos, where an oracle of Orpheus was established.

The character of Orpheus, particularly his lyre-playing and song, makes him an Apolline figure, a missionary of the Hellenic spirit. Yet he lives in Thrace, the home of Dionysiac religion, and appears prominently, if unfortunately, in a Bacchic scene. The orgiastic Thracian religion held, latent or expressed, the promise of immortality. The Orphics worshiped Dionysus, but modified the concept of divine possession by Apolline notions of purification (*katharsis*) and regimen. The combination of Dionysiac and Apolline connections, therefore, may account for his adoption by the sectarians.

Orphic Writings and Doctrine.—Euripides, Aristophanes, Plato and Aristotle knew Orpheus as the author of sacred books whose subjects include theogony, purification and the afterlife. He was also the giver of *teletai*, which means both mystic rites and sacred writings. His poems are occasionally quoted by Plato, but much more freely by the Neoplatonists, and the antiquity of these quotations is disputed. However, the central Orphic beliefs may

ALINARI—ART REFERENCE BUREAU

BAS-RELIEF SHOWING HERMES PARTING EURYDICE FROM ORPHEUS, ABOUT 400 B.C. IN THE NATIONAL MUSEUM, NAPLES

fairly be summarized thus. The theogony borrowed freely from Homer and Hesiod but shows significant differences. The primal god of Love and Light (Eros-Phanes) springs from an egg laid by Chronos (Time) in Aither, and creates a world containing gods and men. Zeus, however, whom every Greek recognized as ruler of the present world order, swallowed Phanes with his creation and brought a new world into being. Dionysus, son of Zeus, was killed and eaten by the Titans, wicked sons of Earth. Zeus destroyed them with a thunderbolt, and from the soot arose the human race, which therefore combines an earthly (Titanic) and a heavenly (Dionysiac) nature and must suppress the former and cultivate the latter. This is accomplished by periodic rituals, whose exact nature is unknown, and by living an Orphic life (Plato, *Laws* 782 c), which includes abstention from meat (a consequence of the doctrine of the transmigration of souls). Like other religions, this one also produced its charlatans who, trading on superstitious fears, sold *teletai* guaranteed to protect the purchaser from harm in the next world.

For Orphic eschatology the literary sources are supplemented by certain thin plates of gold from graves in southern Italy, Crete and Thessaly, inscribed with verses which provide a sort of passport to the nether world and a guide to its topography. They range in date from the 4th century B.C. to the 2nd century A.D., and were extracted from poems which may be considerably older. (That they are Orphic is an inference from their content.) The Orphics laid great stress on rewards and punishments after death, painting a lively picture of heaven and hell. The soul is a divine essence, and only achieves its true life after the death of the body, in which it is shut up as in a tomb or prison (Plato, *Cratylus* 400 c). To achieve full freedom it must undergo a cycle of incarnations, being reborn into a higher or lower form of life according to its previous deserts. This period of purgation in the "weary wheel" could be shortened by the consistent living of an Orphic life. Then the devotee, "son of Earth and starry Heaven," will be recognized by the divine powers as "of heavenly descent" and they will promise him: "Happy and blessed one, thou shalt be god instead of mortal" (quotations from the gold plates).

The only Orphic writings that have survived complete belong to the Greco-Roman age. Their value as evidence for classical Greece is therefore suspect, and in any case they have little bearing on the religious doctrines of the earlier period. They comprise a collection of 88 short hymns (including seven to Dionysus), clearly intended for use by a cult society, the Orphic *Argonautica* and the *Lithica*, a poetical treatise on the virtues of various stones.

Orphism was in many ways opposed to the prevailing current of religious ideas in classical Greece. It lacked moderation and ignored the Hellenic advice to man to remember his mortality and not strive to emulate the gods. It was dogmatic, with an authoritative priesthood and sacred scriptures, and the typical Greek valued his freedom of thought and the lack of an overriding authority in his religion. He did not easily accept ascetic rules of life or a set theological system. Orphism despised the body and exalted life in the next world, whereas most Greeks preferred to take life as it came and live in the present. Again, the Olympian religion was bound up with the common life of the close-knit city-state; Orphism was personal, a matter of individual salvation, and stood outside the social and political order. The Eleusinian mysteries, on the other hand, though promising a better life to come, had been taken over by the Athenian state and transformed into a communal affair. For these reasons Orphism never became popular, and its importance lies in the influence it exercised over a few leading thinkers such as Empedocles and Plato, and through Plato and Neoplatonism on Christian thought.

The romantic story of Orpheus himself had of course a much wider appeal. Through Ovid and Boethius it reached the middle ages, where it appears in England transformed into a northern tale of *Sir Orfeo*, "a lay of Brittany" (which has a happy ending). Its magic persists down to Christoph Gluck's *Orfeo ed Euridice* in the 18th century and Jean Cocteau's *Orphée* in the 20th. *See* also MYSTERY.

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ORPIMENT, the mineral form of arsenic trisulfide, occurs as lemon yellow, usually foliated masses or veins in hot-spring areas, presumably being deposited by ascending, hot, aqueous solutions. It also occurs as a sublimate near fumaroles and as an alteration product of other arsenic minerals, particularly of its frequent companion, realgar.

Orpiment is used as a pigment in dyeing and in the preparation of some depilatories. It is readily synthesized, the artificial product ("king's yellow") often being used in place of the mineral. Orpiment's specific gravity is 3.49; hardness 1.5–2 on the Mohs' scale (*q.v.*). The formula is As_2S_3. Diagnostic properties are its colour, pearly lustre (on cleavage surfaces) and associated minerals. *See* also ARSENIC. (F. D. B.)

ORRERY, ROGER BOYLE, 1ST EARL OF (1621–1679), Irish soldier, statesman and author, who played a part in Irish affairs during the Civil War, the Protectorate and after the Restoration, and was a close companion of both Oliver Cromwell and Charles II. He is best remembered for introducing rhymed heroic drama to England (*see* DRAMA: *Modern Drama: England: Restoration Drama*), and for *Parthenissa* (1651–59; complete, 1676), his romance in the French style.

The fifth son of the 1st earl of Cork (*q.v.*), he was born at Lismore castle, Waterford, on April 25, 1621, and in 1627 was created Lord Boyle, baron of Broghill. In 1630 he entered Trinity college, Dublin, and (1636–39) studied abroad with a tutor. After taking part in campaigns against the Scots (May–June 1639; Sept. 1640), in 1641 he married Lady Margaret Howard, the earl of Suffolk's daughter, and, as one of the courtier poets and dramatists, laid the foundations of his royalist sympathies and literary career.

Returning to Ireland on the eve of the Catholic revolt in Tyrone

(Oct. 1641), he commanded a cavalry regiment under Lord Inchiquin, governor of Munster. In April 1645 he valiantly defended Youghal. He later commanded a brigade under the new lord lieutenant, Lord Lisle, and in 1647 was appointed by parliament to the committee in charge of the Irish army. In May 1647 he charged Inchiquin, as commander of the parliamentary forces, with disloyalty, and when Inchiquin declared for the king (April 1648), parliament made Broghill president of Munster. After Charles I's execution he intrigued with Charles II to raise an Irish army, but was given the choice by Cromwell, in a personal interview, of serving in Ireland with the parliamentary army or of going to the Tower, and in 1650 defeated Lord Inchiquin. In 1651 he was made lieutenant general in charge of the Irish ordinance. While in Ireland, he wrote *Parthenissa.*

He was appointed to Cromwell's cabinet council (1653), and elected to parliament for Munster (July 1654). During 1655–56 he was president of the Scottish council of state. His abilities, shrewd judgment and wit won Cromwell's affection, and he became his confidential adviser. He was among the 60 peers who formed the upper house in the parliament of Jan. 1658. Richard Cromwell reappointed him to the cabinet council, but in Dec. 1659 he secured Munster for Gen. George Monck, leader of the Scottish royalists. In the summer of 1660, as one of three commissioners for Irish affairs, he went to London to greet the king, and was created earl of Orrery (Sept. 5), lord president of the council of Munster and a privy councilor (Oct. 10) and (Dec.) one of three Irish lord justices.

His personal charm made him popular, and he became one of the king's "merry gang" of poets and playwrights. After a discussion at court on the merits of French rhymed heroic drama, he accepted the king's challenge to write a play in rhyming couplets. In Ireland (Dec. 1660–61), during attacks of gout, he wrote his tragicomedy, *The Generall* or *Altemira,* the first full-fledged heroic play. Privately produced (as *Altemira*) in Dublin in Oct. 1662, it was performed in London in Sept. 1664. He followed it with a series of rhymed heroic plays: one, now lost, written for Davenant, and sent in 1662 to the duke of Ormonde and later to the king; *Henry V* (1664); *The Tragedy of Mustapha* (April 1665), both produced by Davenant; *The Black Prince* (Oct. 1667); *Tryphon* (Dec. 1668), which was less well-received; *Herod the Great* (published 1694); and *The Tragedy of Zoroastres,* probably written 1666–67, which was completed in blank verse by an anonymous dramatist and remains in manuscript in the British museum. Another heroic drama, *The Tragedy of King Saul* (published anonymously 1703), is almost certainly his.

While in Ireland, Orrery had designed his own castle, Charleville, at Newtown, Munster (completed Dec. 1663), which remained his Irish home until 1672, when he moved to Castlemartyr. In 1664 he returned to England, to enjoy fame. Dryden praised his manner of writing in the dedicatory preface to *The Rival Ladies* (published 1664; *see* DRYDEN, JOHN). *The Generall* was imitated by Davenant in his revised *Love and Honour,* and the "new mode" was adopted by others of the "merry gang."

Orrery returned to Ireland in June 1665, and in 1667 began an attack on Ormonde. On Ormonde's downfall (Feb. 1669) he hoped to become lord lieutenant. But the constant intriguer was himself the victim of intrigue, and on Nov. 25, 1669, he was summoned to the house of commons to answer charges of treason. He testified forcibly in his own defense and a vote to impeach him was narrowly defeated. Further proceedings against him seem to have been stopped by the king, who prorogued parliament on Feb. 14, 1670. In July 1672 he lost his Irish presidential powers when Essex suppressed the provincial presidencies, and he never held office again, though retaining the king's favour. He died at Castlemartyr on Oct. 16, 1679.

As well as heroic plays, Orrery wrote two prose comedies, *Guzman* (April 1669) and *Mr. Anthony* (1672; published 1690); an unpublished "Poem on His Majesty's Happy Restoration"; and *Poems on Most of the Festivals of the Church* (1681). *Parthenissa: that most fam'd romance* has a place in the history of prose fiction, as the first original English heroic romance, although often remembered only for having "greatly disappointed" Dorothy Osborne. He is reputed to have written *English Adventures,* "by a Person of Honour" (1676), from which Otway derived the plot of *The Orphan.* His *Treatise of the Art of War* (1676) has considerable historical interest. A political pamphlet, *An Answer to a Scandalous Letter* (1662), is included in his *State Letters* (1742).

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CHARLES BOYLE (1674–1731), 4th Earl of Orrery, grandson of the 1st earl, scholar, soldier, and diplomat, was born in Chelsea on July 28, 1674, and educated at Christ Church, Oxford. He succeeded to the earldom in 1703, entered the army in 1704, and fought at Malplaquet. As envoy extraordinary he helped to negotiate the Treaty of Utrecht, and in 1711 was created 1st Baron Boyle of Marston, Somerset. He held office under George I, but in 1722–23 was imprisoned on suspicion of being implicated in a Jacobite plot. He died in London on Aug. 28, 1731.

Interest in science led him to patronize the inventor George Graham, who in 1715 designed a clockwork model showing the motions of the planets around the sun, made at the earl's expense, and called after him an "orrery" (*see* PLANETARIUM).

ORRISROOT (apparently a corruption of iris root), the violet-scented dried rhizomes or underground stems of three species of *Iris, I. germanica, I. florentina* and *I. pallida;* it is principally powdered for use in dentifrices, medicines and toiletries. Usually identified with north Italy, where the best grades are produced, orrisroot is also cultivated to some extent elsewhere in southern Europe.

In August the rhizomes are dug up and freed of the rootlets and brown outer bark; they are then dried and packed in casks for sale. In drying they acquire their delicate but distinct fragrance.

ORRY, JEAN (1652–1719), French economist who exercised considerable influence in the government of Spain in the first years of Bourbon rule there, was born in Paris on Sept. 4, 1652. He was unknown politically when, at the suggestion of Michel Chamillart, Louis XIV, whose grandson had just succeeded to the Spanish throne as Philip V, sent him to Spain in 1701 to report on the finances of that kingdom. Orry drew up a series of detailed memoranda, advising not only a reorganization of Spanish financial administration but also a complete remodeling of the system of government, involving the transfer of political power from the royal councils to a number of ministers like the French secretaries of state. During the War of the Spanish Succession he was too occupied in devising fiscal expedients to pay for troops and provisions to have any opportunity for executing his schemes; moreover, palace revolutions secured his removal from Spain from 1704 to 1705 and from the end of 1706 until 1713. When he did return in April 1713, however, he and the princesse des Ursins (*q.v.*) became the real rulers of Spain; and in the following 20 months he undertook the complete reform of the administration.

By royal decrees in Nov. 1713 and April 1714 Orry swamped the royal councils with new members, so that opposition from this quarter was outvoted. Then, on Nov. 30, 1714, he created four new secretaries of state, whose work he was to co-ordinate as *veedor general.* Meanwhile, local government was centralized by the division of Spain into 21 provinces, each governed by an intendant responsible to the *veedor general.* Before this administration could be established Orry was dismissed and ordered to leave Spain (Feb. 7, 1715). He died in France on Sept. 29, 1719.

Orry was hated in Spain for trying to introduce foreign methods of government and disliked by the French for paying insufficient attention to their interests. Most sources concerning him are therefore biased and unfair; and his successor as *de facto* first minister in Spain, Giulio Alberoni (*q.v.*), misunderstood or misrepresented his attempts at reform. Even so, Orry was first to tackle effectively the powers of the royal councils, and his creation of the secretaries of state and the intendants was an important and enduring achievement.

Orry's son Philibert (1689–1747) became *contrôleur général* of finance in France in 1730. (B. J. R.)

ORSAY, ALFRED DE GRIMOD, Comte d' (1801–1852), French adventurer, a preeminent dandy of the age in which that species was recognized in its perfection, was born in Paris on Sept. 4, 1801. His father, Albert d'Orsay, a man of low origin, was a general in the Napoleonic army; but after the Bourbon restoration the young Alfred was admitted to Louis XVIII's bodyguard (1819), thanks to his maternal grandmother's wealth and to his sister's marriage into the ancient family of Gramont. In 1821, on a visit to London, he was introduced to the earl of Blessington and his wife (*see* Blessington, Marguerite, Countess of). Resigning his commission, he rejoined them in the south of France (1822) and accompanied them on a long tour of Italy (1823–28). Of epicene beauty, with bearded jowl and clean-shaven lips, he was especially pleasing to the earl; and his worldliness and wit greatly impressed Byron, whom he met in Genoa in 1823. Lord Blessington made a will very much in his favour, with the proviso that he should marry Lady Harriet Gardiner (1812–69; Blessington's daughter by a previous wife), and the marriage took place in Naples on Dec. 1, 1827. The earl died in Paris in 1829, and the D'Orsays returned with the widowed countess to London in 1830.

D'Orsay then set himself up brilliantly as man of fashion, arbiter of taste, gambler and sportsman. His continued association with Lady Blessington, though it was most probably not physical, became a matter of scandal, and his unhappy wife left him (1831). Husband and wife were formally separated in 1838.

In London, besides his activities in society, D'Orsay gave help to French exiles in the 1830s and founded a benevolent society for them in 1842. A Bonapartist by family tradition, he brought Prince Louis Napoleon (*see* Napoleon III) into the Blessington circle in 1838. Having spent the Blessington fortune, he fled to Paris to escape his creditors in April 1849, soon to be followed by Lady Blessington, who died there a few weeks later. Louis Napoleon, as president of the French republic, could at first give D'Orsay only discreet and unofficial protection; but finally, as emperor in 1852, he appointed him director of fine arts. The comte d'Orsay died, however, on Aug. 4, 1852.

See M. Sadleir, *Blessington-d'Orsay: a Masquerade* (1933).

ORSHA, a town in Vitebsk *oblast* of the Belorussian Soviet Socialist Republic, U.S.S.R., stands on the Dnieper 50 mi. S. of Vitebsk, where the river cuts through the Smolensk ridge. Pop. (1959) 64,432. An ancient town, first mentioned in 1067, Orsha has long been important as a focus of routes. It is the crossing point of railways from Leningrad to the Ukraine and from Moscow to Warsaw. There are other lines southeast to Krichev and northwest to Lepel. The town is also served by the north–south and east–west highways, and the Dnieper is navigable. Industries include textiles (linen), engineering and food processing. At Orekhovsk, a few miles north, is the large Belgres peat-fed power plant. (R. A. F.)

ORSI, PAOLO (1859–1935), Italian archaeologist who pioneered in the exploration of Sicily and southern Italy, was born in Rovereto on Oct. 18, 1859. A graduate of the University of Padua, he began his distinguished career as one of the founders of modern archaeology in his native Trentino and on Crete. Appointed director of the museum in Syracuse (1888), he devoted himself to the exploration of Sicily. To his excavations and research on sites of every period from the prehistoric to the Byzantine is due a large part of present knowledge of the art and civilization of Sicily, especially in the pre-Hellenic periods. He may be called the discoverer of the Siculan civilization through his numerous excavations of cemeteries all over the island; he laid the groundwork for the chronology of its four periods. His indefatigable and meticulous excavations of Greek cities throughout Sicily and the south Italian provinces of Magna Graecia (his directorship included also Calabria and Lucania) greatly extended many known sites and uncovered numerous new ones; *e.g.*, Syracuse, Camerina, Gela, Leontini, Megara Hyblaea and Centuripe in Sicily, and Locri, Hipponium, Medma, Caulonia, Croton and Crimisa on the mainland. Parallel to his excavations were his organization of the finds in the museums of Syracuse and Reggio and his publications (over 300) which, ranging through all branches of archaeology and all periods, interpret the significance of his explorations in the history of art and architecture. He directed the *Bullettino di Paletnologia italiana, l'Archivio storico della Calabria e Lucania* and *Atti e Memorie della Società Magna Grecia.* Orsi died in Rovereto on Nov. 9, 1935. (L. T. Se.)

ORSINI, one of the oldest, most illustrious and most powerful of the Roman princely families. Their origins, when stripped of legend, can be traced back to a certain Ursus de Paro, recorded at Rome in 998. They first became important in the late 12th century with the election of Giacinto Orsini as Pope Celestine III (1191–98), whose generosity to his nephews founded the territorial fortunes of the family. During the next hundred years allegiance to the papacy developed into a firm, if profitable, tradition in the house of Orsini; they assumed leadership of Guelph interest against the Ghibelline Colonna (*q.v.*), and for centuries afterward the savage rivalry of these two magnate families dominated the politics of Rome and its territory. In 1241, as senator of Rome, Matteo Orsini (d. 1246) saved the city from capture by Frederick II and the Colonna. As the century advanced, the Orsini acquired increasing influence in church policy and administration; four of the family were chosen cardinals and one of them, Giovanni, also became pope, as Nicholas III, in 1277. Their Guelph allegiance also brought them land and lordships in the Angevin kingdom of Naples, where several long-lived lines of the family took root among the nobility. At the end of the 13th century the Orsini were among the principal supporters of Boniface VIII in his attacks on the Colonna and were rewarded for their services with the grant of Nepi in fee. Not all of them however were partisans of Boniface. Napoleone Cardinal Orsini, partly for family reasons, sided with the Colonna and the French, and he it was who promoted in 1305 the election of a French pope, Clement V, first of the "popes of Avignon."

From this time on the history of the family becomes too involved with the annals of Rome and its neighbour states for narrative detail. It need only be said that apart from the brief interval of Borgia rule, when the Orsini were dispossessed of their castles and three of them were done to death, they retained their dominant place among the Roman aristocracy, providing soldiers, statesmen and prelates to the church. In 1629 they were created princes of the Holy Roman empire, and in 1718 they were raised to the princely dignity at Rome. In 1724 Pietro Francesco Orsini was elected pope (Benedict XIII).

The family survives in the Orsini dukes of Gravina, descended from Napoleone Orsini, son of the 13th-century senator, Matteo. Their principal fiefs were Bracciano (near Rome) acquired in the 14th century, and Gravina (near Bari) acquired in the 15th century. They received the ducal title from Pius IV in 1560 and held Bracciano into the 17th century, Gravina down to 1807. From the 16th century it became regular for an Orsini to hold the office of prince assistant to the pontifical throne.

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ORSINI, FELICE (1819–1858), Italian nationalist revolutionary who tried to assassinate the French emperor Napoleon III, was born at Meldola, in Romagna, on Dec. 18, 1819. He graduated as doctor of law from the University of Bologna in 1843. Having participated in the conspiracies of Giovine Italia, the secret society headed by Giuseppe Mazzini (*q.v.*), he was arrested, together with his father, in 1844 and sentenced to the galleys for life but was released when the new pope, Pius IX, granted an amnesty (1846). He was a captain in the Italian war against Austria in 1848 and was elected to the assembly of the Roman republic in 1849. On the collapse of the republic he fled to Nice, where for a time he had a hemp factory; but he was soon busy again serving Mazzini's party. He was sent on missions to Italy, England, Switzerland and Hungary. Arrested by the Austrians and sentenced to death at Mantua for high treason (1855), he escaped by sawing through the bars of his cell window and descending on a rope of sheets. He took refuge in England, where he wrote and lectured on his adventures: his *Austrian Dungeons in Italy* (1856) sold 35,000 copies

in its first year. In 1857 he broke with Mazzini, on the ground that his party was "contrary to true liberty" and favoured "the despotism of its own leader."

Orsini conceived the plan of murdering Napoleon III, whom he wrongly believed to be the great obstacle to Italian independence. On Jan. 14, 1858, in Paris, he and two accomplices threw three bombs at Napoleon and the empress Eugénie as they traveled in a carriage to the opera: several persons were killed but the intended victims were unhurt. Orsini was executed on March 13, 1858, after publishing a plea to Napoleon to take up the cause of Italy. This plea was heard: it was the Orsini incident that stimulated Napoleon to declare war on Austria in 1859, from which the independence of Italy followed.

See M. St. John Packe, *The Bombs of Orsini* (1957). (T. Ze.)

ORSK, a town of Orenburg *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., stands at the confluence of the Ural and Or rivers at the southern end of the Ural mountains about 120 mi. S.E. of Orenburg town. Pop. (1959) 176,214. It was founded in 1735 as the fortress of Orenburg (*q.v.*) which was moved downriver in 1743. Orsk is now a major industrial centre, with a large oil refinery using petroleum brought by pipeline from the Emba field on the Caspian. Other products include nickel, heavy machines, agricultural and building machinery, electrical equipment, synthetic alcohol and processed meat. Power is provided by the Iriklinski hydroelectric plant, farther upstream on the Ural. There are railways to Orenburg, Chelyabinsk and Kandagach, and local branches to the mining and industrial centres of Novo-Troitsk and Dombarovski. (R. A. F.)

ORS Y ROVIRA, EUGENIO D' (1882–1954), Spanish essayist, art critic and novelist, whose influence on contemporary Spanish letters was second only to that of Miguel de Unamuno and José Ortega y Gasset, was born in Barcelona on Sept. 28, 1882. He studied law in Barcelona and philosophy at the Sorbonne. His main recurrent themes—the place of reason and intelligence in life and philosophy, the concepts of space-time and civilization, of passion and restraint—can best be judged in *El secreto de la filosofía* (1947); his acute, agile form of art criticism, in *Tres horas en el Museo del Prado* (1923), or in *Poussin y el Greco* (1922). His mastery of kaleidoscopic, short, penetrating, personal form of essay (*glosas*), which he poured out incessantly, can best be appreciated in *Glosario* (1906–20). He wrote in Catalan a good intellectual novel, *La ben plantada* (1911). D'Ors died at Villanueva y Geltrú in Sept. 1954.

See J. Ruiz de Aranguren, *La filosofía de Eugenio d'Ors* (1948). (R. M. N.)

ORSZAGH, PAVOL (1849–1921), who wrote under the pseudonym of Hviezdoslav, was one of the most powerful and versatile of Slovak poets. He was born at Vysny Kubin, Slovakia, Feb. 2, 1849. In the 1860s, when he began to write in Slovak, the new literary language was still in its uncertain initial stage; by the time of his death the Slovaks already possessed an extensive poetic literature of a high order. Hviezdoslav's contribution to this development was of decisive importance. In his main epics—*Hajnikova zena* ("The Gamekeeper's Wife"; 1886) and *Ezo Vlkolinsky* (1890)—he treated local themes in a style which combined realistic descriptive power with lyric echoes from folksong. In his voluminous lyric output he experimented with a variety of metrical forms and forged a characteristic style, interwoven with neologisms and dialect elements. Most memorable are his *Krvave sonety* ("Blood-Red Sonnets"; 1919) which express a moving and unconventional attitude to World War I. He died in the village of his birth, June 8, 1921. (R. Ay.)

ORTA, LAKE (Lago d'Orta, sometimes called Lago Cusio) in Novara province, Piedmont, north Italy, lies 24 mi. N.N.W. of Novara city just west of Lake Maggiore from which it is divided by the Mottarone mountains. It has an area of 7 sq.mi. and is about 8 mi. in length; the width is 2 mi. Its greatest depth is 469 ft. and the surface is 951 ft. above sea level. The chief village is Orta San Giulio, on a peninsula projecting from the east shore of the lake; just west is the island of San Giulio, which has a picturesque church. At the north end of the lake is another village, Omegna. The lake is the remnant of a larger sheet of water by which the waters of the Toce river flowed south toward Novara. As the glaciers retreated the waters flowing from them sank and were gradually diverted into Lake Maggiore. This explains why no considerable stream feeds Lake Orta, while at its north end the Agogna torrent flows out of it, ultimately joining the Po river. (G. Kh.)

ORTEGA Y GASSET, JOSÉ (1883–1955), Spanish philosopher and humanist who had a pervading and beneficent influence on the cultural and literary renaissance of Spain in the 20th century, was born in Madrid, May 9, 1883, and received a classical training under the Jesuits before studying at Madrid university between 1898 and 1904. He studied in Germany, 1904–08, being profoundly influenced by the neo-Kantian school at Marburg, as he was later by F. W. Nietzsche, G. Simmel, M. Scheler and (particularly from 1929) W. Dilthey. As professor of metaphysics at Madrid (1910), he early diverged from neo-Kantianism in *Adán en el paraíso* (1910), *Meditaciones del Quijote* (1914) and *El tema de nuestro tiempo* (1923; Eng. trans., 1933). He saw man's individual life here and now as the basic reality: reason as a function of life ("vital reason" or "historical reason") is substituted for absolute reason, and for absolute truth the perspective of each individual ("I am I, and my circumstance"). He shared the preoccupation of his generation with the "problem of Spain" and his writings were deliberately "circumstantial" and published in periodicals (he founded *España*, 1915; *El Sol*, 1917; *Revista de Occidente*, July 1923). In active politics (League for Political Education, 1915; Group at the Service of the Republic, 1931; member of *Cortes*) he could not be partisan and preferred voluntary exile in Europe and in Argentina (1936–45). He returned to Spain at the end of World War II and in 1948 founded the Instituto de Humanidades in Madrid. He died there on Oct. 18, 1955. Of his other works, the best-known are *España invertebrada* (1921; Eng. trans., 1937) and *La Rebelión de las masas* (1929; Eng. trans., 1932). Most of his publications are included in *Obras completas*, six volumes (1946–47).

See J. Ferrater Mora, *Ortega y Gasset: an Outline of His Philosophy* (1957); "Homenaje a Ortega y Gasset," *Atenea*, vol. 124, no. 367–368 (Jan.–Feb. 1956). (R. F. B.)

ORTELIUS (Wortels), **ABRAHAM** (1527–1598), antiquarian, cartographer and geographer, was born on April 14, 1527, at Antwerp. He was trained as an engraver and in 1547 entered the Antwerp guild of St. Luke as *afsetter van kaarten.* About 1554 Ortelius set up as a seller of antiquities and maps. He traveled widely in pursuit of business and among his many friends numbered Gerardus Mercator (*q.v.*). About 1560, under Mercator's influence, he became interested in map-making and within a decade he compiled maps of the world on a heart-shaped projection (1564), of Egypt (1565) and of Asia (1567), as well as the first edition of the *Theatrum orbis terrarum*, his magnum opus, by which he became famous. This edition, published by Gilles Coppens de Diest at Antwerp in 1570, included 70 maps engraved in uniform style by F. Hogenberg. Most of the maps were derivatives and Ortelius acknowledged his authorities in a catalogue of 87 authors. The *Theatrum* was an immediate success. Ortelius's treatment of his material was critical, and he regularly revised the maps and text in the light of new information; in 1573 he published 17 additional maps under the title *Additamentum theatri orbis terrarum*—other additions were made to the editions of 1579, 1584, 1590, 1595 and 1598. Abridgments of the *Theatrum* in smaller format were published under the title *Epitome theatri orteliani.* After Ortelius' death his heirs continued to publish the *Theatrum* until 1601 when the prints were sold to J. B. Vrients, an Antwerp publisher who issued editions for a number of years. Editions of the *Theatrum* continued to be published throughout the 17th century.

Ortelius formed a fine collection of coins, medals and antiques and in 1573 published a catalogue, *Deorum Dearumque capita ex vetustis numismatibus . . . ex museo A. Ortelli.* In 1575 he was appointed geographer to Philip II of Spain. His publications, in addition to those mentioned above, included *Synonymia geographica* (1578): the second edition appeared under the title of *Thesaurus geographicus* (1587); *Parergon* (1579); with J. Vi-

vianus, *Itinerarium per nonnullas Galliae Belgicae partes* (1584); *Nomenclator Ptolemaicus* (1584); *C. J. Caesaris omnia quae extant* (1595); and *Aurei saeculi imago, sive Germanorum veterum vita* (1595). Ortelius assisted M. Welser with his edition of the Peutinger Table (1598). He died at Antwerp on July 4, 1598.

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(E. M. J. C.)

ORTHOCLASE: *see* FELDSPAR: *Polymorphism.*

ORTHODONTICS is a branch of dentistry concerned with prevention and correction of irregular teeth, abnormal bite (malocclusion) and malrelation of the jaws and its bad effects on mouth health, chewing and facial appearance. Such abnormalities exist in Neanderthal skulls, were mentioned by Hippocrates (460–377 B.C.) and have persisted throughout the ages and show a tendency to increase. Treatment of tooth irregularities by finger pressure was advised by Celsus (25 B.C.–A.D. 50) and treatment by mechanical means was suggested by Pliny (A.D. 23–79). The methods described by Pierre Fauchard (1728) are the forerunners of modern orthodontics, which was brought to the fore by E. H. Angle (1899). Prevention and treatment of malocclusion did not become widespread until after the beginning of the 20th century, however; orthodontics now is included in government and voluntary public health service programs because of possible personality effects and health hazards in severe conditions.

Some malocclusion is found in over 90% of the population of the United States and severe types requiring treatment affect about 50%. Malocclusion is almost always present in persons with clefts of the upper lip (harelip) and the palate when the ridge that holds the teeth is involved. Causes of malocclusion include: familial inheritance; delayed dental and systemic development; endocrine disturbances; severe childhood diseases, including bone ailments; muscular weakness; dietary deficiencies; postural faults of the jaws, head and neck; and persistence of pressure habits in the dentofacial zone such as finger sucking, tongue thrusting, nail-biting and incorrect swallowing. Among other causes are consumption of soft foods, tooth decay and loss of deciduous (first) teeth before permanent ones are ready to replace them. Persistence of pressure habits after tooth irregularities are corrected can result in relapse of teeth to the approximate original condition.

The type of abnormality present rather than age is the deciding factor in treatment. The teeth of some children erupt earlier than those of others, and some types of crowding may show self-correction following continued jaw growth. Periodic examination of the young child is necessary to determine the need for treatment. Treatment of adults is more limited than that of the young. Success depends on the health of the jawbones and the soft tissues surrounding the teeth. Correction of crowded teeth alone will not eliminate speech defects, although response to speech therapy is aided by correction of dental irregularities, especially in the condition called open bite. The time when treatment should be undertaken depends on the presence of a correctible irregularity. In young children, irregularities that can interfere with continued normal dental development should be treated early.

Standardized X-ray films of the head, on which measurements are made of the related parts, were introduced about 1930. This makes it possible to study maturity changes; locate the sites of growth abnormality, which is necessary in planning treatment; and estimate success of correction.

"Systems" of appliance therapy are giving way to more rational treatment methods related more closely to the specific abnormalities in the individual patient. Treatment is considered from a biophysical approach, since teeth tend to return to their original irregularity if the muscles cannot adapt themselves to the new positions. Tooth movement is achieved by means of metal bands, wires, springs, elastics and plates. Some appliances are fixed to the teeth, while others are removable by the patient and are worn at night and part of the day only. Resistance to pressure required to move irregular teeth is obtained from other firm teeth or from the skull bones. Success of treatment depends on the skill of the operator more than on the merits of the appliance. Extraction of certain teeth to relieve crowding in the dental arches, and treatment before all permanent teeth erupt, are sometimes required to prevent and to treat irregularities and abnormal bite. *See* also DENTISTRY; PEDODONTICS. (J. A. SN.)

ORTHODOX is derived from a Greek word meaning "of the right opinion," which was applied from the early 4th century by the Greek Church Fathers to true Christian doctrine and its adherents as opposed to heterodox or heretical doctrines and their adherents. As almost every Christian group believes that it holds the true faith (though not necessarily exclusively), the meaning of the term "orthodox" in a particular instance can be correctly determined only after examination of the context in which it appears. Further, the word "orthodox" forms part of the official title of the Greek-speaking church, together with those in communion with it, that is, of the Orthodox Eastern Church (*q.v.*). (The Russian translation of the term is *pravoslavny*, "of the right glory," which is another legitimate meaning of the Greek *orthodoxos*, for *doxa* in Greek means both "opinion" and "glory.") Some of the lesser Eastern Churches, which separated from the rest of Christendom as a result of the Monophysite controversy in the 5th century, also include the epithet "Orthodox" in their official titles (*see* ANTIOCH, SYRIAN ORTHODOX PATRIARCHATE OF). The epithet is further applied to a certain type of Protestantism (*see* ORTHODOXY, PROTESTANT) and is used in a nonreligious sense of the accepted views held by any unified body of opinion or in any field of study.

ORTHODOX CATHOLIC CHURCH: *see* ORTHODOX EASTERN CHURCH.

ORTHODOX CHURCH IN AMERICA. In 1797 the first Orthodox mission was sent to Alaska, then a Russian territory, by the Holy Synod of the Russian church. Eight monks from the Russian monastery of Valamo baptized several thousand Aleuts, and in 1848 the mission was transformed into a diocese with a famous missionary, Innocent Veniaminoff, the future metropolitan of Moscow, as the first bishop of Sitka. After the purchase of Alaska by the U.S. in 1867, the episcopal see was transferred to San Francisco (1872). Thus, at its beginnings, the Orthodox Church in America limited its activity to Alaska and the Pacific coast and had no intention of expanding beyond this missionary area.

The situation was radically changed by massive Slavic immigration to the eastern states, which began in the 1880s and reached its peak in the years immediately preceding World War I. The first wave consisted mainly of Slavs from Austro-Hungary. Although united to Rome since 1596 (Union of Brest-Litovsk), the Galicians and the Carpatho-Russians preserved the Byzantine liturgy in Church Slavonic. Among these immigrant Uniats a movement of return to Orthodoxy was initiated by one of their spiritual leaders, Alexis Toth, who in 1891 joined the Russian diocese with his Minneapolis parish. By the end of the century his example had been followed by no fewer than 225,000 former Uniats. Then, between 1900 and 1914, large groups of Russians, Ukrainians, Greeks, Syrians, Rumanians, Serbians and Albanians settled in various parts of the country. Finally, the expulsion of Greeks from Asia Minor (1921), the Russian Revolution (1917) and World War II with its contingent of displaced persons brought the number of Eastern Orthodox in America to 4,000,000 to 5,000,000.

Prior to 1917 all these groups were under the canonical jurisdiction of the Russian church through its diocese of North America and the Aleutian Islands. All bishops were sent from Russia. One of them, Archbishop Tikhon, who headed the American diocese from 1898 to 1907 and in 1901 transferred his see from San Francisco to New York city, was to become later the patriarch of all Russia (1918–24). Although a pastoral seminary was opened in Minneapolis in 1905, almost all priests were Russian-born and supported materially from Russia. But after the Russian Revolution of 1917, which led to great confusion in the Russian parishes in America, each national group created its own diocese with direct canonical connection with its national mother church. The first

Greek bishop was consecrated by the patriarch of Constantinople in 1922; the patriarchate of Antioch established its archdiocese in 1918. As to the Russian diocese, the impossibility of maintaining normal relations with the patriarch of Moscow led to the proclamation of diocesan autonomy (Detroit, 1924) and to its transformation into a metropolitan district consisting of seven dioceses with a primate residing in New York. Two smaller groups, those who maintained their allegiance to Moscow and those who opposed it on purely political grounds (the Russian Church in Exile), were later to form separate dioceses

The Orthodox Church in America consists of:

1. Greek archdiocese of the ecumenical patriarchate of Constantinople; eight bishops, 500 parishes.
2. Russian Orthodox Church of North America; eight bishops, 350 parishes.
3. Syrian Antiochian archdiocese; one bishop, 80 parishes.
4. Serbian Orthodox diocese; one bishop, 60 parishes.
5. Bulgarian diocese; one bishop, 30 parishes.
6. Rumanian diocese; one bishop, 40 parishes.
7. Albanian diocese; one bishop, 14 parishes.
8. Russian exarchate of the patriarchate of Moscow; two bishops, 20 parishes.
9. Russian Synod in Exile; seven bishops, 100 parishes.

There exists also a large Ukrainian Orthodox Church (five bishops, 200 parishes), but certain canonical difficulties hinder its recognition by other Orthodox bodies. All these churches, although maintaining their jurisdictional independence from each other, are united in doctrine, liturgical life and canon law. (*See* ORTHODOX EASTERN CHURCH.)

Though deeply marked by its various national origins, the Orthodox Church in America shows signs of progressive integration into American life. Several states have declared Orthodoxy the fourth major faith. It has an official status in the U.S. armed forces, with a group of chaplains ministering to Orthodox communicants. The majority of churches permit the use of English in worship and preaching, and virtually all jurisdictions conduct the religious education of children in English. In 1948 St. Vladimir's seminary, a graduate school of theology for all branches of the Orthodox Church in America, was founded in New York city with a faculty and a student body representative of all national traditions. Other theological seminaries—the Holy Cross Theological school of the Greek archdiocese in Brookline, Mass., and the Holy Trinity seminary of the Russian Church in Exile at Jordanville, N.Y.—maintain the old national traditions. Translations of liturgical texts and Orthodox books are being published at an ever-increasing rate.

In 1960 an important move was made toward closer co-operation of various national jurisdictions when a Standing Conference of Canonical Orthodox Bishops in the Americas was created in order to co-ordinate church activities in all areas of common concern: Sunday schools, chaplaincy, etc. Virtually all Orthodox churches in America are members of the World Council of Churches and the National Council of Churches of Christ in the U.S.A.

See "Orthodoxy in America," a special issue of *St. Vladimir's Quarterly*, vol. v, no. 2-3 (1961). (Al. S.)

ORTHODOX EASTERN CHURCH, also known as the ORTHODOX CHURCH and the GREEK ORTHODOX CHURCH, is the federation of 13 autocephalous Orthodox churches chiefly in Greece, Rumania, Bulgaria, Yugoslavia, Cyprus, the U.S.S.R. and the middle east. Together they compose about one-sixth of the world's Christian population. As the lesser Eastern churches, regarded by other Christians as Monophysite, also lay claim to the title orthodox ("right believing"), the Orthodox Church needs to be distinguished from them by a further epithet. "Orthodox Eastern" is the most usual appellation, though it has become inadequate because of the growing numbers of this church in the west, especially in the United States. Some Orthodox prefer the title Greek Orthodox Church, as long as "Greek" is understood not in an ethnic sense but as referring to the historical background of the church in the language, thought and civilization of the ancient Hellenic and the Byzantine world.

Nature of the Church.—The church which is the mystical body of Christ consists of all those who believe in him (*see* CHURCH). As founded by Christ who is God it is a divine institution, but as composed of human beings it is also a human one. The church's mission is to bring all men to the truth revealed by Christ (I Tim. ii, 4). By virtue of this mission the church is one, holy, catholic and apostolic, while its body is composed of both clergy and laity. This one church remains unchanged, although many separate churches were formed later, just as Jesus Christ, its founder, is one and forever the same (Eph. iv, 5; Heb. xiii, 8). The Greek Orthodox Church claims to be the unbroken continuation of this original and undivided church. The breaking away of the Monophysites and Nestorians; the schism with the Latin church in the middle ages; and the Reformation, which resulted in the development of a multitude of Protestant churches, did not affect, at least in theory, the oneness of the church. The Bible and holy tradition (to be distinguished from church tradition, which is liable to change) are the formal foundations of the church, while Word and sacraments are the means of God's saving grace.

Historical Outline.—As the Greek Orthodox Church traces its origin back to Christ himself, its history begins with that of the early church. The truth revealed by Christ was spread by his followers, beginning with the apostles, from Palestine throughout the whole Roman empire. Philippi in northern Greece was the apostle Paul's first European stop in his missionary activity; from Corinth he wrote his famous letter to the Romans (*i.e.*, to the Greek-speaking Christian community in Rome). Christian truth was first radiated to the western world from the Greek towns of Antioch, Ephesus, Paphos, Philippi, Athens and Corinth. The new tidings of Christ's message aroused diverse reactions. The Greeks on the Athenian Areopagus met Paul's new doctrine with a philosophic tolerance, while the Roman legal answer to the same doctrine was the sword. The propagation of the new religion in the Roman empire provoked persecutions because it was thought to endanger the empire's security, as the Christians did not belong to one of the legal religions of the empire and were not prepared always to obey the emperor. On the other hand the existence of the church was threatened internally by various heretical teachings (*see* HERESY). Despite all this the church prevailed and became the custodian of true Christian doctrine (*see* EARLY CHRISTIAN CHURCH).

Constantine I the Great (313) by recognizing Christianity as a *religio licita* ("permitted religion") is chiefly responsible for the church's later development and partly for its later decline, as it became an integral part of the secular world with privileges and nominal membership.

The church, now untrammeled by persecution, was free to develop its doctrine as worked out by the great Church Fathers such as Athanasius, Basil of Caesarea, Gregory of Nazianzus, Gregory of Nyssa and Cyril of Alexandria, in their arguments against the heresiarchs such as Arius, Nestorius and Eutyches. Orthodox doctrine was stated in the seven ecumenical councils held between 325 and 787 (*see* CREED; COUNCIL), which also decided on priority among the five patriarchal sees that together formed the pentarchy of Christendom. Rome received the primacy of honour and Constantinople (New Rome) took the second place, followed by the great cities of Alexandria and Antioch and finally by Jerusalem, whose religious importance alone could never rival the political and commercial influence of the other four.

The Byzantine emperors, who summoned the councils, were regarded as the guardians of the true faith, though sometimes political interests inclined them to favour the heretical elements (*see* BYZANTINE EMPIRE). During the 5th and 6th centuries, for example, it was advisable to find a compromise theological formula which would keep Monophysite Egypt within the empire, but the attempt failed and the Egyptian Christians finally preferred the Muslim conquerors to the Orthodox emperors as their overlords. Similarly the Ethiopian, Armenian, Syrian and Nestorian Christians broke away from the Byzantine empire for both theological and political reasons, though a small number of Christians in those areas always remained faithful to Orthodoxy.

A heresy within the empire which was supported by certain emperors in the 8th and 9th centuries was iconoclasm (*see* ICONOCLASTIC CONTROVERSY), the theory that the use of icons in worship

was a form of idolatry that should be suppressed. The seventh and last ecumenical council at Nicaea in 787 defined the correct use of the icon (*see* below), but the heresy broke out again and was not finally repulsed until 843. During this controversy the great supporters of the icons were the monks, who had become a numerous and influential body throughout the empire and especially in Constantinople itself (*see* MONASTICISM).

The next few centuries saw the spread of the faith to the emerging Slav nations. The 9th-century patriarch Photius (*q.v.*) was responsible for sending to Moravia the missionaries Cyril and Methodius who are justly regarded as the apostles of the Slavs and the creators of their written language and literature. In the same century the Bulgarians and Serbs were converted to the Orthodox faith, which the Russians adopted in the 10th century.

During the same period relations with the Western Church finally deteriorated. The western Roman empire since even before the sack of Rome in 410 had been drawing away from the eastern part for geographical, administrative and linguistic reasons. After 410 the papacy became not only the one religious power but also the only effective authority in western Europe, which now developed along quite different lines from the Byzantine empire of which it theoretically formed a part until the coronation of Charlemagne in 800. With the ecclesiastical power of the west centralized in their hands, the popes also claimed jurisdiction in the Byzantine empire, which did not deny their primacy of honour but refused to admit any right on their part to interfere in its affairs.

During the 9th–11th centuries the situation was further acerbated by doctrinal disagreements on various levels, ranging from different methods of tonsuring monks to the west's insertion of the *Filioque* clause into the creed (*see* HOLY SPIRIT). In the 11th century the schism, which still exists, came into being. Later attempts to heal it were prompted chiefly by political considerations, as at the second Council of Lyons (1274) and the Council of Ferrara-Florence (1438–45), held when the Byzantine empire in its struggle against the Muslim Turks was trying to raise military support from the west. Any church unions negotiated by ecclesiastical authorities were always promptly repudiated by the faithful at home, who still bitterly remembered the diversion of the fourth crusade to the sack of Constantinople (1204), with the consequent foreign occupation of the city for over 50 years.

The chief theological development during the last centuries of the Byzantine empire lay in the field of mystical theology, where the Orthodox Church had had throughout the centuries a great tradition represented by such names as Gregory of Nyssa, Macarius the Egyptian, Pseudo-Dionysius the Areopagite, Maximus the Confessor, John of Damascus and Simeon the New Theologian. A certain type of monastic life called hesychasm (*q.v.*) taught the monk to practise ceaseless prayer and thereby to receive the vision of the uncreated light; that is, the divine light which surrounded Jesus Christ when he was transfigured on Mt. Tabor with Moses and Elijah (Mark ix, 2–8). The attempt to achieve this vision by technical means, such as gazing at the navel in order to concentrate the attention, was ridiculed by the 14th-century monk Barlaam, from south Italy, who brought the whole hesychastic way of life into question. After much controversy hesychasm was defended and vindicated at the Council of Constantinople (1341) by Gregory Palamas (*q.v.*), archbishop of Thessalonica, who taught that the light claimed to have been seen by the monks was not a new creation, as Barlaam thought, but a manifestation of divine energy, also uncreated but nevertheless visible to men.

In 1453, when the Byzantine empire fell to the Turks, its church was subjected to Muslim authority, being treated as a millet under its patriarch (ethnarch), who now became the only official channel between the people and their conquerors. There was no intermarriage between Christian and Muslim because of the difference of religion, and although otherwise seriously restricted the church remained free to celebrate the liturgy, which is its chief function. In the course of the 15th century the Orthodox Church in the Slav countries similarly came under Muslim power, save for the Russian church, whose metropolitan in Moscow was raised to the rank of patriarch in 1589, a move strengthened by the notion that since Constantinople, which was New Rome, had fallen, Moscow was now the third Rome.

While western Europe was undergoing the Reformation in the 16th century, the Orthodox Church was thus cut off almost totally from its influence. But efforts were made later by both Roman Catholic and Protestant churches to proselytize in the Orthodox Church, even by such means as political pressure exercised on the Turkish sultans through the embassies of Roman Catholic or Protestant powers, as for instance in connection with Cyril Lucaris (*q.v.*), patriarch of Constantinople. These two rival streams of propaganda led to the appearance of several new Orthodox confessions of faith, influenced either by Roman Catholics, such as those of the patriarch Dositheos (*q.v.*) of Jerusalem and Peter Mogila (*q.v.*), metropolitan of Kiev, or by Protestants, such as that of Cyril Lucaris, who was condemned by the Council of Constantinople (1638). The Council of Jerusalem (1672) condemned the confession but not Cyril himself (*see* JERUSALEM, SYNOD OF).

Unsuccessful negotiations of the Orthodox with the Protestant reformer Philipp Melanchthon and then with the Lutheran theologians of Tübingen (1573–81) under the patriarch Jeremiah II led to further bad relations with the west. Another cause of friction with the Roman Catholics was the creation of the Uniate Melchite Church in Syria (1700) and the granting to them by the Turks of certain sanctuaries in Palestine (1757). In the 18th and 19th centuries, however, efforts were made by the English nonjurors and Tractarians respectively to create friendly relations with the Orthodox Church.

Until the 19th century, when the countries ruled by Turkey won their freedom, the Orthodox Church in the Ottoman empire was greatly restricted. After the various countries became independent of the Turkish sultan in Constantinople, the Orthodox Church in each country wished also to be independent of the patriarch of Constantinople's jurisdiction, though continuing to grant him a primacy of honour above their own chief ecclesiastic. (For a list of the autocephalous Orthodox churches see *Organisation* below.) The churches on emerging from the Ottoman empire had to adapt their life and organization to a free society at a time when established values were being threatened and altered by new developments in thought, science and technology. In the 20th century wars and the Communist revolution increased the instability of life and many church members migrated to western countries where they have shown that Orthodoxy is not necessarily an 'eastern' affair. The majority who remained in Communist countries have had to adapt themselves to a coexistence with governments run on non-Christian principles. Greece is the only Orthodox country not subject to communism; the members of the Orthodox Church in the middle eastern and western countries form only a small proportion of the population.

Contacts between the Orthodox Church and other churches in these changed circumstances have become more frequent and cordial. Most of the autocephalous Orthodox churches are members of the World Council of Churches in which they play an important part. Friendly relations between the Orthodox and Anglican churches have led to contacts such as visits by archbishops of Canterbury on the patriarch of Constantinople and to the recognition by some Orthodox churches of Anglican orders. In the United States the Orthodox, along with Roman Catholics, Protestants and Jews, count as one of the four major religious bodies.

The convening of the second Council of the Vatican by Pope John XXIII in 1962 brought into prominence the question of reunion, or at least reconciliation, between the Orthodox and Roman Catholic churches. Several observers from the Orthodox churches attended the council, and the question of relations with the church of Rome was the subject of discussion at the second conference of the Orthodox churches on Rhodes in Sept. 1963. A communiqué issued at the end of that conference announced that the "beginning of a dialogue on equal terms" between the Orthodox Church and the Roman Catholic Church had been unanimously accepted by the Orthodox delegations present. (These did not include representatives of the Greek church, which

remained hostile to unity appeals.) The ecumenical patriarch Athenagoras and Pope Paul VI met in friendship at Jerusalem in Jan. 1964, and in Dec. 1965 both retracted the anathemas pronounced by their predecessors in 1054.

Doctrine.—Doctrine is based on the Bible and holy tradition and was determined by the seven ecumenical councils (*see* COUNCIL). The first four of these (Nicaea, 325; Constantinople, 381; Ephesus, 431; and Chalcedon, 451) decided on the doctrines of the Holy Trinity and of the Person of Christ as formulated in the so-called Nicene creed and in the Chalcedonian definition. The two next ecumenical councils (Constantinople, 553 and 680–681) completed the doctrine in regard to the will and the energy of the Second Person of the Trinity.

The chief points of the doctrine of the Holy Trinity are: the absolute substantial oneness (Gr. *homoousion*) of the three Persons in the one Godhead; the fully unseparable but yet distinguishable union of the two natures, divine and human, of Jesus Christ in his one person in full submission of the human to the divine nature (Matt. xxvi, 42); the distinction of the specific qualities of each one of the three Persons of Trinity; *i.e.*, that God the Father is not begotten, the Almighty, the Creator of all things visible and invisible; that God the Son is begotten by God the Father in eternity, and born in time from the Virgin Mary, was sent to the world by God the Father to undertake the atonement on the cross for sinful humanity and thus achieve its salvation from sin, has through his resurrection and ascension deified human nature and has left behind his holy church in the world, for the continuation of his redemptive work through Word and sacrament; that God the Holy Spirit is proceeding; he comforts, inspires and guides the faithful to salvation through faith in Christ.

The church guided by the Holy Spirit guards unchanged the true faith which was revealed by Jesus Christ and keeps it free from any alteration by irresponsible men, even additions made with the best intentions, as for instance the *Filioque* clause. This clause was for good reasons introduced in Spain in the 6th century and was gradually accepted in the west in spite of its rejection by Pope Leo III (810). This addition and the doctrine it expresses—although not unknown to the Greek Fathers, some of whom, including Athanasius, taught the procession of the Spirit through the Son—has never been adopted by the east, because the supposed strengthening of the one Person (Son) weakens the position of the other (Holy Spirit), thus creating a disequilibrium in the oneness of the Godhead, even if not really introducing two principles into the Trinity (*see* HOLY SPIRIT). The use of the *Filioque* clause is also unacceptable because it is an addition to the creed.

In regard to the Virgin Mary the Orthodox Church has no special doctrine other than that involved in the Christological doctrine that she is the mother of the incarnate Word. She is thus correctly called Theotokos ("God-bearer"; *see* MARY). The unique privilege of becoming the mother of God excludes the idea that she became the mother of any other human being and naturally entitles her to the highest respect and honour from those who follow her Son; she is revered and venerated for her full devotion to God as his servant, the "handmaid of the Lord" par excellence. But her contribution to the mystery of incarnation in no way resulted before or after it in any change in her person as a human being. Her origin was perfectly normal and the dogma that she was conceived without stain of original sin, as declared by Pope Pius IX (1854; *see* IMMACULATE CONCEPTION), is not accepted by the Orthodox Church. Similarly, the Virgin Mary, who always remained the devoted servant of God, died a natural death, also called the dormition (koimesis), at which her soul was rendered to her Son and God, leaving her body to be buried. The dogma of her bodily assumption, declared by Pope Pius XII (1950), is not accepted by the Orthodox Church.

The other saints are also highly revered as especially devoted servants of God either for having sacrificed their life in martyrdom for Christ and the church or for having devoted their whole life to Christ and the church. There is no official canonization, the criterion being the recognition of such persons as saints by the whole church, both clergy and laity, over a long period of time. Requests to the Virgin Mary and the saints for their intercession to God are offered in the sense of James v, 16.

The Orthodox Church has no special doctrine about purgatory, which is a concept entirely unknown to its theology. Indeed, its eschatological doctrine is not highly developed: every Christian, departed from this world, is in the hands and mercy of God, who preserves him to the last day, when he will come to judge the quick and the dead (Matt. xxv, 31–46).

Holy Tradition.—The Bible alone contains the truth revealed by Jesus Christ, while the authentic interpretation and explanation of this basic truth, given by the church itself (in the sense of I Cor. xi, 2; II Thess. ii, 15; iii, 6, 7), forms holy tradition. The instrument of holy tradition is the ecumenical council, which, once recognized, even tacitly, as such, represents the common consent of the whole church, clergy and laity. The doctrine, for instance, on the Trinity contained in the New Testament is authentically stated by the Nicene creed, which is an important part of the holy tradition. This conception of holy tradition leads to the rejection of the *Filioque* clause and of any new dogma, such as the immaculate conception and assumption of the Virgin Mary and the infallibility of the pope of Rome, proclaimed by the Roman Catholic Church.

Church Tradition.—Church tradition, on the other hand, formed gradually throughout the centuries by the accumulation of customs and practices, concerns only the details of church life. This church tradition, although venerable as having in many instances, such as the Easter rites, its roots in the life of the early church, is neither unchangeable nor infallible. Such church customs, although often related to fundamental truths or practices contained in the Bible and in the holy tradition, are not an essential part of them. Holy orders, for instance, or baptism, instituted by Jesus Christ as stated in the New Testament and testified by holy tradition, are indispensable for the church; but the rites regarding them are subjects of church tradition and can be changed. A striking example of the changing practice in the church is the celibacy of bishops, which has been enforced only since the sixth ecumenical council (692), according to the conditions of the times as evaluated by the church; previously the bishop could be once married, as the Bible allows (I Tim. iii, 2). The same is true of the whole liturgical life, which is a subject of church tradition and can be altered by church authorities to accord with changed circumstances, as long as the teaching of the Bible and of holy tradition is not contravened.

Sacraments.—In regard to the sacraments the Orthodox Church has not developed any doctrine based on the decision of an ecumenical synod, because there has been none on this subject. The Greek Fathers, as late as John of Damascus in the 8th century, speak about two sacraments, baptism and Eucharist; it was only after western influence in the 17th century that the Orthodox Church adopted the doctrine of the seven sacraments, to all of which there is positive reference in the New Testament. There are also, however, in the Orthodox Church, a large number of sacramental practices, such as the blessing of water at Epiphany.

Infant baptism was presumably practised in New Testament times, since whole families, which must have included infants, were baptized (Acts xvi, 15, 33; xviii, 8). The custom of the early church was to baptize adults by immersion. After the 4th century infant baptism prevailed. Baptism, performed by a threefold immersion in water, is in the name of the Father, the Son and the Holy Spirit. The pouring of water instead of immersion is used only in cases of lack of water or of dangerous illness. The sacramental grace given to the candidate through baptism is forgiveness of sin, admission to the church and moral regeneration. Several early liturgical rites, such as the renunciation of the devil, the confession of faith, the anointing with oil before baptism, are still in use in the Orthodox Church for their symbolic significance. Anointing with chrism (which corresponds to confirmation in the west) is performed by the priest immediately after baptism. The chrism has been previously consecrated by the bishops of the autocephalous church concerned or by the ecumenical patriarch. Baptized infants receive Holy Communion regularly as full members of the church; they do not have to wait

until they are old enough to be instructed in the faith and conscious of what is happening, as in the west.

The eucharistic rite, which is called the Divine Liturgy, derives like the Mass and the Communion services of Protestant churches from the Last Supper of Christ before his betrayal (I Cor. xi, 23–26). The liturgy of St. John Chrysostom is the one most frequently used (*see* LITURGY). The faithful are expected to take part each Sunday in the one liturgy that is celebrated, usually in the middle of the morning. There is normally a choir, and the whole service is sung. After the preliminary prayers with readings from the Gospel and Epistle for the day, bread and wine are ceremonially brought to the holy table and consecrated in a long prayer which includes an account of the Last Supper (in which the words of institution "This is my body," "This is my blood" are pronounced aloud by the priest), a recollection (anamnesis) of the saving events of Christ's earthly life and an invocation (epiklesis) of the Holy Spirit, praying him to change the bread and wine into the body and blood of Christ. These changed elements represent the continuation of the sacrifice of Christ once made on the cross for the remission of sins. Intercessions for the church follow, and then those who wish to communicate stand before the priest to receive the two consecrated elements simultaneously from a spoon. There is no special theory to explain how the bread and the wine are changed and, although treated with great reverence, they are not exposed for adoration. Loaves of bread are blessed before the liturgy, and after it the remains of the blessed bread which have not been consecrated are cut into small pieces and distributed among the congregation. Unleavened wafers are not used at the Eucharist.

Holy orders (*q.v.*) are conferred by the bishop on both married and unmarried men, but only the latter may themselves become bishops. Candidates for holy orders must either marry before entering on the diaconate or always remain unmarried, and a married priest if widowed may not marry again. Unmarried priests are normally monks and eligible for the episcopate, which since the 7th century has been confined to the celibate. (*See* also EPISCOPACY; MINISTRY, CHRISTIAN.)

Marriage, regarded as instituted by God at the earliest stage of man's history, has always been blessed by the church, which however at first merely accepted Roman marriage laws. It was only after the 6th century that the church was more officially involved at the contract of a marriage, and it is only since the 9th century that the performance of the sacrament of marriage has been regarded in Orthodox countries as alone constituting a valid marriage, save in Communist countries. Divorce, as at the beginning of the Christian era, is arranged according to the state laws. The church permits remarriages after the death or divorce of the first or second partner, but the ceremonial crowning of the couple is usually of a different type on such occasions.

The public confession of sins to the local church was the practice in the early period of Christianity. For the avoidance of scandal, it later became customary to confess sins privately to a priest as the representative of the church. Orthodox church buildings do not contain confessionals; the penitent stands before the priest, who may at the conclusion suggest certain penalties as tokens or acts of repentance, but penances as punishments are not imposed. The frequency of making confession varies in the different autocephalous churches.

The use of the sacrament of unction for the sick and for penitents continues the practice of the early church mentioned in the New Testament (James v, 14).

Worship.—The worship of God, which is the chief duty of the church, is centred on the celebration of the liturgy that takes place every Sunday and holy day. Each congregation comes together as one body in the presence of God and of the heavenly Host to identify itself with the sacrifice of Christ on the cross and with his glorious resurrection, which is one of the dominant themes of Orthodox worship. Easter, the chief festival of the church year, is celebrated not only once a year but on every Sunday. The laity have their indispensable part to play in the liturgy, which they offer to God together with the priest. Worship is usually conducted in the language of the country or an earlier form of it, the services in most cases having been translated shortly after the bringing of Christianity to that country. Hence the Russians use Church Slavonic, while the Greeks keep the original liturgical language. Worship requires not only faith in God, but love and obedience to his commands. Christian practice is thus both the prerequisite and the consequence of Christian worship.

Worship is also offered to God in the monastic cycle of the canonical hours with readings from the Old and New Testaments, psalms and hymns (*see* HOURS, CANONICAL). Vespers and matins are sung in some churches on Saturday evenings and the evenings of the chief festivals. Orthodox worship is noted for the large part played in it by hymns composed for the various festivals (*see* GREEK LITERATURE; BYZANTINE MUSIC; KANON; KONTAKION). Music is an integral part of the services, though no organ or other musical instrument is allowed, and icons are indispensable.

Icons.—Holy pictures, from frescoes or mosaics on church walls to small portable representations, play an important part in the worship of Orthodox Christians (*see* ICON). Since the early days of the church, letters (such as alpha and omega in Rev. i, 8) and symbols (such as the cross and the fish) were employed to stand for holy persons and subjects. Gradually scenes from the history of the redemption were also portrayed, and by the middle Byzantine period there were complete cycles of iconography showing the chief festivals of the church year as well as single figures of saints and representations of Jesus Christ, from the child on his mother's knee to the august figure of the Pantocrator ("Almighty"). (*See* BYZANTINE ART; RUSSIAN ART.)

Icons are to be venerated but not worshiped, for worship should be directed to God alone. But the distinction between worship and veneration is not always easily drawn, and icons have at times been misused as objects of worship instead of used as aids to worship (*see* ICONOCLASTIC CONTROVERSY). The seventh ecumenical council in Nicaea (787) held the balance between the extremes of idolatry on the one hand and abolition of icons on the other by carefully defining the theology of the icon. Even the veneration paid to the icon is offered not to the icon itself as a material object but to its prototype (*i.e.*, to the subject portrayed).

There is no Orthodox church building without its icons, both on the iconostasis and on special stands, which are venerated with a kiss and with the lighting of a candle by each of the faithful on entering the church, whether to take part in the liturgy or to pray privately. Icons are also censed at various points in the services. No Orthodox home is complete without its icons, which are usually placed high up in corners of rooms or over the beds as the object of concentration for the Christian as he stands in prayer.

Organization.—The whole church in heaven and earth has Jesus Christ as its head, its Lord and its master. The church on earth is organized under him in autocephalous bodies chiefly according to countries.

Each autocephalous church is administered by its bishops and the clergy under them, elected by both clergy and laity. The Orthodox Church federation consists of the following autocephalous churches: the ecumenical patriarchate of Constantinople; the patriarchates of Alexandria, Antioch and Jerusalem; the church of Cyprus; the patriarchate of Moscow; the church of Greece; the patriarchates of Rumania, Serbia and Bulgaria; the church of Georgia; the church of Albania; the church of Poland; the autonomous churches of Crete, Finland, Lithuania and Estonia; and the monasteries of Patmos and Sinai. (The other monasteries in the Orthodox Church, which are independent of one another, are under the jurisdiction of the local bishop, metropolitan or patriarch; *see* MONASTICISM; ATHOS, MOUNT.) The Orthodox churches in the United States belong to several jurisdictions (*see* ORTHODOX CHURCH IN AMERICA). The ecumenical patriarch of Constantinople is the head of the federation but only as *primus inter pares*. (*See* separate articles on the autocephalous churches.)

While all these autocephalous churches are ruled by the same canon law, those among them that are established by the state are also subject to special ecclesiastical state laws. The Orthodox Church, whether established or not in any particular country, avoids interference in political affairs but co-operates with the state for the welfare of its members. Wherever possible it rejects

state interference in its internal affairs, to the extent that its members even face martyrdom, if necessary, as for example under totalitarian governments.

When matters of grave and general importance arise in the Orthodox Church an ecumenical council is convened by common consent. Once convened, the ecumenical council is the highest authority of the church and its decisions regarding faith are infallible. In matters of church order it may modify earlier canons or promulgate new ones, which can only be changed by another ecumenical council. For the final sanction of its authority, however, the ecumenical council depends upon the conscience of the church or the general consensus of both clergy and laity. The pan-Orthodox conferences that took place on Rhodes in 1961 and thereafter, although not ecumenical councils, were of great value as a meeting between representatives of churches which, although united in one body, had for centuries had little opportunity to discuss their common problems and responsibilities.

See also references under "Orthodox Eastern Church" in the Index.

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ORTHODOXY, PROTESTANT, identifies a phase that both Lutheran and Reformed theology went through after the 16th-century Reformation. The two movements, though discrete, share many accidental features as a result of the largely common political, cultural, social and intellectual matrix that included not only the Lutheran and Reformed communities but also the bulk of European Roman Catholicism at the time. Prominent features of this matrix are the economic decline and political disintegration of the Holy Roman empire, the continuing Muslim-Turkish threat in the east, the Thirty Years' War, territorial-confessional churches intimately linked with the government, the general use of Aristotelian thought forms and the rise of the baroque spirit in art.

Lutheran Orthodoxy.—In the Lutheran Church the era of orthodoxy begins around 1560 with the theological effort to reunite the factions that had developed after Luther's death (*see* CONCORD, BOOK OF). The "golden age" of orthodoxy ends in 1713 with the death of the last great systematician, David Hollatz, but orthodoxy remained a potent force into the last quarter of the century, although it was beleaguered by pietism (*q.v.*) and the Enlightenment (*q.v.*). In the United States the theology of the most influential 19th-century Lutheran immigrant groups was largely a revival of orthodoxy.

Lutheran orthodoxy discloses wide variations not only from period to period but also from region to region and even from theologian to theologian. Early orthodoxy is represented by the six authors of the Formula of Concord, among others. A general characteristic of their method is the discussion of theology under a series of major heads or "commonplaces" (*loci communes*), in the tradition of Philipp Melanchthon (*q.v.*), with a minimum of analysis and systematization. The transition to the period of "high orthodoxy" is marked by Johann Gerhard (*q.v.*). This period reveals in general an increasing intellectualization of religion, concern for theological detail and use of analysis. The end of the period is marked by the bitter "syncretistic controversy" between the theologians led by Georg Calixtus and those led by Abraham Calovius. In the writings of a number of theologians of "late orthodoxy," the analytic method triumphs completely; others represent varying degrees of tacit or frank accommodation to the pietist movement that began at Halle with Philipp Jakob Spener and August Hermann Francke. During the latter two periods Lutheran orthodoxy had its greatest influence in Sweden and Finland.

Lutheran orthodoxy has been accused of doctrinaire formalism, narrow and quarrelsome intolerance, sterile neo-Scholastic intellectualism and a divorce between doctrine and ethics. These charges, although true in some cases, are often partisan exaggerations, based on a reading of the dogmatic works of the period to the exclusion of the biblical commentaries and devotional literature produced at the same time and often by the same men. After due allowance has been made for personal differences and for the inescapable influence of the intellectual and political environment, there remains among the orthodox theologians a deep concern for a theology that is simultaneously biblical, Catholic and Lutheran, great intellectual vigour and authentic personal and corporate piety. The central emphases of orthodox Lutheran theology are the primacy of God's Word; the forgiveness of sins exclusively by divine grace for Christ's sake through faith as the core of the biblical message; the vital roles of baptism, absolution, the Eucharist and the sacred ministry; reverence for the inherited expressions of the mind of the historic church, not least in the doctrine of Christ; and a strong polemic-apologetic position over against Roman Catholicism, Reformed Protestantism and Socinianism alike.

Reformed Orthodoxy.—The era of Reformed orthodoxy begins shortly after the death of John Calvin (1564) and ends at the beginning of the 18th century. Reformed theologians originally called themselves "orthodox" in contrast to Roman Catholics and to Lutherans, whom they regarded as only imperfectly reformed. The term soon came to designate a special type of rigid Calvinism which in its severe form stood in conscious opposition to liberal humanism and Socinianism, as well as to Roman Catholicism and Lutheranism. The architects of Reformed orthodoxy are Theodore Beza and Hieronymus Zanchius. It was Beza's concern to preserve the theology contained in Calvin's *Institutes of the Christian Religion* (*see* CALVIN, JOHN). The capstone of this system Beza saw in the doctrine of an absolute decree by which God predestined some men to everlasting life and others to hell. Unlike Calvin, Beza was moved by philosophical rather than biblical considerations. Zanchius gave Reformed orthodoxy its classic formulation of the doctrine of the perseverance of the elect. Other features generally characteristic of Reformed orthodoxy were a symbolistic doctrine of the sacraments, an ethical approach to repentance, a typical "presbyterian" polity, stress on church discipline and practical Christianity and, in comparison with Lutheranism, a more literal approach to the Bible and a greater separation of the divine and human natures in Christ.

The strongholds of Reformed orthodoxy were Switzerland and the Netherlands. In the latter, orthodoxy came into conflict with Arminianism (*q.v.*), which was condemned at the international Synod of Dort (1618–19), convened to resolve the controversy. The *Synopsis purioris theologiae* (1624) by the Leiden theological faculty is a definitive unfolding of Dort orthodoxy.

Driven underground in the Reformed churches, Arminianism exerted a strong influence on 17th-century Anglicanism and subsequently on Methodism. The short-lived victory of Presbyterianism in England under Oliver Cromwell occasioned the formulation of the Westminster standards, including the Westminster Confession (*q.v.*; 1646) and the Larger and Shorter Catechisms (1647), of which the general thrust is orthodox and anti-Arminian as well as anti-Anglican (*see* CATECHISM; CONFESSIONS OF FAITH: PROTESTANT). The influence of the *Compendium theologiae* of the Basel theologian Johannes Wolleb is particularly apparent in the Larger Catechism. Early American Puritanism is a separatist version of English Reformed orthodoxy.

Huguenot theology provoked a further test of orthodoxy. The French Reformed community formally accepted the canons of Dort, but amid the political confusion of the period a vocal humanistic opposition—influenced both by German Reformed theology and revived Zwinglian ideas—developed, notably at the Academy of Saumur. There the Scottish-born John Cameron and his disciple Moise Amyraut (Amyraldus) attempted a new synthesis of orthodoxy and Arminianism. In the Helvetic Formula of Agreement (1675), drafted chiefly by Johann Heinrich Heidegger and François Turretini, Swiss Reformed orthodoxy vainly con-

demned the Saumur theology and reaffirmed the traditional orthodox position. Soon after the end of the century Reformed orthodoxy succumbed almost completely to pietism and rationalism.

Meanwhile German Reformed theology—like Anglicanism—was never orthodox in the strict sense. Along with the influence of the Swiss reformers and their Dutch followers, the influence of Martin Bucer and of those more radical disciples of Melanchthon whom the Formula of Concord had forced out of the Lutheran Church also persisted. The result was the relatively mild Calvinism of the Heidelberg Catechism (1563) and the Consensus of Bremen (1598). In general, German Reformed theology affirmed dialectically Melanchthon's doctrine of universal grace and the Swiss doctrine of election.

Lutheran-Reformed Union.—Since the Reformed religion prior to 1648 enjoyed precarious toleration in the Holy Roman empire only under the pretense of commitment to the Augsburg Confession, plans for various types of union between Lutherans and Reformed engaged much of the latter's attention. The two religions had discovered a way to get along peaceably in Poland-Lithuania (Consensus of Sendomir, 1570) and later in France (Synod of Charenton, 1631). It was argued that similar agreement was possible within the empire also. Efforts in this direction were the Leipzig Colloquy (1631) and the Cassel Colloquy (1661). Both disclosed extensive areas of agreement but led to no practical results. Among Reformed champions of Lutheran-Reformed union, François du Jon (Junius), David Pareus and the Scotsman John Durie made particularly significant contributions. By and large, however, all but the most irenic Lutherans viewed these efforts with suspicion on theological, historical and political grounds.

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ORTHOGENESIS, "straight-line evolution," a term descriptive of the phenomenon in which successive members of an evolutionary series become increasingly modified in a single undeviating direction; the word is further used to designate theories framed to explain such phenomena. Ortho-evolution, ortho-selection, aristogenesis, undeviating evolution, rectilinear evolution are synonymous or related terms.

That evolution frequently proceeds in orthogenetic fashion is undeniable. Theodor Eimer, an early exponent of orthogenesis, based his work on butterfly wing venation; fossil invertebrates show many orthogenetic sequences; H. F. Osborn, W. K. Gregory and others cited numerous examples in vertebrate paleontology. In some cases the structural changes concerned are obviously adaptive, and a Darwinian explanation (ortho-selection) is reasonable. An orthogenetic "family tree" presents the picture of a single straight stem rather than a branching structure; this appearance may be because of the fact that side branches, when begun, were vigorously pruned by natural selection.

In many instances, however, the striking features developed in an orthogenetic phylum appear to have little if any adaptive value and may even be markedly disadvantageous. To explain such cases is more difficult. No genetic evidence has been found (despite search for it) of progressive mutation in a given direction. Various theories have been proposed involving an "inner urge" toward a predestined evolutionary goal or some other mystical or theological concept. But many workers feel that more rational explanations are possible. Work in genetics has shown that even very small mutations may have a definite survival value. Further, the action of a gene is not confined to a single character; the growth of disadvantageous structures (as for example the huge antlers of the extinct Irish "elk") may well have been merely unfortunate genetic concomitants of the development of other structural or functional features of great utility.

Related evolutionary phenomena are parallelism and the so-called law of the irreversibility of evolution. Parallel trends are frequently seen in related but distinct evolutionary phyla; these trends are often orthogenetic in pattern. The "law" of irreversibility is based upon the occurrence of orthogenesis. However, there are many known non-orthogenetic evolutionary lines, and there are numerous instances of reversibility. *See* EVOLUTION, ORGANIC. (A. S. RR.)

ORTHOPEDIC SURGERY is the medical specialty that includes the investigation, preservation, restoration and development of the form and function of the extremities, spine and associated structures by medical, surgical and physical methods.

History.—The term orthopedics was given to this specialty in 1741 by Nicholas André, professor of medicine at the University of Paris. The term was synthesized from the Greek roots *orthos* ("straight") and *pais* ("child"). Although the scope of orthopedic surgery has gone far beyond the prevention and care of deformities in children, the name lasts. The establishment of the first institute for the treatment of skeletal deformities at Orbe, Switz., by Jean André Venel, a physician of Geneva, was a milestone in the development of orthopedic surgery in the 18th century. During the remaining portion of the century, outstanding work in orthopedic surgery was done by William Hunter, who contributed to knowledge of the structure of joints, and by John Hunter, his younger brother, who contributed to knowledge of muscular function and bony growth and development. John Hilton (1804–78) exerted a great influence on the development of orthopedic surgery with his book *On Rest and Pain*, which undoubtedly helped to influence thinking during the long period in which rest was considered to be the most important part of orthopedic care. G. F. L. Stromeyer (1804–76), a German surgeon of Hanover, developed the operation of tenotomy (cutting of tendons), by which deformities could be more easily corrected. It was to Stromeyer that William J. Little (1810–94), the pioneer of orthopedic surgery in England, himself a cripple with a paralytic deformed foot, went to have the deformity corrected in 1836. Little's studies on the causes of clubfoot and his introduction of tenotomy to England were outstanding steps in the development of orthopedic surgery. Hugh Owen Thomas (1834–91), another outstanding leader in the development of this specialty, devised, among other outstanding contributions, the Thomas splint, which is still widely used in the treatment of fractures of the long bones of the leg.

The modern era in the development of orthopedic surgery usually is regarded as beginning with the work of Sir Robert Jones (1858–1933). The organization of the orthopedic centres and curative workshops was carried out under his direction, and many orthopedic British and American surgeons came under his influence. The introduction of surgical methods which could be used in conjunction with splinting in the treatment of fractures and severe injuries of the extremities may be ascribed to the period of World War I and to the leadership of Jones.

In the United States the names of L. A. Sayre, Henry G. Davis and Charles F. Taylor are outstanding in New York city, while in Boston, Mass., orthopedic surgery was developed by John Ball Brown and Buckminster Brown, to be followed by E. H. Bradford, Robert W. Lovett and others.

One of the modern leaders in the development of orthopedic surgery in the United States was F. H. Albee (1876–1945), whose development of the motor bone saw in 1909 led to an entirely new era in bone-grafting methods which are commonly used in the correction of deformities and disabilities of bones and joints. Robert W. Lovett (1859–1924), a leader in the Boston group, did much to develop knowledge of the care of patients affected with anterior poliomyelitis and also helped to develop knowledge of scoliosis (curvature of the spinal column) and its treatment. Michael Hoke (1874–1944) of Atlanta, Ga., contributed much to the correction of foot deformities and stabilization of joints.

Royal Whitman (1857–1946) was an outstanding teacher and orthopedic surgeon, and Willis Campbell (1880–1941) contributed much to the development of modern orthopedic methods and technique. Russell A. Hibbs (1869–1932) devised an operation for stabilization of the diseased or deformed spine and other important operative procedures.

Scope.—In discussing the scope of modern orthopedic surgery, the prevention of disabilities and deformities, as well as their correction, must be stressed. Orthopedic surgery may be divided into two parts, preventive and reconstructive. Deformities may be either congenital or acquired. Of the congenital deformities, there are three types: (1) those caused by disturbances in embryologic development and intrauterine growth; (2) those which are actually inherited and transmitted from generation to generation; and (3) those which are based on evolutionary changes in the human species. Examples of the first group are intrauterine amputations; examples of the second group are congenital dislocations of the hip and the related condition known as congenital dysplasia of the hip; examples of the third group are anomalies of the lumbosacral portion of the vertebral column, resulting from man's change from the quadruped to the biped gait. Many developmental changes in the spinal column have taken place and certain anomalies are occasionally seen.

All congenital deformities cannot be classified into these groups in the light of present knowledge, although many of them no doubt may be so classified as that knowledge improves. Prevention of congenital deformities may seem impossible, although the results of work on the influence of certain deficiency diets in pregnant animals seem to indicate that some of the embryologic maldevelopments may be influenced by nutrition.

Developmental anomalies are likewise a source of troubling and disabling deformities. Among these may be mentioned certain disturbances of growth in the epiphyses (pieces of bone separated from the long bones by cartilage and later becoming part of the long bones) of children which are known as epiphyseal osteochondrosis. Such conditions lead to deformities of the surfaces of the joints and later in life cause painful joints. Severe infections of joints due to pyogenic (pus-forming) organisms formerly were a cause of severe damage which often led to deformities and disabilities, but with the development of chemotherapy these infections were greatly reduced if not prevented. Anterior poliomyelitis is another outstanding cause of disabilities and deformities, but the antipoliomyelitis vaccines gave promise of diminishing or eradicating this disease.

Deformities with their attending disabilities may follow injuries of the bones, joints, muscles and tendons or skin. Any one of these structures, if severely injured and not adequately repaired, will become a potential source of deformity and disability. A fracture that is allowed to heal with fragments of bone in an improper position may cause the patient to walk with the extremity out of proper alignment and in time may lead to serious disability of the neighbouring joint. In the same way, a fracture of the bones in the region of the ankle not accurately reduced, in time, because of abnormal wear and tear on the joint surfaces, may lead to traumatic arthritis and severe disability. Injuries of muscles and tendons not adequately cared for may produce an unbalanced function of an extremity or part and lead to deformity and disability. In a like manner, scars from severe burns often cause contractures or shortening of the soft tissues on one side of a joint and lead to severe deformities and marked disability. In all of these instances, the best prevention is early and adequate treatment designed to produce the best possible function with the least possible deformity.

(*See* also Bone, Diseases and Injuries of; Fractures and Dislocations; Joints and Ligaments, Diseases and Disabilities of.)

Methods and Procedures.—From a specialty which originally depended on the use of heavy braces, splints and methods of treatment which produced rest has evolved an active surgical specialty which is concerned with the correction of existing faults and prevention of the later development of deformities and disabilities by surgical procedures. With the availability of such adjuncts to surgical treatment as chemotherapy, whole blood and, at times, blood substitutes, and improved methods of anesthesia, early restoration of badly shattered parts can be accomplished. The achievements of orthopedic surgery in World War II are ample evidence of this fact.

Reconstructive surgery of the spinal column and extremities is of great importance. Fractures which have failed to unite or have united in a faulty position are treated by surgery. Bone grafts are used widely, and many types of bone grafting have been developed to adapt this useful technique to a variety of purposes.

Tendons may be repaired by tendon grafting and by tendon transplantation where indicated. It is possible, for instance, in the case of hopeless destruction of the musculospiral nerve in the arm, to restore the function of the hand almost to normal by the transplantation of two or three tendons. Use of skin-grafting procedures to replace extensive scars has greatly advanced reconstructive surgery. The various types of skin-grafting procedures are also used to repair extensive chronic ulcers, which are painful and disabling. (*See* also Transplants, Tissue and Organ.)

Surgical methods have been developed to equalize the length of a lower extremity in cases in which a marked difference in length of the extremities impairs the patient's usefulness or threatens to cause further disability. This may be accomplished by lengthening the shorter leg, by shortening the longer leg or by retarding growth in the longer leg.

The development of metals for use in the internal fixation and repair of fractures occupied the attention of many orthopedic surgeons and strong metals that produce little reaction in the tissues are available for use. With the improvement in these materials has grown a better understanding of how to use such devices, and better tools for their handling have been invented.

Many diseases of the skeleton are being studied and their relationship to other organs of the body gradually revealed. Deficiency states and bony diseases secondary to tumours of the parathyroid glands and to other glands of internal secretion are gradually becoming better understood, and better means of treating them are being found. The importance of prevention of deformities caused by various types of arthritis is well known and the more crippling deformities are much less frequently seen than they were in the past.

Understanding of malignant tumours of bone and of tumours of muscles and tendons is slowly improving. Early recognition of these conditions and the prompt use of surgical procedures or X-ray treatment have made many patients more comfortable and in many instances have saved lives. The final answer to cancer of bone and other tissues is probably neither surgery nor radiation.

It may be some, as yet undiscovered, chemical or antibiotic agents.

Improvement in knowledge of methods of amputation, and improvement in the types of artificial limbs, greatly reduced the disabling effects of these procedures. Improvements in plastic amputation made practicable this procedure, by which tendons and muscles in amputation stumps can be used to move artificial hands. (*See* also Amputation; Prosthetics.)

Recognition of the fact that long periods of rest in bed, once strongly advocated by orthopedic surgeons, are in many instances deleterious shortened the period of hospitalization for many patients and greatly reduced the long periods of convalescence which frequently were thought necessary in the treatment of diseases and injuries of the spinal column and extremities.

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(R. K. G.; M. Cl.)

ORTHOPTERA, the scientific name for the order of insects that, in conventional classification, includes cockroaches, mantids, walking sticks, grasshoppers and locusts, katydids and their allies. (Earwigs were long included, but now a separate order, the Dermaptera [*see* Earwig], is recognized for them.) About 24,000

species are known; the United States has about 1,300 species and subspecies, Europe about 600 and Britain 35, including 4 established adventives.

In some classifications the cockroaches, mantids and walking sticks are each often given ordinal rank (*see* INSECT: *Classification*). In many parts of the world certain orthopterans are at times serious pests of crops and bothersome pests in households; a few kinds, such as the mantids, help to reduce the numbers of noxious insects.

Essentially terrestrial, many Orthoptera run rapidly or jump vigorously. The grasshoppers and locusts include many active fliers, though only a few fly long distances in a migratory sense; other groups of Orthoptera are mainly weak fliers. Most Orthoptera are relatively large, the average size being much greater than most insects; some reach a maximum of 13 in. in length. Many, nearly all in the suborder Saltatoria, possess sound-producing organs and stridulate loudly. Others make crackling noises in flight; the sounds produced by the majority are distinctive for each species, when heard by the trained human ear or recorded on tapes for careful study.

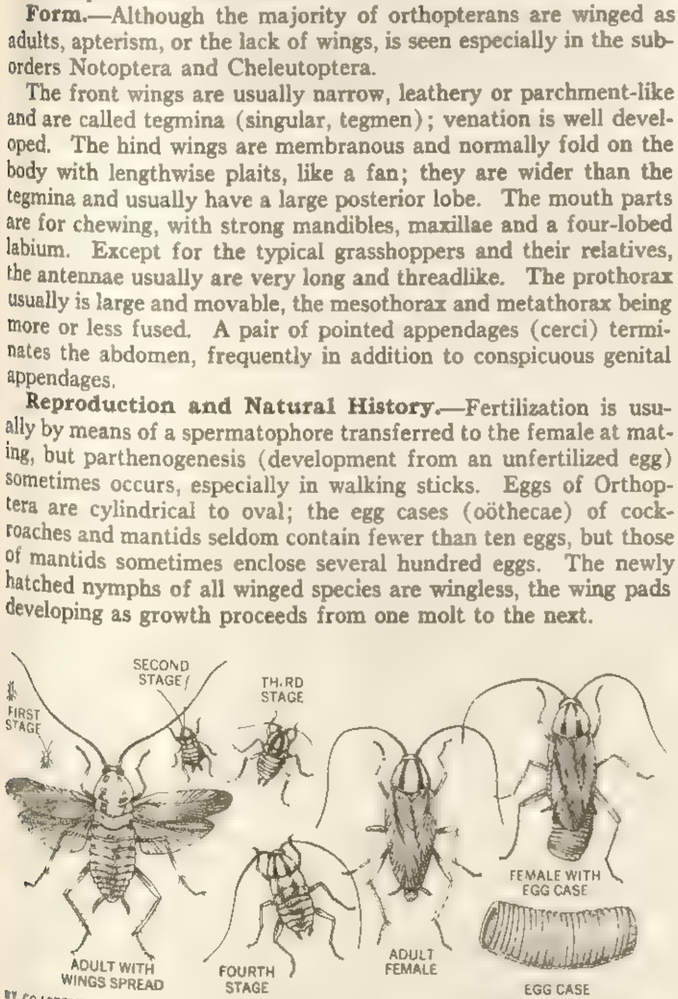
DISTRIBUTION AND GENERAL FEATURES

Range.—The largest families are world wide in range, though all diminish rapidly in number of species as the cooler zones are approached, and very few mantids or walking sticks occur outside the tropics. Most species have limited distributional patterns, and each continental fauna is more or less distinctive. Grasshoppers are excellent indicators of ecological zones; each distinct plant community usually has certain grasshoppers characteristic of that environment. There are few cosmopolitan pests among Orthoptera except in the cockroaches.

Form.—Although the majority of orthopterans are winged as adults, apterism, or the lack of wings, is seen especially in the suborders Notoptera and Cheleutoptera.

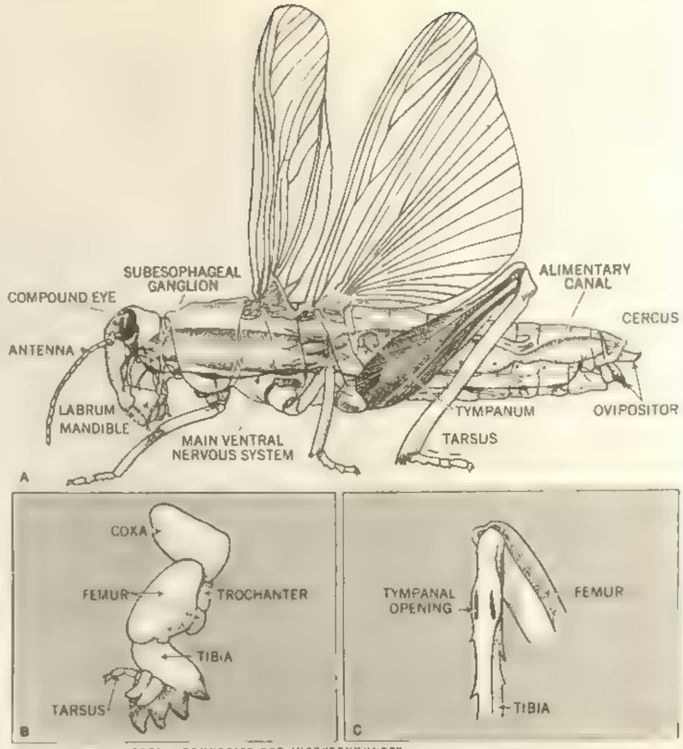
The front wings are usually narrow, leathery or parchment-like and are called tegmina (singular, tegmen); venation is well developed. The hind wings are membranous and normally fold on the body with lengthwise plaits, like a fan; they are wider than the tegmina and usually have a large posterior lobe. The mouth parts are for chewing, with strong mandibles, maxillae and a four-lobed labium. Except for the typical grasshoppers and their relatives, the antennae usually are very long and threadlike. The prothorax usually is large and movable, the mesothorax and metathorax being more or less fused. A pair of pointed appendages (cerci) terminates the abdomen, frequently in addition to conspicuous genital appendages.

Reproduction and Natural History.—Fertilization is usually by means of a spermatophore transferred to the female at mating, but parthenogenesis (development from an unfertilized egg) sometimes occurs, especially in walking sticks. Eggs of Orthoptera are cylindrical to oval; the egg cases (oöthecae) of cockroaches and mantids seldom contain fewer than ten eggs, but those of mantids sometimes enclose several hundred eggs. The newly hatched nymphs of all winged species are wingless, the wing pads developing as growth proceeds from one molt to the next.



BY COURTESY OF THE U.S. DEPARTMENT OF AGRICULTURE

FIG. 1.—NYMPHAL AND ADULT STAGES OF THE GERMAN COCKROACH (BLATTELLA GERMANICA)



FROM HERMANN WEBER, "GRUNDRISS DER INSEKTENKUNDE"

FIG. 2.—ANATOMY OF THE SALTATORIA: (A) BODY OF A GRASSHOPPER (ACRIDID); (B) FRONT LEG OF A MALE CRICKET (GRYLLID); (C) KNEE AREA OF FRONT LEG OF A KATYDID (TETTIGONIID)

The Saltatoria are famous for their "songs," more correctly called stridulation, which rival the calls of cicadas in loudness; in a few cases their sounds can be heard a mile away. Except for mantids, which capture living insects, and some cockroaches, crickets and katydids, which are scavengers, omnivores and occasionally predators, most Orthoptera are herbivores. The most serious orthopterous crop pests are grasshoppers, but certain other orthopterans are also important, as the Mormon cricket on crops and rangeland in the northwestern U.S., field crickets on cotton in the Gulf states and mole crickets on tobacco and vegetables in the southeastern states and the West Indies. About a dozen species of grasshoppers, especially in Africa and Asia, less frequently in South America and Australia and uncommonly in North America, are called locusts because of their strong migratory habits. While immature they move on the ground as marching bands and later fly long distances as swarms of adults. Their depredations have been notorious since biblical times.

Each major family of Saltatoria has tree-, shrub-, herb- and ground-dwelling species, though long-horned grasshoppers and katydids are more arboreal than grasshoppers or crickets. Many species are more specific in host plant preferences than formerly was thought to be the case. Many cave and camel crickets and mole crickets are subterranean, while the small wingless cricket *Myrmecophila* lives in ant nests. The cricket *Hydropeticus,* one of the very few aquatic Orthoptera, skates actively on streams in Fiji much as do the water-striding bugs (Gerridae). A few cockroaches are capable of considerable periods of submergence in the water in the leaf axils of bromeliads and in other natural receptacles; there are isolated examples of semiaquatic katydids and grasshoppers.

CLASSIFICATION AND SURVEY

As usually defined, the Orthoptera is an order in a broad sense. It includes only part of the orthopteroid (straight-winged) insects. It is partly for convenience that such diverse groups as the Dictyoptera, Cheleutoptera, Notoptera and Saltatoria are regarded as suborders of Orthoptera.

Cockroaches are more closely related to termites than to grasshoppers, for example, and the development of a classification more

correctly representing this and other relationships indicated by comparative morphology is desirable, but thus far none of the many proposed modern classifications has become standard.

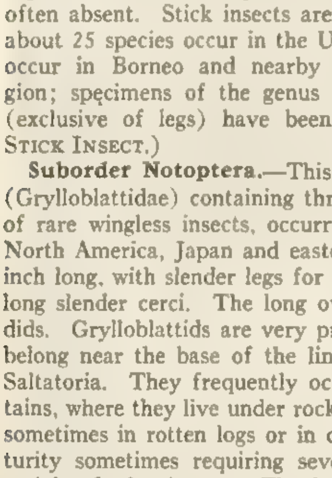
Suborder Dictyoptera.—This group includes the cockroaches (superfamily Blattoidea, consisting of several families often grouped as Blattidae in a broad sense) and mantids (Mantoidea; especially family Mantidae), both descended, together with the termites, from Palaeozoic Protoblattoidea. They have five-segmented tarsi (end parts of legs), primitive wing venation, many-segmented cerci, processes called styli (in males and nymphs) and eggs, except in those cockroaches that have the young born alive (ovoviviparous) from the oötheca. The Blattidae are characterized by a flattened body, large shieldlike pronotum, very broad coxae (basal segments of the legs) and running legs. The Mantidae usually are elongate, but little flattened, and only rarely is the pronotum broad; the most distinctive feature is the predatory front legs, equipped with spines and adapted for seizing prey. Except for this latter specialization and the less flattened bodies, the morphology of mantids shows close relationship to cockroaches. (*See* COCKROACH; MANTIS.)

Suborder Cheleutoptera.—This group includes the walking sticks (stick insects, or phasmids), which traditionally were grouped near cockroaches and mantids because they are mainly elongate crawling types. However, they are now regarded as a distinct orthopterous line and are often given ordinal rank, sometimes under the name Phasmida. The great majority, especially those of the family Phasmatidae, are long and slender, but some forms are heavily bodied, with stout bizarre spines on the body; the family Phyllidae includes the leaf insects.

Antennae usually have long slender segments, tarsi are five-segmented and the ovipositor is short. Tegmina and wings are often absent. Stick insects are primarily a tropical group; only about 25 species occur in the United States. The largest species occur in Borneo and nearby islands of the East Indian region; specimens of the genus *Pharnacia* 13 in. in body length (exclusive of legs) have been recorded. (*See* LEAF INSECT; STICK INSECT.)

Suborder Notoptera.—This group comprises a single family (Grylloblattidae) containing three genera and about nine species of rare wingless insects, occurring in the mountains of western North America, Japan and eastern Siberia. They are about one inch long, with slender legs for running, five-segmented tarsi and long slender cerci. The long ovipositor resembles that of katydids. Grylloblattids are very primitive Orthoptera and probably belong near the base of the line of development leading to the Saltatoria. They frequently occur near the snow line in mountains, where they live under rocks. Others live at lower altitudes, sometimes in rotten logs or in caves. Growth is very slow, maturity sometimes requiring several years. Their food consists mainly of other insects. The first known species was described in 1914; because of the rarity and primitive character of these insects they are of great scientific interest.

Suborder Saltatoria.—This group includes the jumping Orthoptera, the dominant members of the order, comprising the familiar grasshoppers and locusts, the katydids and the crickets, as well as various related but poorer known members. They have hind legs well adapted for leaping and tarsi with fewer than five segments. The ovipositor is well developed. Stridulatory organs are often present in the male, and in many species there is a hearing organ in the form of a tympanum. There are six principal superfamilies of Saltatoria grouped in two series, the Ensifera and the Caelifera.



BY COURTESY OF THE MONTANA AGRICULTURAL EXPERIMENT STATION

FIG. 3.—GRYLLOBLATTID (GRYLLOBLATTA CAMPODEIFORMIS)

Ensifera are characterized by threadlike antennae usually much longer than the body, three- or four-segmented tarsi, a long ovipositor, a tympanum (when present) near the base of the front tibia and a male tegmen often formed for stridulation. Of the three chief superfamilies, the Gryllacridoidea include cave and camel crickets (family Gryllacrididae). In North America many species of cave crickets are common in woods and caves. The Tettigonioidea includes the family Tettigoniidae, the katydids or long-horned grasshoppers, with four-segmented tarsi and a long, broad ovipositor, which is swordlike in cross section. The Grylloidea, chiefly the family Gryllidae, are crickets, with three-segmented tarsi and a slender ovipositor, which is usually round in cross section.

Caelifera are characterized by antennae much shorter than the body, tarsi with three or fewer segments, a short ovipositor composed of hooklike valves, which open widely in a vertical direction, and a tympanum (when present) near the base of the abdomen, on each side. The Tridactyloidea include pygmy mole crickets (family Tridactylidae) and their relatives; they resemble mole crickets but are closer to grasshoppers in structure. The Tetrigoidea, family Tetrigidae, are pygmy grasshoppers or grouse locusts. They look like miniature grasshoppers with the pronotum greatly developed and covering much of the abdomen. They rarely exceed one inch in length, and there are many strange tropical forms. The Acridoidea includes the family Acrididae, or grasshoppers and locusts, the most important and most universally distributed and abundant Orthoptera. The tarsi have three segments, antennae are short, cerci consist of a single segment and tegmina (usually present) are usually leathery or horny. Many grasshoppers stridulate by scraping a toothed ridge on the hind femur against a sharp-edged vein on the closed tegmen; some make buzzing or crackling noises in flight. *See* CRICKET; GRASSHOPPER; GROUSE LOCUST; KATYDID; LOCUST; *see* also ENTOMOLOGY; INSECT.

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ORTIGÃO, JOSÉ DUARTE RAMALHO (1836–1915), an outstanding Portuguese essayist and journalist, was born on Nov. 24, 1836, in Oporto. He became a teacher of French in the Oporto Colégio da Lapa, and began to write for the *Jornal do Porto* at the age of 19. In 1868 he moved to Lisbon to take up an appointment in the office of the Academia Real das Ciências. In Lisbon he continued writing assiduously for Portuguese journals and established contact with the progressive intellectuals and writers, Antero de Quental, Oliveira Martins, Eça de Queirós and others. Ortigão and his lifelong friend, Queirós, together started the satirical review, *As Farpas*, in 1871, and after the departure overseas of Queirós late in 1872, Ortigão produced the review alone until 1888. In his hands *As Farpas* gradually became less satirical and more didactic and descriptive.

Throughout his life Ortigão, a robust, athletic figure, traveled widely. His writings reveal his mastery of Portuguese prose, his remarkable descriptive power and his intense love of and concern for the welfare of his native land. But his most outstanding book is probably *A Holanda* (1885) in which fine descriptions of the country are combined with praise for the mode of life and achievements of the Dutch people. With advancing years his political outlook became more conservative; he was opposed to the republican coup of 1910 and, in protest, resigned his public appointments as keeper of the Ajuda library and secretary to the Academia Real das Ciências. He died on Sept. 27, 1915, in Lisbon. Ortigão's complete works were published in 39 volumes (1943–49).

See R. Jorge, *Ramalho Ortigão* (1915); J. De Barros, "Ramalho Ortigão," in *História da Literatura Portuguesa Ilustrada dos Séculos XIX e XX* (1932). (N. J. L.)

ORTNIT (ORTNID, OTNIT, ORTNEID), a figure in German heroic poetry. His story has come down to us in Middle High German as one of those collected in *Das Heldenbuch* (*q.v.*). Ortnit

ruled at Garda in Lamparten (Lombardy). Helped by a supernatural dwarflike figure, Alberich, who reveals himself as his father, Ortnit journeys to the east and captures the daughter of the heathen king Machorel whom he brings back to his kingdom as his bride. The bride's father, feigning reconciliation, sends to Ortnit's lands two huge eggs which hatch into two dragons who ravage the country and kill Ortnit. His death is avenged in another story by Wolfdietrich (*q.v.*).

The Ortnit poem is probably an earlier work of the *Wolfdietrich* poet. Versions of the story are found also in Low German and in the Icelandic *Thidrekssaga*.

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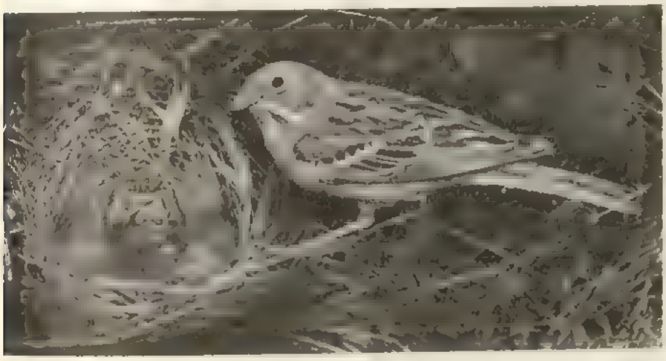
ORTOLAN (ORTOLAN BUNTING), a bird (*Emberiza hortulana*) of the passerine family Fringillidae. It differs from similar buntings in having pinkish-buff underparts and a yellow throat. A native of most European countries—the British Isles excepted—as well as western Asia, the ortolan is celebrated for the delicate



ERIC HOSKING

ORTOLAN BUNTING (EMBERIZA HORTULANA) AT ITS GROUND NEST

flavour of its flesh and is netted in great numbers to be fattened for the table. It is migratory in the north where its reappearance late in April or May is associated with the return of fair weather. It is most abundant in open hilly country but also occurs in the lowlands. The song is much like that of the related yellowhammer (*E. citrinella*), but is slower, more varied and usually of six or seven clear notes followed by an occasional flourish. The nest is placed on or near the ground and may contain four or five glossy greenish-white eggs, variously marked with purple and brown. *See* also FINCH. (E. R. BE.)

ORTONA, a town of Chieti province in the Abruzzi e Molise region of Italy, lies on the Adriatic coast 13 mi. S.S.E. of Pescara by rail. Pop. (1961) 21,960 (commune). It is on a promontory 230 ft. above sea level and connected by a funicular railway with the small port below. The population is engaged chiefly in fishing and trade; there are also brick and *pasta* factories (producing spaghetti). Vines are cultivated in the area and grapes are exported in large quantities to northern Europe.

Ortona is an ancient settlement; Strabo and Pliny the Elder place it in the territory of the Frentani, a clan that allied itself with Rome in the 4th century B.C. It was later a Roman municipality. It was several times devastated by earthquakes. In the 18th century, it was annexed to the kingdom of Naples and subsequently absorbed into modern Italy.

Important monuments are the cathedral, with a fine portal by Nicolo Mancini (1312), and the Aragonese castle (15th century), both heavily damaged during World War II. (M. T. A. N.)

ORURO, a department on the Altiplano of central Bolivia, bounded north by La Paz, south by Potosí, west by the Republic of Chile and east by Potosí. Area 20,690 sq.mi. Pop. (1962 est.) 265,400. The department was established in 1826, during the administration of Antonio José de Sucre. It comprises eight provinces: Cercado, Pantaleón Dalence, Carangas, Poopó, Sabaya, Sajama, Abaroa and Ladislao Cabrera. The region has a cold climate and is semiarid, conditions militating against successful agriculture. Lake Poopó, a shallow body of water 62 mi. long by 28 mi. wide, lying at 12,119 ft. above sea level, has a strong salt content, and salt deposits are abundant nearby. A small stream, Lacajahuira, is the only outlet and this disappears below the surface within a few miles. The Desaguadero river, which drains Lake Titicaca to the south, flows into Lake Poopó.

Mining is the basis of the economic life of Oruro; in mineral wealth the department is almost as notable as Potosí. Minerals comprise tin (Cercado; Poopó; Abaroa), zinc (Poopó), wolfram (Cercado), silver (Cercado; Poopó; Abaroa), bismuth (Poopó; Cercado) and gold (Cercado). Agriculture and stock raising are carried on in traditional primitive fashion by the rural inhabitants, chiefly Indians. Principal crops cultivated are potatoes, quinoa, cañahui and barley. The llama and alpaca are the important livestock raised there, and to a lesser extent, cattle, sheep and mules.

The capital of the department is the city of Oruro lying at 12,160 ft. above sea level. Transportation facilities within the department include a highway system in addition to air and railway lines. (J. L. TR.)

ORURO, a city of Bolivia, capital of the department of the same name and of the province of Cercado. Pop. (1962 est.) 86,985. The city was founded by Manuel Castro de Padilla in 1606, with the name "Real Villa de San Felipe de Austria" ("Royal Town of St. Philip of Austria"), conferred upon it by King Philip III of Spain. It lies at an elevation of 12,160 ft. above sea level; the annual average temperature is 50° F. The city was notable during the colonial period as a centre of a rich silver mining region. It lost importance with the decline of silver production in the 19th century but regained status with the rise of tin mining, as this ore is abundant there. Wolfram and copper are also worked in the district. Oruro is the hub of the Bolivian railway system and lies 141 mi. from La Paz, 131 mi. from Cochabamba and 575 mi. from Antofagasta, Chile. (J. L. TR.)

ORVIETO (an Etruscan city, later Roman name URBS VETUS, from which the modern name is derived), a town of central Italy in the region of Umbria, province of Terni, lies on the Paglia river 78 mi. (126 km.) N.N.W. of Rome by road. Pop. (1961) 25,769 (commune). It crowns an isolated rock 640 ft. above the plain, and is approached by a funicular railway from the main line station. There are many fine 13th-century houses and palaces. The cathedral was begun in 1290 to commemorate the miracle of Bolsena (*q.v.*) and was decorated by many medieval painters and sculptors. The west facade, a fine polychrome monument of richly sculptured marble from the designs of, and begun by, Lorenzo Maitani of Siena, is divided into three gables with intervening pinnacles. The mosaics are mostly modern. Beautiful sculptures in relief flank the doorway. In the interior, the Cappella (chapel) del Corporale has a large silver shrine, enriched with figures in relief and with enamel work. Begun by Ugolino di Vieri of Siena in 1337, it contains the Holy Corporal (linen cloth) from Bolsena. The Cappella Nuova o della Madonna di S. Brizio is separated from the nave by a fine 15th-century wrought-iron screen. The walls and vault are covered with frescoes by Fra Angelico and Luca Signorelli (the latter date from 1499 to 1504). They had a great influence on the young Michelangelo. The choir stalls, of tarsia and rich wood carving (1331–1340), are by Giovanni Ammannati da Siena. The cathedral is especially rich in 16th-century sculpture, with statues, groups and altar reliefs by Simone Mosca and Ippolito Scalza. Nearby are two Gothic buildings, the Palazzo Vescovile or bishop's palace (1264) and the Palazzo dei Papi (1296–1302), the latter containing the civic museum with many works of art and also objects from the Etruscan necropolis of Volsinii. The Palazzo Faina has another Etruscan collection. The Palazzo Comunale (16th century) was built by Scalza on the site of a 13th-century building. S. Andrea and S. Giovenale are Romanesque churches of the 11th–13th centuries; the former was probably built on the site of a pagan temple. The Palazzo del Popolo dates from the 13th century and the abbey of SS. Severo e Martirio, 1 mi. S. of the town, from the 11th–12th. The church of S. Domenico contains a fine sculpture (1282) by Arnolfo di Cambio and the Romanesque church of S. Lorenzo

de Arari has an altar standing on Etruscan foundations. The fortress (1364) has been converted into public gardens. The disused St. Patrick's well or Pozzo di S. Patrizio (about 200 ft. deep) is surmounted by a low tower, encircled by two spiral staircases (each with 248 steps) and lit by 72 windows; it was begun by Antonio da Sangallo the Younger in 1527 and completed by Mosca in 1540.

Orvieto is linked with Rome and with Florence via Arezzo by rail and road. Handcraft industry is represented by ceramics and lace; the white wine of Orvieto is well known. (Lu. T. C.)

ORWELL, GEORGE (pseudonym of Eric Arthur Blair) (1903–1950), English writer whose satirical novels *Animal Farm* and *Nineteen Eighty-Four* are reminiscent of Jonathan Swift in their savage anger and love of liberty, was born at Motihari, Bengal, in 1903. From a preparatory school which, he later claimed, determined his views on the English class system, he won a scholarship to Eton. From 1922 to 1927 he served in the Indian imperial police in Burma. After returning to Europe, he lived in great poverty in Paris and London, and described his experiences in his first book, *Down and Out in Paris and London* (1933) and in *The Road to Wigan Pier* (1937). He was exceptional among writers of his generation in deliberately living under the social conditions he wrote about.

This singleness of purpose in pursuit of his material and the uncompromising honesty which marked him both as a man and a writer made Orwell sharply critical of intellectuals whose political attitudes seemed to him dilettante. Thus, though a writer of the left, he wrote the most savage criticism of his generation against left-wing writers, and his anti-Communism resulted from experience of Communism and its methods acquired while fighting in the Spanish civil war, and described in *Homage to Catalonia* (1938). From this period also derived both the anti-Stalinism expressed in his fantasy *Animal Farm* (1945) and the distrust of all political parties which inspired *Nineteen Eighty-Four* (1949), an elaborate satire on modern politics prophesying a world perpetually laid waste by warring dictators. His best work was always based on experience and the lessons he had learned from it.

While teaching in private schools and working in a London bookshop and in a village store (1933–35), Orwell was gradually making a literary reputation. After returning from Spain, he lived in Hertfordshire, writing, raising hens and growing vegetables. Rejected as unfit for service in World War II, he joined the BBC's Indian service. He died in London, Jan. 21, 1950.

As a prose writer, Orwell is in the radical tradition of Defoe and Cobbett. His criticism (*Critical Essays*, 1946) is revealing and enjoyable. In his essays (*Shooting an Elephant*, 1950, etc.) he shows lightness and grace. (S. H. Sr.)

ORYX, the name of a genus of African antelopes of large size, with long horns present in both sexes, and long tufted tails. They are desert animals. The true oryx is the east and northeast African beisa oryx (*Oryx beisa*), which is replaced in south Africa by the gemsbok (*q.v.*). In northern Africa the group is represented by the scimitar-horned oryx (*O. algazel*) and in Arabia by the very pale *O. leucoryx*.

See Antelope.

ORZESZKOWA, ELIZA (née Pawłowska) (1841–1910), one of the most popular Polish novelists of the period after 1863, was born on May 25, 1841, at Milkowszczyzna, near Grodno. In 1858 she married a landowner, Piotr Orzeszko. The marriage was annulled in 1869, whereupon she settled in Grodno. In 1882 the Russian authorities closed down the Polish publishing house and bookshop which she had founded in 1879 and placed her under police surveillance for five years. In 1894 she married S. Nahorski who died in 1896. She died in Grodno on May 18, 1910. The ill-fated uprising of 1863 cast a lasting shadow over her life but she clung to many of the insurgents' ideals: social justice and equality, individual freedom and the brotherhood of man, which, with a faith in human perfectibility, animate her writings.

Many of Eliza Orzeszkowa's novels were translated into Russian, German and Swedish, and three into English. Among her works *Meir Ezofowicz* (1878; Eng. trans. 1898) presents a lurid picture of Jewish life in a small town in Belorussia and preaches not so much toleration as the assimilation of the Jewish community; and *Cham* ("The Boor," 1889), the tragic story of a humble fisherman's love for a neuropathic and sophisticated chambermaid, displays great narrative skill and psychological insight.

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OSAGE, a Siouan-speaking tribe related to the Omaha, Ponca, Kansa and Quapaw. Like other members of this subgroup, they have traditions of an early home in the lower Ohio valley. By 1673 they were living in the Ozark plateau and the prairies of what is now western Missouri, with their villages on the Osage river. Intrigues of rival fur traders in the early 19th century split the tribe, part of which moved to the Arkansas river in Oklahoma, but both factions later united on a reservation established for them in Kansas. In 1872 they were moved to a new reservation in Oklahoma, comprising the present Osage county.

Their culture was of the prairie type, marked by the characteristic alternation of village agriculture and buffalo hunting. Other important game animals were deer, bear and beaver. The villages consisted of longhouses, covered with mats or skins and arranged irregularly about an open space used for dances and council meetings. Tepees were used during the hunting seasons. Social organization was very similar to that of the Omaha (*q.v.*), with patrilineal clans grouped into moieties symbolizing earth and sky. However, Osage ceremonies were more elaborate and played a greater role in tribal life; and their earth moiety included two subdivisions symbolically representing dry land and water. Each moiety had a hereditary chief concerned with enforcing peace within the tribe.

Even before the discovery of oil on their reservation at the beginning of the 20th century, the Osage were the wealthiest Indian tribe in the United States. Their allotment act, passed in 1906, included a provision that all mineral rights on the reservation remain tribal property, with royalties divided on a per capita basis. As a result, they have become one of the richest communities in the world. In the 1960s the Osage numbered about 4,900.

See also Plains Indians.

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OSAGE ORANGE (*Maclura pomifera*), a thorny tree with large, yellowish-green, wrinkled orangelike fruit and a milky sap that can produce dermatitis. The tree, which is the only species of its genus, belongs to the mulberry family (Moraceae). It is native to rich soils in the south central United States from Missouri and Kansas to Texas, but has been planted extensively in the Mississippi valley and occasionally in the eastern states, being hardy in New England. It is often trained as a hedge; planted in rows along a boundary, it forms an effective spiny barrier. The very hard, strong, flexible, yellow-orange wood, formerly used for bows and war clubs by the Osage and other Indians west of the Mississippi, is utilized for railway ties (sleepers) and fence posts.

J. HORACE MCFARLAND CO.

OSAGE ORANGE (MACLURA POMIFERA), FOUR TO FIVE INCHES IN DIAMETER

Osage orange is also known as bowwood and *bois d'arc*. The wood yields a yellow dye principle. Attempts have been made to prepare an edible meal or flour from the hard globular fruit, often five inches across, which was long considered poisonous.

OSAGE RIVER, the largest tributary of the Missouri river (*q.v.*) in Missouri, rises as the Marais des Cygnes in the Flint

hills near Eskridge, Kan. It becomes the Osage after junction with the Little Osage in Missouri, then flows east through the Ozark highlands to its mouth near Jefferson City. In the Ozarks it has deeply intrenched meanders with a relative relief of 200 to 400 ft., but in Kansas meanders are not intrenched and relief is less. The Osage is 500 mi. long, drains 15,300 sq.mi. and has an average discharge of 9,000 cu.ft. per second near Bagnell dam about 100 mi. above the mouth, with peak flows from March to June. The major tributaries are the Pomme de Terre and Niangua. In Lake of the Ozarks, covering 93 sq.mi. and lying equidistant from St. Louis and Kansas City, it has one of the best known and most scenic recreation areas in Missouri. Nearby are the famous Hahatonka limestone caverns. Bagnell dam, which impounds the lake, was built (1931) to produce electricity for the St. Louis power system. Normal annual production in the 1960s was 440,000,000 kw.hr. In the 1950s the U.S. congress authorized an Osage basin flood control, water conservation, recreation and power plan involving four reservoirs in Missouri and five in Kansas. (D. S. St.)

ŌSAKA, an urban prefecture (*fu*) of Honshu, Jap., is at the eastern end of the Inland sea. Area: 699 sq.mi., pop. (1960) 5,504,746. Its main part is a delta plain formed by the Yodo and Yamato rivers and almost encircled by low mountain ranges. Prefectural life is dominated by Ōsaka, Japan's second largest city and one of its most diversified industrial centres. Around it are industrial satellite cities like Sakai, Fuse (*qq.v.*), Kishiwada and Kaizuka and residential satellites like Toyonaka and Suita. Steadily shrinking agricultural areas are cultivated intensively, producing cut flowers, vegetables and fruits. (J. D. Ee.)

ŌSAKA, Japan's second largest city, one of its two greatest commercial and industrial centres, and capital of Ōsaka urban prefecture. It is located on the delta of the Yodo river at the head of Ōsaka bay (eastern Inland sea) only slightly above sea level. It is so intersected by river distributaries and canals that hundreds of bridges are employed to link parts of the city. Ōsaka occupies one of the longest settled sites of western Japan and for centuries (known as Naniwa) was the main port serving the interior capital cities of Nara and Kyōto. Its growth was checked by the rise of port and trading facilities at Sakai, to the south. However, the powerful general, Toyotomi Hideyoshi, selected Ōsaka as his headquarters and in 1583 built a powerful castle on an elevated terrace slightly inland from the coast, protected by massive stone walls and broad moats. Destroyed by fire in 1868, the castle was later recreated in reinforced concrete form and towers above the modern city centre. During the feudal (Tokugawa) era, Ōsaka became Japan's key commercial city, serving as the collection point for rice, other foodstuffs and raw materials destined for shipment to Edo (modern Tokyo), Kyōto and other large cities. The influence of the rich merchants who handled this business extended throughout Japan. Ōsaka suffered a momentary setback with the crumbling of the feudal order and the inadequacy of its shallow port to accommodate large ships. Yet, the rapid development of an outport, Kōbe (16 mi. W.), opening of the national mint (1871), stock exchange, commercial colleges, and continuation of the famous Dojima rice exchange helped Ōsaka move into modern commercial life. Turning to industry, the city initially became Japan's leading cotton textile producer and after World War I, expanded into heavy industrial products. Amalgamation of adjacent areas and in-migration caused the population to grow from about 50,000 in 1895 to 3,250,000 in 1940, second only to Tokyo. Badly damaged in World War II, it was slow to recover, and the 1960 census gave a population of 3,011,563. Deterrents to more rapid rehabilitation were the loss of continental Asian markets on which much of Ōsaka's business depended, powerful central government controls that encouraged industrial location in the competing Tokyo-Yokohama area, and absorption of some of its prewar population by adjacent cities.

Although still a great cotton textile centre, Ōsaka turns out a variety of other manufactures. Metals (steel), machinery, chemicals, ships, electrical equipment and cement are typical specialties. The city's commercial core is near the castle, while industry has concentrated heavily on reclaimed waterfront land and lowlands along the Yodo river. Ōsaka is the industrial nucleus of a broader industrial belt that extends westward from the Hyōgo cities of Kōbe, Nishinomiya and Amagasaki, south through Sakai, Kaizuka and Kishiwada, and inland through a host of industrial and residential satellite cities. Similarly, Ōsaka serves as the financial and commercial capital of western Japan, noted for its large banks, trading firms, department stores and wholesale outlets. It is also the location of Ōsaka university and prefectural library. Ōsaka's modern rise has been paralleled by improvements in its port, which is entirely artificial. Dredging permits the entry of 10,000-ton ships to the industrial heart of the city. The city's airport is at Itami, nine miles to the northwest. (J. D. Ee.)

OSAWATOMIE, a city of Miami county in eastern Kansas, U.S., is located about 45 mi. S.S.W. of Kansas City on the Marais des Cynges river at the mouth of Potawatomie creek. It is near oil and gas fields in the centre of an agricultural region which produces beef and dairy cattle, corn, wheat, oats and fruit.

Founded in 1854 with support of the Massachusetts Emigrant Aid company, Osawatomie was the site for John Brown's free-state operations in Kansas territory. In retaliation for Brown's slaying of four prosouthern settlers at Potawatomie creek, the Abolitionist stronghold was invaded on Aug. 30, 1856, by a party of about 250 Missourians. Brown and 40 of his followers were dispersed, and the town was ransacked and burned. The 23-ac. John Brown State park located there commemorates this skirmish and Brown's career. Osawatomie, a word which combines the names of the Osage and Potawatomi Indians, was incorporated in 1883. Its population grew to between 4,000 and 5,000 by 1900 and remained fairly steady thereafter. (C. N. Gl.)

OSBORN, HENRY FAIRFIELD (1857–1935), U.S. paleontologist and for many years president of the American Museum of Natural History, for whose rise to a high level in exhibition, public education and research activities he was largely responsible, was born at Fairfield, Conn., Aug. 8, 1857. Before graduating from Princeton in 1877, he and his friend William Berryman Scott led a fossil collecting expedition to Wyoming, and both determined to take up a career in vertebrate paleontology. Both went abroad for graduate study, and both returned to Princeton, Scott as professor of geology, Osborn as professor of natural history and anatomy. In 1891 Osborn moved to New York, where he became curator of vertebrate paleontology in the American Museum of Natural History and professor in the newly organized department of zoology at Columbia university.

Although he served for a short time as dean of the faculty of pure science, and retained a research professorship until his death, his connection with the university gradually slackened, and his interests were concentrated on the museum. He became its president in 1908. Despite his engagement in administrative affairs, he continued active work in vertebrate paleontology, and in addition to his own work built this museum department into an outstanding research centre with the world's largest and most important collection of fossil vertebrates.

Osborn's publications on fossil vertebrates, particularly mammals, were numerous and important. Among his major works were: *From the Greeks to Darwin* (1894); *Evolution of Mammalian Molar Teeth* (1907); *The Age of Mammals* (1910); *Men of the Old Stone Age* (1915); *Origin and Evolution of Life* (1917); *Man Rises to Parnassus* (1927); *The Titanotheres of Ancient Wyoming, Dakota and Nebraska* (1929); *Proboscidea*, 2 vol. (1936–1942). He was interested in evolutionary processes, but his ideas on "aristogenesis" and kindred themes are incompatible with modern knowledge of hereditary processes and have met with little acceptance. He died Nov. 6, 1935.

See obituary by William King Gregory (with portrait) in *Biogr. Mem. Nat. Acad. Sci.*, vol. xix, no. 3, pp. 53–119 (1938). (A. S. Rr.)

OSBORNE, DOROTHY (1627–1695), the wife of Sir William Temple (*q.v.*), is remembered as the writer of a series of letters to him before their marriage which are regarded as among the best in the English language. The daughter of Sir Peter Osborne (1585–1654), who, as lieutenant governor of Guernsey, held Castle Cornet for the king during the English Civil War, she was born in 1627, probably at Chicksands priory, Bedfordshire; the

family seat. In 1642, when their estates were confiscated, Lady Osborne and her children went to St. Malo, and after returning to England (1644) lived with friends and relations. In 1646, Sir Peter, forced to resign his command, retired to St. Malo, and Dorothy Osborne's first meeting with William Temple took place in 1648 in the Isle of Wight, when she was on her way to visit her father.

Both families opposed the marriage, and only after a lengthy and trying courtship, prolonged by Temple's absences abroad, by Dorothy's care of her father (who returned to Chicksands in 1649), by the importunity of other suitors and, finally, by an attack of smallpox, were they eventually married on Dec. 25, 1654. Thereafter her life story is that of her husband's. A devoted wife, she helped him in his career as statesman and diplomat, and in the latter part of her life was a friend of Queen Mary. Of their nine children, seven died in infancy; an only daughter died in 1684, and their eldest son, John, drowned himself in 1689, a few days after accepting office as secretary at war. Lady Temple died in Feb. 1695, and was buried in Westminster abbey.

Her husband preserved the group of letters written to him between Dec. 1652 and Oct. 1654, and they remained in manuscript until the 19th century, when they came into the possession of R. B. Longe. They were sold to the British museum, London, in 1891. Extracts, printed in the appendix to T. P. Courtenay's *Life of Sir William Temple* (1836), were highly praised in Macaulay's review of Courtenay's book (*Edinburgh Review*, Oct. 1838).

Dorothy Osborne's letters admirably fulfill the requirements she herself laid down: "All letters, methinks, should be free and easy as one's discourse, not studied as an oration, nor made up of hard words like a charm." They are lively, tender, and full of good sense, humour and keen observation, giving an attractive picture of the life of a young English gentlewoman in the Commonwealth period, with shrewd and amusing accounts of her suitors (who included Henry Cromwell, son of the Protector), her reading, her dogs, her occasional visits to London and such pleasant incidents as a stroll on a common near Chicksands where she met "a great many young wenches" keeping "sheep and cows" sitting "in the shade singing of ballads." Of the few later letters preserved, one to her husband from The Hague in Oct. 1670 shows the keen interest she took in his political activities, and the continuance of the love and understanding between them.

BIBLIOGRAPHY.—*The Letters From Dorothy Osborne to Sir William Temple*, including those taken from Courtenay's appendix and others acquired later were first edited by E. A. Parry (1888; rev. ed. 1903; Wayfarer's library, 1914). A fuller and more scholarly edition, *The Letters to William Temple*, by G. C. Moore Smith, appeared in 1928. *See* also the sympathetic study by Lord David Cecil in *Two Quiet Lives* (1948). (V. DE S. P.)

OSBORNE HOUSE, a former royal residence in the Isle of Wight, Eng., lies southeast of Cowes. It was bought by Queen Victoria in 1845, with 800 ac., subsequently increased to 5,000. The present house was completed in 1851 by Thomas Cubitt from plans prepared by Prince Albert. The grounds were also laid out and planted under the supervision of the prince. Osborne was the queen's private property and was, therefore, not subject to government control. Queen Victoria died there, and after her death it was given by King Edward VII to the nation and used as a naval training college till 1921 when it was converted into a convalescent home for officers. The state apartments and the queen's private suite have been open to the public since 1956. (R. T. B. F.)

OSCAN was one of the Italic dialects (*q.v.*); the name was given by the Romans to that dialect (*lingua Osca*) which they found spoken by the Osci of Campania. Inscriptional and other records (*i.e.*, local and personal names and glosses in ancient authors) manifestly of the same dialect have been found in Campania, where the dialect was probably not original but imposed upon the Oscans by Samnite invaders in the 5th century B.C. Records have also been found in other areas: further south, namely in northern Apulia (*q.v.*), Lucania, in the country of the Bruttii (the "toe" of Italy), and even in the northeast angle of Sicily at Messana (the modern Messina), which was captured by the Campanian Mamertines *c.* 289 B.C.; in Samnium proper, including the territory of the Frentani and Hirpini; and finally, farther north, in the country of the Paeligni, Marrucini and Vestini. Thus there are distinguished, geographically, and dialectally, three main groups of Oscan: (1) Central Oscan of Campania and the Samnite tribes, (2) Southern Oscan and (3) Northern Oscan. These are all closely related to one another as compared with the dialect of the Volsci and of the Umbrian townships (Iguvium, the modern Gubbio; Tuder, modern Todi; and one or two others); while Oscan, Volscian and Umbrian, taken together, make one of the two great divisions—the other being Latin (*q.v.*) with Faliscan—into which the Italic branch of the Indo-European family of languages falls. Since the Samnitic tribes, whose expansion by successive migrations—"sacred springs" as they were called—diffused the Oscan speakers from their home in central Italy, knew their land (in Latin, Samnium) by the name *Safinim*, it has been proposed to describe their dialects as "Safine," a title at once more comprehensive and historically truer than "Oscan." The stock to which the Samnites (*q.v.*) belonged used commonly a suffix *-no-* (*e.g.*, in *Sabi-ni*) to form their tribal names, as distinguished from the suffixes *-co-* and *-(a)ti-* of an earlier stratum of population (*e.g.*, in *Vols-ci*, *Tea-te*). In names like *Marru-ci-ni*, *Ardea-ti-ni*, the superimposed *-no-* suffix bears witness to a conquest or overlordship of the earlier by the later stock.

Until the Roman advance gradually replaced it by Latin—important stages of this advance are marked not so much by the three Samnite wars as by the destruction of Capua in 211 B.C. and the Social War of 91–89 B.C.—Oscan held its place as a language in recognized official and educated usage side by side with, or instead of, Latin or Greek. The poet Ennius is said to have spoken all three tongues (Gellius 17,17,1), and if Strabo (5, p. 233 C) may be trusted, the rude farces or puppet shows introduced from the Oscan town Atella (*fabulae Atellanae, ludi Osci*) were actually performed at Rome in Oscan. The latest Oscan inscriptions, painted on the walls of houses at Pompeii, were written shortly before the eruption of Vesuvius which overwhelmed that city in A.D. 79, and it is probable that the dialect, which has left its mark on modern south Italian dialects, survived in remote country districts as a local patois for some time longer. None of the Oscan inscriptions, on the other hand, is older than the 5th century B.C.

Many of the inscriptions are carefully, indeed almost with phonetic accuracy, written in a native alphabet which was itself derived, with certain necessary modifications, from the Etruscan alphabet; but a few belonging to the southern group, and including all those from Sicily, are in the Greek, and some from Lucania and elsewhere in the rustic or Colonial Latin alphabets. Over 250 in number, the majority are quite short; nevertheless, they furnish materials adequate to give us a fairly complete conspectus of the dialect. About two-thirds of the whole come from Campania, and most of those from Capua and Pompeii.

In character they fall mostly into the following classes: (1) official documents—municipal regulations (Bantia), a treaty (Nola and Abella), inscriptions relating to public works (Pompeii and elsewhere); (2) religious—an inventory of statues and altars in a sacred grove at Agnone (Samnium), the interesting group of heraldic *iovilae* from Capua, recording or prescribing special ceremonies connected with family cults, numerous simple votive and dedicatory inscriptions; (3) military and election announcements (from Pompeii); (4) private documents—epitaphs, bricks inscribed with names, and (from Campania) a few belonging to the interesting group of curses, inscribed on lead and deposited in tombs; (5) coin legends, including those of the Social War reading *vítelliú*, *i.e.*, "Italia."

Oscan has many peculiarities which distinguish it from Latin in sound changes, word forms and vocabulary; in syntax the differences are much less marked. But it also possesses certain features which distinguish it among the Italic dialects themselves. Their nature and extent may be indicated roughly by a specimen text (on a sundial found at Pompeii):

mr atiniís mr kvaisstur eítiuvad
múltasikad kúmbennieís tangi(nud)
aamanaffed

This in Latin would be:

M(a)r(a) Atinius M(a)r(ae) (filius) quaestor pecunia
multaticia conventus scitu
fieri iussit

(Mara Atinius, son of Mara, quaestor, in accordance with a decree of the assembly, had this set up from fine-money.)

See also LATIN LANGUAGE and references under "Oscan" in the Index.

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(J. WH.)

OSCAR I (1799–1859), king of Sweden and Norway from 1844 to 1859, was born in Paris on July 4, 1799, and was christened Joseph-François. When his father, Marshal Bernadotte, became Swedish crown prince in 1810 and King Charles XIV John in 1818, Oscar became prince and then crown prince. By his marriage (1823) with Josephine of Leuchtenberg, he had four sons, of whom two (Charles XV and Oscar II) succeeded to his throne, and one daughter. As crown prince Oscar was much influenced by liberal ideas, especially in connection with fiscal policies, freedom of the press, education and penal reform. Despite his liberalism, his relations with his more conservative father remained good. After his accession (March 8, 1844) he furthered various reforms but his attitude was paternalistic; he became increasingly conservative in constitutional questions, especially after the revolutions of 1848, and he sought to emulate Napoleon III. In foreign affairs he reversed his father's pro-Russian policy. He supported Denmark against the Germans in 1848, sending Swedish and Norwegian troops to the Danish island of Fyn. He took part in the negotiations resulting in the London protocol of 1850, which guaranteed the integrity of Denmark, and in the agreement made two years later on the Danish succession. During the Crimean War (1854–56) he made a treaty (1855) with Great Britain and France against Russia. He prepared an expedition to recover Finland but the peace of Paris in 1856 frustrated his design. He became ill in 1857 and his son, the future Charles XV, acted as regent. Oscar died in Stockholm on July 8, 1859. *See* NORWAY: *History;* SWEDEN: *History.*

See A. Söderhjelm and C. F. Palmstierna, *Oscar I* (1944).

(S. C. O. C.)

OSCAR II (1829–1907), king of Sweden from 1872 to 1907 and of Norway from 1872 to 1905, son of Oscar I, was born in Stockholm on Jan. 21, 1829. As prince (Oscar Fredrik) he was duke of Östergötland. He married Sophie of Nassau in 1857 and had four sons, of whom the eldest succeeded him as Gustavus V. Associated with the navy from childhood, Oscar always retained a special interest in its development and organization. He was an outstanding orator, loved music and literature and himself published several books of verse and wrote on historical subjects. In home politics a conservative, in foreign policy he favoured Scandinavian co-operation. After 1866 he supported Germany, hoping that that country would provide a bulwark against Russian aggression, and when he became king (Sept. 18, 1872) he encouraged the Germanophile trend which characterized Swedish political and cultural life from the 1870s until the outbreak of World War I in 1914.

During the struggle over customs duties in the 1880s King Oscar's sympathies were with the free traders. In the 1890s he supported the efforts of the prime minister, E. G. Boström, to strengthen Swedish military power. He tried hard to maintain the union of Norway with Sweden, and was much grieved when he was obliged to abdicate the Norwegian throne in 1905. He refused to allow the use of force against the Norwegians but forbade any prince of his house to accept the Norwegian crown. He died in Stockholm on Dec. 8, 1907. *See* NORWAY: *History;* SWEDEN: *History.*

See S. J. Boëthius, *Oskar II*, in *Sveriges historia till våra dagar*, ed. by E. Hildebrand and L. Stavenow, vol. xiii (1925); Oscar II, *Mina memoarer*, 3 vol. (1960–62).

(S. C. O. C.)

OSCEOLA (*c.* 1804–1838), a leader of the Seminole Indians during the Second Seminole War, which began late in 1835 when the U.S. government attempted to move the Seminoles to the Indian territory west of the Mississippi river. Born in Georgia about 1804, Osceola (also known by his English father's name, Powell) and his mother moved to the Florida territory. When in 1835 the U.S. commissioners negotiated with the Seminoles for removal, Osceola led the opposition of the young warriors. In 1835 he and a band of his braves murdered Charley Emathla, a chief who was preparing to emigrate with his people, and Gen. Wiley Thompson, the U.S. Indian agent at Ft. King.

For the next two years, U.S. troops tried to crush Seminole opposition. Withdrawing into the Everglades, the Indians harassed the troops with their guerrilla tactics. During this period Osceola was a recognized leader of his people. In Oct. 1837 he and several other leading chiefs went to St. Augustine under a flag of truce for a parley with Gen. T. S. Jesup. By special order of the general, the Indians were seized and imprisoned. Osceola was removed to Ft. Moultrie at Charleston, S.C., where he died Jan. 30, 1838. The war continued until 1842 but after Osceola's death the Indians were not very active.

See *Florida Historical Quarterly*, vol. xxxiii (Jan.–April 1955), pp. 161–305.

(G. C. O.)

OSCILLATOR, in electrical engineering, is a device which generates electrical oscillations. One of the more common applications of such oscillators is the production of high-frequency carrier signals in radio transmission. *See* BROADCASTING: *The Broadcast Transmitter;* RADIO RECEIVER; TRANSISTOR.

OSCILLOGRAPH. An oscillograph is an electromechanical device used for recording such electrical oscillations as alternating-current wave forms. An early practical version, the Duddell bifilar string oscillograph (1893), long served as the model for similar instruments. Basically, it consisted of a pair of series-connected wires running parallel between the pole pieces of a powerful permanent magnet. The current under study imposed torque on the pair of wires by generating around them a variable magnetic field which interacted with the uniform field from the permanent magnet. Changes in the magnitude and direction of this twisting force on the wires were proportional to variations in the amplitude and direction of the current. These changes were recorded on moving photographic film with a narrow beam of light reflecting from a tiny mirror cemented to the wires. A reliable time base for the record was provided by moving the photographic film at constant speed.

The developed film provided a permanent record of the instantaneous variations in amplitude and direction of the current relative to time. With the film at a reasonable distance, even minute deflections of the mirror were readily discernible.

The rigidly suspended pair of wires and the mirror constituted a natural vibratory system when current flowed, and the system was damped by immersion in an oil bath. Because of the mass of the vibratory system, the instrument was limited to currents of relatively low frequency (approximately 100 cycles per second).

Modern oscillographs and such related instruments as the recording voltmeter, recording current meter and process recorder produce continuous ink records of a variety of cyclic electrical and mechanical phenomena on strips of paper moving at constant speed. Mechanical oscillations (acoustical vibrations, for example) are readily converted to electrical oscillations with suitable transducers (*see* MICROPHONE).

One or more inked pens trace the pattern of change on the moving paper. Usually, each pen is activated by a current-carrying coil, or a moving vane, immersed in a steady magnetic field. As in a galvanometer, the coil carries the current being investigated and moves under the influence of the magnetic fields active in the system. In moving vane instruments, the current to be examined flows through coils mounted on the permanent magnet and magnetizes the vane, causing it to move in the field.

Modern oscillographic devices function over a greater frequency

range than was available with earlier instruments and, depending on their design, can record oscillations ranging from D.C. fluctuations up to those of about 2,000 cycles per second. Ordinarily, it is feasible to record complex wave forms only when their fundamental frequencies are substantially below the 2,000-cycle limit because of possible distortion of higher frequency harmonic components. The natural vibration frequency of the drive mechanism is another limiting factor. The highest frequency to be recorded should be well below the natural vibration frequency of the drive system. To achieve the desired sensitivity, some of these devices are equipped with calibrated electronic amplifiers.

Each drive system and its recording mechanism constitute an element or a channel. Commercial devices are available as single channel and multichannel units. Each channel can function independently, permitting a number of phenomena to be recorded concurrently, as in the electroencephalograph and in the polygraph used in lie detection.

For additional applications of oscillographic devices and more details regarding the principles by which they operate *see* INVESTIGATION, CRIMINAL: *Detection of Deception;* HEART, COMPARATIVE PHYSIOLOGY OF; CATHODE-RAY OSCILLOSCOPE; INSTRUMENTS, ELECTRICAL MEASURING. (J. F. RR.)

OSCILLOSCOPE: *see* CATHODE-RAY OSCILLOSCOPE; OSCILLOGRAPH.

OSEE, PROPHECY OF: *see* HOSEA, BOOK OF.

OSH, an *oblast* and town in the Kirgiz Soviet Socialist Republic of the U.S.S.R. The *oblast* was formed in 1939, and in 1959 incorporated the Dzhalal-Abad *oblast.* Area 28,533 sq.mi.; pop. (1959) 869,408, of which 278,726 were urban. Besides the Turkic-speaking Kirgiz, there are many Russians, Uzbeks, Ukrainians and Tadzhiks. The *oblast* is mountainous, the valleys lying at altitudes from 2,400 to 9,800 ft. The climate is continental and dry. The main rivers are the Kara-Darya and the Naryn, whose waters are used for irrigation. There are important deposits of coal, oil, gas, antimony, mercury and lead. The *oblast* accounts for one-third of the industrial produce of the Kirgiz republic and rich deposits of mercury and antimony are worked. The main crops are grain, tobacco and cotton; 990,000 ac. are under cultivation. The towns are Osh, Dzhalal-Abad, Kyzyl-Kiya, Kok-Yangak, Sulyukta, Uzgen, Maili-Sai and Tashkumyr. Branch lines connect Osh, Dzhalal-Abad, Kok-Yangak and Tashkumyr with the Fergana railway, but roads provide the main means of transport.

Osh, the administrative centre (pop. [1959] 65,197), stands on both sides of the Akbura river at the southeastern fringe of the Fergana valley and at the head of the Osh-Khorog motor road, 30 mi. E. of Andizhan. Industrial activities include silk and cotton ginning and food processing. (G. E. WR.)

O'SHAUGHNESSY, ARTHUR WILLIAM EDGAR (1844–1881), English poet, strongly influenced by Swinburne and the Pre-Raphaelites, was born in London on March 14, 1844. At the age of 17 he became a copyist in the British museum library and later a herpetologist in the zoological department. He published four volumes of verse: *An Epic of Women* (1870); *Lays of France* (1872); *Music and Moonlight* (1874); and *Songs of a Worker* (1881), published after his death in London on Jan. 30, 1881. His best-known poem is probably the "Ode" ("We are the Music Makers") included in F. T. Palgrave's *Golden Treasury* and other anthologies. He is representative of those Victorian poets for whom concentration on musicality and on intense but vague emotions took the place of moral grappling with the intellectual problems of the age. (G. S. F.)

OSHAWA, a manufacturing city and port of entry in Ontario county, Ontario, Can., on the north shore of Lake Ontario, 30 mi. E.N.E. of Toronto. Founded as a settlement on the military Kingston road in 1795 and named Oshawa in 1842 with the establishment of a post office there, it was incorporated as a town in 1879 and city in 1924. Pop. (1966) 77,706. Principal manufactures include automobiles, trucks and auto parts; foundry products, fabricated metals, stampings and machine parts; glass, plastics, textiles and pharmaceuticals; furniture, kitchen equipment, leather and cement products. In the 1960s over 85% of the homes in Oshawa were owner occupied. The city has good public and parochial schools, a public library, a general hospital, many parks and recreational areas, golf courses and a municipal airport. (F. G. R.)

O'SHEA, WILLIAM HENRY (1840–1905) and **KATHARINE** (1845–1921), whose connection with the Irish politician Charles Stewart Parnell (*q.v.*) brought about his downfall. William Henry O'Shea was the only son of a Dublin Catholic solicitor, Henry. Educated at Oscott and at Trinity college, Dublin, he became a cornet of the 18th hussars in 1858, and was retired as captain in 1862. In 1867, he married Katharine, sixth daughter of the Rev. Sir John Page Wood of Rivenhall place, Essex. They had one son, Gerard, and two daughters.

O'Shea was elected member of parliament for County Clare, and supported Parnell for the leadership of the Irish Nationalist party in 1880. It is not clear when he became aware of the existence of intimate relations between his wife and Parnell, though he subsequently alleged that only his wife's intercession prevented a duel in 1881. O'Shea seems to have been perpetually in financial embarrassment, and forever involved in schemes to get out of it. On four occasions, his intervention in the political activities of the Parnellite party had decisive results on public opinion. In 1882 he claimed credit as unofficial intermediary in negotiating the "Kilmainham treaty." Discrepancies revealed publicly in significant documents thereafter led Parnell to distrust him. In 1885 he claimed to have negotiated an agreement between Parnell and Joseph Chamberlain (*q.v.*) for a local government scheme in substitution for Home Rule. Not until 1888 did Chamberlain realize that O'Shea's version, if published, would damage him. After 1885 O'Shea attached himself to Chamberlain and used this contact to secure Parnell's support for his candidature at Galway in 1886. The publicity directed on this occasion to the relations between Parnell and Mrs. O'Shea led her husband to align himself with Chamberlain, and, like him, he failed to support the Home Rule bill. Thereafter O'Shea resigned his seat in the house of commons. Subsequently he gave evidence in favour of the authenticity of Parnell's signature to the forged Pigott letter in the special commission inquiry into Parnellism and crime.

On the death of Mrs. Benjamin Wood, the aunt with whom Mrs. O'Shea resided, her will, by which her considerable property was left to her niece, was contested by O'Shea among others; but this secured him little financial advantage. The divorce action in which Parnell was named as corespondent was not defended lest any suggestion of collusion might lead the queen's proctor to intervene, thus preventing the subsequent marriage of Mrs. O'Shea with Parnell. The divorce proceedings destroyed Parnell's political career, but also terminated that of O'Shea, who after 1890 retired to Brighton, where he died on April 22, 1905. Mrs. Parnell's reminiscences, published in 1914, included material relating to O'Shea, inserted at the instance of their son, Gerard. The composite nature of this publication was not fully recognized until, after Mrs. Parnell's death in 1921, there appeared the publications of Capt. Henry Harrison. (R. D. Es.)

OSHKOSH, a city of eastern Wisconsin, U.S., is located about 80 mi. N.N.W. of Milwaukee on the west shore of Lake Winnebago at the mouth of the Fox river; the seat of Winnebago county. The French were active in the area from the late 17th century, and from an early date Lake Winnebago and the Fox river formed an important link in one of the main routes from the Great Lakes to the Mississippi.

Although there was sporadic occupation earlier, permanent American settlement did not begin until 1836, the year the Menominee Indians ceded their claims to the area. At first the town was called Athens, but in 1840 it was given the name of Oshkosh in honour of a friendly Menominee chief. It was incorporated as a village in 1846 and as a city in 1853. In 1957 it adopted a council-manager form of government. In its early years lumbering was the main occupation, but other industries moved in later. Manufactures include finished wood products, luggage, clothing, machinery, trucks and processed foods. It is the site of Wisconsin State college, Oshkosh, founded in 1871 as State Normal school. For comparative population figures *see* table in WISCONSIN: *Population.* (RE. H.)

OSHOGBO, the capital town since 1951 of the Oshun division of Western Nigeria, Federation of Nigeria, lies at 1,025 ft. on the Oshun river between forest and savanna, 182 mi. by rail northeast from Lagos. Pop. (1961 est.) 143,813 (African pop.). The town hall and the Central mosque stand at the Oba's market in the centre of the town. There are a government trade centre, eight churches and 42 schools including a grammar school and several teachers' training colleges. The town, which has piped water and electricity, stands at a trunk road junction and has been on the main railway since 1906. The airport, five miles distant, is served weekly by internal airlines. The people are chiefly occupied in trading and farming. Local industries include dyeing and weaving, and there is a cotton-ginning plant.

Settlers from Ibokun, headed by the Owa Olaage, founded Ipole, 5 mi. from Oshogbo, but were driven from there by the drying up of the Omu river. Led by Laro, they settled at Ita-Ohuntoto, on the Oshun, from where they were eventually driven by floods. They called their new settlement, at the crossroads, Oshogbo which means "the town that serves as a link to other towns." The Oshun river has much influence on the life of the people and is worshiped at an annual festival in August. Two shrines are connected with this worship, the Ile Oshun, at the Oba's market, in which are stored the idols of this cult, and the Ojubo Oshun, on a bend of the river at the earlier site, which is the centre of the worship. Both are smeared with chalk and camwood. Among the idols is the wooden image of a woman who sold victuals to travelers at the crossroads and whose spirit was associated with the Oshun. The oba holds the title Ataoja ("he who stretches out his hand and takes the fish") first given to Laro, who fed the fishes and in return received from them a liquid held as efficacious against sterility in women. The position of the town at the edge of the forest protected it from the attacks of northern horsed armies, but the military support given during the 19th century by the more powerful Ibadan resulted in the exaction by that town of a tribute (discontinued in 1951) from the people of Oshogbo. (S. AD.; M. O. A.)

OSIANDER, ANDREAS (1498–1552), German theologian, a brilliant, original and erratic Lutheran reformer and ancestor of a long line of eminent theologians and scholars, was born on Dec. 19, 1498, at Gunzenhausen, Brandenburg, the son of a blacksmith. He was educated at Leipzig, Altenburg and the University of Ingolstadt. Ordained priest in 1520, he helped reform the imperial free city of Nürnberg on strictly Lutheran principles. He won Albert von Hohenzollern, grand master of the Knights of the Teutonic Order, for the Lutheran movement (1522); helped write the influential Brandenburg-Nürnberg Church Order (1532); drafted the preface to Nicolaus Copernicus' *De revolutionibus orbium* (1543) that kept this work off the *Index Librorum Prohibitorum* until the next century; and compiled the liturgically very conservative Pfalz-Neuberg Church Order (1543). In 1548, when the emperor compelled Nürnberg to accept the Augsburg Interim, Osiander fled, first to Breslau (Wroclaw), then to Königsberg (Kaliningrad), where, despite his lack of a theological degree, he was appointed professor primarius of the new university's theological faculty (1549). The envy of his colleagues and his own refractory personality combined to produce a violent theological controversy (1550). One Lutheran faculty and synod after the other pronounced against Osiander's depreciation of the "forensic" element in the justification of a sinner and his exaggerated stress on the indwelling of the "essential" righteousness of Christ's Godhead as the principal factor. (*See* also LUTHERANISM: *History*.)

Osiander died Oct. 17, 1552, while the controversy was still going on.

The two works in which Osiander set forth the characteristic features of his system most fully are *An filius dei fuerit incarnandus si peccatum non introvisset in mundum, item de imagine dei* (1550) and *Von dem einigen Mittler Jesu Christo und Rechtfertigung des Glaubens* (1551).

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OSIER, the common name of certain European willows with pliable straight stems (rods) used for basketry and making furniture. In North America the red-stemmed dogwood (*Cornus stolonifera*) is called red osier. Osier cultivation from cuttings goes back at least 2,000 years. Wicker fragments dated at 100 B.C. have been found in the Glastonbury Lake Village site, and it is suspected that early potters, lacking the wheel, used molds of osier for shaping clay. The Romans made beehives of osier.

Several species of *Salix* are cultivated for their stems, but only two (together having some 50 varieties) are important: the common osier, *S. viminalis* (varieties: brown merrin, French osier, mealy top, yellow osier, etc.) and *S. triandra* (varieties: black maul, black Spaniard, champion red, glibskins, stone rod, etc.). A hybrid between these two species, called black top, locally yields the heaviest crop in parts of England. *Salix fragilis* and *S. purpurea*, of lesser importance, have very slender rods, which are employed principally by market gardeners for bunching vegetables. *S. fragilis* was extensively cultivated as hedges in the United States in the early 1900s. *Salix triandra* supplies the best rods for peeling (stripping the bark) when young, but inferior rods when used older. The hardier and more vigorous *S. viminalis* is employed primarily in coarse work.

The common osier, a tree 10 to 20 ft. tall, is native to Eurasia, where it is most frequently seen in osieries or plantations. Probably because of more severe winters, it does not thrive so well in North America. An abundant cropper, it is cut nearly to the ground each year, some varieties yielding rods 12 ft. long. Most varieties have pithy rods, but those called stone osiers are harder and, when peeled, are employed in the finest basket and furniture work.

Although tolerant of site, osiers prosper best in rich loam, ideally on a slope. While occasional floods are helpful to growth, the soil must be naturally or artifically well drained. Willows do not deplete the soil, and the abundant leaf fall replenishes humus annually, allowing some osiers to produce continually for 30 years or longer. They will not stand excessive wind or frost. As a crop, osiers respond quickly and yield much greater profits with appropriate growing conditions. From November to April, cuttings or sets, usually of two-year-old wood, about 1 ft. long, are planted up to 6 in. deep, 12 ft. apart in 18-in. rows. Weeds must be kept down in the warmer months, when osiers may grow an inch a day.

Harvesting ideally is done in early winter after leaf fall or in the spring as soon as sap flow sets in. Rods peeled in the spring are "couched" in damp straw, set in at a slight angle, with the butt ends on the ground, the tips being covered with rotting leaves to cause fermentation preparatory to peeling. Peeling is done as soon as tiny leaves appear at the tip ends. The peeled rods are sun-bleached white and are stored for sale. Unpeeled rods may be rendered various colours by immersion in boiling water for six hours, allowing the tannin in the bark to penetrate the wood, giving them a buff or brownish-yellow hue, or with extended treatment, even black. The finer rods were formerly peeled by drawing them by hand through a two-bladed iron "brake"; however, a modern motor-driven machine not only reduces damage but also produces a superior product. Rods are sorted by size, varying from three to seven feet long. Coarser rods, called "brown stuff," made into baskets or hurdles for fences, are soaked for a few hours before use to renew pliability.

As with other crops intensively propagated by vegetative means alone, the stock has gradually weakened over the centuries. Furthermore, the industry is beset by problems from vermin, fungi and insects. Osier cultivation is practised in Great Britain and across Europe, except for Scandinavia and the warmer southern countries. It was introduced into the United States in 1840 by German immigrants and has been carried on in several areas, primarily New York. It has never become an important crop in North America because of the high cost of labour and the ease with which needs could be imported. None of the native American species of willow is cultivated for basketry. After the 1940s osier cultivation dropped drastically in England because of labour costs.

See W. F. Hubbard, "The Basket Willow," *U.S. Department of Agriculture Farmers' Bulletin*, no. 341 (1909); D. Mullins, "Willows: a Valuable Genus," *World Crops*, vol. 5, no. 4, pp. 143–145 (1953); W. P. Elmore, *The Cultivation of Osiers and Willows* (1919). (R. E. S.)

OSIJEK (Ger. ESSEG; Hung. ESZÉK), chief town of Osijek *srez* (district) in the Socialist Republic of Croatia, Yugos., lies on the Drava river, 163 km. (101 mi.) N.W. of Belgrade by road. Pop. (1961) 71,843. The upper or old town contains the fortress, and the lower or new town is the commercial and residential centre. Osijek has several Orthodox and Roman Catholic churches. It was the birthplace of Bishop Joseph George Strossmayer, who was the main protagonist of the Yugoslav movement in the 19th century. The town is linked by road and rail with Belgrade, Zagreb and Hungary. It has a thriving trade in grain (the chief centre in Croatia), fruit, livestock, *slivovica* (plum brandy) and timber. There are cotton mills, tanneries and a sugar-beet factory. Nearby in Borovo is the largest shoe factory in Yugoslavia. Osijek owes its origin to its fortress, which existed in Roman times under the name of Mursia. (V. DE.)

OSIRIS, one of the most important Egyptian gods, who composed a trinity with Isis and Horus (*qq.v.*) the child. The name is the Greek form of the Egyptian *us-yri* ("occupier of the throne" —*i.e.*, the king; or, according to H. Bonnet, "a joy to behold").

At first, he was chiefly an agricultural deity in whose cult were combined the killing of the divine man and the belief in the dead god's resurrection. At Abydos, the centre of Osiris worship in Upper Egypt, the ritual concentrated on the fertility of the crops: the seed-corn, modeled with earth or sand in the form of the god, was buried in the ground and watered with Nile water and the plants were hailed as the resurrection of the god. This cult belonged only to Upper Egypt in early times, Lower Egypt being largely marshland and therefore unsuitable for agriculture. But by the time of Herodotus the cult had spread to all parts of Egypt.

Osiris later came to be identified as a god of the dead, and this is his best-known role. Plutarch's *De Iside et Osiride* relates the legend: Osiris, king of Egypt, was murdered by his brother Setekh (Set), his body was enclosed in a wooden chest and thrown into the Nile river. It floated to Byblos on the Syrian coast where it was found by Isis and brought back to Egypt. Set, however, found the chest and tore the body into 14 pieces, which he flung broadcast over the land and of which Isis went in search. When all the pieces were collected she brought Osiris back to life and he remained in the underworld as king and judge of the dead.

Representations of Osiris are rare before the New Kingdom (*c.* 1580–*c.* 1200 B.C.), when he is shown as a mummy with his arms crossed on his breast, one hand holding the crook, the other the flail. He wears the narrow plaited beard characteristic of the king and the gods and on his head is the crown of Upper Egypt in the stylized form of a sheaf of corn. Plutarch, himself an initiate of the Osirian mysteries, gives some idea of the spiritual and mystic beliefs which underlay the materialistic appearance of the cult: mortal eyes cannot see

> the most pure and truly holy Osiris, for the souls of men are not able to participate in the divine nature whilst they are encompassed about with bodies and passions. . . . . When they are freed from these impediments and remove into purer and unseen regions, 'tis then that this God becomes their Leader and King, upon him they wholly depend, still beholding without satiety, and still ardently longing after that beauty, which is not possible for man to express or think.

As the greater part of modern knowledge of Egyptian religion is derived from tombs and their contents and inscriptions, Osiris' aspect as god of the dead is overemphasized. He was equally important as a living god, as the giver of fertility, especially of the crops.

See also references under "Osiris" in the Index.

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OSLER, SIR WILLIAM (1849–1919), British physician, professor of medicine successively at McGill (1874–84), Pennsylvania (1884–89), Johns Hopkins (1889–1904) and Oxford universities (1904–19), was born July 12, 1849, at Bond Head, Ont., and educated at Toronto and at McGill, where he took his M.D. in 1872. He traveled and studied widely in Europe. His religious upbringing and exposure to the classics and humanities led to the development of a style of writing which makes his works among the most readable by any physician, and he excelled as a medical teacher and inspirer of young men. His memory lives and is treasured by medical scholars everywhere.

Osler had "a figure smaller than average, lithe and quick; the penetrating eyes and dark Celtic features whose incisiveness was made gentle by a capacity for 'sunburnt mirth'; the careful observation of the sick person, who saw him as a friend even while being the subject of a most intense scrutiny; the summing up of facts and their evaluation in the light of fruitful and diligent work in ward, autopsy room, and library—and then the synthesis with clarity made luminous by the capacity to tell it in succinct phrase and deft epitome to underscore the lesson driven home. Then the intimate brief friendliness before he moved on. Though it was widely diffused it never became attenuated and each person in the group felt that it was focused on him." (Reprinted by permission of the publisher, Abelard-Schuman Limited from *Osler Aphorisms* by R. B. Bean and W. B. Bean. Copyright 1950.)

Osler had a capacity for friendship, a love of medicine and of man and the power of complete concentration. Hard work he practised and preached. Through his writings is a strain of melancholy, as though some sorrow weighed upon him, but this melancholy never degenerated into pessimism. One outlet he had; he was an inveterate perpetrator of extravagant practical jokes. His fierce pride in the honour of the medical profession at times provoked him into outspoken righteous indignation.

He made many clinical discoveries and did notable work on diseases of the heart and blood. His essays and printed addresses preserve the magic of his magnetism. At McGill is located the Bibliotheca Osleriana, based on his own library, a monument to his devotion to books and medicine. His British heritage flowered at Oxford, where he was curator of the Bodleian library, trustee of Radcliffe and delegate of the Clarendon press. He was created baronet in 1911 and died Dec. 29, 1919.

Among Osler's publications are *The Principles and Practice of Medicine* (1892); *Aequanimitas*, a volume of essays (1904); *An Alabama Student* (1908); *Chorea and Choreiform Affections* (1894); *Angina Pectoris and Allied States* (1897); and *The Diagnosis of Abdominal Tumors* (1901). (W. B. BN.)

OSLO (known as CHRISTIANIA, 1624–1877; KRISTIANIA, 1877–1924), capital and largest city of Norway, forming also a separate *fylke* or county, and the seat of a bishop. Pop. (1960) 475,562, (1963 est.) 482,495, about 14% of the population of Norway; area 175 sq.mi. An important seaport, it is the nation's chief industrial, commercial and cultural centre. It lies in southern Norway at the head of the Oslo fjord, about 65 mi. from the Skagerrak in an island-studded basin surrounded by hills.

The main thoroughfare is Karl Johans gate, containing the Frederician university (founded 1811), the national theatre (1899) and the *storting* (parliament) building (1866, new wing 1956) with the royal palace (1848) at its western end. Farther east near the market square is the cathedral, begun in 1694 and restored in the 19th and 20th centuries. North of the national theatre are the historical museum, the national gallery and, farther east, the new government building (1959). South of the theatre Roald Amundsens gate leads down to the harbour past the Rådhuset or city hall (1950), an impressive landmark richly decorated by Norway's leading artists. Southeast of the city hall, on a rocky promontory, stands Akershus castle (*c.* 1300), still used for important state occasions. Across the harbour, on the Bygdøy peninsula, are the museum housing the "Fram" (Fridtjof Nansen's and Amundsen's polar exploration ship); the Kon-Tiki museum, with the raft on which Thor Heyerdahl and five companions crossed the Pacific ocean in 1947; the Viking ship museum, housing three magnificent viking ships; and the Norwegian folk museum, with old wooden buildings and farmsteads rebuilt there, an old stave church, Henrik Ibsen's study and a Lappish section. The natural history museums and the botanical gardens are at Tøyen, to the east, as well as the Edvard Munch museum erected in the

early 1960s. At Etterstad, on the southeastern outskirts, is the Norwegian technical museum (1959).

A characteristic feature of modern Oslo is a number of parks with open-air sculpture, chief among which is the Frogner park, on the western outskirts, covering 75 ac. and comprising 150 monumental groups, all by Adolf Gustav Vigeland. At Blindern, to the northwest, are the science buildings of the university (1935 and 1957), the broadcasting house (1950) and the municipal Ullevål hospital, the largest in Scandinavia. Above the city, silhouetted against the sky, is the famous Holmenkollen ski jump with the ski museum. The corporation owns all the forest surrounding the city (47 sq.mi.), and by an agreement of 1950 the whole woodland area around Oslo (97 sq.mi.) was secured as the city's playground in perpetuity. Beaches and islands, too, were purchased to ensure that they would remain open to the public.

The city council, elected by universal suffrage, itself elects from among its own members 21 aldermen and a mayor. In the early 1960s the municipal budget was about kr. 1,000,000,000 annually, about one-fifth of the total being accounted for by social security and welfare payments, such as mothers' and children's allowances, medical and dental care, and disablement and old-age pensions.

Oslo is the junction of the road, rail and airways network of the country. Fornebu airport is five miles from the city centre. Oslo is also Norway's chief port. The merchant fleet belonging to shipowners in Oslo totals 5,000,000 gross tons. The length of the wharves is eight miles, and the harbour has dry docks, floating docks and elevator facilities. It is ice-free; the tide is scarcely noticeable and there are no currents. In the mid-1960s merchandise discharged exceeded 3,300,000 tons annually.

Besides shipping and commerce, Oslo is an important manufacturing centre. Factories, mostly concentrated along the Aker river and at Økern and Løren, produce woolens, linens, paper, wood, pulp, machinery, bricks and tiles, flour, margarine, oil, hardware, glass, chemicals, beer and spirits. No fewer than 18,000 inhabitants are engaged in agriculture, forestry and market-gardening. Electric power is supplied by the municipal power station; consumption in the mid-1960s exceeded 2,500,000,000 kw.hr. annually.

The original site of Oslo was east of the Aker river. The city was founded by King Harald III (Hårdråde) about 1050 and had its period of brilliance in the 14th century, when it became the *de facto* capital. After it was destroyed by fire in 1624, the ruins were abandoned, and the city was rebuilt farther west, under the walls of Akershus castle. This new city was named Christiania after Christian IV of Denmark-Norway. The growth of the city's population in the 19th century (9,500 in 1801; 230,000 in 1900) was due in part to the absorption of surrounding municipalities, and in 1948 the capital was amalgamated with the neighbouring municipality of Aker (population at that time 131,016; Oslo 288,-222). The rapid increase in population and a rising standard of living necessitated an extensive building program. In order to facilitate better communication between the newly built suburbs (such as Lambertseter, Bøler and Veitvedt) and the city centre, large extensions of the underground (subway) and suburban lines were undertaken in the 1960s.

During World War II the Germans occupied Oslo on April 9, 1940, but not before the cruiser "Blücher" was sunk by gunfire and torpedoes from the Oscarsborg fortress on an island at the narrowest part of the Oslo fjord; the city was not damaged materially but its inhabitants endured great hardship during the occupation.

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OSMAN I (d. 1326) is regarded as the founder of the Ottoman Turkish state. The collapse, in the years around 1300, of the Byzantine frontier defenses in western Asia Minor led to the establishment of a number of Turkish amirates in that region, including that of Sögüt established by Osman's father, Ertughrul. With Sögüt as a base Osman and the Muslim frontier warriors under his command—warriors (*ghazis*) devoted to the ideals of the *ghaza* (or *razzia*) against the Christian infidel—waged a slow and stubborn conflict with the Byzantines, who sought to defend the restricted territories still left to them along and in the hinterland of the Asiatic shore opposite Constantinople. Ottoman control was extended gradually to embrace at first a number of local fortresses, including Yenishehir. The fall of Yenishehir gave the Ottomans a strong base for further advances westward toward Bursa and northward in the direction of Nicaea (Iznik). As yet the Ottomans had not the resources to win by direct assault such well-fortified Byzantine towns. Their method was to maintain around them a more or less permanent military and economic blockade. The great success of the reign was the capitulation of Bursa, which yielded, according to the Ottoman chronicles, in 1326. Osman died at Sögüt shortly afterward. *See* also TURKEY: *History*. (V. J. P.)

OSMAN II (1603–1622), Ottoman sultan of Turkey from 1618 to 1622, son of Ahmed I, was born at Istanbul on Nov. 15, 1603, and came to the throne on Feb. 26, 1618, at the age of 14. He was ambitious and energetic and, unlike previous sultans, wanted only one wife. He married a daughter of the *sheikh ul-Islam*. An expedition he led to Hotin (Khotin) in Poland in 1620 failed because the janizaries were out of control, so he punished them by cutting their pay and closing all the coffee shops and wine-houses, measures which raised strong feeling against him. Osman then attempted to go on a pilgrimage to Mecca, with the intention of raising a fresh army with which to overthrow the janizaries. Hearing of the scheme, however, the janizaries revolted; Osman was deposed on May 19, 1622, and was strangled the next day in the castle of Yedi Kuk at Istanbul. *See* also TURKEY: *History*. (E. Z. K.)

OSMAN III (1699–1757), Ottoman sultan of Turkey from 1754 to 1757, the son of Mustafa II, was born at Istanbul on Jan. 2, 1699, and succeeded his brother Mahmud I, on Dec. 14, 1754. He had by then lived half a century in complete seclusion. He was well-meaning but nervous and conservative. His first act as a ruler was to abolish the tax paid by officeholders to a new sultan. Hating women, he forbade them to wear coloured dresses and ordered them to stay in on four days of each week. He also issued an edict to regulate the dress of his Christian subjects. Osman had little regard for the rights and lives of his grand viziers; several were put to death. He died at Istanbul on Oct. 30, 1757. *See* also TURKEY: *History*. (E. Z. K.)

OSMANABAD, a town and district previously in Hyderabad state and now in Maharashtra, India. Pop. (1961) 18,868. The town, headquarters of the district, lies 35 mi. N. of Sholapur. Two miles from Osmanabad is a group of caves, mostly Jain and Vishnuite, supposed to have been excavated between the 5th and 6th centuries A.D.

OSMANABAD DISTRICT has an area of 5,504 sq.mi. and had a population (1961) of 1,477,656. Average annual rainfall is 33 in. and there is no forest; the principal crops are jowar, wheat, rice, cotton, groundnuts (peanuts) and bajra. At Thair (Ter), 12 mi. N.E. of Osmanabad town, an annual fair is held at the shrine of St. Goroba. At Naldurg is a fort built by a Hindu raja; it passed to the Bahamani kingdom and later to the 'Adil Shahi kings of Bijapur. Interesting structures are: a dam across the Bori river; and Pani Mahal (water palace). The latter is a hall within the fort, over the roof of which passes the water of the reservoir built by Ibrahim 'Adil Shah II. Latur, terminus of the branch railway from Kurduwadi, is a commercial centre. (S. AH.)

OSMAN ALI (1886–), formerly nizam (ruler) of Hyderabad, was born in Hyderabad on April 6, 1886, and, after a private education, succeeded his father, Mahbub Ali, as nizam on Aug. 29, 1911. He achieved considerable learning; patronized the foundation of Osmania university, Hyderabad, in 1918; and lived frugally despite enormous riches. Unlike some neighbouring princes he maintained the feudal character of his state and showed little interest in the increasing voice of the Hindu majority among his people. With the advice of senior officials appointed by the government of India, however, he did spend considerable sums of money on improving their conditions and standard of living. Supported by the Majlis Ittehad al-Muslimin (movement for Muslim

unity) with its private army, the Razakars, he refused to accede to India in 1947 on the withdrawal of British rule and the partition of the subcontinent. He disputed India's claim to Great Britain's lapsed paramountcy; appealed to his special alliance with the British (in 1918 the king-emperor, George V, had conferred upon him the titles of "exalted highness" and "faithful ally"); and placed his case before the United Nations. He rejected an Indian ultimatum and on Sept. 13, 1948, Indian troops entered his state. Four days later the nizam yielded. He was constitutional head (*rajpramukh*) of the state from 1950 until 1956, when it was absorbed by neighbouring states in the general reorganization of boundaries. After that date he lived in retirement in Hyderabad. Osman Ali was created knight grand commander of the Star of India in 1911 and knight grand cross of the British empire in 1917; he was awarded the Royal Victorian chain in 1946. *See* also HYDERABAD.

OSMAN DIGNA (*c.* 1840–1926), Sudanese leader in the mahdist revolt, was born at Sawakin in the eastern Sudan. His father was a merchant of Kurdish descent and his mother a member of the local Hadendowa tribe. He was arrested and imprisoned about 1877 for shipping slaves to Arabia, an incident which permanently embittered him against the British and the Turks. He tried unsuccessfully to cause unrest in Sawakin during the Egyptian revolt of 1882 and was forced to leave the town. Early in 1883 he joined the mahdi (Mohammed Ahmed; *q.v.*), who had risen against the Egyptian government in the Sudan. The mahdi appointed him an amir with the mission of raising revolt in the Red sea hinterland. Osman Digna rallied the Beja tribesmen of the hills and in Nov. and Dec. 1883 destroyed two Egyptian columns near Tokar, which fell in Feb. 1884. Alarmed by these losses the Egyptian government dispatched an expedition commanded by Valentine Baker Pasha, which was attacked by an inferior mahdist force at El Teb on Feb. 4 and fled in panic. A small Egyptian garrison at Sinkat was also destroyed on Feb. 8. A British force under Gen. Sir Gerald Graham landed at Sawakin and defeated the tribesmen at El Teb (Feb. 29) and Tamai (March 13) and in two further battles near Sawakin in March 1885. After a period of military inactivity an Anglo-Egyptian force recaptured Tokar on Feb. 19, 1891. Although present at the battles of Atbara and Omdurman in 1898, Osman Digna took no active part in them but was captured in the Red sea hills on Jan. 19, 1900. He was imprisoned at Rosetta and Damietta until 1908. Thereafter he lived at Wadi Halfa, devoting himself to religion and in 1924 made the pilgrimage to Mecca. He died at Wadi Halfa on Dec. 7, 1926.

See H. C. Jackson, *Osman Digna* (1926). (R. L. HL.)

OSMANLI, the tribal name of the Turks of the Ottoman empire. The Osmanli include a heterogeneous group of peoples, the original conquering Osmanli having mixed very considerably with the conquered peoples, until physically they have ceased to have a definite separate existence. *See* TURKEY: *History.*

OSMAN NURI PASHA (1832–1900), Turkish pasha and *mushir* (field marshal), was born at Tokat in Anatolia in 1832. After graduating from the military academy of Istanbul, he entered the cavalry in 1853 and served in the Crimean War. Later he took part in the campaigns in Lebanon (1860), in Crete (1866–69) and in the suppression of an insurrection in Yemen (1871). He was given command of an army corps at Vidin in 1876. In the same year, because of his successes against the Serbian army, he was promoted to the rank of *mushir*. During the Russo-Turkish War of 1877–78, after the Russians had crossed the Danube in July 1877, Osman entrenched himself at Plevna (Pleven, in Bulgaria) on the right flank of the Russian line of communications. He repulsed three Russian assaults and, after being closely invested, held the position until Dec. 9 when, compelled to cut his way out, he was wounded and forced to capitulate. This famous defense made Osman the hero of Plevna with the title of Ghazi ("Victorious"). After he returned from imprisonment in Russia, he was appointed marshal of the court. He was also four times war minister. He died at Istanbul on April 14, 1900. *See* also RUSSO-TURKISH WARS. (E. Z. K.)

OSMIUM, a metallic chemical element, silver-gray in colour and one of the six platinum metals (*see* PLATINUM METALS). The specific gravity of osmium, experimentally determined by X-ray, is 22.56, the same as that of iridium, these two metals being the densest known terrestrial materials. Osmium (symbol Os, atomic number 76, atomic weight 190.2) has the highest melting point (2,700° C.) of any of the platinum metals; fusing and casting of the metal are therefore difficult. Because wires of the metal can be heated to high temperatures, they were used for filaments of early incandescent lamps; however osmium was replaced by tungsten for this purpose. The boiling point of the element is estimated to be above 5,300° C. Osmium is hard, brittle and difficult to work, even at high temperatures. A hard alloy of osmium and iridium is used commercially for tips of fountain pens and phonograph needles.

Osmium is included in most platinum ores; it occurs with iridium as a major fraction of the native alloy, osmiridium. This component of platinum ores does not dissolve in aqua regia, nor does it alloy with lead in the common methods employed to recover native platinum. Smithson Tennant in England first recovered osmium by repeated alternate acid and alkali treatments of the fractions of platinum ores which did not dissolve in aqua regia. In 1804 he announced its isolation and some of its properties. He named it osmium (from the Greek, "smell") because of the unpleasant odour frequently associated with the element. In modern practice the osmiridium concentrate is heated with zinc to form an alloy which is rapidly soluble in acid.

Once osmium is dissolved, it can be separated easily and cleanly from other heavy metals. It is readily oxidized to the tetroxide, OsO_4, a compound with high volatility (boiling point 131° C.). When an osmium compound is boiled with nitric acid, OsO_4 distills away from other heavy metals and can be collected by condensation. At room temperature OsO_4 forms colourless or pale yellow crystals which melt at 41° C. It possesses an unpleasant odour, somewhat like chlorine, and is extremely poisonous, attacking mucous membranes, the lungs and eyes. Sufficient exposure will cause temporary blindness. Of the platinum metals, osmium is the most rapidly attacked by air. The odour of the oxide can be detected when samples of powdered metal are exposed to air at room temperature, and oxidation becomes rapid at about 200° C. Therefore osmium must be excluded from alloys of the platinum metals which are heated in the air. Ruthenium, the only other element known to exist in the 8+ oxidation state, requires a stronger oxidizing agent such as sodium bromate to form RuO_4. The action of aqua regia on pure osmium to form OsO_4 is inconveniently slow; fuming nitric acid is somewhat more satisfactory. In water, osmium tetroxide exhibits weak acidic properties; its aqueous solution is sometimes called osmic acid. It can be extracted from water into organic liquids such as carbon tetrachloride. It is a fairly strong oxidizing agent with limited use in the synthesis of organic compounds, being used in steroid syntheses wherein it oxidizes olefins to glycols. Because it is reduced to the black hydrous dioxide OsO_2 by some biological materials it is sometimes used to stain tissues for microscopic examinations. In addition to the tetroxide a few other compounds can be made with the 8+ state such as OsF_8 and $KOsO_3N$.

Well-characterized and stable compounds of osmium contain the element in the 3+, 4+ and 6+ oxidation states in addition to the 8+, and there is evidence for compounds with other states. Mild reduction of the tetroxide yields yellow-brown solutions containing negative ions of osmium(VI); *e.g.*, OsO_4^{2-} and $OsO_2Cl_4^{2-}$. These ions are stable only in basic solutions; in acid they react to yield osmium(IV) and OsO_4. The salt K_2OsO_4 can also be prepared when osmium metal dissolves in a fused mixture of potassium hydroxide and potassium nitrate. Osmium(VI) can be reduced to give compounds of osmium(IV) and osmium (III). In these states coordination complexes are formed in which chloride, water, ammonia or other groups are bonded covalently to the central osmium atom. $K_3(OsCl_6)$ and $K_2(OsCl_6)$ are examples of stable complex-containing compounds. The complexes are kinetically inert in that the groups are replaced slowly. Hydrous oxides of these states are slowly formed from alkaline solutions. All compounds of osmium are easily reduced or decomposed by heating to form the free element as a powder or sponge. (D. S. MN.)

OSMOSIS, in its simplest definition, is the spontaneous passage, or diffusion (*q.v.*), of water or other solvents through a semipermeable membrane (one that blocks the passage of dissolved substances, or solutes). This process was first thoroughly studied in 1877 by the plant physiologist W. Pfeffer. His observations laid the foundation for the important theory of dilute solutions of van't Hoff (*see* SOLUTIONS). Earlier workers had made less accurate studies of leaky membranes (*e.g.*, animal bladders) and the passage through them in opposite directions of water and escaping substances, which R. J. H. Dutrochet named endosmose (inward movement) and exosmose (outward movement), respectively. The more general term osmose (now osmosis) was introduced in 1854 by Thomas Graham.

Osmosis is important in many physiological processes in animals and plants: it is involved in the excretion of urine, the interchange of nutrients and wastes between tissue cells and their surroundings, the flow of sap and in many other vital functions. Unidirectional movements into living cells of permeating solutes, closely followed by water, result in volume changes that are frequently used for quantitative measurements of cell permeability. The investigation of more complex osmotic problems, involving special solute effects, electrical forces, anomalous osmosis and bulk flow, has been greatly facilitated by the increasing availability of artificial membranes of known chemical, structural and electrical properties.

In simple osmosis the driving force is the "escaping tendency" of the solvent; when these forces are unequal on the two sides of a semipermeable membrane solvent molecules move in such a way as to establish equilibrium. As an example, consider a 5% sugar solution (in water) contained in a membranous sac that allows free passage of water molecules but not of sugar molecules. The sac, fitted with a cork through which a glass tube extends, is placed in a beaker of water. The following conditions obtain as osmosis proceeds: the water outside the sac moves into the sac at a greater rate than the water inside the sac moves into the beaker, thus causing the water to begin moving slowly up the glass tube; when equilibrium is attained water moves at equal rates into and out of the sac.

In a constant-pressure system in which the escaping tendency of the internal water has been lowered by solutes to a degree below that prevailing externally, equalization involves a greater inward flow of water, with a resulting increase of volume. A mammalian red blood cell behaves in this manner; because of the delicacy of its plasma membrane, and in particular its biconcave form, considerable degrees of swelling are possible with only negligible increases of internal pressure. In a constant-volume system, on the other hand, the entrance of sufficient water for equalization by dilution is impossible; in its place an increase of internal pressure, according to a well-known thermodynamic principle (*see* THERMODYNAMICS), raises the escaping tendency of the internal water to a state of balance. Plant cells with rigid, though permeable, cellulose cell walls give a close approximation to this condition; the pressures they develop when placed in water may amount to several and sometimes many atmospheres. Most animal cells thus treated show osmotic increases in both volume and pressure, though the latter are usually relatively small.

When a constant-volume system containing a solution of a nondiffusible solute is equilibrated with pure water, the internal pressure so developed is frequently called the osmotic pressure of the solution. The use of this term in connection with osmosis requires some qualification. The observed pressure does not belong to the solution itself and is not the driving force of osmosis, but, on the contrary, a result of osmosis, which it opposes and eventually stops. Furthermore, normal osmosis occurs in a freely expansible system in the virtual absence of pressure changes.

An important problem in mammalian physiology is the manner in which the body prevents the loss of the blood plasma during its passage under pressure through the necessarily leaky capillaries. The explanation given by E. H. Starling near the end of the 19th century is that an average state of balance is maintained between outward filtration of a protein-free solution and inward osmosis—the latter being a consequence of the colloid osmotic pressure of the plasma proteins. From a different point of view it might be said that dissolved proteins, to which the capillary walls are almost impermeable, lower the escaping tendency of the plasma water by an amount that statistically, in time and space, just balances the rise due to the capillary blood pressure.

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OSMUNDA, a genus of rather coarse but attractive deep-rooted ferns with variously divided fronds growing to five feet in large crowns, the spore-bearing segments much contracted and forming panicles, or in *O. claytoniana* some of the segments only are spore-bearing. The cinnamon fern (*O. cinnamomea*), the interrupted fern (*O. claytoniana*) and the royal fern (*O. regalis*) are native to and widespread in North America and Asia. They are excellent ferns for the garden but should be given ample water and good drainage. The matted fibrous roots constitute osmunda fibre, osmundine or orchid peat, which is broken up and used as a rooting medium for epiphytic orchids. (J. M. BL.)

OSNABRÜCK, a town of Germany which after partition of the nation following World War II was located in the *Land* (state) of Lower Saxony, Federal Republic of Germany. It lies on the Hase river between the Teutoburger Wald and the Wiehengebirge mountains, 58 mi. N.E. of Dortmund. Pop. (1961) 138,658.

The town still broadly conforms to its medieval plan. Important examples of ecclesiastic architecture are the Catholic cathedral (13th century), one of the finest examples of high Romanesque style in Lower Saxony and Westphalia; the early Gothic St. John's Catholic church, built 1256–91, with an early 16th-century altar and interesting cloisters; the Gothic St. Mary's church (Evangelical), with a 16th-century Flemish carved altar; and the Gothic St. Katherine's church (Protestant), mid-14th century. In 1543 the reformer Hermann Bonnus was called by the town council to introduce the Lutheran doctrine at St. Mary's church; since then the town has been predominantly Protestant. The Carolinum grammar school is housed in the south wing of the former Jesuit college, which dates back to a foundation of Charlemagne in 804. There are still town houses of the 13th–19th centuries and one of those in the main square was the birthplace of Justus Möser (*q.v.*; 1720–94). The late Gothic town hall (1487–1512) with its historic peace hall (Friedenssaal) houses the city's treasure. A part of the medieval walls remains; a promenade replaces the rest which was leveled in the 19th century. The old Bucks tower belongs to the town museum and has a collection including armour and instruments of torture. The Waterloo gate (1817) commemorates local soldiers killed at Waterloo.

Trading rights were granted in 889. The emperor Frederick I Barbarossa granted civic liberties in 1171. The town, well known for its linen, was once in the Hanseatic league. The Catholic bishopric founded by Charlemagne in 785 was secularized in 1803, but after 1858 the see was reestablished. From 1643–48 Osnabrück was the base for the Protestant negotiators at the treaty of Westphalia, which stipulated that the bishopric was to be held alternately by Catholics and Protestants. Ernest Augustus I, the first Protestant bishop, was the father of George I of England, whose brother became the second Protestant bishop. Frederick of York was the bishop when the see was secularized. The castle of the elector bishops (1667–90) has survived.

Osnabrück is a major road and rail junction. It has steel and cable works; other manufactures include machinery, automobile equipment, hardware, chemicals, textiles and paper.

(H. P.-MA.)

OSORNO, a province in southern Chile, extends from the Pacific to the Argentine frontier and is bounded by the provinces of Valdivia on the north and Llanquihue on the south. Area 3,566 sq.mi.; pop. (1960) 143,955. The province, created in 1940 with territory taken from Llanquihue and Valdivia provinces, is divided into two departments for administrative purposes, Osorno and Río Negro. Osorno province lies in the temperate rain forest zone and is composed of the three longitudinal physiographic regions (coastal mountains, interior valley and Andean cordillera)

which characterize much of Chile. Renewed volcanic activity began with the disastrous earthquakes of May–June 1960. The east and west are sparsely settled. The central valley, traversed by the Santiago-Puerto Montt line of the state railways, is a good agricultural and stock-raising region. Beef cattle, dairy products, wheat, potatoes and oats are the most valuable products. The eastern part is noted for its lakes (Puyehue, Rupanco) and mountain scenery (notably Mt. Osorno and Mt. Puntiagudo), lakeside thermal springs, fishing and skiing facilities.

Osorno (pop. [1960] 55,091), capital of the province and department of the same name, was founded in 1553 and re-established in 1558. Indians devastated the settlement in 1602; it was repopulated in 1796 by order of Ambrosio O'Higgins. The German influence, strong in all present phases of life, began with colonies established in the 1850s. Most vigorous growth came after 1895, when railway communication was opened to the north. The city of Osorno has the distinction of being the only large urban centre in the province, the fourth largest city in southern Chile, the gateway to southern Chile's famous tourist region and the western terminus of an important international route which leads to the Argentine town of Bariloche. Its industries include grain and lumber milling and dairy and meat processing. Large numbers of live cattle are shipped from the city to central Chile.

Río Negro (pop. [1960] 3,661) is the second town and administrative centre in the province. (J. T.)

OSPINA PÉREZ, MARIANO (1891–), president of Colombia, 1946–50, was born on Nov. 24, 1891, in Medellín. He studied mining at the University of Antioquia and did graduate work in engineering and economics in the United States and Belgium. The grandson of one president and nephew of another, Ospina entered politics in 1915 as a Conservative and held many elective offices including the presidency. Having inherited wealth, he accumulated much more in mining, finance, commerce and agriculture. He taught in several Colombian universities. At a time of developing interparty conflict, Ospina was elected president but failed to check the growth of violence despite recourse to coalition government. The more moderate upper-class segment of the Conservative party, of which Ospina was a major figure, commonly opposed the majority faction headed by Laureano Gómez, who succeeded him as president; the hostility between the two Conservative leaders presented a serious problem for the National Front government of Colombia. (R. L. Ge.)

OSPREY (*Pandion haliaetus*), often called the fish hawk in North America, is a large, long-winged hawk, reaching a length of two feet in the female, somewhat less in the male. It is brown above, white below, with some white on the head. Its internal structure differs enough from that of other hawks for the osprey to be placed in a family of its own, the Pandionidae. The species comprises several geographic races. The osprey lives along seacoasts and larger interior waterways, where it can obtain its chief article of diet, fish. It fishes by flying over the water, hovering over its prey and then plunging feet first to seize the fish in its long, curved talons. With grip secured by sharp spicules on the underside of the toes, the bird carries its prey to a favourite perch to feed. Sometimes, after feeding, the osprey flies low, dragging its feet in the water, apparently to wash them.

ROGER T. PETERSON FROM NATIONAL AUDUBON SOCIETY

OSPREY (PANDION HALIAETUS)

Throughout its wide breeding range, which extends to all the continents except South America, where it occurs only in winter, the osprey nests singly or in colonies on tall trees, at ground level on small islands or on ledges of cliffs. Always the nest is a bulky structure, up to six feet across, composed of haphazardly arranged sticks. Two to four boldly marked eggs are laid: the downy young, which hatch after five weeks' incubation, are fed by both parents. (A. L. Rd.)

OSROENE (Osrhoene), an ancient kingdom in northwestern Mesopotamia occupying an area between the Euphrates and Tigris rivers and lying across the modern frontier of Turkey and Syria. Its capital was Edessa (*q.v.*), the modern Urfa. The name of the kingdom (which Pliny the Elder gives as Orrhoene) appears to be derived from Urha (the Syriac name for Edessa); Urha, in turn, may be derived from that of a certain Osroes or Orhai, who founded the state about 136 B.C. at the time of the disintegration of the Seleucid empire. To judge from his name, this Osroes was of Iranian origin and may have been a Seleucid governor. The next ruler of the kingdom, however, was an Arab, Abdu bar Ma'zur, and from then onward the throne remained almost continuously in Nabataean or Arab control, the commonest royal names being Abgar and Ma'nu.

The kingdom embraced the cities of Melitene (Malatya) in the north, Nusaybin (Nisibin) in the east, Zeugma (close to modern Birecik) in the west, Singara (Sinjar) on the southeast and Carrhae (Harran) on the southwest. It thus commanded not only the great strategic highway from west to east which followed the southern edge of the Kurdish plateau from Singara to Zeugma, but also that section of the trade route from Asia Minor to Mesopotamia (the old Persian royal road), which passed probably from Melitene to Carrhae. Osroene was therefore in a strong strategic position during the wars between Rome and Parthia from the 1st century B.C. to the 2nd century A.D. and formed alliances at different times with one or the other. During the Armenian campaigns of Lucullus (69 B.C.), Pompey (66) and Crassus (54–53) it kept generally to the Roman side, though Abgar II (known to the Romans as Ariamnes) was responsible for betraying Crassus to the Parthians in 53. About A.D. 50, Sanatruces, king of Adiabene, the eastern neighbour of Osroene, occupied Nusaybin and Edessa, but in A.D. 109 Abgar VII reestablished the indigenous dynasty. Trajan deposed him, however, after quelling the Mesopotamian revolt of A.D. 116, and two foreign princes then successively occupied the throne. In 123, however, Ma'nu VII, brother of Abgar VII, succeeded under the protection of Hadrian. Thereafter the state maintained a certain measure of autonomy until 216, when Caracalla occupied Edessa and abolished the kingdom.

Under its Arab dynasties, Osroene became increasingly influenced by Aramaic culture and acted as a centre of national reaction against Hellenism. The cultural standing of Osroene was raised by the arrival there in the 3rd century A.D. of Chaldean Christians exiled by the Persian Sassanids. By the 5th century Edessa had become the headquarters of Chaldean Syriac literature and learning, while Nusaybin was a centre of the Nestorians. Osroene retained its name until the 7th century. In 608 it was taken by the Sassanid Khosrau II. The east Roman emperor Heraclius recaptured it in 625, but in 638 it fell to the Arabs. *See* also Mesopotamia. (Wm. C. B.)

OSS, a town of North Brabant province in the Netherlands, is situated 11 mi. E.N.E. of 's Hertogenbosch. Population, mainly Roman Catholic, was estimated at 34,132 (mun.) in 1964.

Civic rights were granted by the duchess of Brabant in 1399. Oss was the centre of the Dutch margarine industry and now specializes in bacon and cooked meats. The manufacture of pharmaceuticals, especially insulin and vitamins, has become important. Other products include electrical equipment, wool, boxes and metalware. (P. M. J. v. S.)

OSSA, a mountain near the coast in the *nomos* (department) of Larissa, Greece. Its hard crystalline limestones, resting on schists, form a broad, steep-sided plateau, rising to a pyramidal peak of 6,489 ft. Its eastern slopes especially carry rich forests of oak, chestnut and beech. The mountain is famous in mythology for the attempt of the twin giants, Otus and Ephialtes, known as the Aloadae (*q.v.*), to climb up to heaven by piling Ossa on Olympus and Pelion on Ossa. (Wm. C. B.)

OSSETIA (Osetiya) is a general name given to that part of the Caucasus which is inhabited chiefly by Ossetians, and lies

athwart the middle of the Greater Caucasus. Most of these people live in two administrative divisions of the U.S.S.R., the North Ossetian (Severo-Osetinskaya) Autonomous Soviet Socialist Republic (A.S.S.R.) of the Russian S.F.S.R. on the northern flank of the main Caucasus range, and the South Ossetian (Yugo-Osetinskaya) Autonomous Oblast of the Georgian S.S.R. on the southern flank. The North Ossetian A.S.S.R. was created as an autonomous *oblast* in 1924 and made an A.S.S.R. in 1936. Its area is 3,089 sq.mi. and its population (1959 census) was 450,581. The South Ossetian *oblast*, created in 1922, covers 1,506 sq.mi. and had 96,807 inhabitants.

Both areas are mountainous and hardly extend beyond the Caucasus foothills. The main range reaches 15,669 ft. in Mt. Gimarai-Khokh. Other peaks over 14,000 ft. are Uilpata, Tepli and Laboda. Nearly all the highest peaks have ice fields, often quite large. Parallel to the main crest range is a series of lower ranges, through which the rivers have cut deep and picturesque gorges. The highest of these subsidiary ranges is the Bokovoi (Peredovoi) Khrebet, on the north of the crest range. The northern republic lies wholly in the basin of the upper Terek and its fastflowing tributaries, the Ardon, Gizeldon, Urukh and Fiagdon, which emerge from the mountains to come together in the broad, tectonic Vladikavkaz basin, before cutting through the Sunzha range to the north in another deep gorge. A northern panhandle of the republic extends over the Sunzha and Terek ranges to include part of the middle Terek plain around Mozdok. The South Ossetian *oblast* is drained by minor tributaries of the Kura, chiefly the Great (Bolshiye) and Little (Malaya) Liakhvi. Climate, soils and vegetation all vary sharply with the relief and are characterized in general by vertical zoning. In the lowest areas there is steppe vegetation on chernozem (black earth) soils, which gives way higher up to dense deciduous forest of oak and beech. Higher still is coniferous forest of spruce, fir and pine, eventually giving way to alpine meadow and finally to bare rock and ice. The severity of the temperature regime and the rainfall both increase with height. In the basins precipitation is 18 in. a year, or less; on higher areas up to 48 in.

The Ossetians (Ossetes) are a people of mixed Iranian-Japhetic (Caucasian) origin. From the 7th century B.C. to the 1st century A.D. Ossetia came under Scythian-Sarmatian influence. This was succeeded by that of the warlike Alani (*q.v.*), believed to be the direct ancestors of the present-day Ossetians. Later the Tatar empire of the 13th century extended its sway over Ossetia. In the late 18th and 19th centuries Russian colonization began in the northern-Ossetian area, especially after the establishment of the fortress of Vladikavkaz in 1784, but only in the towns are Russians a dominant proportion of the modern population. In the 1959 census 410,000 Ossetians were recorded in the U.S.S.R. as a whole. South of the mountains Georgians are also found, while Armenians, Tatars and others share in the mixed urban populations. The urban proportion of the total population varies sharply between the two areas. In 1959 in North Ossetia the urban population of 237,454 formed 53% of the total. There are 4 towns and 4 urban districts, the largest being the capital, Ordzhonikidze (*q.v.*; formerly Vladikavkaz), with 164,420 inhabitants. In contrast only 25% of the South Ossetian population (23,961) were urban. Of these 21,641 live in the capital Tskhinvali and there are only two other small urban districts.

Industry is relatively little developed outside Ordzhonikidze and consists of processing agricultural products—fruit canning, jam making and flour milling. At Beslan in North Ossetia maize (corn) is processed into starch, glucose, molasses and dry fodder in a huge *kombinat* plant. Mining is important, especially for lead and zinc. The main areas are the Ardon valley of the north, centred on Sadon, and the Kvaisi region of the south. Silver is mined in small quantities in the north and talc in the south, and there are unexploited deposits of molybdenum, copper, tin and gold. In the mountains timber exploitation, particularly of the beech forests, is important on both flanks of the Caucasus. The fast mountain streams are well suited for hydroelectric power and plants have been built on the Terek at Ordzhonikidze and on the Gizeldon.

The lower areas in both north and south, especially the Vladikavkaz basin and Mozdok area, are intensively cultivated with the aid of irrigation. Winter wheat and maize are usually the main crops. In North Ossetia potatoes, sunflowers and hemp are also important, and South Ossetia is noted for sugar beet. In both areas there are many orchards of apples, pears, plums, cherries and peaches and small areas under vines. In the higher parts there is little or no arable land and stock rearing based on transhumance is dominant. Sheep are by far the most important variety of stock. Cattle are usually found only in lower areas. In winter the flocks of sheep move down to low pastures, not only in Ossetia, but also far beyond its boundaries in the semidesert regions of the Caspian lowland.

Although the rugged relief makes communication difficult and many smaller valleys are isolated, two major highways across the Caucasus pass through the North Ossetian republic—the Georgian and Ossetian Military highways, built in the 19th century during the Russian conquest of the Caucasus. The former uses the Krestovy pass (7,835 ft.) near Kazbek Gora and the latter the Mamisonski pass (9,281 ft.). Ordzhonikidze is also linked by highways with Grozny and the Caspian and with Rostov. A loop of the Rostov-Baku trunk railway, between Prokhladny and Grozny, passes through the Vladikavkaz basin and from it branch lines run to Ordzhonikidze and Alagir. A branch line also links Tskhinvali to the main Trans-Caucasus trunk railway at Gori. In Ossetia there are many mineral springs, especially around Alagir, and a number of sanatoriums have been built. Many of the settlements are also popular vacation resorts. (R. A. F.)

OSSETIC LANGUAGE, one of the Iranian languages (*q.v.*) spoken by the Ossetes in the northern Caucasus. There are two primary dialects: (1) eastern, called Iron, and (2) western, called Digor. The majority of Ossetes speak Iron and it is the basis of the literary language now written in the Cyrillic alphabet. Ossetic is the modern descendant of the language of the ancient Alani, a Sarmatian people, and the medieval As. Ossetic loanwords in Hungarian were borrowed in the Alan period when the two peoples were neighbours. Ossetic preserves many archaic features of Old Iranian such as eight cases and verbal prefixes. The phonology of the language has been greatly influenced by the non-Indo-European languages of the Caucasus and the present vocabulary has many loanwords from Russian. There are many folk epics in Ossetic, the most famous being the tales about hero warriors, the Narts. The literary language was established by the national poet Kosta Khetagurov (1859–1906).

See V. Miller, *Grundriss der Iranischen Philologie*, vol. i (for grammar) and *Ossetisch-Russisch-Deutsches Wörterbuch*, 3 vol. (1927); V. I. Abaev, *Osetinskii Yazyk i Folklor* (1949). (R. N. F.)

OSSIETZKY, CARL VON (1889–1938), German journalist and pacifist, winner of the Nobel peace prize for 1935, was born at Hamburg on Oct. 3, 1889. He was the son of a former German army officer who was a member of a germanized branch of the Polish Roman Catholic family of Osiecki.

In 1912 he joined the German Peace society (Deutsche Friedensgesellschaft) but was conscripted into the army and served throughout World War I. In 1920, in Berlin, he became secretary of the D.F.G. Convinced that "nothing was more devastating for peace and democracy than the omnipotence of the generals," he helped to found the Nie Wieder Krieg organization in 1922. He was associate editor of the daily newspaper *Berliner Volkszeitung* and a contributor to *Weltbühne*, a left-wing political weekly. He became editor of *Weltbühne* in 1927 and in a series of articles unmasked the *Reichswehr* leaders' secret preparations for rearmament. Accused of treason, he was sentenced in Nov. 1931 by the Leipzig supreme court to 18 months' imprisonment, but was amnestied in Dec. 1932. On Hitler's accession to power Ossietzky refused to flee abroad and resumed publication of *Weltbühne*. At the end of Feb. 1933 he was arrested and sent to the Papenburg concentration camp from which, suffering from tuberculosis, he was transferred in May 1936 to a prison hospital in Berlin and a few months later to a public hospital where, however, he remained in custody until his death on May 4, 1938. On Nov. 24, 1936, he had been awarded by the Norwegian *storting* the Nobel peace prize

for 1935. Hitler's reply to this was a decree of Jan. 30, 1937, forbidding Germans to accept any Nobel prize in the future.

See A. Williams-Ellis (ed.), ***What Was His Crime? the Case of Carl von Ossietzky*** (1937); K. R. Grossmann, *Ossietzky, ein deutscher Patriot* (1964).

OSSINING, a village of Westchester county, N.Y., U.S., is located on the steeply ascending east bank of the Hudson river, about 17 mi. N. of the Bronx (New York city) between Tappan Zee and Haverstraw bay and opposite Hook Mountain State park. Surrounded by attractive wooded countryside, it is the home of the Maryknoll (Roman Catholic) missions, and the site of Sing Sing (state) prison founded in 1824 with the idea of using convict labour to work nearby marble quarries. The village derives its name from the home of the Sin Sinck Indians, a branch of the Mohican tribe, and its name means "stone upon stone." The village site was within a large tract granted in 1680 by Charles II to Frederick Phillipse, who finally acquired actual title to this section by purchase from the Sin Sincks in 1685. Phillipsburgh manor, as this area was known, was confiscated by New York state in 1779 because of the Tory sympathies of its last lord. It was then broken up and sold in 1785, mainly to patriot tenant farmers. The two hamlets, Sparta and Hunter's Landing, developed and were incorporated as the village of Sing Sing in 1813. To avoid too close identification with the prison, the village name was changed to Ossining in 1901. Manufactures include hearing aids, office furniture, wire, drugs, maps, precision instruments and wallpaper. For comparative population figures *see* table in NEW YORK: *Population.* (M. D. HH.)

OSSORY (OSRAIGHE), an ancient kingdom of Ireland that won for itself a semi-independent position as a state within the kingdom of Leinster probably in the 1st century A.D. In the 9th century it was ruled by an able king, Cerball, who allied himself with the Norse invaders and figured in later centuries as an ancestor of some important families in Iceland. When surnames were introduced the dynasts descended from him in Ireland were known as Mac Gillapádraig, a name transformed under Norman influence into Fitzpatrick. In the 11th century they contended for the kingship of Leinster but were soon overwhelmed by the south Leinster family of McMurrough. In feudal times the Butlers became the most powerful lords in that area. The diocese of Ossory, with its see at Kilkenny, still gives a clear idea of the extent of the ancient state. (J. J. RY.)

OSTADE, the name of two Dutch painters whose father had moved to Haarlem early in the 17th century from the village of Ostade near Eindhoven. The artists were the eldest and youngest sons of a large family.

ADRIAEN VAN OSTADE (1610–1685) was baptized Dec. 10, 1610, in Haarlem, where he lived his entire life. He is traditionally supposed to have been a pupil of Frans Hals, and it is possible that both he and his Flemish contemporary Adriaen Brouwer (*q.v.*) were in Hals's studio about 1627, though some sources suggest Salomon van Ruysdael as his master. In 1662 he was president of the painters' guild in Haarlem.

His works won him much popularity during his lifetime and he became a fairly wealthy man. Although Ostade and Brouwer may for a time have been pupils of Hals, the latter's style was not a major influence on either of them, and there is a much closer resemblance between the paintings of the two younger men than between their pictures and those of any older master. Both delighted in scenes of low peasant life, tavern brawls, etc., usually in dimly lit interiors with a single source of light illuminating the principal group. Both treated these themes with a broad and vigorous technique and in a subdued range of colours that at times borders on monochrome, and both used a considerable element of caricature to underline the coarseness of their peasant types. There is little doubt that Brouwer's artistic personality was the stronger and that he was the most important influence in shaping Ostade's style. Ostade's colour schemes in the early period are largely confined to a range of neutral bluish-grays and browns, sometimes enlivened by a single note of more positive colour. Later, from the 1640s onward, he gradually adopted a brighter palette, and his subjects, though still mostly from peasant life, tend to become less violent and grotesque. In the works of his maturity are found more outdoor subjects, such as figures by a cottage door or peasants making merry outside an inn. Although the great majority of his works are genre pieces, he experimented also with religious subjects, portraits and landscapes. He worked in water colour as well as oil, was a spirited draftsman with the pen and produced a number of etchings. He was a prolific artist, painting usually on panel and invariably on a small scale, and is well represented in the principal collections of Europe and America. His most important pupils or followers were his brother Isack, Cornelis Bega, Cornelis Dusart and Jan de Groot.

ISACK VAN OSTADE (1621–49) was born in Haarlem, where, as far as is known, he spent the whole of his short life. He was at first a pupil of his brother Adriaen, whose manner he followed so closely that some of his early genre pieces have been confused with the elder Ostade's work. However, he was too accomplished and individual an artist to remain an imitator of his brother, and soon branched out into a style that was more ambitious both in scale and in complexity of composition. The works of his most distinguished period include a small number of winter landscapes, with sleighers and skaters on the ice, which can be ranked among the finest of all Dutch paintings in this genre, but his most characteristic subjects are those that depict parties of travelers with carts and horses resting outside an inn, in a vein reminiscent of some similar compositions by Salomon van Ruysdael. They show an excellent grasp of design in the disposition of the different groups, together with great vivacity in the treatment of individual figures. His rendering of misty or smoke-laden atmosphere is equally masterly. His work is well represented in the National gallery, London, and the Wallace collection has a fine painting of "A Market Place." Perhaps the most celebrated of the winter scenes is that in the Louvre, Paris. He was buried on Oct. 16, 1649.

Since he died at such an early age, Isack van Ostade can have had few if any pupils, yet his influence on the succeeding generation of Haarlem painters was by no means negligible. Philips Wouwerman (*q.v.*), in particular, seems to have owed much to him, carrying on his characteristic subject matter of travelers, horses and wayside inns and apparently deriving his favourite motif of the gray horse directly from Ostade's example.

See C. Hofstede de Groot, ***Catalogue of Dutch Painters,*** vol. iii (1910). (R. E. W. J.)

OSTAIJEN, PAUL VAN (1896–1928), the most important personality of the Flemish expressionist movement, was born in Antwerp, Feb. 22, 1896. While a clerk in the municipal service (1914–18), he began to contribute to newspapers and periodicals. His first volume of verse, ***Music-Hall*** (1916), introduced modern city life as a subject for poetry. His second, ***Het Sienjaal*** (1918), showed the influence of the war and of German expressionism and affirmed a pathetic belief in humanity. It inspired the humanitarian expressionist movement in Flanders, later developed by Wies Moens, Marnix Gijsen, Karel van den Oever, Achilles Mussche and others. Compromised as a political activist, Van Ostaijen went into exile in Berlin (Nov. 1918–21). The political and artistic climate there and the hardships he endured made him a nihilist; he changed over to dadaism as a writer of poetry in rhythmic typography (***Bezette Stad***, 1921) and of grotesque prose. But he soon came to consider dadaism an antidote and developed a poetic system of his own, an "organic expressionism," aiming at a "pure poetry" that gave up personal and humanitarian confessions. Words were freed from their traditional syntactic relationships and images replaced by associations. These concepts, which bordered on the experiments with the absolute word of the German *avant-garde* review, *Der Sturm,* especially of August Stramm, were embodied in "Het eerste boek van Schmoll" (part of *Gedichten*, 1928), containing his best and most original poems, evocative fragments of exceptional sensibility and haunting musicality.

His essays on art and literature and his pithy but biased criticism are also important (*Krities proza*, 2 vol., 1929–31). His creative prose (*e.g.*, *Vogelvrij*, 1927; *De bende van de stronk,* 1932; *Diergaarde voor kinderen van nu*, 1932) consists mainly of grotesque sketches showing keen cerebral imagination and con-

cerned less with telling a story than with capturing whimsical associations. By its lucidity, stubborn analysis of a theme and underlying restlessness, this prose sometimes recalls Kafka, of whom Van Ostaijen was the first foreign translator, publishing five of Kafka's short prose pieces in Flemish in 1925.

After his return to Flanders, Van Ostaijen worked in the book trade and then became an art dealer in Brussels (1925–26). He died at Miavoye-Anthée near Namur, March 18, 1928.

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OSTEND (Flemish Oostende), a town in West Flanders, Belg., situated on the coast 115 km. (71.5 mi.) W.N.W. of Brussels by road. It is a fashionable seaside resort, a royal residence and the first fishing port of the kingdom. Pop. (1961) 56,494. Because of the many sieges and bombardments the town has undergone, no ancient buildings remain. The damage caused during World War II was so widespread that the reconstruction of whole districts and most of the public buildings has entirely changed the character of the town. The central post office, town hall, museum, library, yacht club headquarters, and *Vismijn* or *Minque* (fish market) have all been rebuilt. The *Digue* (promenade) extends for more than three miles along the shore from the long jetty of the Estacade to the modern race course (Hippodrome Wellington) at the west. Important buildings on this promenade are the Casino (Kursaal), noted for its concerts, the Châlet Royal (both entirely rebuilt), and the Institut Thermal (for hydropathic and electrotherapeutic treatment). Ostend is the native town of the painter James Sydney Ensor (1860–1949), whose house in the rue de Flandre is a museum. Also in this street is the Place d'Armes (market square), with the municipal library and museum of modern art. Opposite the central post office is Leopold park, with an attractive flower-clock.

The modern docks can accommodate ships of large tonnage. As continental railhead of main lines to central and eastern Europe, and connected to England by regular boat services and an air transport service for passengers and cars, Ostend can be considered a gateway to Europe. It is also the terminus of secondary railways along the coast and to the southern towns of Flanders. The port is the heaquarters of the Belgian fishing fleet, and is renowned for its lobster and oyster beds. Industries include shipbuilding and the manufacture of soaps, tobacco and keys.

In spite of its vivid modernity, Ostend has a history going back to the 9th century. In 1601 the Spaniards besieged the town, the siege lasting nearly four years. In 1722 the town entered a period of prosperity: the Compagnie Impériale et Royale des Indes, founded under Charles VI, was granted 30 years of trade monopoly with India and Africa. The company, known as the Compagnie d'Ostende, was soon making considerable profits, which caused jealousy in commercial centres such as Amsterdam and London. Under threats from the great naval powers, Charles VI suspended the privileges of the company after five years. Under Joseph II (1780–90) Ostend enjoyed another period of commercial prosperity. From 1830 onward the town began to be developed as a popular seaside resort and its reputation as such has increased ever since. During World War I the Royal Navy's "Vindictive" was sunk in the port in May 1918, which rendered Ostend useless to the Germans as a submarine base. After the war the ship was raised and broken up and parts of it were made into a memorial near the docks. The town was occupied by the Germans again in 1940. (F. P. E.)

OSTEND COMPANY, the name of a trading company established in the Austrian Netherlands by the emperor Charles VI in 1722. A rival to the English and Dutch East India companies, the Ostend company played an important if subsidiary role in European diplomacy until 1731.

The peace settlement at the end of the War of the Spanish Succession (1713–14) transferred the Spanish Netherlands to Austria but maintained Dutch control over the Scheldt and so over the commerce of Antwerp as under the peace of Westphalia (1648). In Ostend, however, the Flemings had a port on the open sea, and from 1715 onward attempts were being made, both by the Ostenders themselves and by foreign adventurers, to exploit its geographical advantages for trading in emulation of the Dutch and English East India companies. These private enterprises led to protests and to the seizure of interloping ships by the Dutch and English companies. Meanwhile the imperial government, prompted to some extent by the schemes of the English adventurer John Colebrooke, and desirous of increasing its revenue, was considering a major undertaking on the same lines. In 1722 the emperor granted a charter for 30 years to a company that was to be based on Ostend to trade to the East and West Indies and Africa; in return for the charter the imperial treasury was to enjoy 3%–6% of the profits. The company founded two settlements in India, and trade proved at first highly profitable, particularly as the company was able to benefit from extensive smuggling into England. The protests of the English and Dutch companies, whose shares slumped before this competition, were reinforced by those of their governments, who, particularly when Spain gave its support to the venture (1725), were alarmed at its political as well as commercial implications.

Public opinion was aroused, and the British parliament declared participation by a British subject in the Ostend company to be a criminal offense. In consequence of this alarm the fate of the new company loomed large in the diplomacy of the great powers from 1725 to 1731. On this, as well as on other more vital issues, Great Britain, France, the United Provinces and, later, Russia and Prussia, allied themselves against the emperor and Spain. In 1727, however, the emperor's desire for international recognition of the pragmatic sanction ensuring the succession of his daughter Maria Theresa led him to agree to suspend the company for seven years; and in 1731, under the treaty of Vienna, the company was dissolved in return for the recognition of the pragmatic sanction. The suspension of its charter did not immediately end the company's activities. Attempts by the Danish East India company to attract its members were checked by the vigorous representations of Great Britain, the United Provinces and France, but the servants of the defunct company continued to carry on their trade in India until they lost their last settlement in 1744.

See H. Huisman, *La Belgique commerciale sous l'empereur Charles VI* (1902); M. Laude, *La Compagnie d'Ostende* (1944). (L. S. Sd.)

OSTEND MANIFESTO, a secret dispatch of Oct. 18, 1854, from James Buchanan, John Y. Mason and Pierre Soulé (U.S. ministers respectively to Great Britain, France and Spain) to Secretary of State William L. Marcy recommending that the United States acquire Cuba from Spain. Under instructions from Marcy, who acted in accord with the views of Pres. Franklin Pierce, the three ministers met, supposedly in secrecy, first in Ostend, Belg., and then in Aix-la-Chapelle (Aachen), Prussia, to formulate plans for the acquisition of Cuba. Their joint report, primarily the work of Soulé, restated old arguments as to why Spain should sell Cuba and why the United States should buy it. The dispatch compared the alleged "africanization" of Cuba to a fire in a neighbour's house that justified tearing down the structure if there were not other means of preventing the flames from destroying one's own house. Under the circumstances, the report said, if Spain would not sell Cuba, "then, by every law, human and divine, we shall be justified in wresting it from Spain if we possess the power." Since the dispatch was not a public declaration, it was not in any sense a true manifesto. News of the ministers' meetings and of the flamboyant language of the report leaked out, stimulated an unsavoury publicity that shocked Europeans and Americans and led Marcy to reject the proposals.

The Ostend manifesto symbolized aggressive expansionism and marked the high point of U.S. efforts to acquire Cuba in the 1850s. (A. De C.)

OSTEOARTHRITIS: *see* Arthritis.

OSTEOLOGY, in anatomy, the study of the structure, gross and minute, of the bones and the skeleton. *See* Bone; Connective and Supporting Tissues; Skeleton, Vertebrate; etc.

OSTEOPATHY is a form of healing first promulgated by Andrew T. Still (*q.v.*), who developed the doctrine that all dis-

eases are due to abnormalities in or near joints and that the treatment for every disease is the correction of these abnormalities without the use of drugs, which he considered poisons. He developed the concept of what later came to be called the "osteopathic lesion"—a localized area of disease process which may occur in a bone, muscle, joint, ligament or other tissue. These lesions, he believed, may be produced by injury, strain, infection, reflexly from disease elsewhere, or simply by nervous influences. As a result, local stiffness develops, movement of the affected part becomes impaired and the flow of blood to the surrounding tissues slows down, causing acidosis and irritating neighbouring nerves, which in turn affects distant organs supplied by the nerves and produces disease in those organs (*e.g.*, appendicitis) by reducing their blood supply. A further consequence of these lesions, or subluxations as they are called when referring to joints, is an interference with the ability of the body to produce its own antitoxins and antibodies to fight infections. The correction of all of these disturbances, according to Still, is primarily manipulation.

By the mid-20th century osteopathic philosophy had undergone considerable change. It holds that the body is a unit that possesses the inherent ability to overcome most curable diseases. It recognizes that physical, chemical and nutritional factors influence the state of health and that drugs and surgery are necessary in the treatment of many diseases. However, its concept of the lesion still persists. Spinal joint subluxations (the original "osteopathic lesions") have been shown on a stereoscopic X-ray examination; they are nonsurgical and in themselves nonfatal. They are manifested by single or multiple areas of pain, tenderness, muscle spasm and localized limitation of motion in and about joints, principally those of the spine. They are regarded as a symptom complex and not as a disease per se, although still considered capable of frequently causing disturbances in distant organs. When there is no recognized disease elsewhere, manipulation alone may be used with the expectation that in a large percentage of cases immediate permanent, protracted or temporary relief may be obtained. When relief is not obtained, rest, physical support, mechanical traction, heat, diathermy, exercises and pain-relieving and muscle-relaxing drugs are used according to indications in the individual case.

The importance of avoiding overtreatment and employment of manipulation in the absence of indications for its use is stressed. When the symptom complex occurs in conjunction with recognized disease elsewhere, manipulation may or may not be employed. When it is, it is used as an adjunct to and not as a substitute for accepted methods of treatment. It is no longer considered definitely curative in all disease states.

Teaching, Licensing and Organizations.—Still first proclaimed his doctrine on June 22, 1874, and the American School of Osteopathy was established in 1892 at Kirksville, Mo. In 1967 there were five colleges of osteopathy in the United States. Their curriculums were more or less identical in content with those of allopathic medical schools, with the exception that the concept of the osteopathic lesion and the technique of manipulative therapy were still being taught. However, the emphasis given the latter was not great and in some schools was actually very little. The colleges had departments of medicine, surgery, obstetrics, etc., as do medical schools. Admission requirements were comparable with those of medical schools. The colleges owned and operated their own hospitals, which they used for their clinical teaching. The length of the course was four years and the degree given on graduation was D.O. (doctor of osteopathy). By 1966, D.O.'s had attained full rights to practise medicine in 40 states and the District of Columbia. In 21 of these states the same licensing examination was given to D.O.'s as to holders of the M.D. degree. Osteopathic physicians and surgeons from 1966 held commissions in the medical branches of the U.S. armed forces, and are included with M.D.'s and dentists as qualified practitioners in the Medicare program. Osteopathic physicians and surgeons in the U.S. have generally resisted proposals to merge with medical doctors in professional organizations.

The American Osteopathic association was organized in 1897 with headquarters in Chicago, Ill. It publishes a monthly journal. There are also regional, state and local societies, and several specialist societies. The association in 1966 listed more than 300 osteopathic hospitals.

In Great Britain there are two teaching centres, the London College of Osteopathy, where only medical graduates are taught, and the British School of Osteopathy, which does not limit its students to medical graduates. The length of the course at the former is 15 months and at the latter four to five years. Both these teaching schools place special emphasis on the teaching of osteopathic subjects. The London college is under the direction of the British Osteopathic association; the British school is associated with the Osteopathic Association of Great Britain. There is also the General Council and Register of Osteopaths, which has a function similar to that of the Medical Register.

Outside the U.S. and the U.K., the largest concentration of osteopathic physicians in the late 1960s was in Canada, chiefly in Ontario. Osteopaths also practise in France, Germany, Holland, Norway, the West Indies, Japan, the Philippines, India, Australia and other countries.

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(J. M. K.; X.)

ÖSTERDAL: *see* GLOMMA.

ÖSTERGÖTLAND ("land of the Eastern Goths"), a *län* (county) in central Sweden between Lake Vättern and the Baltic. Area 4,278 sq.mi. Pop. (1960) 357,693. It extends about 80 mi. east-west and north-south. In the south the land rises to 1,072 ft. on the edge of the Småland plateau and in the west to 862 ft. in the granite hill of Omberg. The uplands are losing population but the lowland, crossed by the Göta canal, has important towns: Norrköping, where Jews were allowed to settle in 1782, is a great textile manufacturing centre, has a good harbour, is the fourth largest town in Sweden and has a wide variety of industries; Motala, with waterpower, developed as an engineering centre as the result of Walloon immigration; Linköping is the county town.

(A. C. O'D.)

OSTERMAN, ANDREI IVANOVICH, COUNT (1687–1747), a statesman of German descent who influenced Russian foreign and internal affairs under Peter I the Great and more powerfully under the four succeeding rulers, was born at Bochum in Westphalia on July 9, 1687, and was baptized Heinrich Johann Friedrich. He studied at Jena, but fled to Holland after a duel and became secretary to Vice-Adm. Cornelis Cruys, who took him to Russia in 1703. Having acquired a good knowledge of Russian, Osterman was in 1708 appointed by Peter I the Great to be interpreter at the Russian foreign office and in 1710 was given the rank of secretary. In 1711 he assisted the vice-chancellor Petr Pavlovich Shafirov in the peace negotiations with the Turks.

At the Åland peace congress in 1718, toward the end of the Great Northern War (*q.v.*), Osterman represented Russia together with Gen. J. D. Bruce, but in fact he played the leading part even before 1719, when he went to Sweden in an attempt to persuade the Swedes to accept the Russian conditions. For the successful conclusion of the treaty of Nystad in 1721, Osterman was created baron. Two years later he signed a favourable treaty with Persia and was made vice-president of the reorganized foreign office. Though he was also consulted on internal problems, as in the case of the reorganization of the foreign office in 1720, foreign affairs remained his special sphere under Peter.

Under Catherine I (1725–27) Osterman became vice-chancellor, member of the supreme secret council, postmaster general and president of a special commission for commerce, which posts gave him not only complete control over foreign affairs but also occasion to introduce financial and economic measures. He was also governor to the future emperor Peter II, retaining this post even after the latter's accession in 1727. Osterman's shrewd behaviour in 1730, during the abortive attempt to curtail the powers of the empress Anna Ivanovna on Peter II's death, secured his further career: he was created count and was from 1731 on a member

of the new cabinet of ministers. In 1740, after Anna's death, he became admiral-general and, in addition to foreign affairs, took over naval matters (which had preoccupied him earlier). Toward the end of Anna Leopoldovna's regency for Ivan VI (1741) some people considered Osterman as the actual ruler.

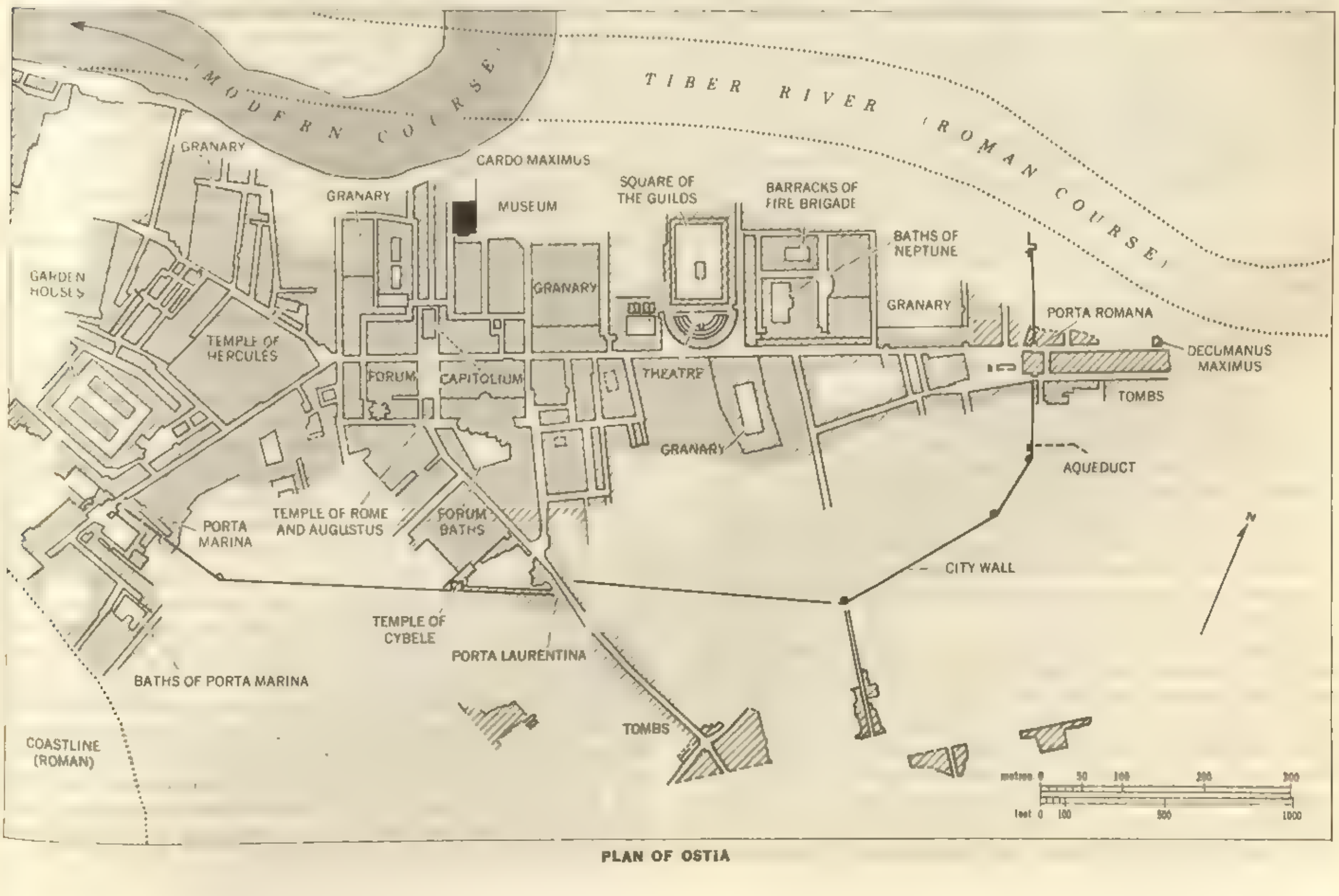
Osterman's steady ascendancy during the period when women ruled Russia through their favourites was due to his great experience and to the skill with which he adapted himself to changes and paved his way with intrigues. However, his foreign policy was consistently based on the alliance with Austria. The two costly wars that ensued, the War of the Polish Succession (1733–35) and the war against Turkey (1735–39), raised Russia's prestige; but the Russo-Turkish treaty of Belgrade (Sept. 18, 1739), following the separate Austro-Turkish treaty, brought only moderate gains to Russia. Moreover, intent on avoiding warfare on two fronts, Osterman had restored to Persia the conquests made by Peter the Great. Anglo-Russian relations improved as a result of the commercial treaty concluded in 1734, but Osterman's firm adherence to the Holy Roman emperor Charles VI's Pragmatic Sanction for the Austrian succession brought Russia into conflict with Austria's enemy, France, and this proved fatal for him. The French ambassador J. J. Trotti, marquis de La Chétardie, was behind the *coup d'état* of 1741 that led to the accession of the empress Elizabeth, whom Osterman had consistently neglected. Osterman was tried and condemned on charges of interfering with the imperial succession, reprieved on the scaffold and banished to Siberia (1742). He died at Berezov on June 11 (new style; May 31, old style), 1747.

See R. Nisbet Bain, *The Pupils of Peter the Great* (1897) and *The Daughter of Peter the Great* (1899). (Lo. L.)

ØSTFOLD, a *fylke* (county) of Norway, lies on the eastern side of Oslofjord. Area 1,614 sq.mi. Pop. (1960) 202,641; (1963 est.) 206,073. Its forested and hilly landscape is a Pre-Cambrian peneplain with heights of 800–1,000 ft. above sea level. The river Glomma crosses it from north to south. Quaternary marine deposits cover the bedrock to a large extent up to 500–650 ft. The Glomma and the Tistedal rivers have cut through the terminal moraine stretching southeastward from Moss, the administrative centre. Østfold is one of the most densely populated areas of Norway. The Fredrikstad–Sarpsborg area along the lower, navigable part of the Glomma has 92,500 inhabitants; the other urban areas, Halden and Moss, have 10,039 and 21,143. Manufacture of paper and pulp, rubber and chemical products and shipbuilding are principal industries. The farms of Østfold are among the chief suppliers of milk and vegetables to Oslo, from which a railway and two main roads run through the county. (L. H. Hg.)

OSTIA, the name of an ancient town (modern name Ostia Antica) 15 mi. from Rome, originally at the mouth of the Tiber but now about 4 mi. upstream. The modern seaside resort of Ostia (Lido di Roma) is 3 mi. S.W. of Ostia Antica. Ostia was traditionally regarded by the Romans as their first colony, founded by their fourth king, Ancus Marcius, to produce salt. No such settlement has yet been found but the tradition goes back at least to the 3rd century B.C. and is probably genuine. The earliest Ostia known dates from the middle of the 4th century B.C. It is a rectangular fort (about 5½ ac.) with strong walls of Fidenae tufa and gates in the middle of its four sides. Its purpose was to protect the coastline, the first of the long series of Rome's maritime colonies. When Rome developed a navy Ostia became a naval base, and during the Punic Wars (264–201) it was the main fleet station on the west coast of Italy and the headquarters of one of the Roman quaestors. After the Punic Wars the emphasis shifted to trade, and particularly the grain trade. In the fighting between Sulla and Marius both sides realized that by holding Ostia they could starve Rome. Marius sacked the town but soon afterward new walls were built. Ostia had expanded considerably, and without any firmly controlled plan, outside the 4th-century fort; the new walls enclosed about 160 ac.

A pirate raid in the 60s was a temporary setback, but by the end of the republic Ostia was a prosperous little town; the river harbour, however, was becoming increasingly unsatisfactory. A sandbar at the mouth made it impossible for the larger merchantmen to enter the river and the docks were too congested. Claudius



PLAN OF OSTIA

therefore built a new harbour about 2½ mi. to the north, which was connected by canal with the Tiber and so with Rome. The loss of 200 ships in this harbour in 62 showed that it could be dangerous; Trajan added a landlocked inner basin (*see* PORTUS).

But though most of Rome's shipping now went to the imperial harbours Ostia remained the administrative and business centre and new granaries continued to be built to store grain reserves for Rome. In fact Ostia reached the peak of its prosperity in the first half of the 2nd century A.D. It had already profited from the expanding economy of the early empire. Under Augustus new buildings included a *Capitolium* and a theatre. Further temples, baths, warehouses and other utilitarian buildings were added in the Julio-Claudian period, including an aqueduct which brought in a good supply of water from the hills four miles to the east.

Growing prosperity led to an increase in population, which in turn dictated a revolution in housing. In the Flavian period and, more intensively, under Trajan and Hadrian individual houses were replaced by tall brick apartment blocks of three, four and sometimes five stories. These blocks, which reflect the dominance of the middle class, were strongly built and well windowed; the floors were paved with mosaic and the walls elaborately (and sometimes skilfully) painted; the larger flats had up to 12 rooms. This intensive housing development suggests that since the end of the republic the population of Ostia had more than doubled, perhaps to around 50,000. The capital which financed the new building must have come primarily from trade, because Ostia's territory was neither extensive nor rich. Its main function was to provide for the unloading of merchantmen that were too large to complete the journey by river to Rome, to store what could not be dispatched at once, and to service the river boats that carried the bulk of Rome's imports upstream. Its own population also provided a growing market for importers, craftsmen and shopkeepers.

The growth in wealth raised the standard of public generosity that was expected from leading citizens. Public funds were restricted, but magistrates were expected to show their appreciation of honours in a practical way. It was they who provided most of the sculpture that adorned the public buildings and public places and who built most of the temples. Ostia also was sufficiently vital to Rome to expect the attention of emperors. Its three largest sets of public baths were owed to imperial generosity. The theatre was perhaps built under Agrippa's auspices and enlarged by Commodus. Aurelian presented a new forum by the sea.

Ostia's prosperity was reflected in the character of the governing class. In the republic and early empire it was dominated by a limited aristocracy who monopolized high office. By the 2nd century new wealth could raise new men quickly and it was rare for men to hold the highest office for more than a year. Though freed slaves were debarred it became increasingly easy for their sons to enter the council and hold office. The rise of the middle class was also accompanied by a rapid development of the guilds. Every trade seems to have had its own guild, with an elaborate hierarchy of offices, a detailed constitution and a guild house. Dining and office-holding were among the main attractions, but they were also concerned with upholding the business interests of their members, especially in relations with the imperial bureaucracy. Unlike local government the guilds made no distinction between freedmen and free. Increasing prosperity increased sharply the number of slaves employed in trades and households, and inscriptions suggest that a hard-working Ostian slave could expect his freedom early. Many former slaves became rich and respected enough to become presidents of the builders', bakers' and other important guilds.

Changes in the character of the population also brought changes in the religious pattern. The cults of Vulcan and of Castor and Pollux had the deepest roots in the colony and the *pontifex Volcani* exercised a general control over religion. To these cults had been added by the end of the republic temples of Jupiter, Hercules, Fortuna, Ceres, Venus, Hope and others unidentified. Under Augustus there is evidence for a *Capitolium* and a temple of Bona Dea, and the foundations of the imperial cult are laid. The first sign is the institution of *Augustales*, a priesthood confined to freedmen; under Tiberius a temple of Rome and Augustus, presided over by a *flamen Romae et Augusti*, was built at the south end of the forum. Later, deified emperors had each his own flamen (*q.v.*). Of oriental cults there is no evidence until the empire and no clear emphasis until the 2nd century. The synagogue in its original form is 1st century; it was enlarged and reconstructed in the 4th century. The sacred area of Cybele and her associates dates from Hadrian (though there may have been an earlier cult), the temple of Sarapis was dedicated in 127, the first Mithraeum known is not earlier than Antoninus Pius and most of them are from the 2nd or 3rd centuries. Nor should the influence of these oriental cults be exaggerated. Mithraism, the most widely spread, appealed primarily to the humbler folk, and even Isis and Sarapis seem to have found most of their adherents outside the governing class. While these cults were spreading the old temples were kept in repair and restored on a more ambitious scale. There was much more religious conservatism in Ostia than might be expected in a cosmopolitan trading town.


AUTHENTICATED NEWS
RUINS OF ROMAN COLONY AT OSTIA, ITALY

Toward the end of the 2nd century there are signs that Ostia has passed its peak. Apart from Commodus' attention to the grain supply there is little new building. The office of quaestor (town treasurer) becomes ominously important. The public generosity of wealthy citizens dries up. These tendencies were sharply accentuated in the disintegration of the 3rd century. The weakening of the imperial economy affected Ostia more than most towns. The shrinking volume of trade was concentrated even more in the imperial harbours, and Constantine recognized the realities by making Portus independent of the old town.

The buildings of Ostia reflect the general decline. There are no major restorations in the warehouses after the middle of the 3rd century. The large apartment blocks are increasingly neglected. But the collapse of the middle class was accompanied by the resurgence of an aristocracy. Independent houses were maintained and new ones were built. These private houses of the late empire were richly furnished. They had elaborate marble inlay (*opus sectile*) pavements, marble dadoes on their walls, and they display a passion for running water in fountains and in nymphaea. These houses probably belonged mainly to rich men, including Roman senators, who were little concerned with local government (now centrally controlled by an official from Rome) but found residence in a seaside town which had lost most of its trade attractive. Many of them were still pagans through the 4th century, though Christianity had already spread widely among the lower and middle classes in the 3rd century. But there were some influential Christians among them, such as the unknown household with whom St. Augustine stayed with his mother on his way back to Africa. The moving scene of her death at Ostia is vividly described in his *Confessions*.

During the 4th century the main emphasis in building was on amenities. Public baths were restored, the theatre was adapted to spectacles on water, and new public fountains and nymphaea were added, but building standards had declined seriously since the 2nd century and some parts of the town were failing into slum conditions. In the 5th and following centuries raids and the threat of raids quickened decline, but it was not until the 9th century that the site was abandoned, when Pope Gregory IV (827–844) built a small new fortified enclosure, Gregoriopolis, to the east of the town, from which the modern village developed.

In the middle ages the Roman site became a quarry for building material, in the Renaissance for sculpture and inscriptions. Systematic excavation was begun in the 19th century under papal authority, continued by the state in 1907 and sharply accelerated in a special campaign, 1938–42. About two-thirds of the Roman town can be seen.

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(R. Me.)

OSTRACISM, a political device peculiar to Athens in the 5th century B.C. (though somewhat similar institutions were found at Syracuse and Argos) whereby a prominent citizen who threatened the stability of the state could be banished without any charge being brought against him. At a fixed meeting in midwinter each year the people decided, without debate, whether they would hold a vote on ostracism (*ostrakophoria*). If they decided to do so, the vote took place some weeks later. Any citizen entitled to vote in the assembly could write a citizen's name on a sherd (*ostrakon;* over 1,600 of these have been unearthed in various places). To make a valid ostracism, either 6,000 votes had to be cast in all and the man with the majority was ostracized, or at least 6,000 votes had to be cast against a particular man for him to be ostracized—it is not known which was the case. The ostracized man had to leave Attica within ten days and stay in exile for ten years. He remained owner of his property.

It is not known when the law instituting ostracism was passed. Aristotle, in his *Constitution of Athens* (ch. 22), attributes it to Cleisthenes (*q.v.*) and says that the motive was suspicion of the Pisistratid party. The date would presumably be near 508 B.C. (though one modern writer entertains the possibility that Cleisthenes survived to propose the law in 488). Later Aristotle says that the first man ostracized was Hipparchus, son of Charmus, the original target of the law, though this event did not occur till 488/487. Androtion, while agreeing on the motive and the first victim, had dated the law to 488. Aristotle was probably contradicting him on the date, but there is no way of deciding between them. After Hipparchus, four more men, the last of them Aristides (*q.v.*), were ostracized before the amnesty in 481 preceding Xerxes' invasion. About 472 Themistocles, in 461 Cimon and in 443 Thucydides, son of Melesias, the opponent of Pericles, were ostracized. The institution fell into disuse after it was used ineffectively, probably in 417, to resolve the political impasse caused by the rivalry of Nicias and Alcibiades. They combined to procure the ostracism of Hyperbolus, a man not of the calibre to justify the use of this weapon.

The procedure was basically unjust; there was no charge and therefore no possibility of defense. Moreover the more powerful of two contestants was likely to secure the ostracism of his chief opponent and this tended to increase rather than diminish the danger of tyranny.

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(A. R. W. H.)

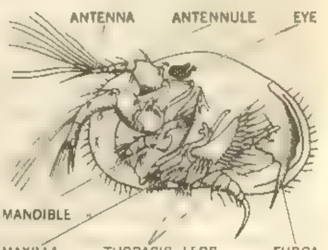
OSTRACODA, a subclass of the class Crustacea (*q.v.*) comprising minute clamlike forms found in fresh water and in the sea as floaters, swimmers or bottom dwellers; a few may be parasitic; several live only in water held by the leaves of air plants (epiphytes) or in moist debris in holes in trees. Of their food habits little is known. Many are omnivorous, some carnivorous and others feed on aquatic plants and diatoms. All are im-


P. S. TICE
FRESHWATER OSTRACOD

portant as food for larger organisms including fish; some fossil forms are used in age determination. Ostracods are distinguished by having the body and limbs completely enclosed in a hinged double shell (bivalve). They are remarkable for having a smaller number of appendages than any other crustacean, there being not more than four pairs and sometimes only two pairs of limbs behind the mouth parts (mandibles). The antennules and antennae are used for swimming or creeping. The mandibles have a large fleshy palp, often forked (biramous) and sometimes leglike. The remaining limbs are varied in form: some of them are leglike and used in locomotion. The breeding habits of the ostracods present several interesting features. Development of eggs without fertilization (parthenogenesis; *q.v.*) is common, at least among the freshwater species, in many of which males are rarely seen; in some species males are not yet known. A colony of a species of *Cypris* has been kept in an aquarium for more than 30 years and during the whole of that time no males have made their appearance, the colony reproducing exclusively by parthenogenesis. In some ostracods the threadlike spermatozoa are not only relatively but absolutely larger than those of any other animals. In one species, which, when adult, is no longer than $\frac{1}{32}$ in., the spermatozoa are about $\frac{1}{4}$ in. long.

Most species live on or near the bottom, creeping among weeds or burrowing in mud, but some marine species are floaters (planktonic). One of the latter, *Gigantocypris*, is the largest member of the group, reaching a length of almost an inch; most species, however, are much smaller and some do not exceed .02 in. in length.

Ostracods are classified by paleozoologists solely on fossil shell characters; zoologists working on living forms classify them mostly on the basis of soft parts. Four orders comprise the subclass: Myodocopa, Cladocopa, Platycopa and Podocopa. The first three are exclusively marine. To the Podocopa belong the vast majority of living genera, including all the known freshwater forms. The order is characterized by an unbranched (uniramose) second antenna and a styliform or vestigial tail fork (caudal furca). The Myodocopa have an anterior notch in the valves of the body covering (carapace), a biramose second antenna, a heart and four pairs of postoral limbs. Both orders have a median eye in the nauplius larval stage, later adding a pair of compound eyes. The Cladocopa and Platycopa differ from the Myodocopa in the absence of the anterior notch and the eyes; the Cladocopa have two pairs of postoral appendages, the Platycopa three pairs. Classification of the fossil families is still unsettled; however, the "straight-backed" forms have been placed in an additional order Paleocopa. (W. T. C.; I. G. S.)



FROM D. J. BORROR AND D. M. DELONG, "INTRODUCTION TO THE STUDY OF INSECTS" (1954); REPRODUCED BY PERMISSION OF HOLT, RINEHART AND WINSTON, INC
LATERAL VIEW OF FRESHWATER OSTRACOD CYPRIDOPSIS WITH LEFT VALVE OF CARAPACE REMOVED

OSTRACODERM, a small extinct fishlike Paleozoic vertebrate, members of which belonged to several orders particularly abundant in late Silurian and early Devonian formations of Europe and North America (period from about 350,000,000 to 300,000 years ago). Jaws were not developed and paired appendages were often absent. These are primitive characteristics which show that they were allied to the living Cyclostomata (*see* Cyclostome)—hagfish and lampreys—with which they are often grouped to form the vertebrate class Agnatha. Ostracoderms carried bony

armour, and internal bony areas (ossifications) are sometimes present as well.

There are three major orders: Osteostraci, Anaspida and Heterostraci. In the Osteostraci (Cephalaspid-like form) such as *Cephalaspis*, the head and gill region were covered by a broad crescent-shaped shield of bone. Dorsally there were paired orbits, a median eye and, anterior to this (as in lampreys), a median opening leading to the nasal organ and hypophysis. Areas of small checkered or tessellated plates, to which large nerves led, are thought to represent electric organs or pressure-sense organs. The "head" region is ossified internally; delicate dissection and sectioning has revealed cavities for brain, nerves and blood vessels of a pattern broadly comparable to that of lampreys. The underside of the head region was covered by a series of small plates, with about ten round gill openings at either margin. The mouth was small. Internally there was a large branchial or gill chamber; the animal appears to have been a filter feeder after the fashion of lower chordates. In many osteostracans there were paired paddle-shaped structures behind the shield in the position of pectoral fins.

The Anaspida include small spindle-shaped (or fusiform) fishes with a narrower and deeper form than that of osteostracans. There was no expanded head shield and this region was covered by a series of small oat-shaped scales. No internal structures are known but the pattern of openings for sense organs and gills was similar to that of the Osteostraci.

In the Heterostraci (Pteraspid-like form) the anterior part of the long slender body was enclosed in a set of large plates that were fused to a variable degree. In contrast with the other two orders of the group the small paired eyes were laterally placed. There was no dorsal nostril opening; the nares may have been paired and placed at the corners of the mouth opening. The mouth was a transverse ventral slit, bounded posteriorly by small movable plates, suggesting a mud-grubbing mode of feeding. No internal structures have been preserved, but impressions inside the plates indicate the presence of large gill chambers. There was a single external gill opening on either side. Possibly related to the Heterostraci are *Thelodus* and other genera in which no plates or large scales were present, but, rather, the whole body was covered with minute scales.

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OSTRAVA (Ger. Ostrau; Polish Ostrawa), a town in Czechoslovakia, headquarters of the North Moravian region (Severomoravsky *kraj*) and the nucleus of an important mining and manufacturing area, lies 358 km. (222 mi.) E. of Prague by rail and on the southern edge of the Upper Silesian coalfield. The population of Ostrava proper was 25,528 in 1960 but the conurbation of greater Ostrava contained 264,278 people in 1961. The coal measures are the most valuable in Czechoslovakia and the most useful in Silesia, for the seams, unlike those in Polish Silesia, have a considerable proportion of coking coal required for heavy industrial undertakings. Ostrava is also set in a neighbourhood of good farming land; thus a local labour force was not attracted as the mines developed, and peasants from the Carpathians and Poles from Galicia came to work in the mines.

The Ostrava conurbation has an area of more than 400 sq.mi. It was formed from four original and older settlements: Privoz (north), Marianske Hory and Slezka Ostrava (centre), and Vitkovice (south). Slezka Ostrava (Silesian Ostrava) lies to the east of the Ostravice river in Silesia; the other settlements, collectively Moravska Ostrava, are in Moravia. The economic expansion of these settlements began only in the mid-19th century and as a result, primarily, of railway building and the development of coal mining. North of Privoz, the Ostravice joins the Oder before the Oder passes through the Moravian Gate (Moravska Brana).

Ostrava's industrial landscape of mining and manufacture stretches eastward to the Silesian mines of Karvina and southeast to the iron- and steel-producing town of Trinec. After World War II a considerable amount of planned settlement (mainly residential and shopping quarters for workers, but also new factories) was added. Much of it is on the eastern side, filling in the open spaces between the older settlements. The most important planned towns are Bludovice and Havirov; the latter fringes two older towns of the area, Senov and Sumbark, and was recognized as a town in 1955. No pains have been spared in providing the area with housing, services and amenities.

The output of hard coal from the Ostrava mines exceeds 20,000,000 tons a year. Much of it is processed in the Ostrava coking plants which supply all the foundries in Czechoslovakia. There are three large iron- and steel-producing works, two older ones at Vitkovice and Trinec, and the newer one (Klement Gottwald foundry) at Kuncice in the centre of the conurbation. The coal mining is also a support to the chemical industries for the production of ammonia and nitrate fertilizers. Poorer grade coal is used to supply the power stations in Ostrava and at Trebovice, which provide electricity for the surrounding areas.

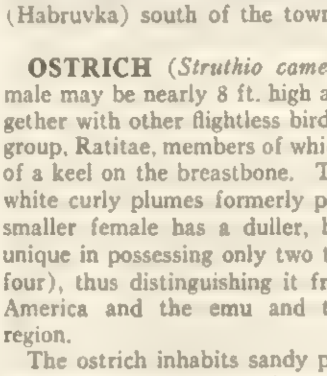
A network of railways and roads connects Ostrava with all the chief towns of Czechoslovakia and with Poland. An airfield (Habruvka) south of the town operates services to Prague.

(H. G. S.)

OSTRICH (*Struthio camelus*), the largest living bird; the male may be nearly 8 ft. high and weigh 300 lb. The ostrich, together with other flightless birds, is sometimes placed in a special group, Ratitae, members of which are characterized by the absence of a keel on the breastbone. The cock bears the fluffy black and white curly plumes formerly prized in the millinery trade. The smaller female has a duller, brownish plumage. Ostriches are unique in possessing only two toes (all other birds have three or four), thus distinguishing it from the ostrichlike rhea of South America and the emu and the cassowary of the Australian region.

The ostrich inhabits sandy plains and open country in Africa, being more abundant in the eastern than the western portion of that continent. Formerly abundant in Arabia as well, it has not been sighted there since 1941.

Ostriches travel in small troops of five or six; usually one bird is a cock and the rest hens. At other times a troop will form mixed herds with zebras and various antelopes. The bird has keen eyesight; when resting or hiding, it may sit and stretch its lanky neck along the ground, peering intently at some far-off threat. At a distance only the ostrich's bulky body is visible; hence the belief that the bird hides its head in the sand. When danger is imminent, however, the ostrich warily moves off, the male all the while producing a loud hissing sound, somewhat like a muffled roar.



W. SUSCHITZKY

OSTRICH (STRUTHIO CAMELUS) NATIVE TO AFRICA

Extremely fleet of foot, the ostrich can stride across a flat plain at speeds up to 40 m.p.h. (Because of this ability, some captives have been trained for racing, whether harnessed to light, two-wheeled carts, or saddled for riding.) When brought to bay, it often uses its strong legs to deliver vicious kicks.

The hen may lay up to 15 buffy-white, rough-surfaced eggs, each weighing about three pounds—the largest egg of any living bird. Several hens combine to lay their eggs in one nest, and on these the cock sits by night while the females relieve one another by day (this is more to guard the eggs from beasts of prey than to incubate them, the heat of the sun sufficing for that). Yellowish and black-striped young, hatching in about six weeks, are covered with a bristly down. The parents display great solicitude for their agile little chicks. They forage together for anything fit to eat—small animals as well as fruit and other plant parts.

The great value of ostrich feathers, combined with the growing

scarcity of the birds themselves, led to the establishment of ostrich farms, where the birds are kept and deprived of their plumes at regular intervals. Ostrich farming was carried on in Cape Province (in south Africa), Egypt, Algeria, the French Riviera, the southern U.S. and elsewhere, but the commercial raising of the birds has dwindled away in France and America.

All ostriches belong to a single species, which has six races including the now extinct Arabian one. The best known are *Struthio camelus camelus* of north Africa, ranging from the Atlas mountains to the Sudan; *S. c. molybdophanes* of Somaliland and northern Kenya; *S. c. Massaicus* of eastern equatorial Africa; and *S. c. australis* of south Africa. The southern race is now quite local, finding its optimum numbers in the Kalahari desert of Bechuanaland and in adjacent portions of South West Africa, Southern Rhodesia, northern Transvaal and Mozambique. In Rio de Oro, on the northwest coast of Africa, is a small and little-known race *S. c. spatzi*. *See* also references under "Ostrich" in the Index. (Ht. Fn.)

OSTROGOTHS (East Goths), one of the two main branches into which the Goths were divided, the other being the Visigoths. *See* Goths; also references under "Ostrogoths (East Goths)" in the Index.

OSTROVSKI, ALEKSANDR NIKOLAEVICH (1823–1886), Russian dramatist, generally considered the greatest representative of the Russian realistic period, was born on April 12 (new style; March 31, old style), 1823, in Moscow. His grandfather, a priest, entered a monastery and his father was educated at a seminary but became a lawyer and was for several years a member of the Moscow high court. Ostrovski's mother died when he was eight, and his father allowed him the run of his library as well as of the streets, both of which were of great use to him as a playwright. Neither at school nor at Moscow university, where he studied law, did Ostrovski excel. He left the university in his third year after a quarrel with one of his professors. From 1843 to 1848 he was employed as clerk at the Moscow juvenile court, the so-called "Court of Conscience." He wrote his first play, *Kartiny semeinogo schastya* ("Scenes of Family Happiness") in 1847. His next play, *Bankrot* ("The Bankrupt"), later renamed *Svoi lyudi sochtemsya* (*It's a Family Affair, We'll Settle It Among Ourselves*, 1917), written in 1850, provoked an outcry because it exposed bogus bankruptcy cases among Moscow merchants, and brought about his dismissal from the civil service. He was placed under police supervision and his play was banned, the ban only being removed 13 years later under the more liberal administration of Alexander II.

In 1856 Ostrovski took part in a survey of literary documents in various parts of central Russia and as a result wrote several historical plays; *e.g.*, *Kozma Zakharich Minin Sukhoruk* (1862), *Dmitri Samozvanets* (1867). His main dramatic work, however, was concerned with the Russian merchant class. It included two tragedies, *Groza* (1860; *The Storm*, 1898) and *Bespridannitsa* ("The Girl Without a Dowry," 1879) and numerous comedies, such as *Bednaya nevesta* (1852; *The Poor Bride*, 1933), *Bednost ne porok* (1854; *Poverty is No Crime*, 1917), *Dokhodnoe mesto* ("A Profitable Post," 1857), *Ne v svoi sani ne sadis* ("Don't Get Into Another Man's Sledge," 1853), as well as several comedies of "high life," such as *Beshenye dengi* (1870; *Easy Money*, 1944, 1957), *Volki i ovtsy* (1875; *Wolves and Sheep*, 1944), *Na vsyakogo mudretsa dovolno prostoty* (1868; *Even a Wise Man Stumbles*, 1944; adapted as *The Diary of a Scoundrel*, 1948) and *Les* (1871; *The Forest*, 1926). His *Snegurochka* ("The Snow Maiden," 1873) was adapted as an opera by Rimski-Korsakov in 1880–81.

Ostrovski was closely associated with the Maly ("Little") theatre, Moscow's only dramatic state theatre, where all his plays were first performed under his supervision. He was first president of the Society of Russian Playwrights, founded on his initiative in 1874, and in 1885 became artistic director of the Moscow Imperial theatres. He died in Slykovo on June 14 (N.S.; 2, O.S.), 1886.

See Eng. trans. of *Groza* by C. Garnett (1898) and by D. Magarshack (1960); Eng. trans. *Easy Money and Two Other Plays* (*Even a Wise Man Stumbles* and *Wolves and Sheep*) by D. Magarshack (1944). (D. Mr.)

OSTROWIEC SWIETOKRZYSKI, an industrial town in eastern Poland, in the Kielce *wojewodztwo* (province), lies 169 km. (105 mi.) S. of Warsaw by road and on a minor railway line and is linked by road also with Lublin and Kielce. Pop. (1960) 38,000. The town lies in the Little Polish highlands on the Kamienna river, a tributary of the Vistula. The date of its origin is uncertain (16th or 17th century). Its development dates from the 1830s, when the Bank of Poland established an iron foundry there, exploiting the local ores of the old Polish mining basin. It is now an important industrial centre, producing machinery, building materials, ceramics, food and rolling stock. (T. K. W.)

OSTROW WIELKOPOLSKI, a town in the Poznan *wojewodztwo* (province) of west central Poland and a district capital, lies 117 km. (73 mi.) S.E. of Poznan by road. Pop. (1960) 42,000. It is in the southern part of the great Polish plain, on a postglacial elevation, and is a railway junction for Lodz, Wroclaw, Leszno, Poznan and Kepno. The machine industry, started there before World War II, has developed and there are timber, ceramic, clothing and machine-tool industries. Mentioned in the 13th century it acquired town rights in the 18th century. After the second partition of Poland in 1793 it was seized by Prussia. It belonged to the duchy of Warsaw between 1807 and 1815, when it was returned to Prussia. It passed to Poland in 1918. (K. M. Wi.)

OSTWALD, WILHELM (1853–1932), German chemist who organized physical chemistry into an almost independent branch of chemistry and won the 1909 Nobel prize in chemistry for his work in catalysis, chemical equilibrium and reaction velocities. He was born at Riga, Latvia, on Sept. 2, 1853, and was educated at the University of Dorpat in Estonia, where he received his doctorate in 1878. He taught for a time in a high school, in 1882 became professor at the University of Riga and from 1887 to 1906 taught at the University of Leipzig. He then retired to devote himself to his many outside interests.

During his academic career he wrote his great *Textbook of General Chemistry* (1885–88) and followed this with several other influential texts on physical and analytical chemistry. He early became a close friend of Svante Arrhenius and J. H. van't Hoff (*qq.v.*) and with them he established physical chemistry on a firm basis. He was chiefly responsible for the founding in 1887 of the *Zeitschrift für physikalische Chemie*, long the most influential journal in the field.

His chemical work began with studies on the dynamics of reactions in solutions, but the work of Arrhenius on conductivity directed his attention to electrochemistry and he carried on much work in this field. It is probable, however, that his activities in publicizing the numerous important studies by many workers through his textbooks and journal were even more important for the science of physical chemistry than were his experimental investigations. However, in 1894 he gave the first valid modern definition of a catalyst. This led him to study a number of catalytic reactions. In 1902 he patented a process for the catalytic conversion of ammonia to nitric acid that later became of great industrial importance.

Throughout his life he was interested in historical problems. In 1889 he began publication of the important series of *Klassiker der exakten Wissenschaften*, in which were reprinted almost all the important papers in physics and chemistry that had appeared up to that time. His approach to science always tended to be strongly philosophical. He was probably the last great chemist who refused to believe in atoms, seeing the explanation for all material phenomena in energy alone.

After his retirement from the University of Leipzig he took up a wide variety of activities. He wrote a number of books and articles on the philosophy of science. He investigated the psychological causes of scientific productivity in his book *Grosse Männer* (1909). He published a three-volume autobiography (1926–27). Toward the end of his life his interest in painting led him to a prolonged investigation of the theory of colour, which he approached both from the psychological and the experimental viewpoints.

He died at Grossbothen near Leipzig on April 4, 1932, and his

home was converted into a museum in his memory.

A good biography of Ostwald is to be found in E. Farber's *Great Chemists* (1962). (H. M. L.)

OSTWALD, WOLFGANG (1883–1943), German chemist and specialist in colloid chemistry, was born at Riga, Latvia, on May 27, 1883. He was educated at Leipzig, majoring in zoology. In 1904 he was assistant to Jacques Loeb at the University of California, Berkeley. He returned to Leipzig, and became interested in colloid chemistry. The whole of his academic career was spent at Leipzig, where he eventually held the professorship of colloid chemistry in the famous institute built and directed by his father, Wilhelm Ostwald (*q.v.*). From 1907 to his death he edited the *Kolloid Zeitschrift* and the *Kolloidchemische Beihefte*. He died at Dresden on Nov. 22, 1943.

See R. Oesper, *J. Chem. Educ.*, vol. xxii, p. 263 (1945). (R. E. O.)

OSTYAK (KHANT), a western Siberian people belonging to the Ugrian branch of the Uralic language family. The language of the Khant is most closely related to that of their neighbours, the Vogul (Mansi), and somewhat more distantly to the Hungarians (Magyars). (*See* URAL-ALTAIC LANGUAGES.)

The Khant territory lies between the Ural mountains and the Ob river; it is a cold, flat country of marsh and bog within the Siberian taiga. When the Ostyaks settled their present habitat is not precisely known but it was probably in the middle of the first millennium A.D. They and their congeners, the Vogul (Mansi), moved there from the south Ural steppe region, and have a continuous occupancy of their present territory of about 1,500 years. Their traditions in the 1960s still recall that distant time when they were steppe horse breeders (*see* VOGUL).

There is some confusion over the name Ostyak, which has been indiscriminately applied to the Khant or Ob Ostyaks, the Ket or Yenisei Ostyaks and the Sel'kup or Samoyed Ostyaks. Some of the Mansi have also been referred to as Ostyaks. Therefore a more precise terminology has been adopted, reserving the name Ostyak to the Khant. (*See* also KET; SAMOYED.)

The Khant and the Mansi have a common habitat, common traditions, economy and organization. Together they are known as the Ob Ugrians. Their principal source of subsistence is hunting and fishing. They hunt in their traditional culture with bow and arrow and by trapping for hare, reindeer, lynx and bear. They fish with nets, weirs, seines and traps. Limited reindeer domestication has come only in recent centuries. Other forms of animal breeding are poorly developed and agriculture is a minor source of food. Their dwellings reflect available natural resources; in winter they use log cabins, which yield to birch-bark tents in summer. Travel over water is by dugout, and over snow by skis.

These Ob Ugrian peoples were divided into tribal units, each with a distinctive locality (territorial grouping). The tribal units, in turn, were divided into clans, each with its proper name, sign and internal organization. The most striking kinship feature is their dual organization; the territorial units were divided into pairs. These dual organizations were exogamic, and later the clans became the exogamic units. The prevailing principle in the tracing of descent lines, kinship and the establishment of marriage rules was patrilineality of kinship in the male line. They worshiped family, clan and territorial spirits. Their ritual also included an ancestor cult and an animistic cult of animals and fish. (*See* also UGRIC PEOPLES.)

These two peoples lived in the 1960s in the Khanty-Mansi national district of the U.S.S.R. The Khant numbered 19,410 (Soviet census of 1959). This was a decline of 15% from their number in 1926 (22,300). The Mansi numbered 6,449 (1959), a slight increase over 1926 when they numbered 5,800.

See S. A. Tokarev, *Etnografiya Narodov SSSR* (1958); M. A. Czaplicka, *Aboriginal Siberia* (1914). (L. K.)

ŌSUMI-GUNTŌ, a group of islands, lying south of the Ōsumi peninsula of Kyushu, in Kagoshima prefecture, southern Japan. Area 396 sq.mi. Pop. (1960) 57,276. They consist of the two larger islands of Tanega-shima and Yaku-shima and several smaller islands. Tanega-shima is famous because in 1543 the Portuguese landed there and introduced the first guns into Japan. (R. B. H.)

OSUNA, a town of southern Spain in Seville province, Andalusia, lies below a hill at the edge of an extensive plain. The small rivers Salado and Peinado run near the town. It is E.S.E. of Seville by road. Pop. (1960) 20,775 (mun.). The many fine 16th–18th-century buildings include the Capilla del Santo Sepulcro (1534–39) where the dukes of Osuna are buried, and the Colegiata with a baroque portal of the "Crucifixion" by Jusepe de Ribera. The former university (1549–1820) now houses the Instituto Nacional de Enseñanza Media. Of Iberian origin, the town was the Roman Urso. It supported Pompey against Caesar, who later made it a colony. In the middle ages it was called Ursona and the Muslims called it Oxuna. Conquered by Castile in 1239, it came eventually to the Girón family. In 1562 Pedro Téllez Girón, 5th count of Ureña, was created 1st duke of Osuna. The town was prosperous in the 17th and 18th centuries.

Osuna is on the railway from Seville to Málaga and the main Seville-Granada road. Agriculture is the main occupation, but flour, olive oil, unslaked lime and gypsum are produced, and esparto is manufactured. (F. O. M.)

OSWALD, SAINT (*c.* 605–641), Anglo-Saxon king of Northumbria, was a son of King Aethelfrith by Acha, daughter of Aelli, king of Deira. When Acha's brother Edwin succeeded Aethelfrith in 616, Oswald was expelled from Northumbria; with his younger brother Oswiu he spent some years at Iona and was converted to Christianity. In 633 Oswald defeated and slew the British king Cadwallon near a stream called Denisesburn, now known as Rowley water in Northumberland. Cadwallon had previously killed Edwin (632) and Oswald's elder brother Eanfrith (633), who had succeeded as king of Bernicia. Oswald now became king of Northumbria, effectively reuniting Bernicia and Deira. Bede states that Oswald ruled over "all the peoples and provinces of Britain, which includes four languages, those of the Britons, Picts, Scots and Angles"; he also classes him as one of the seven overlords of all southern English peoples. The most important feature of Oswald's reign was his introduction of Celtic missionaries into Northumbria. At his request Aidan was sent from Iona as bishop of the Northumbrians; his see was established at Lindisfarne, near the royal stronghold of Bamburgh. Early in his reign Oswald stood sponsor to the West Saxon king Cynegils, whose daughter he married. In 641 he was defeated and slain at a place called Maserfeld, probably Oswestry in Shropshire, by Penda of Mercia.

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OSWALD, SAINT (d. 992), Anglo-Saxon bishop of Worcester and archbishop of York, a leading figure in the 10th-century movement for monastic reform, was probably of Danish birth. With the approval of his uncle Oda, archbishop of Canterbury, he entered the monastery of Fleury on the Loire river, at that time a great centre of reformed Benedictinism. Returning just after Oda's death (June 958), Oswald was in 961 consecrated bishop of Worcester by Dunstan, the new archbishop of Canterbury. Oswald was translated to the archbishopric of York in 972, but was allowed to retain the see of Worcester, where he mainly resided, and where he died on Feb. 29, 992.

Soon after his appointment to Worcester, Oswald founded a small monastery at Westbury-on-Trym in Gloucestershire. About four years later, when King Edgar ordered the establishment of many new monasteries, Oswald founded Ramsey abbey, Huntingdonshire, on a site provided by Aethelwine, ealdorman of East Anglia. Ramsey was colonized from Westbury, but had also close ties with Fleury. From Ramsey Oswald brought monks to his cathedral at Worcester, where they gradually replaced the secular clerks.

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OSWEGO, a city and lake port of north-central New York, U.S., is located about 35 mi. N.W. of Syracuse, on Lake Ontario, at the mouth of the Oswego river; the seat of Oswego county. The site, known as Osh-we-geh, an Iroquois term meaning "pouring-out place," was visited about 1616 by Samuel de Champlain and was later a station for Jesuit missionaries and *coureurs de bois*. A British trading post, founded there in 1722 and fortified in 1727, was the western terminus of the water route connecting the Mohawk and Hudson rivers with Lake Ontario. Oswego played a role in the French and British colonial wars, its two forts, Ontario and Oswego (1755–56), being captured and destroyed by General Montcalm in 1756. Ft. Ontario was restored by the British in 1759 and ceded to the U.S. in 1796. In 1814 it was again briefly in British hands; it was rebuilt by the U.S. in 1839, abandoned in 1899 and reconstructed again in 1905. It is the oldest fort in the U.S. that is still garrisoned. Permanent settlement began with the 1796 cession to the U.S., and in 1817 the first steamboat on Lake Ontario put in at Oswego. With the opening of the Oswego canal in 1828, Oswego became the Lake Ontario port of the Erie canal; it was incorporated as a village that same year and became a city in 1848. Through the canal, salt, manufactured goods and immigrants poured westward, and Canadian lumber entered the United States. Railroad transportation, however, practically killed the port, and about 1880 Oswego turned to manufacturing. Manufactures include boilers, cornstarch, malt, textiles, matches, paper and paper products, machinery and candy.

In 1917, following completion of the New York State Barge canal system, the port revived, handling principally Canadian cement and wood pulp, Pennsylvania coal and western grains. With the opening of the St. Lawrence seaway in 1959, Oswego, most easterly port on the Great Lakes, became a world port. It is the hydro- and steam-electric power centre of central New York and has unlimited water supplies for industrial and other uses.

The State University College at Oswego, founded by the city as a normal school in 1861, was taken over by the state in 1867 and after 1948 was a unit of the State University of New York. Pop. (1960) 22,155. For comparative population figures *see* table in NEW YORK: *Population*. (M. E. MA.)

OSWEGO TEA (*Monarda didyma*), a North American plant of the mint family (Labiatae), called also bee balm or fragrant balm, native to moist soil from Quebec to Michigan and southward to North Carolina and Georgia. It is a stout, somewhat hairy perennial, 2–4½ ft. high, with opposite, lance-shaped, sharply toothed leaves, and tubular showy scarlet flowers, about 1½ in. long, borne in terminal clusters and surrounded with red-tinged bracts. The Oswego tea, so named because of former medicinal use, is an easily cultivated ornamental; horticultural forms with rose or white flowers are available.

OSWESTRY, a market town and municipal borough in the Oswestry parliamentary division of Shropshire, Eng., 18 mi. N.W. of Shrewsbury by road and near the Welsh border. Pop. (1961) 11,215. Situated on a slope which rises gently from the Shropshire plain toward a spur of the Berwyn mountains, Oswestry lies largely between Offa's and Wat's dykes—at one time famous boundary lines. Its name may be derived from Oswald, king of Northumbria, who was killed by Penda, the ruler of Mercia at the battle of Maserfeld (641) which probably took place at or near Oswestry. The heavily fortified encampment of "Old Oswestry," about a mile from the town, suggests early border warfare. On an eminence known as Castle bank are the ruins of the ancient castle built by Madog, prince of Powys, whose widow married Alan, lord of Clun in Shropshire. The title of baron of Oswestry is still held by the Fitzalans, earls of Arundel. The town was twice burned by Welsh invaders in the middle ages. In the 15th and 16th centuries a weekly market was held for the sale of Welsh woolen goods, but Shrewsbury drapers ruined the trade by refusing to buy cloth there. In 1559 Oswestry suffered from the plague and the market was moved to a site marked by the Croeswyllan stone (the Cross of Weeping). Oswestry received its first royal charter in 1398; other charters date from 1617 and 1674. In 1642 the castle was garrisoned for Charles I but fell to the parliamentary forces in 1644. The church of St. Oswald, originally conventual, is Early English and Decorated, but has been much restored. In it is a memorial to Elihu Yale, the benefactor in 1718 of the U.S. university that bears his name. The grammar school, founded in 1407, was moved in 1776 to bigger buildings, but the original house, near the church, still stands. Llwyd mansion is a half-timbered house in Cross street. Oswestry's industries include agriculture, with a big cattle market; railway works and running sheds; plastics, clothing and printing. It was the birthplace of the musician Sir Henry Walford Davies (1869–1941) and of the poet Wilfred Owen (1893–1918).

OSWIECIM (Ger. AUSCHWITZ), the county town of the Cracow *wojewodztwo* (province) of southern Poland, lies 51 km. (32 mi.) W. of Cracow city at the confluence of the Vistula and Sola rivers in the marshy valley of the same name. Pop. (1960) 31,000. It was formerly a fortress in the province of Cracow and was incorporated in Silesia at the end of the 12th century. Town status was granted in the 13th century and from 1306 it was the capital of a principality, made subject to Bohemia in 1307. It was returned to Poland in 1457. Seized by Austria at the first partition of Poland in 1772, it was restored to Poland in 1918.

During World War II, the Germans established near Oswiecim the notorious concentration camp called Auschwitz-Birkenau (Oswiecim-Brzezinka), covering about 40 sq.km. (15 sq.mi.). It consisted of three main camps, and there were 39 supplementary camps throughout Silesia. The first prisoners arrived on July 14, 1940, and the camp was evacuated and closed on Jan. 27, 1945. About 400,000 prisoners (two-thirds Jews) were registered in Oswiecim camp, but the total number of persons exterminated there has been variously estimated as between nearly 1,000,000 and (by Soviet sources) four times that number. The camp was situated in an uninhabited area, from which the populations of the nearby villages were evacuated. The entire complex of buildings in Brzezinka, used for mass extermination of prisoners in gas chambers and the cremation of their remains, was camouflaged and later converted or destroyed before the camp was abandoned. In 1946 the Oswiecim State museum was founded on the site of the camp; it has become a place of pilgrimage from Poland and abroad. A chemical factory, erected by prisoners in the Dwory camp 4 km. (2.4 mi.) from Oswiecim, was rebuilt after its complete destruction and is now one of the largest and most up-to-date factories in Poland. Oswiecim is a centre of communications, where five railway lines meet.

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OSWIU (d. 670), Anglo-Saxon king of Northumbria, son of King Aethelfrith, succeeded to Bernicia after his brother Oswald was slain at Maserfeld on Aug. 5, 641. Deira was ruled by Oswine, a kinsman of King Edwin (d. 632), until Oswiu brought about his death in 651, and then by Oethelwald, son of King Oswald, under the protection of Penda of Mercia, until 654. In that year, Penda brought a great force, including British princes and English subkings, to invade Bernicia. Oswiu failed to buy him off, and defeated and killed him at the battle of the Winwaed. This victory made Oswiu king of all Northumbria, and overlord of all the southern English kingdoms. He annexed northern Mercia, and gave Mercia south of the Trent to Penda's son Peada, who had married his daughter Allflaed. Peada was murdered in 656, and in 657 three Mercian ealdormen led a revolt which established Penda's son Wulfhere as king of Mercia, and ended Oswiu's overlordship of the southern English. At some date after 664 his son Alhfrith, whom he had made subking of Deira, rebelled against him, and is not mentioned again. Oswiu died in 670, and was succeeded by Egfrith, his son by Eanflaed, daughter of King Edwin.

On the eve of the battle of Winwaed, Oswiu had vowed to give to God his infant daughter Aelfflaed (Elfled), and 12 estates, 6 in Bernicia, 6 in Deira. She was placed under St. Hilda, first at Hartlepool, then at Whitby. Oswiu persuaded Sigeberht of Essex to accept Christianity, and Peada of Mercia became Christian

when he married Oswiu's daughter. In Oswiu's reign a synod was held at Whitby in 663 or 664 which accepted the practices of the Roman party in the church. The Celtic bishop of Northumbria, Colman, and many of his clergy, therefore left Northumbria. In 667 Oswiu joined with King Ecgberht of Kent in finding an archbishop for Canterbury. Their nominee died at Rome and the pope appointed Theodore of Tarsus.

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OTAGO, a land district of New Zealand. Pop. (1961) 176,-375. Area 14,070 sq.mi. The district extends across the South Island where it is broadest and has a narrow front on the Tasman coast north of Milford sound. Inland it reaches from Lake Ohau to Lake Wakatipu and on the east coast from the Waitaki river to Chaslands. Lowland is limited to a narrow east-coast strip north and south of Dunedin (*q.v.*), which is the principal city and port, and most of the people live there. Inland are broad, frosty tussock basins, bare schist mountain blocks and superb lakeland scenery. Formerly the river basins yielded gold; but sheep, hydroelectric power production and stone-fruit growing are the bases of the modern economy. (K. B. C.)

OTAKAR I (properly PREMYSL OTAKAR I) (d. 1230), king of Bohemia from 1198, was a younger son of Prince Vladislav II, who was king as Vladislav I from 1158 to his abdication in 1173. Recognized as ruler of Bohemia by the Holy Roman emperor Henry VI in 1192, he was soon dispossessed; but in 1197 his brother, Prince Vladislav III, ceded Bohemia to him, contenting himself with Moravia. Whereas two of his predecessors in Bohemia had held the royal crown and title only as personal honours, Otakar obtained them as hereditary dignities for himself and his successors from the Hohenstaufen Philip of Swabia in 1198, as a reward for his support of Philip's claim to the German kingship. After a temporary lapse into support of Philip's Welf rival Otto IV, Otakar finally returned to the Hohenstaufen side and, under the so-called Golden Bull of Sicily (1212), secured confirmation of Bohemia's autonomy from Frederick II. Dying on Dec. 15, 1230, he left a powerful, united and comparatively peaceful kingdom to his son Wenceslas (Vaclav) I. (R. R. Bs.)

OTAKAR II (PREMYSL OTAKAR II) (*c.* 1230–1278), king of Bohemia from 1253, was a son of King Wenceslas (Vaclav) I. Margrave of Moravia from 1247, he was elected duke of Austria by the Austrian estates in 1251 and proceeded to marry Margaret, widow of the German king Henry (VII) and sister of the last Babenberg duke of Austria and Styria, Frederick II (d. 1246). Having succeeded his father as king of Bohemia in Sept. 1253, he took the leading part in a crusade to East Prussia (1254), where the castle of Königsberg ("King's Mount") was founded and named after him. He won Styria—a part of the Babenberg inheritance which the Hungarians had disputed with him—by his great victory over Béla IV of Hungary in the battle of Kressenbrunn (1260); made himself master of Carinthia (1269); and extended his dominions to the Adriatic sea by the acquisition of Carniola. He was thus the most powerful prince within the Holy Roman empire when the electors met to choose a new German king in 1273. They chose Rudolf of Habsburg rather than Otakar.

Rudolf soon took measures to reduce Otakar's power. Having first outlawed him, he invaded Austria in 1276 and forced him to renounce all his territories except Bohemia and Moravia (peace of Vienna, Nov. 1276). Attempting to reassert himself, Otakar was defeated by Rudolf at Dürnkrut and killed in flight from the battlefield on Aug. 26, 1278. Though he had been much occupied by external interests, Bohemia had benefited from administrative reforms and prospered during Otakar's reign.

See O. Lorenz, *Geschichte des Königs Ottokars II.* (1866); V. Novotný and J. Šusta, articles in *České dějiny*, i, 4 (1912), and ii, 1 (1935), respectively. (R. R. Bs.)

OTARU, a commercial town on Otaru bay, Hokkaido, Japan. Pop. (1960) 198,511. It is the most important seaport next to Hakodate and the largest industrial and commercial city on the west coast of the island. The word Otaru is a corruption of the Ainu word *Otarunai*, meaning "sandy beach." The development of Otaru as a modern town was undertaken by the Japanese government around 1875. Provided with a good natural harbour, the town developed rapidly. After the loss of Sakhalin Island to the U.S.S.R. at the end of World War II, Otaru's prosperity suffered some decline. (R. B. H.)

OTFRID (OTFRIED) (fl. 9th century), monk of Weissenburg (Wissembourg) in Alsace and the first German poet whose name is known. He was trained in the monastery school of Fulda under Rabanus Maurus, who directed it from 802 to 824. Otfried's fame rests on his *Evangelienbuch* (*c.* 870), a poem of 7,416 lines, which is extant in three good contemporary manuscripts. It is an exceptionally valuable document not merely linguistically as the most extensive work in the South Rhine Franconian dialect of Old High German but also theologically as an introduction to early Christian thought in Germany. In German literary history it is also a milestone since it is the first poem to use rhyme and not alliteration, adopting the stylistic device of the Latin hymn rather than following the tradition of Germanic verse. The *Evangelienbuch* deals with the life of Christ, presenting the narrative in small chapters and interposing short passages of interpretation or commentary. Although Otfried wrote his epic to counteract the influence of popular heathen songs, it seems likely that his poem was meant not to be sung but rather to provide passages for daily study. He made concessions to the pagan Germanic outlook in his presentation of Christ and hoped to show that his native Franconian dialect was as suitable as the classical languages for poetic writing. His efforts to achieve rhyme made his poem somewhat laboured, however.

See editions of *Otfried* by J. Kelle, 3 vol. (1856–81), O. Erdmann (1882; 2nd ed. by E. Schröder, 1934) and P. Piper, 2nd ed. (1882–84). (W. W. Cs.)

OTHMAN ('UTHMAN) (*c.* 576–656), the third of the Muslim caliphs, reigned from 644 to 656 (*see* CALIPHATE). Born at Mecca, of the clan of 'Abd-Shams or Omayya of the Meccan tribe of Quraish (Koreish), and married to Mohammed's daughter Ruqayya, he was one of the first Muslims. He went on the migration to Ethiopia but returned in time to join in that to Medina along with Mohammed. Though wealthy, he played no prominent part in affairs until on the death of Omar I (644) he was elected caliph by a conclave (*shura*) of Meccan nobles. He carried forward the policy of Omar. The conquests continued in east and west, and on the north Byzantine territory was raided. Fleets based on Syria and Alexandria were organized, the Byzantines were defeated at sea, and Cyprus was occupied. By about 650, when the conquests were slowing down and military expeditions becoming less profitable, the social malaise consequent on the rapid expansion from a small state to an empire became manifest. Military discipline and bureaucratic administration proved irksome to Arabs from the desert. Othman was accused of having favoured his own clan of Omayya in appointments to governorships (which he had done, but probably for reasons of efficiency). His arrangements for a standard text of the Koran also provoked criticism. Troops mutinied in Iraq and Egypt. Mutineers from Egypt besieged Othman in his house in Medina. He got little support from the Muslims in Medina and was killed there on June 17, 656. The caliph Mu'awiya I (660–680), first of the Omayyads (*q.v.*), was the son of Othman's cousin Abu Sufyan. (W. M. WT.)

OTHO (1815–1867), king of Greece from 1832 to 1862, was born at Salzburg in Austria on June 1, 1815, the second son of the future king of Bavaria, Louis I, and his consort Theresa of Saxe-Altenburg; his Christian name in its original German form was Otto. Chosen by the conference of London in May 1832 to occupy the newly erected throne of Greece and elected king by the Greek national assembly on Aug. 8, he accepted the kingdom on Oct. 5 and arrived at Nauplia on Feb. 6, 1833, accompanied by a council of regency composed of Bavarians under the presidency of Josef Ludwig, Graf von Armansperg (1787–1853). The regency ended when he came of age, on his 20th birthday, in 1835; but he retained Armansperg as "archchancellor" on the advice of his father and under pressure from the British and from the Rothschilds, since they all thought that Greece's supreme need was a capable finance minister. The Greeks, however, who had now to

pay more tax than they had paid to the Turks, resented the new system of government by official regulations and found moreover that they had exchanged a Muslim sovereign for a Catholic one, to them a heretic. Otho's good intentions and genuine fondness for his adopted country were not enough to make his rule acceptable.

Otho married Princess Amalia of Oldenburg in 1836, but she made herself unpopular by interfering in the government. Though Armansperg was dismissed in 1837, many important posts remained in Bavarian hands and the granting of a constitution was postponed. The king's attempts to conciliate Greek opinion by enlarging the country's frontiers, for instance when he sought to acquire Crete in 1841, had no effect but to alienate the powers. When the last of his Bavarian troops were withdrawn in 1843, insurgent Greeks surrounded his palace in Athens (Sept. 14–15) and forced him to grant a constitution and to appoint a wholly Greek ministry. He took the oath to the constitution in March 1844.

Otho's resistance to British bullying in the affair of David Pacifico (*see* GREECE: *Modern History*) in 1850 raised his prestige, but his intervention against Turkey in the Crimean War provoked a Franco-British occupation of the Piraeus (1854–57) and failed to win any territory for Greece. The king became more and more discredited. The student Aristidis Dosios who tried to assassinate the queen (Sept. 1861) was hailed as a national hero; the garrison at Nauplia mutinied in Feb. 1862; and in Oct. 1862, while Otho and Amalia were in the Peloponnese, Gen. Theodoros Grivas and his troops in Acarnania declared for the king's deposition. A provisional government was set up in Athens; and Otho and his queen, having returned by sea to the Piraeus on Oct. 23, left Greece on a British warship next day. Back in Bavaria, Otho died in Bamberg on July 26, 1867.

See L. Bower and G. Bolitho, *Otho I, King of Greece* (1939).

OTHO, MARCUS SALVIUS (A.D. 32–69), Roman emperor January–April, A.D. 69, was born into a family which had held the consulship under Augustus. After a youth spent in pleasure at Rome he married Poppaea Sabina, the divorced wife of a Roman knight; but when Nero too fell in love with her, Otho was appointed to Lusitania. This province he governed with integrity for ten years, till in 68 he joined the rising of Galba (*q.v.*), governor of the neighbouring province, Tarraconensis. During the march to Rome that autumn he set himself to win over the troops, hoping to be adopted as Galba's successor; and when Galba disappointed him by adopting L. Piso Licinianus in Jan. 69, his plans were laid. The praetorian guard rose, Galba and Piso were murdered in the forum, and Otho was acclaimed emperor (Jan. 15).

Before Galba's death, however, the legions in Germany had declared for Vitellius (*q.v.*), whose troops were already moving toward Italy. Otho acted with speed and determination, sending a naval expedition to Narbonensis (Provence), summoning the Danube legions, and marching out himself on March 14, preceded by an advance guard which had been able to hold the advanced Vitellian forces on the Po. But although substantial forces joined Otho from Illyricum, by early April the Vitellian concentration was stronger, and the disparity was increased when Otho withdrew a contingent to his headquarters at Brixellum (Brescello). Experienced advisers counseled delay, but Otho insisted on action, and his main army moved westward from Bedriacum (near modern Calvatone). Their exact plans were obscure in antiquity and are controversial today. They were completely defeated east of Cremona, and Otho committed suicide in his tent (probably on April 16), though the praetorian guard wanted to renew the struggle.

Otho's disreputable private life did not impair his energy or ambition, and he seems to have had a dispassionate interest in administration. He enlisted some support by appealing to the memory of Nero, but his rule was too short to show what the full character of his policies would have been.

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OTIS, ELISHA GRAVES (1811–1861), inventor of the safety elevator (lift), was born at Halifax, Vt., on Aug. 3, 1811. He worked as a builder in Troy, N.Y., in 1834, and later, while employed as a master mechanic in a bedstead factory in Albany, N.Y., invented several laboursaving machines. As a result he was sent to Yonkers, N.Y., in 1852 to build a new factory. There he designed and installed the first elevator equipped with an automatic safety device to prevent it from falling. The next year he set up a small elevator shop and sold his first freight machine on Sept. 20, 1853. Orders were few until May 1854 when, at the Crystal palace in New York city, he demonstrated his elevator by riding the platform high in the air and ordering the rope cut. In 1857 he installed the first safe elevator for passenger service in a store in New York city. After he died in Yonkers on April 8, 1861, his sons Charles and Norton carried on the business.

(D. SN.)

OTIS, JAMES (1725–1783), American politician and publicist who helped formulate the colonists' case against the English government in the year preceding the American Revolution. He was born at West Barnstable, Mass., on Feb. 5, 1725, the eldest son of James Otis (1702–78), a descendant of one of the first settlers of Hingham, Mass. The elder James Otis was elected to the provincial general court (legislature) in 1758, was its speaker in 1760–62, and was chief justice of the court of common pleas from 1764 until 1776; he was a prominent patriot in the colony of Massachusetts. The son graduated from Harvard in 1743, and after studying law in the office of Jeremiah Gridley (1702–67), a well-known Boston lawyer, rose to great distinction at the bar, practising first at Plymouth and after 1749 at Boston. In 1760 he published *Rudiments of Latin Prosody*, a book of authority in its time. Soon after the accession of George III to the throne of England in 1760, the British government decided upon a rigid enforcement of the navigation acts and of the Sugar act of 1733, some parts of which had long been disregarded by the colonists. General writs of assistance issued in 1755 to assist in the enforcement of the British acts were about to expire, and it was decided to issue new ones. Such general writs authorized customhouse officers to search any house for smuggled goods; neither the house nor the goods had to be specifically mentioned in the writs. Much opposition was aroused in Massachusetts, the legality of the writs was questioned, and the superior court consented to hear argument.

The case was argued at Boston in Feb. 1761, and the chief speech was made by Otis. His plea was fervid in its eloquence and fearless in its assertion of the rights of the colonists. In approaching the question at issue, he dealt with the fundamental relationship between the English in America and the home government, and argued that even if authorized by act of parliament such writs were null and void. He was elected in May of the same year as a representative from Boston to the Massachusetts general court. To that position he was reelected nearly every year of the remaining active years of his life, serving there for a time with his father. In 1766 he was chosen speaker of the house of representatives, but the choice was negatived by the royal governor of the province.

In Sept. 1762 the younger Otis published *A Vindication of the Conduct of the House of Representatives of the Province of Massachusetts Bay*, in defense of the action of that body in sending to the governor a message (drafted by Otis) rebuking him for asking the assembly to pay for ships he had (with authorization of the council but not of the representatives) sent to protect New England fisheries against French privateers. According to this message "it would be of little consequence to the people whether they were subject to George or Louis, the king of Great Britain or the French king, if both were as arbitrary as both would be if both could levy taxes without parliament." He also wrote various state papers addressed to the colonies to enlist them in the common cause, or sent to the government in England to uphold the rights or set forth the grievances of the colonists. His influence at home in controlling and directing the movement of events which led to the American Revolution was universally felt and acknowledged; and few Americans were so frequently quoted, denounced or applauded in parliament and the English press before 1769 as the recognized head and chief of the rebellious spirit of the New Eng-

land colonists. In 1765 Massachusetts sent him as one of its representatives to the Stamp Act congress at New York city, and there he was a conspicuous figure, serving on the committee that prepared the address sent to the British house of commons.

Otis had long shown signs of mental disturbance. After being struck on the head during an altercation with a crown officer in 1769 he was harmlessly insane almost continually until his death, though he had occasional lucid intervals, serving as moderator of a Boston town meeting as late as 1778. He was killed by lightning at Andover, Mass., on May 23, 1783.

Otis' political writings exercised great influence, some of his pamphlets being among the most effective presentations of the arguments of the colonists against the arbitrary measures of the British ministry. His pamphlets were the *Vindication*, noted above; *The Rights of the British Colonies Asserted and Proved* (1764); *A Vindication of the British Colonies Against the Aspersions of the Halifax Gentleman* (1765); *Brief Remarks on the Defence of the Halifax Libels* (1765); and *Considerations on Behalf of the Colonists in a Letter to a Noble Lord* (1765).

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OTRANTO, a seaport of the province of Lecce, region of Apulia (Puglia), Italy, lies 28 mi. (45 km.) S.E. of Lecce city by road. Pop. (1961) 4,107 (commune). It is on the east coast of the peninsula of ancient Calabria (*see* CALABRIA [ANCIENT]) forming the Italian "heel," and is the most easterly town in Italy. The Strait of Otranto is about 40 mi. wide. Otranto is connected to the main east-coast road and is an old port of communication with Greece. The castle, erected by Alfonso of Aragon, was the setting of Horace Walpole's *Castle of Otranto* (1765). The cathedral, consecrated in 1088, has a rose window and side portal of 1481. The interior contains a mosaic pavement of 1165. The church of S. Pietro has Byzantine frescoes. The district between Otranto and Capo Santa Maria di Leuca, the southeast extremity of Italy, is thickly populated and fertile. Otranto occupies the site of the ancient Hydrus or Hydruntum, a town of Greek origin. In Roman times it was less important than Brundisium (Brindisi) as a point of embarkation. It was taken by Robert Guiscard in 1068. In 1480 it was destroyed by the Turkish fleet, and never recovered its importance.

OTSU, the capital of Shiga prefecture in southern Honshu, central Japan. Pop. (1960) 113,547. It is located on the shore of Biwa-ko, the largest lake in Japan, and was a castle town established by Toyotomi Hideyoshi in the 16th century. Situated at the junction of ancient highways, including the Tokaido (Tokyo-Osaka) route, Ōtsu has been a gateway to Kyōto and a centre of transportation. There are many places of historical interest and scenic beauty in the vicinity. *See* also SHIGA. (R. B. H.)

OTTAVA RIMA, an Italian eight-lined hendecasyllabic stanza, rhyming *a b a b a b c c*, which originated in the late 13th and early 14th centuries, and was later introduced into Spain, Portugal and England. Perhaps derived from the *ottava siciliana*, which had an alternating rhyme scheme, the ottava rima was developed by Tuscan poets for religious verse and drama, and troubadour songs. Its adoption by Boccaccio for his romantic epics *Filostrato* (*c.* 1338) and *Teseida* (1340–41), and for *Ninfale fiesolano* (perhaps 1344–45), led to its becoming the standard form for epic and narrative verse. In the following century it gained a classical elegance from Poliziano who greatly developed its descriptive power. From its use by Luigi Pulci for *Morgante* (begun *c.* 1460) and by Matteo Boiardo for *Orlando Innamorato* (begun *c.* 1476), it acquired a mock-heroic, burlesque character, later imitated by Alessandro Tassoni and Giambattista Marino. The form acquired new flexibility and variety in Ariosto's *Orlando Furioso* (*c.* 1507–32) and Tasso's *Gerusalemme Liberata* (1575).

Introduced into Spain and Portugal in the 16th century, with other Italian metres and poetic forms, the form was first used in Spain by Juan Boscán and Garcilaso de la Vega; and in Portugal, by Francisco de Sá de Miranda, and became the standard form for epic and heroic poetry (*see* SPANISH LITERATURE: *The Renaissance and the Siglo de Oro;* PORTUGUESE LITERATURE: *The Italianate School*).

The English form of ottava rima, with decasyllabic lines, was introduced by Edward Fairfax (*q.v.*) in his translation of Tasso (1600). By strengthening the final couplet, he considerably altered the style of the stanza, and this led to the popularity of the couplet for serious ("heroic") poetry in the 17th and 18th centuries. Ottava rima was reintroduced for burlesque by J. H. Frere in *The Monks and the Giants* (1818), and adopted from him by Byron, whose *Beppo* (1818) and *Don Juan* (1819–24) are the best English examples of its use. Shelley's *Witch of Atlas* (published 1824) exemplifies its English use for a serious subject.

OTTAWA, the national capital of Canada, a city of Carleton county, province of Ontario, is on the south bank of the Ottawa river, 101 mi. W. of Montreal and 217 mi. N.E. of Toronto. Pop. (1961) 268,492; greater Ottawa (1961) 429,750, which also includes the city of Hull (*q.v.*), the town of Eastview and various other suburbs.

Physical Setting.—Ottawa has an attractive physical setting. It is located near the confluence of three rivers, the Ottawa from the northwest, Gatineau from the north and Rideau from the south. The swirling waters of the Ottawa at Chaudière falls and the tumbling, misty waters of the Rideau at Rideau falls contribute to the scenic beauty of the site. Above the Chaudière falls, the Ottawa river is broken by the Deschênes rapids and beyond these it expands into Lake Deschênes. Hydroelectric power is developed on the Ottawa and Gatineau rivers near Ottawa.

The city is built on a cluster of hills, 60 to 155 ft. above the river along the high southern bank and commanding a fine, panoramic view in places. The surrounding lowland, particularly the broad valley of the Ottawa, is a prosperous agricultural area. The heavily wooded Laurentian hills to the north are broken by the picturesque Gatineau valley. Fast-running rivers, a lowland of early lumbering and agricultural potential and a forested upland underlie both the beauty and the development of Ottawa and its environs.

History.—The single most important fact about Ottawa is its role as the national capital of Canada. In 1858 it was selected by Queen Victoria as the capital of the united province of Canada, its rival claimants being Montreal, Quebec, Toronto and Kingston. The British North America act of 1867 made Ottawa the national capital. Prior to its selection as capital, Ottawa was a small lumbering community on the northern frontier of settlement; since its selection it has developed into a city of international importance, with over 60 foreign countries maintaining representatives in it.

Samuel de Champlain reached and described the future site of Ottawa in 1613. For almost 200 years the Ottawa river was important only as a thoroughfare to the interior. Explorers and fur traders became familiar with the Chaudière portage while traveling by canoe via the Ottawa, Mattawa, Lake Nipissing and French river route to Georgian bay and the country to the west. Following U.S. independence and the arrival of United Empire Loyalists in Upper Canada, the Ottawa area became a place of opportunity for settlement. Early in the 19th century the strategic importance of a transportation route between Montreal and Kingston, sufficiently remote from the U.S. border to afford military protection, brought about the development of the Rideau canal system linking the Ottawa river with Lake Ontario. These events and developments assured Ottawa of a promising future.

The first settler in the area was Philemon Wright of Woburn, Mass. In 1800, accompanied by 25 men and their families, he established a permanent settlement on the north bank of the Ottawa river at the site of the present city of Hull. Land was cleared for agriculture but within a few years lumbering became the most important industry in the Ottawa valley. Square timbers cut from the magnificent stands of white pine were rafted down the Ottawa and St. Lawrence rivers to Quebec, beginning in 1807 and continuing during the heyday of lumbering in the 19th century.

Settlement was slow to begin on the south bank of the Ottawa river. Finally, about 1820, Nicholas Sparks moved across the river and cleared a farm in what is now the heart of the capital

NATIONAL FILM BOARD OF CANADA

CENTRE BLOCK OF THE PARLIAMENT BUILDINGS ON PARLIAMENT HILL, OTTAWA. THE PEACE TOWER IS AT CENTRE, WITH THE COMMONS WING AT LEFT AND THE SENATE WING AT RIGHT. THE SPIRE OF THE LIBRARY OF PARLIAMENT IS IN THE BACKGROUND

city. The real impetus to settlement came later, in 1827, shortly after Col. John By and his royal engineers were sent from England to build a canal from a point below the Chaudière falls to Kingston on Lake Ontario. The canal was completed in 1833 at a cost of almost $4,000,000. It was never called upon to fulfill its primary object of enabling gunboats and military supplies to reach the lakes from Montreal without being exposed to attack along the St. Lawrence frontier; it did, however, create a thriving community at the Ottawa end, which came to be known as Bytown. In 1854 the population of Bytown was estimated at 10,000. In that year it was incorporated as a city, the name being changed to Ottawa, the English form of the name of the band of Indians who inhabited the area at the time of the first white contacts. The flourishing lumber industry began at that time to bring rapid economic development. In addition, capital status gave the city an important role in the political development of the nation and assured civic growth.

Buildings.—The crowning architectural feature of the city is the splendid group of Gothic buildings on the summit of Parliament hill. The three blocks are on the sides of a great quadrangle, the fourth side being historic Wellington street, along which a number of government buildings are located. The cornerstone of the main building on Parliament hill was laid by the prince of Wales in 1860. With the exception of the library, it was destroyed by fire in 1916 and was later rebuilt. It contains the house of commons and the senate chambers. In the 300-ft. tower is a remarkably beautiful war memorial chamber, and above it is hung a carillon of 53 bells. Other national institutions with impressive buildings scattered throughout the city are the public archives, royal mint, National Research council, Central post office, Dominion observatory, the Dominion bureau of statistics and the National Art gallery. Other noteworthy buildings include the new city hall, the University of Ottawa, St. Patrick's college, Carleton university (founded 1942), the Roman Catholic and Church of England cathedrals and Rideau hall, the governor-general's residence. The War memorial on Confederation square is a striking monument. City charities include a large civic hospital and nurses' home, a general hospital supported by the Roman Catholics and three special hospitals devoted to contagious diseases.

National Capital Plan.—Efforts toward the systematic development and beautification of Ottawa as a national capital began as early as 1899, when the Ottawa Improvement commission was organized. The Federal District commission was formed in 1927 to promote such an objective and some miles of urban scenic drives and parks were developed. Following World War II the government initiated a program for the development of the national capital district, comprising 900 sq.mi. of territory and about 30 municipalities on both sides of the Ottawa river. The Federal District commission, renamed the National Capital commission in 1958, assumed responsibility for the work.

The principle of a green belt surrounding the city was adopted, the necessary land being purchased by the commission from private owners. Many miles of parkway have been built in Ottawa and in Gatineau park, a 75,000 ac.-area in the Laurentians to the north of the city. The commission plan provided for the removal of railway lines from the heart of the city and the building of arterial roadways to ease the flow of traffic. Congestion in the central part of the city was being reduced by the erection of new governmental buildings in outlying parts of the city.

Industries.—Ottawa is not a city of impressive industrial development; selectivity has been and is being exercised in the types of industry encouraged to locate in the national capital. Greater Ottawa, including Hull, has a number of industries reflecting the availability of cheap hydroelectric power and the vast timber resources of the Ottawa and Gatineau river valleys. In addition to lumber, pulp and paper, and cement, manufactures include stoves, refrigerators, washing machines, camping equipment and furniture.

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OTTAWA, a city of north-central Illinois, U.S., is located about 85 mi. S.W. of Chicago on the Illinois river at the mouth of the Fox river; it is the seat of La Salle county. First visited by French explorers and missionaries in the 17th century, the town was laid out in 1830. At first called Carbonia, from rich coal deposits nearby, Ottawa, renamed for the Indian tribe, was incorporated as a town in 1837 and as a city in 1853. Ottawa became an important river port for shipping grain, grown in the surrounding region, to Chicago. Local deposits of St. Peter (Lower Ordovician) sandstone made it important in the silica sand and glass-making industries. Manufactures include glass products, firebrick, tile, pottery, sewer pipe, farm machinery, asphalt, playground equipment and roofing materials. On Aug. 21, 1858, Ottawa was the scene of the first of the Lincoln-Douglas debates. For comparative population figures *see* table in Illinois: *Population.* (M. Ws.)

OTTAWA RIVER, chief tributary of the St. Lawrence (*q.v.*), is a wide, swift river rising in wild bush country of western Quebec and forming the boundary between the provinces of Quebec and Ontario for most of its 696 mi. Its total drainage basin is 55,560 sq.mi. Through a series of lakes it flows westward to Lake Timiskaming, then southeastward the rest of its course to join the St. Lawrence at the island of Montreal. The principal tributaries on the left bank are the Rouge (115 mi.), North Nation (60), Lièvre (205), Gatineau (240), Coulonge (135), Dumoine (80); and on the right bank, the South Nation (90), Mississippi (105), Madawaska (130) and Petawawa (95). The only navigable one is the Rideau, which with its canal system connects the Ottawa with Lake Ontario. Above Lake Timiskaming are four major dams for storage reservoirs, having a drainage area of 28,900 sq.mi. Below Timiskaming are large power developments at La Cave, Des Joachims, Bryson, Chenaux, Chats and Chaudière, generating more than 1,000,000 h.p. Above Pembroke is Chalk River, the Canadian government's establishment for atomic research.

The Ottawa is bordered by wooded hills through most of its course, its upper reaches being barely settled. Below Pembroke is considerable farming country, several towns and two cities, Ottawa, Ont., capital of Canada, and Hull, Que., a lumber centre. The main industry of the lower valley has always been lumbering. Logs cut from surrounding forests are floated down the river or its tributaries to mills where they are processed into wood products, chiefly pulp and paper.

The Ottawa was first explored by Samuel de Champlain in 1613. Thereafter it became a favourite route of explorers and fur traders to the Great Lakes. Travelers in canoes and bateaux followed

the river from Montreal, portaging at rapids and falls, to Mattawa, then westward through Lake Nipissing to Georgian bay. In 1825 first canals were cut on lower Ottawa at Ste. Anne's, Carillon and Grenville, later being deepened to accommodate eight-foot draft at low water, making the river navigable as far as Chaudière falls at Ottawa. During the 19th century there was much traffic in lumber barges and steamboats. With the coming of railways and highways it disappeared, and, since early in the 20th century, traffic has been mainly in pleasure craft. (E. D. L.)

OTTER, any of several species of semiaquatic mammals of the subfamily Lutrinae of the weasel family (Mustelidae). The common otters widespread throughout the world belong to the genus *Lutra*. They have the same general proportions as a weasel—the lithe, slender body, long neck, small ears and short legs. The head is flattened, and the base of the tail is almost as thick as the body. A large male measures 4½ ft. overall, stands 10 in. high and weighs 20 lb.; the female is smaller. The pelage consists of a dense, fine underfur of dark gray-brown, overlaid with a heavy coat of long, straight, glistening dark brown guard hairs; the muzzle and throat are grayish. Few other animals produce a fur so highly valued by man and so durable; the darker furs of northern animals are the most prized.

Otters are among the most nearly aquatic of all the mustelids. They swim easily with webbed feet, and can travel underwater for a quarter of a mile without surfacing for air. They prefer to travel by water but (their short legs notwithstanding) can travel on land faster than a man can run. They travel extensively and methodically. Their food consists of all manner of small aquatic animals, including fish, which they catch expertly, sometimes by teamwork; they also prey on other small mammals, and a few otters can decimate a muskrat colony in several days. The sense of smell is acute; of sight, good; of hearing, mediocre.

Otters live in and around lakes and streams, especially in timbered areas. The den may be a burrow dug in a bank by some other animal, a muskrat or beaver lodge or even a hollow log. There the one to five young are born in midspring after a gestation of 61–63 days. The young, whose eyes open in about five weeks, are cared for by the mother until the next litter is due—about a year. The males may have several mates in one season.

Unlike almost all other wild mammals, otters are playful, almost frivolous, as adults. A favourite sport is sliding down a steep bank of mud or snow and plunging into water or a snowdrift. This is repeated until the slide is smooth and polished. Adults, even old ones, throw stones in the water, dive in after them and catch them as they sink, seemingly purely for pleasure. They are intelligent, friendly and inquisitive and, when obtained young, can be trained readily.

W. SUSCHITZKY

EURASIAN OTTER (LUTRA LUTRA)

The common otters include the river otter (*L. canadensis*), of North America; the southern river otter (*L. annectens*), of Central and South America; the Eurasian otter (*L. lutra*), of northern Africa north to the arctic and west to Burma and southern China; and *L. cinerea*, of the East Indies. Other otters, of related genera, include the Brazilian giant otter, or saro (*Pteronura* species), the Asiatic dwarf otter (*Amblonyx* species) and the African small-clawed otter (*Aonyx* species). The larger, rare and very valuable sea otter (*Enhydra lutris*) is entirely aquatic and lives in the northern Pacific ocean. *See* also CARNIVORE; FUR. (K. R. KN.)

OTTERY ST. MARY, a market town and urban district in the Honiton parliamentary division of Devon, Eng., 12 mi. E.N.E. of Exeter by road. Pop. (1961) 4,121. Area 15.6 sq.mi. The town stands on the river Otter at the foot of the Blackdown hills, and is notable for some fine Elizabethan buildings, such as Cadhay house and Knightstone manor. S. T. Coleridge, the poet, was born at the rectory. The splendid church of St. Mary was consecrated in 1259 and rebuilt by Bishop John Grandisson, who made it into a collegiate church, in 1338–42. An annual carnival (Nov. 5) preserves the ancient custom of the "Rolling of the Barrels." The town has a large agricultural trade.

OTTO I THE GREAT (912–973), German king from 936 and Holy Roman emperor from 962, was born on Oct. 23, 912, the son of the future king Henry I, of the Liudolfing or Saxon dynasty, and his second wife, Mathilda. Little is known of his early years, but he probably shared in some of his father's campaigns. He married Eadgyth, daughter of the English king Edward the Elder, in 929; she obtained as her dowry the flourishing town of Magdeburg. Nominated by Henry as his successor, Otto was elected king by the German dukes at Aachen on Aug. 7, 936, a month after Henry's death, and crowned by the archbishops of Mainz and Cologne.

Whereas Henry I had been content with asserting a merely nominal suzerainty over the dukes, the new king took a firm stand with regard to them. This led immediately to war, especially with Eberhard (*q.v.*) of Franconia and with his namesake Eberhard of Bavaria, who were joined by discontented Saxon nobles under the leadership of Otto's half brother Thankmar. Thankmar was defeated and killed, the Franconian Eberhard submitted to the king, and Eberhard of Bavaria was deposed and outlawed. In 939, however, Otto's younger brother Henry revolted; he was joined by Eberhard of Franconia and by Giselbert of Lotharingia and supported by the French king Louis IV. Otto was again victorious: Eberhard fell in battle, Giselbert was drowned in flight, and Henry submitted to his brother. Nevertheless Henry in 941 joined a conspiracy to murder the king. This was discovered in time; and while the other conspirators were punished, Henry was again forgiven (Christmas 941). Thenceforward he remained faithful to his brother. In 947 Henry was given the dukedom of Bavaria. The other German dukedoms were likewise bestowed on relatives of Otto.

Despite these internal difficulties, Otto found time to strengthen and to extend the frontiers of the kingdom. In the east the margraves Gero and Hermann Billung were successful against the Slavs, and their gains were consolidated by the foundation of the monastery of St. Maurice in Magdeburg in 937 and of the bishoprics of Havelberg and Brandenburg in 948. In the north the bishoprics of Schleswig, Ripen and Aarhus (followed in 968 by that of Oldenburg in Holstein) were founded to extend the Christian mission in Denmark. A first campaign in Bohemia was a failure, and it was not until 950 that the Bohemian prince Boleslav I was forced to submit and to pay tribute.

Having thus strengthened his own position, Otto could not only resist France's claims to Lorraine (Lotharingia) but also act as mediator in France's internal troubles. Similarly he extended his influence into Burgundy. Moreover, when the Burgundian princess Adelaide (*q.v.*), the widowed queen of Italy whom the margrave Berengar of Ivrea had taken prisoner, appealed to him for help, Otto marched into Italy in 951, assumed the title of king of the Lombards and married Adelaide himself (his first wife had died in 946). In 952 Berengar did homage to him as his vassal for the kingdom of Italy.

Otto had to break off his first Italian campaign because of a revolt in Germany, where Liudolf, his son by Eadgyth, had risen against him, together with Conrad the Red of Lotharingia, Archbishop Frederick of Mainz and some Saxon and Bavarian nobles. Having failed to take either Mainz or Regensburg by siege, Otto found himself compelled to withdraw to Saxony; but the position of the rebels began to deteriorate when the Magyars invaded Germany in 954. The rebels could then be accused of complicity with the enemies of the *Reich*. After prolonged fighting, particularly around Regensburg, Liudolf had to submit in 955 (he died in 957). This made it possible for Otto to defeat the Magyars decisively in the battle of the Lechfeld, near Augsburg, on Aug. 10, 955; they never invaded Germany again. In the same year Otto and the

BY COURTESY OF THE METROPOLITAN MUSEUM OF ART, NEW YORK, GIFT OF GEORGE BLUMENTHAL, 1941

THE EMPEROR OTTO I, DEPICTED IN AN IVORY ALTARPIECE, DEDICATING MAGDEBURG CATHEDRAL TO CHRIST, c. 970

margrave Gero also won a victory over the Slavs. A further series of campaigns led by 960 to the subjection of the Slavs in the basin of the Havel river between the middle Elbe and the middle Oder. The archbishopric of Magdeburg was founded in 968, with Meissen, Merseburg and Zeitz-Naumburg as its suffragan bishoprics. Even Mieszko of Poland paid tribute to the German king.

In May 961 Otto procured the election and coronation of the child Otto II (*q.v.*), his elder son by Adelaide, as German king, so as to ensure the succession. Then he went for a second time to Italy on the appeal of Pope John XII, who was hard pressed by Berengar of Ivrea and his son Adalbert. Arriving in Rome on Feb. 2, 962, Otto was thereupon crowned emperor. Eleven days later a treaty known as the *Privilegium Ottonianum* was concluded, to regulate relations between emperor and pope. This confirmed and extended the temporal power of the papacy; but it is a matter of controversy whether the proviso enabling the emperor to ratify papal elections was included in the original version of the treaty or added in Dec. 963 when Otto deposed John XII for treating with Berengar and set up Leo VIII as pope instead. Berengar was captured and taken to Germany, and in 964 a revolt of the Romans against Leo VIII was suppressed.

When Leo VIII died in 965 the emperor chose John XIII for pope, but John was expelled by the Romans. Otto therefore marched for a third time to Italy, where he stayed from 966 to 972. He subdued Rome and even advanced into the Byzantine south of Italy. Prolonged negotiations with Byzantium, conducted mainly by Liudprand of Cremona, resulted in the marriage of Otto II to the Byzantine princess Theophano on April 14, 972. Having returned to Germany, the emperor held a great assembly of his court at Quedlinburg on March 23, 973. He died in Memleben on May 7, 973, and was buried in Magdeburg at the side of his first wife, Eadgyth.

Otto I's achievement rests mainly on his consolidation of the *Reich*, that is, the old kingdom of the East Franks, which his father had kept together only with difficulty. He deliberately made use of the bishops to strengthen his rule and thus created that "Ottonian church system of the *Reich*" which was to provide a stable and long-lasting framework for Germany. By his victorious campaigns he gave Germany peace and security from foreign attack; and the preeminent position that he won as ruler gave him a sort of hegemony in Europe. His Italian policy and the acquisition of the imperial crown constituted a link with the old Carolingian tradition and was to prove a great responsibility for the German people in the future. All areas under Otto's rule prospered and the resultant flowering of culture has been called "the Ottonian renaissance." Otto's chancery documents and the legislative acts of the reign are printed in the *Monumenta Germaniae historica*, series *Diplomata*, vol. i (1879), and series *Constitutiones*, vol. i (1893), respectively.

See also references under "Otto I" in the Index.

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For modern studies *see* R. Koepke and E. Dümmler, *Jahrbücher der deutschen Geschichte: Kaiser Otto der Grosse* (1876); J. F. Böhmer and E. von Ottenthal, *Regesta imperii*, vol. ii (1893); C. W. Previté-Orton and A. L. Poole, chapters in *The Cambridge Medieval History*, vol. iii (1936); H. Günter, *Kaiser Otto der Grosse* (1941); M. Lintzel, *Die Kaiserpolitik Ottos des Grossen* (1943); H. Jantzen, *Ottonische Kunst* (1947); F. Ernst, "Das Reich der Ottonen im 10. Jahrhundert," in *Gebhardts Handbuch der deutschen Geschichte*, 8th ed., vol. 1 (1954); L. Santifaller, "Zur Geschichte des ottonisch-salischen Reichskirchensystems," in *Österreichische Akademie der Wissenschaften, Sitzungsberichte 229*, no. 1 (1954); H. Decker-Hauff, "Die 'Reichskrone,' angefertigt für Kaiser Otto I," in *Schriften der M.H.G.*, 13, part 2 (1955); K. Hampe, *Herrschergestalten des deutschen Mittelalters*, 6th ed. (1955); R. Holtzmann, *Geschichte der sächsischen Kaiserzeit*, 3rd ed. (1955); G. Tellenbach, "Otto der Grosse," in *Die grossen Deutschen*, vol. 1 (1956). (K. RE.)

OTTO II (955–983), German king from 961 and Holy Roman emperor from 967, sole ruler from 973, was born at the end of 955, the son of Otto I and his second wife, Adelaide of Burgundy. During his father's lifetime he was crowned German king at Aachen in May 961 and emperor by Pope John XIII in Rome at Christmas 967. On April 14, 972, he married the Byzantine princess Theophano. On his father's death (May 973) he assumed the government without difficulty at first; but after some trouble in Lorraine (Lotharingia) he had to make war against Harald III Bluetooth of Denmark in 974. He conquered Denmark up to the Schlei river. In 974 also his cousin Henry II the Quarrelsome, duke of Bavaria, revolted against him for dynastic reasons and won support not only from Poland, from Bohemia and from some members of his mother's family (the Bavarian dynasty of the Liutpoldings) but also even from Otto's mother, Adelaide. After long fighting Otto overcame the revolt (978). Bavaria meanwhile had in 976 been granted to Otto of Swabia, son of the emperor's deceased half brother Liudolf, but Carinthia was detached from Bavaria and erected into a separate duchy and the Bavarian East Mark (the later Austria) was granted to the house of Babenberg. In 978 Lothair, the Carolingian king of France, invaded Lorraine and sacked Aachen, but a campaign of revenge brought Otto to Paris, though he failed to take the town. At a meeting in 980, however, Lothair renounced all claims on Lorraine.

In the autumn of 980 Otto crossed the Alps, to resume the Italian policy of his father. During the campaign he became reconciled to his mother, Adelaide, and to her brother, King Conrad the Peaceful of Burgundy. In Rome, Otto restored Pope Benedict VII, who had been driven from his see by a Roman faction; and he enhanced the prestige of the papacy by a great synod, held in Sept. 981. At this synod, in agreement with the pope, the bishopric of Merseburg, which Otto I had founded, was dissolved.

Otto II planned to expel the Saracens from southern Italy and to bring the whole peninsula under his rule. His campaigns in Apulia and in Calabria were at first successful, but ended with a decisive defeat at Cape Colonne in July 982; the emperor saved his life only by swimming out to a Greek ship.

Otto summoned the diet of the empire to Verona for Pentecost 983, to prepare a new campaign against the Saracens. At this diet

FOTO ANN MUNCHOW

OTTO II, ENTHRONED: MINIATURE FROM HIS GOSPEL, *c.* 975, NOW IN THE TREASURY OF AACHEN CATHEDRAL

he had his namesake, the three-year-old Otto III, elected German king; and he also appointed new men to several of the German duchies. He next moved southward again to Rome where he arranged the election of John XIV as pope in succession to Benedict VII. He was then informed that the Danes were in revolt and that insurgent Slavs, having taken Havelberg, Brandenburg and Hamburg, were being held only with difficulty on the Elbe-Saale line; but Otto died on Dec. 7, 983. He was buried in St. Peter's.

Energetic and courageous, Otto had tried to continue his father's policy and to make closer the relations between Germany and Italy. He left to his successor a firmly established realm. His chancery documents and his legislative acts are printed in *Monumenta Germaniae historica*, series *Diplomata*, vol. ii (1888), and *Constitutiones*, vol. i (1893).

As well as works cited in the bibliography under OTTO I, *see* K. Uhlirz, *Jahrbücher des deutschen Reiches unter Otto II* (1902); J. F. Böhmer and H. L. Mikoletzky, *Regesta imperii*, vol. ii, part 2 (1950).
(K. RE.)

OTTO III (980–1002), German king from 983 and Holy Roman emperor from 996, was born in July 980, the son of Otto II and the Byzantine princess Theophano. Elected German king at Verona in June 983 (during his father's lifetime), he was crowned in Aachen on Dec. 25, shortly after his father's death. The deposed duke of Bavaria, Henry II the Quarrelsome, got possession of the three-year-old king and tried to become king himself, but the diet of the empire on May 29, 984, forced him to hand Otto over to Theophano. Theophano was regent for Otto in Germany till her death in 991, after which her place was taken by Otto's grandmother Adelaide (*q.v.*), supported by Archbishop Willigis of Mainz, till Otto came of age and began to rule for himself in Sept. 994. He made a campaign against the Slavs in 995 and then crossed the Alps for the first time in 996. He had been called to Rome by Pope John XV, who wanted his help against Crescentius II (*see* CRESCENTII). When John XV died, Otto nominated his cousin Bruno of Carinthia to the papacy. Bruno took the name of Gregory V and crowned Otto emperor on May 21, 996, but was driven from Rome by Crescentius after Otto's withdrawal. Otto therefore marched again into Italy late in 997. Having taken Rome (spring 998), he executed Crescentius and deposed the antipope John XVI.

Otto then proceeded to execute his plans for a *renovatio imperii Romanorum*, a renewal of the Roman empire. Rome was to be the capital; the building of an imperial palace was begun on the Aventine hill; Roman and Byzantine dignities, titles and ceremonies were revived; and the Caesars as well as Charlemagne were taken as models. This Roman empire, however, was also to be a universal Christian empire. Common adherence to Christianity would make national differences meaningless; and the pope would be subordinated to the theocratic emperor, who styled himself "the servant of Jesus Christ" and "the servant of the apostles." On Gregory V's death (999) Otto raised his friend Gerbert of Aurillac to the papacy; and the new pope's choice of name, Silvester II, shows that he agreed with the emperor's plans and saw his relationship with Otto as comparable to Pope Silvester I's with Constantine the Great. At the same time Otto was strongly inclined to mystical piety and was attracted by such men as Adalbert of Prague (d. 997) and by the penitential hermits Nilus (d. 1005) and Romuald (d. 1027).

Otto visited Poland in 1000. On this occasion Gniezno, where Adalbert of Prague was buried, was erected into a metropolitan see for Poland; and Otto formed a close friendship with the Polish prince Boleslaw I. In this manner Otto hoped to incorporate Poland into the universal Christian empire; and he and the pope pursued the same aim in Hungary, where the archbishopric of Esztergom was established and where Stephen I was crowned as apostolic king. On a visit to Aachen, Otto opened the tomb of Charlemagne and is said to have found him seated on a throne.

At the end of May 1000 the emperor went again to Italy. Early

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OTTO III, FROM A MINIATURE OF *c.* 998

in 1001, while he was himself in Rome, the Romans rose against him. He withdrew to Ravenna, where he did penance in the monastery of S. Apollinare in Classe and entered into secret negotiations with the doge of Venice, Pietro Orseolo II. Despite military operations, Otto had still not won Rome back when he died at the castle of Paterno on Mt. Soracte, on Jan. 23, 1002; he was less than 22 years old. Taken to Germany, his body was buried at Aachen. Highly cultured and early mature, Otto had a pronounced sense of the dignity of his office and a high concept of the rule that he wished to establish; but he paid too little attention to political realities. His chancery documents and legislative acts are printed in *Monumenta Germaniae historica*, series *Diplomata*, vol. ii, part 2, and *Constitutiones*, vol. i (1893).

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OTTO IV (*c.* 1175 or *c.* 1182–1218), German king from 1198 and Holy Roman emperor from 1209, was either the second or the fourth son of the Welf Henry (*q.v.*) the Lion by his second wife, Matilda, daughter of Henry II of England. Otto was brought up at the court of his uncle Richard I of England, who made him earl of York in 1190 and count of Poitiers and duke of Aquitaine in 1196. In Sept. 1197, however, Frederick Barbarossa's son and successor the emperor Henry VI died. As Henry VI's son Frederick (*see* FREDERICK II, Holy Roman emperor) was an infant, the German princes favourable to the Hohenstaufens elected his uncle Philip (*q.v.*) of Swabia as German king in March 1198; but the opposing party, led by Archbishop Adolf of Cologne, looked for a rival candidate and finally, at Cologne on June 9, 1198, elected Otto, who was crowned at Aachen on July 12.

War ensued between the two factions. Philip II Augustus of France, on the Hohenstaufen side, forced John of England to withhold the support that Richard I had naturally promised to Otto; but in 1201 Otto obtained Pope Innocent III's support by agreeing to the papacy's territorial claims in Italy. His fortunes then improved. In 1204, however, some of Otto's chief partisans in Germany went over to Philip of Swabia; and in 1208, when Otto was holding only the Welf allodial lands in Brunswick (partitioned between him and his brothers Henry and William), the pope recognized Philip as king. Then, on June 21, Philip was murdered. Many of Philip's former supporters now made overtures to Otto, who submitted to a new election. He was chosen king at Frankfurt on Nov. 11, 1208. To strengthen the reconciliation, he was betrothed to Philip's ten-year-old daughter Beatrix (the marriage was deferred till 1212). The pope recognized Otto again and obtained far-reaching concessions with regard to the German Church.

Otto set out for Italy in Aug. 1209 and was received by Innocent at Viterbo. He now refused to concede to the church all the territory that the papacy had been claiming from the empire since 1197, but he agreed not to claim suzerainty over Sicily—of which Frederick of Hohenstaufen had been crowned king, as a vassal of the papacy, in 1198. Otto was crowned emperor in Rome on Oct. 4, 1209, but the ceremony was followed by fighting between his German soldiers and the Romans. Innocent asked Otto to leave Roman territory, but Otto remained near Rome for some days, demanding compensation for his troops' losses.

The breach between pope and emperor soon widened; and in violation of his undertakings Otto tried to recover for the empire all the territory that Innocent had already succeeded in annexing to the papal state. Having occupied Tuscany, he next invaded the mainland part of Frederick's kingdom of Sicily. Disregarding the pope's sentence of excommunication (Nov. 1210; renewed in March 1211), he proceeded to conquer southern Italy. Innocent and Philip Augustus, however, incited fresh opposition to Otto in Germany; and in Sept. 1211 an assembly of princes at Nürnberg declared Otto deposed and invited Frederick to take his place.

Otto returned to Germany in March 1212 and made some headway against his enemies; but the death of his wife in August (a few weeks after their marriage) alienated the southern duchies, and he failed to prevent Frederick's entering Germany. Frederick was crowned at Mainz in Dec. 1212, but Otto was able to hold out against him in the lower Rhine district. Otto moreover had the support of the Ascanians in northeastern Germany and help from his uncle John of England. With John he entered into a coalition against Philip Augustus, and the defeat of this enterprise at Bouvines (*q.v.*) in July 1214 was his ruin. Barely escaping from the battlefield, he took refuge in Cologne, while his former friends transferred their allegiance to Frederick.

FOTO RATHSCHLAG

OTTO IV, DEPICTED ON THE SHRINE OF THE THREE KINGS, C. 1200, IN COLOGNE CATHEDRAL

In 1216 Otto left Cologne for Brunswick. His brother Henry was already at war with Denmark; and the fall of Hamburg to the Danes was a further blow to the Welf cause. Otto died at the Harzburg on May 19, 1218, his excommunication having been lifted. He was buried in the church of St. Blasius in Brunswick.

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OTTO OF FREISING (1111 or 1112–1158), German bishop and author of one of the most important historico-philosophical works of the middle ages, was a son of the Babenberg margrave Leopold III of Austria by his wife Agnes, daughter of the German king Henry IV. His father made him prior of Klosterneuburg; but in 1127 or 1128 Otto was sent for further education to Paris. On the way back (1132 or 1133) Otto entered the Cistercian monastery at Morimond (in eastern Champagne), of which he became abbot in 1138. In the same year, however, he was called as bishop to Freising in Bavaria. Since through his mother he was a half brother of the Hohenstaufen German king Conrad III and an uncle of Frederick I Barbarossa, Otto exercised some influence on the policy of the *Reich*. He took part in the second crusade (1147–49) and was present at the imperial diet of Besançon in the county of Burgundy (1157). Otto was a steadfast opponent of the Wittelsbachs in Bavaria and was also engaged, in the last months of his life, in a dispute with Henry the Lion, duke of Saxony and Bavaria, who had founded the flourishing town of Munich at the expense of the bishopric of Freising. Otto fell ill on a journey to Morimond and died there on Sept. 22, 1158.

Otto's *Chronica sive Historia de duabus civitatibus* is a history of the world from the beginning to 1146. Following St. Augustine, it interprets all secular history as a conflict between the *civitas Dei*, or realm of God, and the world; and it views its contemporary period as that in which Antichrist is to appear. Yet even in this work Otto is much closer to realities than Augustine was; and in his second work, the *Gesta Friderici*, which deals with the house of Hohenstaufen and with the deeds of Frederick Barbarossa up to 1156, he hails Frederick's achievement as the renewal of the great deeds of past ages and becomes the herald of a Hohenstaufen "philosophy of empire." Otto of St. Blasien (d. 1223) continued the *Chronica* down to 1209; and the author's own pupil Rahewin continued the *Gesta* down to 1160, with an appendix for the next decade. The *Chronica* is edited by G. Hofmeister, 2nd ed. (1912), and by W. Lammers and A. Schmidt (1963); the *Gesta Friderici* by G. Waitz and B. von Simson, 3rd ed. (1912), and by F. J. Schmale and A. Schmidt (1965). There is an English translation of the *Gesta* by C. C. Mierow and R. Emery, *The Deeds of Frederick Barbarossa* (1953).

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OTTO OF NORDHEIM (d. 1083), duke of Bavaria, was one of the leading opponents of the German king Henry IV. He was invested with the duchy of Bavaria by Agnes of Poitou, regent for her young son Henry IV, in 1061. In 1062, however, he assisted Archbishop Anno of Cologne to deprive Agnes of the regency, and from then till the end of the king's minority he played a prominent part in the government of the *Reich*. He led an expedition against the Hungarians in 1063; went with Anno to Italy to settle the schism between Pope Alexander II and the antipope Honorius in 1064; helped to secure the dismissal of Archbishop Adalbert of Bremen from the king's court in 1066; and was in Italy again on the king's behalf in 1066 and 1068. In 1070, however, he was accused of complicity in a plot to murder the king. Required to confront his accuser in ordeal by battle, he asked for a safe-conduct and, when this was refused, declined to present himself. Stripped of his ducal rank, he was unable to defend himself in Bavaria; but though his Saxon lands were attacked he found support in Saxony and withstood the king for some months. Taken prisoner in 1071, he was restored to his patrimonial lands in 1072.

When the Saxon rising against Henry IV broke out in 1073 (*see* GERMANY: *History*), Otto soon assumed the leadership of it; and the short-lived peace of Gerstungen (1074) stipulated his restoration to Bavaria. When Henry led his expedition of June 1075 against the Saxons, Otto was taken prisoner again but was pardoned again and made administrator of Saxony. After the excommunication of Henry (1076) Otto rejoined the Saxon rebels; and as soon as his restoration to Bavaria was assured he assented to the election of Rudolf of Rheinfelden as German king in opposition to Henry (1077). A brave and skilful fighter, he inflicted losses on Henry's forces at Mellrichstadt in Franconia (Aug. 1078) and at Flarchheim in Thuringia (Jan. 1080) and won a victory in the battle on the Elster river (Oct. 1080), where Rudolf, however, received a mortal wound. Otto died on Jan. 11, 1083.

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OTTO, NIKOLAUS AUGUST (1832–1891), German engineer, who introduced a gas engine which marked an important stage in the development of internal-combustion engines, was born at Holzhausen on June 10, 1832. Otto realized that there was a need for an improved gas engine as a prime mover for small workshops, since steam engines and their equipment were too large for this purpose. He and his partner E. Langen made an improved free-piston engine which they exhibited in Paris in 1867. Alphonse Beau de Rochas had patented the first description of the four-stroke cycle for gas engines in France in 1862; it had one working stroke for every four strokes of the piston. He did not build an engine and the cycle was not employed successfully until 15 years later. Then its advantages were emphasized by Otto and Langen when they incorporated it in their silent gas engine, which was patented in 1877. This proved a smooth-running reliable engine of considerable efficiency. Otto died in Cologne on Jan. 26, 1891. *See* also INTERNAL-COMBUSTION ENGINE.

See A. Langen, *Nicolaus August Otto der Schöpfer des Verbrennungsmotors* (1949). (C. ST. C. B. D.)

OTTO, RUDOLF (1869–1937), German theologian and philosopher, was born Sept. 25, 1869, at Peine, a small town in Hanover. Nurtured in the Lutheran faith, Otto was attracted during his student days at Erlangen and Göttingen to the theology of Albrecht Ritschl and the romanticism of Friedrich Schleiermacher (*qq.v.*). While professor of theology at Göttingen some years later (1907–14), his major concern gradually shifted to the history and psychology of religion (*Religionswissenschaft*). At Göttingen he became a leading spokesman of the neo-Friesian school that flourished there for a time, and his *Kantish-Friessche Religionsphilosophie* (1909; Eng. trans., *The Philosophy of Religion*, 1931), an important publication of this movement, provides the fullest statement of his own philosophy of religion based upon the post-Kantian idealism of Jakob Friedrich Fries (*q.v.*). After three years on the theological faculty at Breslau (1914–17), Otto became professor of systematic theology at the University of Marburg, where he remained until his death on March 6, 1937.

Visits to north Africa, India and Japan in 1911–12 turned Otto's attention to the more primitive expressions of religion and also gave him an enduring appreciation of the great oriental faiths. Numerous studies of the religious thought of India gained him a place among the influential and sympathetic European interpreters of Hinduism. Among the more important of these studies are *West-Östliche Mystik* (1926; Eng. trans., *Mysticism East and West*, 1932) and *Die Gnadenreligion Indiens und das Christentum* (1930; Eng. trans., *India's Religion of Grace and Christianity*, 1930). Otto's last work, completed just prior to his death, was a series of German translations and commentaries upon the Bhagavad Gita and the Katha Upanishad.

The immediate and strong impact of his major work, *Das Heilige* (1917; Eng. trans., *The Idea of the Holy*, 1923), established Otto as a leading figure in German theological circles and at once brought him to the attention of religious thinkers throughout the world. Its discerning psychological analysis of religious experience and creative synthesis of the major tendencies in modern German theology mark *The Idea of the Holy* as one of the significant religious books of the first half of the 20th century. Otto portrays in convincing fashion a depth in human experience and an awareness of the otherness of God that liberal Protestantism had largely lost sight of. Within 12 years of its publication translations appeared in English, Swedish, Spanish, Italian, Dutch, French and Japanese. During those years Otto wrote a number of influential theological and historical essays developing further its central ideas. These essays later appeared in two independent volumes, *Das Gefühl des Überweltlichen* and *Sünde und Urschuld* (1932; Eng. trans. in part in *Religious Essays*, 1931).

Otto made important practical contributions also to the devotional life of the Lutheran Church and to its missionary enterprises. In a chapel near Marburg he worked throughout his life in experimental fashion to develop a vital worship service reflecting his conviction that at the heart of religion there lies a sense of profound mystery and "creature-feeling." In 1923 he published a volume on public worship built around this concept of religion, and for years he collaborated in the preparation of devotional materials for use in church service, schools and private worship.

Throughout Otto's work as a whole, whether theological or devotional, historical or philosophical, one unifying principle is always apparent—a constant emphasis upon the autonomy of religion. In the distinctly religious moment of human experience he identifies three major components: a unique quality of feeling, the numinous; an autonomous category of interpretation and valuation, the sacred; and an independent intuitive insight, expressed in myth or ideogram. These Otto takes to be separate but essential aspects of an a priori religious category of meaning and value. Since the 1930s, in almost every significant study of the nature of religion the issues he raised are debated.

See Robert F. Davidson, *Rudolf Otto's Interpretation of Religion* (1947). (R. F. D.)

OTTOMAN EMPIRE, the empire of the Ottoman Turks, which was founded by Osman (Othman) I (d. 1326). Constantly varying in extent it included at different epochs: Asia Minor, and beyond to the Caspian sea; the Balkan states, Greece, Crete and Cyprus; parts of Hungary, Austria and southern Russia; Syria, Iraq, Palestine and Egypt; north Africa as far west as Algeria; and parts of Arabia. The period of the empire ended when Sultan Mohammed VI fled from Turkey on Nov. 17, 1922. *See* TURKEY: *History; see* also references under "Ottoman Empire" in the Index.

OTTRELITE (from Ottrez, Belg., the original locality) is the manganese-bearing member of a group of closely related hydrous iron aluminum silicate minerals in which the iron is often in part replaced by magnesium or manganese. On account of its petrographic importance the term ottrelite is often used as the group name for this series, though the name clintonite is

also in use. They are gray, green or black micaceous minerals, but in distinction from the "elastic" micas and "flexible" chlorites they are often referred to as the brittle micas on account of the brittleness of their laminae. The chief members of the group are chloritoid ($H_2 Fe Al_2 SiO_7$), sismondine ($H_2[Fe,Mg]Al_2SiO_7$), in which the magnesia rises to 7%, and ottrelite, the manganiferous variety ($H_2[FeMn]Al_2SiO_7$) in which the MnO content may rise to 8%.

Like the micas and chlorites the ottrelites possess monoclinic symmetry and a perfect cleavage parallel to the flat surface of the plates. Their superior hardness ($H=6.5$) readily distinguishes them from both these groups of minerals. Multiple twinning on the mica law is exceedingly common, and a zonal structure (often of hourglass type) is often apparent. The ottrelite group of minerals is confined to metamorphic rocks—particularly those developed in regional metamorphism—in slates, phyllites and schists. Noteworthy occurrences of this mineral are in the slates of the Ardennes, of Tintagel (Cornwall) and in the Mesozoic and Permian schists of the Swiss and Italian Alps.

The minerals margarite, xanthophyllite and kossmatite show some relations with the ottrelite group of minerals. They are distinguished by an inferior hardness and contain calcium as an essential constituent. Margarite ($H_2CaAl_4Si_2O_{12}$) occurs in white pearly scales associated with corundum and is a common mineral of emery deposits. Xanthophyllite occurs in talc-chlorite schists at Slatoust, in the Urals, and in altered limestone at Riverside, Calif., while kossmatite is a lime-rich mineral ($H=2.5$) occurring in the dolomite marbles of west Macedonia. (C. E. T.; X.)

OTWAY, THOMAS (1652–1685), English dramatist and poet, whose masterpiece, *Venice Preserved*, was one of the greatest theatrical successes of his period, was born at Trotton, near Midhurst, Sussex, on March 3, 1652, the son of Humphrey Otway, vicar of Woolbeding, Sussex. He entered Winchester college in 1668 and in the following year was admitted to Christ Church, Oxford, as a commoner, but left, without taking a degree, in 1671. He appears to have gone to London and found employment as an actor through the help of Aphra Behn (*q.v.*).

His first play, a poor rhyming tragedy called *Alcibiades*, was produced at the Duke's theatre at Dorset Garden in Sept. 1675. The part of Draxilla in this play was created by the famous actress Elizabeth Barry, and there is a tradition that Otway fell violently in love with her. The sole evidence for this story, however, is to be found in six unsigned love letters, said to be addressed by Otway to Mrs. Barry, which were published in a collection that appeared in 1697, 12 years after Otway's death. His second play, *Don Carlos*, produced in June 1676, had an immense success on the stage and is the best of his rhyming "heroic" plays. It is dedicated to the duke of York, and, in his preface, Otway boasts of the patronage of the earl of Rochester, who introduced his work to Charles II and the duke. He dedicated to Rochester two adaptations from the French, *Titus and Berenice* and *The Cheats of Scapin*, published together in 1677. Little is known about Rochester's connection with Otway and the legend that he was at first favoured and afterward persecuted by the earl is based only on an interpretation of two passages in Rochester's poems where Otway is satirized.

Early in 1678 Otway obtained a commission, through the influence of the earl of Plymouth, in an English regiment serving in the Netherlands and he was abroad when his first comedy, *Friendship in Fashion*, was staged in April of that year. His regiment was among the troops disbanded after the peace of Nijmegen and he had returned to England by June 1679, when he fought a duel with John Churchill, later duke of Marlborough. In August his next play *Caius Marius* was staged, a curious mixture of a story from Plutarch with an adaptation of *Romeo and Juliet*. In the following year, he published his powerful, gloomy autobiographical poem, *The Poet's Complaint of His Muse*.

Otway's most memorable dramatic work was done in the last years of his short life. In the spring of 1680 his fine blank verse tragedy *The Orphan* had a great success on the stage and on March 1 in the same year his best comedy *The Soldier's Fortune* was also produced. *Venice Preserved* was first performed at the Duke's theatre in Feb. 1682. Dryden wrote a prologue for it and the parts of Jaffier and Belvidera were created by Thomas Betterton and Mrs. Barry respectively. Until the middle of the 19th century it was probably revived more often than any poetic play except those of Shakespeare; all the most famous English actors and actresses of the 18th and 19th centuries appeared in it, and it has been translated into most European languages. The plot is founded on the Abbé de Saint-Réal's historical novel, *La Conjuration des Espagnols contre la république de Venise en l'année 1618* (1674), but Otway modified the story considerably. The pathetic character of Belvidera is his own invention and Pierre and Jaffier, insignificant in the novel, are given leading parts in the play and are practically original creations. The piece has a political reference enforced in the prologue. The "popish" plot was certainly in Otway's mind and Anthony, 1st earl of Shaftesbury, the Whig leader, is caricatured as the ridiculous senator Antonio. Dryden, who seems to have regarded Otway's earlier work somewhat coldly, was generous in his praise of *Venice Preserved:* "Nature," he wrote, "is there, which is the greatest beauty."

Another comedy, *The Atheist* (printed 1684), some poems and *The History of the Triumvirates*, a piece of hack work published posthumously in 1686, complete the list of Otway's writings. His literary success did not bring him prosperity and he seems to have spent the last years of his life in extreme poverty. No credit, however, can be given to the sensational story, told by Theophilus Cibber in his *Lives of the Poets* (1753), that his death was due to the ravenous eating of a roll bought with money given to him by a compassionate stranger when he was in a state of starvation. According to the most trustworthy account, that of Anthony à Wood, he died at a house called The Bull on Tower hill on April 14, 1685. He was buried on April 16 in the churchyard of St. Clement Dane's. A tragedy called *Heroick Friendship* was published as Otway's in 1719 but it is almost certainly spurious.

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OUACHITA MOUNTAINS, a lens-shaped rugged hill land extending approximately 225 mi. east-west from Little Rock, Ark., to Atoka, Okla. The north-south extent is approximately 50–60 mi. from the Arkansas river valley to the northern margin of the coastal plain. The hilly area is essentially coincident with the visible portion of underlying strata much faulted and closely folded to form an anticlinorium, or arch. Ridges trend generally east-west and are approximately the same height. The highest elevation (2,950 ft.) is on Rich mountain, near the Oklahoma-Arkansas boundary. Oak-pine forests cloak the hills and cultivation is restricted to favoured valley bottoms. (A. H. Dr.)

OUACHITA RIVER rises in the Ouachita mountains of west central Arkansas, U.S., and flows east, then south and southeast for about 605 mi. to its junction with the Red river in Louisiana. The lower 57 mi. of the Ouachita is known as the Black river. Most of the 25,000-sq.mi. drainage basin lies in the Upper Coastal Plain of Arkansas and Louisiana and the Mississippi Alluvial valley. Chief tributaries of the Ouachita are the Little Missouri, Saline, Bayou Bartholomew, Boeuf and Tensas rivers. Discharge at Monroe, La., ranges from 300 to 100,000 cu.ft. a second.

The Ouachita has been used for navigation since the late 18th century. Six locks and dams built prior to 1924 provide 6½-ft. depth for 351 mi. from the mouth of the Black river to Camden, Ark. Shallower depths are found upstream to Arkadelphia, Ark., generally considered to be the head of navigation. In 1950 a nine-foot channel was authorized to Camden. Logs, pulpwood and chemicals are the chief cargo below Camden.

Three dams on the upper Ouachita within the Ouachita mountains provide power for a private power company and recreational facilities, and alleviate flood damage downstream. Lakes Catherine and Hamilton, formed by Remmel and Carpenter dams, cover 11,000 ac. while Lake Ouachita, formed by Blakely Mountain dam in 1955, covers over 75 sq.mi. The Narrows dam, forming Lake Greeson, is a multipurpose dam on the Little Missouri tributary.

Chief cities on the Ouachita are Arkadelphia and Camden, Ark., and Monroe, La. (M. W. M.)

OUADDAÏ (WADAI), prefecture (cap. Abéché) in the eastern part of the Republic of Chad; formerly an independent Muslim sultanate extending west and southwest to Kanem and Baguirmi (*qq.v.*) and southeast to Dar Runga, a region presently divided by the borders of Chad, the Sudanese and Central African republics. Total area of Ouaddaï is about 29,000 sq.mi. (75,000 sq.km.).

Crossed by caravans linking the Sahara with Equatorial Africa and by Muslim pilgrim routes from West Africa toward Mecca, Ouaddaï is an amalgam of cultural and ethnic influences. The dominant people, the Maba, though probably of Sudanic origin, are Muslims and probably reflect some mingling of blood lines as well. Other inhabitants include various Negro and Negroid tribes, Arabs, Fulani, Tibbu, and half-castes. Total population is about 310,000.

Though Arab geographers had described the area, Ouaddaï was not generally known until after 1873, when it was explored by the German geographer Gustav Nachtigal (*q.v.*). The history of Ouaddaï before the 17th century is chiefly legend and conjecture. About 1640, however, a Maba chieftan, Abd-el-Kerim, conquered the country, overthrowing the Tungur, a dynasty originating in Darfur (*q.v.*). For the next 200 years there were intermittent wars with Baguirmi and Kanem, many for the purpose of maintaining Ouaddaï's supply of slaves and eunuchs for shipment to Arab courts in the north.

Mohammed Sherif (sultan 1838–58) introduced the Senusi brotherhood (*see* SENUSI), which remained the dominant political (and religious) force until Ouaddaï was conquered by the French. Although it had been recognized as within the French "sphere of influence" according to the Anglo-French agreement of March 21, 1899, Ouaddaï retained its effective independence until 1904 when Ouaddaïans—probably instigated by the Senusi—attacked French outposts in the Shari region. Fighting continued sporadically until 1908 when the Ouaddaï sultan, Doud Murra, proclaimed a holy war (*jihad*) against the French. Dividing his army into units under feudal lords (*aguids*), he was no match for French troops and was soundly beaten. By 1912 the French had pacified the area and abolished the sultanate, and although the Senusi were active during World War I, Ouaddaï remained under control. Darfur was occupied by the Sudanese government in 1916, which led to an end of strife on the eastern border, and a frontier was demarcated in 1923.

A famine in 1913–14 devasted Ouaddaï. From more than 2,000,000 (Nachtigal's estimate in 1872), the population was reduced to about 300,000, according to an observer in 1917, who further noted that Abéché "retained few traces of its ancient splendour," though it was later rebuilt by the French.

For later history and for the geography and economy of modern Ouaddaï, *see* CHAD, REPUBLIC OF.

OUAGADOUGOU, capital of the Republic of Upper Volta, west Africa, is linked by road with Niamey (250 mi. E. in the Republic of Niger) and with Bobo Dioulasso (200 mi. S.W.), the road forking from there west to Bamako (Mali) and south to Abidjan (Ivory Coast). It is also the terminus of the railway from Abidjan and has an international airport serviced by French airlines. Pop. (1961) 59,126. Ouagadougou is the seat of the *morho naba* ("big lord") of the ancient and numerous Mossi people. The districts of this sprawling, thinly populated town are separated by waste ground. A broad avenue runs from the administrative area to the European quarter and the market. Opposite the *morho naba's* palace are African quarters (Dapoya, Bilibambili) laid out in squares. There are two hospitals, the newer built in 1959. The only industries are Mossi handicrafts (statuettes, carpets). Peanuts and produce of the shea butter tree (karité) are exported. Many of the men go to work in the Ivory Coast and in Ghana. (J. D.)

OUAHRAN (formerly ORAN), a city and port of Algeria and the capital of the *département* of the same name.

The City.—Ouahran, built on a series of terraces, stands on the Mediterranean coast, about halfway between Tangier and Algiers, at the point where Algeria is closest to Spain. Pop. (1960) 350,087. After July 1962 the European population was reduced to about 30,000.

The town was successively under Arab, Spanish, Turkish, and French occupation, and it shows a great variety of architectural styles. It was originally divided into halves by the ravine of Raz el-Aïn, now for the most part covered by boulevards and buildings. There are three sections: La Blanca, the fortress and old town on the hill; La Marine, near the sea; and the Ville Nouvelle, built on the terraces on the right bank of the ravine.

West of the ravine lies the old port, and above it is La Blanca, crowned by the ancient citadel of Santa Cruz. Originally built by the Turks, Santa Cruz was altered by the Spaniards in the 16th century and eventually restored by French military engineers in the 19th. The Spanish quarter of La Blanca also contains the former cathedral of St. Louis, originally the church of Our Lady of the Victory, built by Francisco Cardinal Jiménez de Cisneros on the site of a mosque and the first church in Oran. Severely damaged by the earthquake of 1790, it was rebuilt by the French in 1838 and rededicated as a cathedral in 1866. It became a church again in 1913. Other traces of the town's Spanish past include the Porte de Canastel (reconstructed in 1734), which was the chief gateway to Ouahran, and the fountain in the Place Emerat (1789).

In the Turkish part of the town (in the Rue Philippe) is the mosque built by the Turks in 1796 with money obtained from the ransoming of Spanish prisoners. To the east lies the Château Neuf, once the seat of the beys of Ouahran and later a French army headquarters. With its massive 14th-century keep, its drawbridge, and its vast reception hall with Hispano-Moorish arches, this impressive building commands the sea approaches and in the past protected the city against the incursions of pirates. In the highest part of the old city is the Kasbah, surrounding the old Spanish castle, close to which is the elegant mausoleum of Sidi el-Haouari, a scholar and monk of the 15th century. Behind the Kasbah are the former barracks of the janizaries and the harem of the beys.

The construction of the French town was begun in 1831, and

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OUAHRAN, WITH THE CITADEL OF SANTA CRUZ ON THE HILL. IN THE FOREGROUND IS A MINARET FROM WHICH THE MUEZZIN CALLS THE MUSLIM FAITHFUL TO PRAYER

the buildings that composed it gradually spread across the ravine Raz el-Aïn. Around the Place Kléber, in the centre, are grouped the government buildings, including the prefecture (1952), the municipal buildings, and the chamber of commerce. After World War I the new town was extended far outside the second city wall, built in 1866 (now largely demolished), and many suburbs were formed, the chief of which are Saint-Eugène, Gambetta, Eckmühl, Choupot, and Boulanger.

Ouahran's notable buildings include the *hôtel de ville* (1882–85), with its imposing Renaissance-style facade and its vast staircase flanked by two bronze lions; the municipal opera house (1906) in the classical Italian style with two gilded domes; and the railway station (1913), in Hispano-Moorish style. The fine arts museum, which was built in 1930 and enlarged in 1955, contains the municipal library and a school of fine arts, as well as a museum. Between the Jewish cemetery and the public park is the so-called Negro Village (Sidi-Okba), built in 1845.

Communications and Industries.—Ouahran is a port of call for ships sailing from Europe, the U.S., and South America. Greatly enlarged by the French after 1848, the harbour became the centre of a flourishing trade. Its jetty is nearly 4,000 ft. (1,200 m.) long, and it has five large basins covering an area of about 330 ac.

Near the Place Karguentah is a station for motor buses (coaches), controlled by the Algerian railway authorities. The railway connects Ouahran with Algiers to the east, Morocco to the west, and Colomb-Béchar to the southwest. The airport lies beyond the village of La Sénia, south-southeast of the city.

The industrial part of Ouahran, in the outlying south-southeastern districts, contains various food-processing factories, including dairies, flour mills, and processing plants for olives and other fruits, vegetables, and fish. There has also been a growth in heavy industry, with foundries, factories for making agricultural machinery, and shipbuilding. New industries developed after World War II include glassworks, distilling, and the manufacture of soft drinks and shoes. There are also spinning and weaving mills, and carpets, baskets, and cigarettes are made. Ouahran's principal exports include wines, cereals, vegetables, fruit, and preserved olives; among its chief imports are foodstuffs, building materials, timber, paper, textiles, fertilizers, agricultural machinery, and automobiles. A 120-mi. (193 km.) pipeline from Hassi-R'mel in the Sahara to Arzew (the city's export port) and Ouahran brings natural gas to the city.

History.—Andalusian sailors settled at Ouahran at the beginning of the 10th century, using it as a base for their commercial operations with the African interior. From the 10th century to the 16th it grew in importance as a seaport, because of its maritime connections with Marseilles, Barcelona, Venice, and Genoa. It became the seaport of the kingdom of Tlemçen, having been taken by the sultan in 1437. It was also an emporium for trade with the Sudan, the city where the products of European industries were exchanged for ivory, gold dust, ostrich feathers, and slaves. It was highly prosperous till the 15th century, when the Portuguese gained control of the sea route of the Gulf of Guinea. In 1492 and 1502 Spanish Muslims, fleeing forcible conversion to Christianity, took refuge in Ouahran and founded a colony. During the early 16th century the town decayed and, with the nearby seaport of Mers-el-Kébir, became a centre for pirates. In 1509 the Spaniards occupied the town.

Until the 18th century the people of Ouahran were imprisoned in their fortifications, blockaded by Arabs or Turks, ravaged by plague, and only irregularly provisioned by the Spaniards. In 1708, after a siege lasting five months, the town, which by that time had only 2,000 inhabitants, fell to the Turks. The population rapidly increased after the entry of indigenous peoples from the African interior and of French merchants, and the import-export trade revived.

The constant raids of pirates from Mers-el-Kébir led the Spaniards to retake Ouahran in 1732. In 1774 it had about 10,000 inhabitants, of whom 4,300 were soldiers. In 1790 an earthquake destroyed a third of the city, particularly the Kasbah and old town, and half the population was killed. In 1792 the town was evacuated and the Spanish king Charles IV ceded it to the Turks, who settled a Jewish community among the adventurers who had established themselves there. The Jews built the Jewish village between the ravine Raz el-Aïn, the Rue des Jardins, and the Boulevard Joffre. Ouahran remained in Turkish hands until the French conquered it in January 1831, when it had a population of 6,000 to 7,000.

In June 1940, at the time of the Franco-German armistice, a considerable portion of the French fleet took refuge at Ouahran and its naval base of Mers-el-Kébir. Negotiations by the British, with the object of preventing the vessels from falling into Axis hands, came to nothing, and on July 3 a British naval force bombarded them, sinking some and severely damaging others. Ouahran was one of the principal objectives in the Allied landings in North Africa, and it was captured by U.S. forces on Nov. 10, 1942. After World War II it grew in importance as an administrative town, harbour, and trading centre.

Ouahran, like Algiers, was the scene of bloodshed and violence between Europeans and Muslims during the period immediately before and after Algerian independence in July 1962. The Mers-el-Kébir naval base, under the agreement by which Algeria became independent, was leased to France for 15 years.

(R. Tn.; E. Ck.; X.)

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OUARZAZATE, the name of a province in southern Morocco and of its chief town. Ouarzazate town lies south of the High Atlas, 275 km. (171 mi.) S.E. of Marrakesh, to which it is connected by a road that crosses the Atlas at the Tichka pass. Pop. (1960) 4,200. With the French occupation, a military post was established near a *ksar* (fortified village) and from it a small centre grew up.

Ouarzazate Province extends from the crests of the High Atlas to the borders of the Sahara. Area 23,062 sq.mi. Pop. (1960) 434,486, practically all rural. It is a land of arid mountains (the Siroua and the Sagho), only the valleys being habitable, chiefly those of the Dadès and the Dra, along which are strung a series of oases. Its greatest wealth lies in the manganese mines of Imini and the cobalt mines of Bou-Azzer. The province is divided into three *cercles* (administrative subdivisions).

(A. Am.)

OUDENAARDE (French, Audenarde), a town of East Flanders, Belgium, is situated on the Scheldt about 27 km. (17 mi.) S. of Ghent by road. Pop. (1961) 6,923. The town's prosperity was based on the cloth industry. The town hall (1526–31) was built on the site of a 13th-century cloth hall; it has a five-story belfry. The church of St. Walburga was built 1150–1525 in various styles. The Roman Gothic church of Our Lady of Pamele (1234) has leaning walls and columns. To the south of the town is the hilly region known as the "Flemish Ardennes." The old bishop's residence was the birthplace of Margaret of Austria, duchess of Parma, the natural daughter of Charles V by Johanna van der Gheenst. The town is on the main railway from Brussels to Courtrai. Beer and textiles are now its main industries. When the cloth industry waned in the 15th century, its place was taken by tapestry. Many weavers later emigrated to Paris.

The battle of Oudenaarde (June 30–July 11, 1708), in which Marlborough and Prince Eugene defeated the French under Vendôme, was fought northwest and north of the town, which was fortified and garrisoned. For the events leading to the battle, *see* Spanish Succession, War of the. The French army, after an abortive attempt to besiege Oudenaarde, took up a position north of the town when Marlborough and Eugene arrived with the main allied army and crossed the Scheldt after a forced march. Fighting with his back to the Scheldt and with weary troops, Marlborough gained an outstanding victory. No monument marks the spot, but there is one to the American soldiers who died in the vicinity in 1918. (R. M. An.)

OUDH (Awadh), an area of about 24,000 sq.mi. comprising the Lucknow and Fyzabad divisions of the Indian state of Uttar

Pradesh. The name is a corruption of that of the ancient city of Ayodhya. Oudh corresponds to the "Middle Country" (*Madhyadesha*) of the *Mahabharata* and the *Ramayana*. A part successively of the Delhi sultanate, the Sharqi kingdom of Jaunpur, the Delhi sultanate again and later of the Mogul empire, Oudh became independent *de facto* under Nawab Sa'adat Khan Burhan ul-Mulk (1722–39). After Nawab Shuja ud-Daula's defeat by the English at Buxar in 1764 it became a subordinate ally of the East India company. It remained an independent and important centre of traditional Muslim culture until 1856 when it was annexed, on the plea of misgovernment, by Lord Dalhousie. This annexation, and the consequent land settlement which deprived many of the hereditary land revenue receivers (*taluqdars*) of their vested rights, was a major factor in the mutiny of 1857. Oudh was joined with the presidency of Agra in 1877, the union being known as the United Provinces of Agra and Oudh from 1902 until 1937, when it became simply the United Provinces.

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OUDINÉ, EUGÈNE ANDRÉ (1810–1887), French sculptor and medalist often considered the "father of the modern medal," was born in Paris in 1810. He devoted himself from the beginning to the medalist's branch of sculpture, although he also excelled in monumental sculpture and portrait busts. He gained the grand prize for medal engraving in 1831 and in the same year exhibited his "Wounded Gladiator." Subsequently he was official designer to the inland revenue and to the mint. His most famous medals are those struck in commemoration of the annexation of Savoy by France and of the peace of Villafranca, between Austria and France, in 1859. Others are "The Apotheosis of Napoleon I," "The Universal Exposition," "The Establishment of the Republic" and "Napoleon's Tomb at the Invalides." Oudiné died in 1887.

OUDINOT, NICOLAS CHARLES, DUC DE REGGIO (1767–1847), French army officer of the Revolutionary Wars who became one of Napoleon I's marshals, was born on April 25, 1767, of a business family of Bar-le-Duc. He led the local volunteers in 1792, fought on the Moselle and in the Vosges and was made a general in June 1794 for heroic resistance at Kaiserslautern. Wounds at Mannheim (1795) and at Ingolstadt (1796) added to his reputation as a soldier, and he served well as chief of staff to André Masséna in 1799 at Zürich and in 1800 in Italy. His reputation for courage placed him next to Jean Lannes, with whom he served in 1805–07 with an élite division of grenadiers. He did not accompany Lannes to Spain in 1808, but organized reserves in Germany under his friend L. N. Davout; these reserves became a corps in the Austrian war of 1809. When Lannes was killed at the battle of Aspern-Essling, Oudinot took his place. He was made a marshal on July 12, 1809, after the battle of Wagram and created duc de Reggio on April 14, 1810. He was in Holland from 1810 to 1812.

Napoleon treated Oudinot as if he were Lannes—that is, as a lieutenant for detached and improvised commands. In the campaign of 1812 against Russia nothing could have been less effective than Oudinot's handling of the left wing on the Dvina river, or more heroic than the way in which the wounded marshal, lying on a bed with musket in hand, defended a hut surrounded by Cossacks. In 1813 he had an Italo-Croat corps. Detached with this and two other corps to take Berlin in Aug. 1813, he retreated in confusion from the battle of Grossbeeren and was superseded by Michel Ney, with Napoleon's comment that it was "impossible to have less head than Oudinot."

Oudinot served loyally in France in Jan.–March 1814 in minor commands and led troops drawn from Spain in the final defeat at Arcis. He welcomed Louis XVIII in 1814 and did not rejoin Napoleon in 1815. He took a corps to Spain in 1823 and was governor of the Invalides (from 1842) when he died on Sept. 13, 1847. (I. D. E.)

OUDRY, JEAN BAPTISTE (1686–1755), French portrait and animal painter, was born in Paris on March 17, 1686. His father was a painter and art dealer and Oudry lived among unpretentious artists. His real master was Nicolas de Largillière, with whom Oudry was on intimate terms and through whom he made useful connections. He started as a portrait painter and became a member of the Royal Academy in 1719. King Louis XV commissioned him to paint the dogs of his pack and he became official painter of the royal hunts. In 1734 he became head of the Beauvais tapestry factory, which he re-established by bringing in new artists such as François Boucher and Charles Joseph Natoire. Oudry made 267 drawings for an edition of the *Fables* of La Fontaine (1755) and illustrated *Don Quixote* and *Le Roman comique*. His lively studies of nature are surprising for his time. Among his clients were Tsar Peter the Great, who wanted to take him to Russia, the queen of Sweden and the prince of Mecklenburg-Schwerin. Works by this most popular animal painter are to be found in the Louvre, Paris, the palace of Compiègne, the Wallace collection, London, and the Metropolitan museum, New York city.

Oudry died in Beauvais on April 30, 1755.

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OUGHTRED, WILLIAM (1574?–1660), was one of the most influential students of mathematics in England in the first half of the 17th century. His early training was at Eton and at Kings college, Cambridge, where he served as a fellow for several years. In 1604 he left the university to be vicar of Shalford and subsequently rector of Albury, both in Surrey. Although his years in the ministry included the period of the Commonwealth when more than 8,000 clerics were deprived of their charges, Oughtred was permitted to continue in his parish. John Aubrey is responsible for the tale that Oughtred died of joy on hearing of the return of Charles II. Augustus de Morgan commented, "It should be added by way of excuse that he was then eighty-six years old."

During his residence in Albury, Oughtred had a succession of students coming to him for the instruction in mathematics which the universities did not then afford.

His most important published work was the *Clavis mathematicae* (1631), which included a description of Hindu-Arabic notation and decimal fractions and a considerable section on algebra. Oughtred experimented with many different algebraic symbols and he seems to have been responsible for the use of :: in writing a proportion, and × for multiplication. Oughtred adapted John Napier's logarithms to a scale, inventing a circular slide rule before 1632 and a rectilinear rule by 1633. The priority of the circular rule was contested by one of his former students, Richard Delamain, but evidence points to the conclusion that the two men worked independently. Oughtred's *Trigonometria* (1657) treated plane and spherical trigonometry. He died at Albury on June 30, 1660.

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OUIDA (pen name of MARIA LOUISE RAMÉ or DE LA RAMÉE) (1839–1908), English novelist, famous for her extravagant melodramatic romances, was born at Bury St. Edmunds on Jan. 1, 1839. Although her father was French, she was brought up in England; encouraged by W. Harrison Ainsworth, she published her first novel, *Granville de Vigne* (renamed *Held in Bondage*, 1863), as a serial in the *New Monthly* in 1860. She used the pseudonym "Ouida," derived from a childhood version of "Louisa," and her imaginative account of high society life, often wildly inaccurate, caught the public's fancy and made her extraordinarily popular. *Strathmore* (1865) and *Chandos* (1866) were followed by *Under Two Flags* (1867) with its aristocratic hero the Hon. Bertie Cecil, known to the brigade of guards as "Beauty." After traveling in Italy, she settled at Florence in 1874, and among many subsequent novels *Moths* (1880) was one of her best. Her reckless extravagance reduced her to acute poverty in later life. She died at Viareggio on Jan. 25, 1908.

See E. Bigland, *Ouida* (1950).

OUJDA, the name of a province of Morocco and of its principal city. In eastern Morocco, Oujda city is near the Algerian

frontier, 61 km. (38 mi.) from the Mediterranean coast. Pop. (1960) 128,645. In the late 1950s and early 1960s the number of Algerians temporarily increased because of the war in Algeria, while the number of Europeans diminished. The modern town, which bounds the old walled town on three sides, has wide avenues and fine gardens. About 3¾ mi. from the town is the charming oasis of Sidi-Yahya, near abundant springs. Oujda is on the Morocco-Algeria road and railway and is a rail junction for Colomb-Béchar. There is an airport with regular service.

Founded in 944 by Zenata Berbers, the town was disputed by the rulers of Fès and Tlemcen, whether Berbers, Arabs or Turks. The sultan Mulay Sliman in 1797 took possession of Oujda, which had been occupied by the Turks; after this it was acknowledged as Moroccan by the Franco-Moroccan treaties. On three different occasions it was occupied by French troops, in 1844, 1859 and 1907.

OUJDA PROVINCE extends along the eastern border of the country from the Mediterranean to the oasis of Figuig, in the Sahara, the greater part of it being made up of high plateaus consisting chiefly of pasture land. Area 15,286 sq.mi. Pop. (1960) 523,130, about half rural, half urban. The wealth of the region derives from mining: the Jerada coal mines and the rich lead and zinc mines of Boubeker and Touissite. Agricultural products are wines, citrus fruit, early vegetables and grain; sheep, wool and esparto come from the arid interior. The province is divided into four *cercles* (administrative subdivisions). The largest towns, in addition to Oujda, are Berkane (pop. [1960] 20,496), Jerada (18,872) and Ahfir (10,794). (A. AM.)

OULU (Swedish ULEÅBORG), the capital of Oulu *lääni* (county) in northern Ostrobothnia (Pohjanmaa), Fin., lies at the mouth of the Oulujoki at Finland's narrow waist, about 620 km. (385 mi.) N. of Helsinki by road. Pop. (1960) 58,197. The cathedral was built in 1770–76 and renovated in 1892. The town has been the seat of a bishopric since 1900. It is an important educational centre with a university (founded 1959), a summer university, and several schools. Oulu has had railway connections to the south since 1886, to Tornio since 1903 and to Nurmes since 1929. There are domestic airline services to Helsinki, Kemi and other places. Industries include sulfite, pulp and flour mills, a shipyard and foundry, the state railway works and the Merikoski power station.

There was a trading post at the mouth of the Oulujoki in the middle ages. A castle was built there in 1590 but destroyed in 1793. Oulu was granted town rights in 1610 and staple rights in 1765. The town was almost entirely destroyed by fire in 1822. In the late 18th and early 19th centuries it was an important seaport. During the Crimean War its harbour installations and tar depots were bombarded by a British squadron commanded by Adm. J. H. Plumridge. In 1944 about 200 buildings were damaged in an air raid.

OULU LÄÄNI is the second largest county in Finland. Pop. (1960) 406,992. Area 23,574 sq.mi., including water area. It was founded in 1776 when the former county of Ostrobothnia was divided into the new counties of Oulu and Vaasa. Main towns are Oulu, Kajaani and Raahe. The surface is flat by the coast rising in the east to forested hills. Agriculture (mostly barley with some oats) and forestry are the main occupations. There is an iron ore mine at Otanmäki. (E.-S. KU.)

OUNCE: *see* WEIGHTS AND MEASURES.

OUNDLE, a market town and urban district of Northamptonshire, Eng., lies on the river Nen, 28 mi. N.E. of Northampton by road. Pop. (1961) 2,547. The manor belonged to the abbot of Peterborough and after the Dissolution it was granted to John, earl of Bedford. The church of St. Peter has Early English, Decorated and Perpendicular work, and a crocketed spire which is a landmark for miles. Built of local gray limestone, Oundle is a small residential and educational town. Twice yearly there is a pleasure fair. Oundle school was founded in 1556 under the will of Sir William Laxton, lord mayor of London. It became famous during the headmastership, 1892–1922, of Frederick William Sanderson (*q.v.*), and in 1930 it was granted a royal charter. This school and Laxton grammar school, which was separated from the public school in 1876, originated from the grammar school founded by the Guild of Our Lady of Oundle by Robert and Joan Wyatt (1507).

OURO PRETO (Portuguese for "Black Gold"), a city of the state of Minas Gerais, Brazil, 336 mi. by rail N. by W. of Rio de Janeiro and about 300 mi. W. of Vitória, Espírito Santo; on the eastern slope of the Serra do Espinhaço and within the drainage basin of the Rio Doce. The city is built upon the lower slope of the Serra do Ouro Preto, a spur of the Espinhaço, deeply cut by ravines and divided into a number of irregular hills. Narrow, crooked streets are built upon the hills and groups of houses form each a separate nucleus. From a mining settlement the city grew as the inequalities of the site permitted. The climate is subtropical and humid, though the elevation (3,700–3,800 ft.) gives a temperate climate in winter. The days are usually hot and the nights cold.

The city dates from 1701, when a gold-mining settlement was established by Antonio Días of Taubauté. The circumstance that the gold turned black on exposure to air gave the name of Ouro Preto to the mountain spur and the settlement. Within a decade of its founding the settlement had become the centre of the greatest gold rush in the Americas up to that date. When it was raised by royal decree to the status of a city, with the name of Vila Rica, in 1711, it retained many of the characteristics associated with boom towns—prices were high, there was much gambling, tempers were easily aroused. The inhabitants had already fought in a civil war for control of the mining region. In 1720, Vila Rica became the capital of the newly created captaincy of Minas Gerais. Five years later a smelting house and mint were opened as part of an effort by the Portuguese crown to reap a greater share of the wealth.

Near the end of the century residents of the city participated actively in the abortive *Inconfidência* movement to free Brazil from Portugal. In 1823, following the winning of independence, Ouro Preto was made the capital of the province of Minas Gerais, a distinction it held until 1897 when because of transportation difficulties in reaching Ouro Preto the state administration was transferred to the new city of Belo Horizonte.

Long before it lost the capital, Ouro Preto had entered upon a period of decay. Its population, which surpassed 60,000 by 1760 had dwindled to less than 10,000 by 1900 and to 14,722 in 1960. Although it has a respected school of mines, a few factories and some agriculture, Ouro Preto lives largely in the past. In 1933 it was decreed a national monument and the surrounding region a national park. The objective of the federal government was to preserve or restore the city's elaborate public buildings, churches and private homes. These buildings, dating for the most part from the late 18th century, make the city a veritable open-air museum. The old colonial governor's palace houses the National School of Mines (founded 1876) and a museum that contains an outstanding collection of minerals native to Brazil. The massive colonial penitentiary contains the Museum of the *Inconfidência*, dedicated to the history of gold mining and culture in Minas Gerais. The colonial theatre, restored in 1861–62, is the oldest in Brazil.

The city has many baroque churches. Church architecture and religious sculpture attained their highest perfection in the city and perhaps in all Brazil under the skilful hands of Antonio Francisco Lisbôa, better known as O Aleijadinho ("The Little Cripple"), who is generally conceded the outstanding sculptor to have practised his art in Latin America. The church of St. Francis of Assisi is probably his masterpiece. Much of the ornateness of the churches of Ouro Preto is said to have resulted from white and Negro lay brotherhoods competing with one another during the colonial period. In the 20th century Ouro Preto has provided a gold mine of subjects for artists from many parts of the world. (J. J. J.)

OUSE, an English river name, ultimately derived from a Sanskrit word for water.

1. The Great Ouse, the most important river system draining the east Midlands and the Fens (*q.v.*), rises at about 500 ft. O.D. (ordnance datum) 5 mi. W. of Brackley, Northamptonshire, and follows an irregular meandering course in a clearly

defined valley across Jurassic rocks past Buckingham, Newport Pagnell, Bedford, St. Neots, Huntingdon and St. Ives to Earith, Huntingdonshire, where, on the borders of Cambridgeshire and the Isle of Ely, it enters the Fens proper. In this part of its course, which is 100 mi. in length, its gradient falls from 20 ft. per mile above Buckingham to about 2 ft. per mile toward Earith. The main tributaries received are, on the left bank, the Tove at Stony Stratford and the Kym at St. Neots; and, on the right bank, the Ouzel at Newport Pagnell and the Ivel between Bedford and St. Neots. The discharge at Bedford averages 330 cu.ft. per second with extremes of 9,820 and 2 cu.ft. per second and this increases to an average of 495 cu.ft. per second with extremes of 11,000 and 28 cu.ft. per second near Earith. From Earith to its mouth at the southeastern corner of the Wash near King's Lynn, Norfolk, a distance of 35 mi., the course is almost wholly artificial: the straight Bedford rivers (the New Bedford being the more important) lead the Ouse to Denver sluice. North of Denver the river has been extensively straightened. Its average gradient from Earith is only about 4 in. per mile in spite of the fact that the artificial course is at least a third shorter than the old natural course via Ely and Littleport. The discharge into the Wash is probably twice as great as that at Earith. Parts of the upper valley and the valleys of the Ouzel and Tove are followed by the Grand Union canal, which has a disused branch to Buckingham, and there are locks upstream from the mouth to Bedford. The river is now mainly used, however, for pleasure craft, coarse fishing and gravel working in the floodplain.

2. The Ouse is also the name given to that part of the Yorkshire river system from the junction of the Swale and the Ure near Boroughbridge as far as the junction with the Trent below Goole, where it becomes the Humber. It flows southward through the broad glaciated Vale of York, developed in Triassic rocks, and is thought to have captured a number of rivers originally flowing eastward down the flank of the Pennines directly into the North sea, namely the Swale, Ure, Nidd, Wharfe, Aire and Calder. York, Selby and Goole are the principal towns sited on its banks. The river system as a whole is about 140 mi. long from its farthest source to the sea, and the section called the Ouse occupies about one third of this. The Aire and Calder valleys are used by canals between the Yorkshire industrial region and the Humber, while the northern rivers, the Ure, Nidd and Wharfe, have a number of reservoirs supplying water to Yorkshire towns.

3. The Ouse in Sussex is a short river rising near Handcross on the south side of the central Weald and reaching the sea at Newhaven 30 mi. away, though its original outlet was 2 mi. farther east at Seaford. Like the Arun, Adur and Cuckmere it flows at right angles to the direction of folding of rocks and is thought to have been superimposed. It flows through a marked gap in the South Downs, with a flat alluvial marshy floor at the northern end of which Lewes is sited. It is navigable for small vessels, though little used, to Lewes. Its headwaters, dammed to form hammer ponds, once provided power for the former Wealden iron industry. (B. W. S.)

OUTRAM, SIR JAMES (1803–1863), English general and Indian political officer, "the Bayard of India," was born at Butterley hall, Derbyshire, on Jan. 29, 1803. He was given an Indian cadetship in 1819 and, early proving himself a successful officer and sportsman, was chosen in 1825 to reclaim the wild robber Bhils of Khandesh and raise a Bhil light infantry corps. After serving with distinction in the early stages of the first Afghan War, which he nevertheless thought was a dangerous folly, Outram was appointed political agent in lower Sind (1839) and in upper Sind also (1841). He won the confidence of the amirs of Sind, whose case he pleaded, and though dismissed on the appointment to Sind of Sir Charles Napier (*q.v.*), persuaded them to accept a harsh new treaty. Though Outram disapproved of Napier's treatment of the amirs, and was to enter into a war of words with him, it was Napier who toasted Outram as "the Bayard of India."

In 1847 Outram was appointed resident at Baroda, but was removed for exposing official corruption. Vindicated and restored in 1854 he was made resident at Lucknow, where in 1856 he carried out the annexation of Oudh. In 1857 he successfully commanded an expedition against Persia, but, the Mutiny having broken out, was recalled to command two divisions and resume his Oudh commissionership. He joined Sir Henry Havelock (*q.v.*) at Cawnpore (Kanpur), and with quixotic generosity allowed him to command during the relief of Lucknow. He held the city until Sir Colin Campbell's second relief, and thereafter held the Alambagh (a walled park) against great odds until the final capture of Lucknow. As chief commissioner he was responsible for softening Lord Canning's measures against the great landowners and securing their submission. In 1858 he was awarded a baronetcy and was appointed military member of the governor general's council. He returned to England in 1860 and died at Pau, France, on March 11, 1863. (J. B. Ha.)

OU-YANG HSIU (1007–1072), Chinese poet, essayist, historian, and statesman, was a moving spirit in a singularly innovative and brilliant generation. His father, a minor local official, died when he was three and his boyhood was spent in poverty in a small town north of modern Hankow. Taught by his mother, he early acquired an enthusiasm for classical literature, and his precocious skill in versifying attracted attention. He borrowed books from neighbours and after initial failures in the state examinations gained admission to a public school at K'ai-feng, the capital of China under the Northern Sung dynasty. He passed the doctoral tests with great distinction in 1030.

He then rose rapidly in the national scholarly institutes. The governmental reform program of Fan Chung-yen soon attracted him, and when Fan was attacked and demoted Ou-yang, through persistently defending him, also suffered. On returning to influence, Ou-yang held increasingly important positions including service as ambassador to the Khitan and as administrator of the Bureau of Policy Criticism and of the capital. From 1061 to 1067 he served in the highest council of state. Among younger men he sponsored was the innovator Wang An-shih (*q.v.*). While his opposition to Wang's authoritarian procedures later alienated the two, at Ou-yang's death Wang expressed his grief and esteem in a moving tribute.

The personal influence and many-faceted activity of Ou-yang Hsiu had a lasting effect. As a statesman he worked to regenerate political life through classical Confucian principles; he criticized fearlessly and recommended promotion of able men who eventually led opposing parties. He was early captivated by writings of Han Yü (*q.v.*), whose opposition to Buddhism he shared, though in a more moderate form. He revived Han's advocacy of a simpler, more direct prose like that of Mencius, to replace the mannered and excessively rhythmic style then popular, and his writings in the resultant *ku-wen* style established a model emulated thenceforth. He emancipated the *fu* prose-poems from strict conventions and left superb examples of these as well as of the newer *tz'u* (lyrics to popular tunes) and other literary forms. In his "New History of the Five Dynasties" (*Hsin Wu-tai Shih*) and in the "New History of the T'ang Dynasty" (*Hsin T'ang Shu*), which he edited, he amplified the standard history form and praised or censured men and institutions through terse but exact description implying moral judgment, in supposed emulation of Confucius. As scholar he ignored later commentaries to seek fresh and immediate understanding of early texts. He contributed to archaeological study and as a painter helped create the new *literati* style. His preserved writings include not only his histories but over 150 chapters of poems, state papers, letters, and other smaller pieces.

Bibliography.—Only a few of Ou-yang's poems and essays are translated into English. For examples, *see* Clara Candlin, *The Herald Wind*, pp. 40–42 (1955); Arthur Waley, *More Translations from the Chinese*, pp. 141–143 (1919); W. T. de Bary, Wing-tsit Chan, and Burton Watson (comp.), *Sources of Chinese Tradition*, pp. 441–448 (1960).
(E. A. Ke.)

OVANDO, NICOLÁS DE (*c.* 1451–1511), Spanish military leader and first royal governor of the Indies (1501–09). Born in Brozas, Extremadura, to a family of the nobility, he was the younger son of Capt. Diego de Cáceres and Isabel Flores Gutierrez. He grew up close to the court of Ferdinand and Isabella and was among the companions of the heir apparent to the throne. As a knight of the order of Alcántara, Ovando was active in the reorgan-

ization of the order, being named *visitador* for two terms and *comendador mayor* in 1503. His work was so effective that he was chosen to replace Francisco de Bobadilla as governor of the Spanish colony in the West Indies. Ovando arrived in 1502 in Santo Domingo with ample powers and a great fleet. He was soon driven to a war of conquest in order to secure native labour, hanging the ruling princess Anacaona for treason. He also let Christopher Columbus linger for a year without help in Jamaica, where the explorer had run aground, probably apprehensive lest Columbus stir up the just-pacified Santo Domingo by his return. These two acts have overshadowed Ovando's record of constructive service in establishing in Santo Domingo a stable Spanish community that became the base and model for all later Spanish colonial settlements. (U. S. L.)

OVERBECK, FRANZ CAMILLE (1837–1905), German church historian and New Testament scholar regarded by Karl Barth as the forerunner of dialectical theology, was born on Nov. 16, 1837, at St. Petersburg. A pupil of F. C. Baur, he lectured on church history at Jena (1864–70) and he was professor of New Testament and church history at Basel (1870–97), where he became a friend of Nietzsche and published *Über die Christlichkeit unserer heutigen Theologie* (1873) and *Studien zur Geschichte der alten Kirche* (1875). His other books, *Das Johannes-Evangelium* (1911), *Vorgeschichte und Jugend der mittelalterlichen Scholastik* (1917) and *Christentum und Kultur* (1919) appeared after his death at Basel on June 26, 1905. He held that Christianity was "nothing other than Christ and belief in him" and the waiting for his second coming. The church is not Christianity, but a religious society dating from the patristic period and having no connection with the "prehistoric embryo" of the gospel. Christianity and civilization are opposed. God is unknowable and has nothing to do with men. Overbeck was in fact a radical agnostic.

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OVERBECK, JOHANN FRIEDRICH (1789–1869), German painter, the reviver of "Christian art" in the early 19th century, was born at Lübeck on July 3, 1789. In 1806 he entered the Academy of Vienna. Disappointed in the pseudo-classicistic methods of teaching, Overbeck, with his friend Franz Pforr and some other young painters, founded in 1809 the "Lucas Brotherhood," aspiring to the renewal of arts by virtue of Christian faith. For inspiration, they turned to the old German (Dürer) and to the *quattrocento* masters of Italy (Perugino, early Raphael).

In 1810, the "Lucas Brethren" went to live in Rome, and, in 1813, Overbeck joined the Roman Catholic Church. The group, which now included Peter von Cornelius (*q.v.*), Schnorr von Carolsfeld, Philipp Veit and Wilhelm von Schadow-Godenhaus, became known as the "Nazarenes." Their painting was characterized by nobility of conception, precision of outline and clear, bright colours, emphasizing symbolic qualities. Overbeck, with his lofty ideals, was the natural leader of the party.

In 1816 the Prussian consul, J. L. S. Bartholdy, commissioned them to decorate his villa in Rome with frescoes on the story of Joseph and his brethren. This led to another commission from Prince Massimo to paint the interior of his pavilion (1817–29). In 1829 Overbeck executed "The Rose-Miracle of St. Francis" for the chapel called the Portiuncula, at Assisi. As he advanced in years, Overbeck's painting became pallid and stereotyped. Yet these late works influenced European devotional art until the beginning of the 20th century, whereas his notable early pictures and imposing drawings were not rediscovered until the early 20th century. There are relations with the Pre-Raphaelites, too, the connecting link being William Dyce (*q.v.*).

Overbeck died in Rome on Nov. 12, 1869. His principal paintings are: "Christ's Entry Into Jerusalem" (1809–24; destroyed in Lübeck, 1942); "Adoration of the Magi" (1811–13; Hamburg); "Germania und Italia" (1811–28; Munich); "Family Portrait" (1820; Lübeck); and "Vittoria Caldoni" (1821; Munich).

See M. Howitt, *Friedrich Overbeck* (1886); C. G. Heise, *Overbeck und sein Kreis* (1928). (G. Le.)

OVERBURY, SIR THOMAS (1581–1613), English poet and essayist, the victim of a famous intrigue at the court of James I, was born in 1581 at Compton Scorpion, Warwickshire, and baptized on June 18, 1581. In 1595 he became a gentleman commoner of Queen's college, Oxford. He entered the Middle Temple, London, in 1598.

While in Edinburgh in 1601, he met Robert Carr, then a page to the earl of Dunbar. Overbury became a servant of Sir Robert Cecil, traveled twice to the Low Countries, later writing *Observations in His Travailes Upon the State of the XVII Provinces* (1626). Returning from his first visit in 1606, he found that Carr had attracted the attention of James I, and was becoming the king's favourite. He became Carr's secretary and closest adviser, and was knighted in 1608 and appointed a servitor in ordinary to the king. As Carr rose, Overbury's influence grew and it was said that "Overbury governed Carr and Carr governed the King."

Early in 1611 Carr, now earl of Rochester, became enamoured of Frances Howard, countess of Essex. The affair, supported by Frances' relatives, the earls of Northampton and Suffolk, who saw a marriage between Frances and Rochester as a means to enhance their position at court, at first received Overbury's encouragement. When he realized that Lady Essex would reduce his influence over Rochester, and make him the tool of one court faction instead of the arbiter between factions, Overbury bluntly expressed his opinion of Lady Essex to Rochester, who repeated it to her. At the same time Overbury circulated manuscript copies of a poem called *A Wife*, which was a picture of the virtues a young man should demand of a woman, and which was interpreted as an indirect attack on Lady Essex.

"A man of unbounded and impudent spirit," in the words of Francis Bacon, Overbury had incurred the displeasure of James I and his queen, and it was not difficult for the Howards to contrive his imprisonment. Overbury was offered a post abroad and, on refusing it, was thrown into the Tower in April 1613, charged with disrespect to the king. Suffolk and Northampton, now abetted by Rochester, were content to see Overbury imprisoned while they secured the divorce of Lady Essex from her husband. She, however, was resolved that Overbury "should return no more to this stage." She bribed the jailer, aided by a Mrs. Turner, the widow of a physician, and by an apothecary called Franklin, to poison Overbury. His constitution long withstood the timid doses they gave him, but he eventually died in the Tower on Sept. 15, 1613.

In December Rochester, now earl of Somerset, married Lady Essex. More than a year passed before suspicion was aroused, and when it was, the king showed disinclination to bring the offenders to justice. In the trial which followed, the plot was discovered. The accomplices were hanged; the countess of Somerset pleaded guilty but was spared, and Somerset himself was disgraced.

Naturally, Overbury's fame as a writer was enhanced by so much posthumous publicity. His *A Wife*, entered on the Stationers' Register in Dec. 1613 and published early in 1614, ran through several editions within a year. To the second edition were added 21 *Characters*, increased in following editions until, by 1622, they numbered 82. Only a few were by Overbury, the remainder being by others, including John Webster, Thomas Dekker and John Donne. Their portraits of Jacobean "types," drawn with wit and satire, give a vivid picture of contemporary society, and are important in the development of the essay.

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OVERHEAD COSTS are various business expenses that cannot be readily identified with specific products or services produced or sold. Some overhead expenses, such as the salary of the company's senior executives, relate to the entire business; others, such as depreciation on machinery, apply to a part or division of the firm. All overhead expenses are common to more than one thing, but they have this quality in different degrees.

Nearly all general, administrative, and selling expenses are regarded as overhead. Manufacturing costs are often subdivided into those that are direct (materials, parts, and labour that can be identified with the products being fabricated) and those that

are indirect. The latter, sometimes called manufacturing overhead, factory overhead, burden, or on cost, include depreciation, insurance, taxes, and other expenses. Expenses for research and development, royalties, inspection, and packaging are sometimes treated as manufacturing overhead. For factories it is common to assign the costs on a departmental basis and then reassign the expenses of the so-called service departments to the producing departments.

Some overhead expenses do not vary from period to period; others increase or decrease in proportion to changes in activity. Since so many factory overhead expenses are wholly or partially fixed, the process of assigning such costs to the production of the plant is complex. Sometimes an effort is made to allocate all such expenses of a period to what is produced in that period. This causes unit product cost to increase or decrease as production volume varies. To avoid this, the overhead may be assigned on a so-called normal capacity basis. The expenses are budgeted for the level of activity considered normal, and a predetermined rate is established to use in assigning factory overhead to products fabricated. Some accountants favour direct costing, which treats fixed factory overhead as an expense of the period rather than as a part of the cost of the units produced. (A. B. CA.)

OVERIJSSEL, a Netherlands province, bounded south and southwest by Gelderland, west by the IJsselmeer, north by Friesland and Drenthe and east by the Federal Republic of Germany. Its population (775,759 in 1960) has more than doubled since the beginning of the 20th century; area 1,324 sq.mi. It is in part a varied glaciated delta land consisting of a sandy flat relieved by hillocks, and was originally covered with waste stretches of heath broken by patches of woodland and moist, swampy meadows. Vast high peat regions once extended to the northeast. North of Zwolle there is a quite different landscape: the coastal strip north of Zwartsluis consists largely of low peat, partly covered with clay, but especially to the west of Steenwijk a type of landscape occurs resulting from peat digging, with many lakes and broad ditches.

Drainage is determined by two main glacial ridges, of which the smaller (eastern) one, separating the Dinkel and Regge rivers, extends from Enschede northward into the West German county of Bentheim; the larger one runs parallel with it and, commencing at Lochem (Gelderland), extends to the Vecht river. In the south it separates the IJssel and Regge, where it also attains its summit height (Holterberg, 246 ft.). The Vecht crosses the province from east to west joining a number of small streams near Zwolle to form the Zwartewater, which communicates with the IJsselmeer by the Zwartemeer and Ketelmeer; the IJssel enters the IJsselmeer separately below Kampen by the Ketelmeer. The province has many canals, large and small.

The northwestern part of Overijssel is meadowland (with exception of some reclamations west of Steenwijk) supporting cattle farming and dairy factories; in the sand regions there is cattle rearing based on a type of mixed farming. The region of high peat in the northeast, like that in Drenthe and Groningen, has become a farming region, specializing in cereals and potatoes.

Overijssel has developed into a highly industrialized province. Textile manufacturing is particularly important, especially in the Twente district where cotton spinning, weaving and bleaching came into prominence in the 19th century. The inhabitants for long had practised weaving as a homecraft but immigrants, partly Mennonite refugees, who arrived in the 17th and 18th centuries organized it into an industry. Enschede, Almelo (*qq.v.*) and Oldenzaal are the main textile and clothing centres. In Hengelo engineering and salt making are dominant. The provincial capital is Zwolle (*q.v.*), an industrial and communications centre with one of the largest cattle markets in the Netherlands. Deventer (*q.v.*), on the IJssel, is a regional shopping centre with important industries (tinplate packing, food products, cotton spinning and the manufacture of tinplate fittings and chemicals); it has preserved many of its old buildings, including a 16th-century weighhouse of unusual design. Kampen (*q.v.*), on the IJssel with its harbour long since silted up, was once a thriving Hanseatic town; its economy, which depends on inland shipping and light industry, is reviving because of connections with the reclaimed polders in the Zuider Zee. Tucked away in the extreme north near the Drenthe border is the picturesque water village of Giethoorn, with each house possessing its own quay, bridge and boat.

Overijssel was first known, under the name of Oversticht, as a part of the secular domain of the bishop of Utrecht. In 1528 it was incorporated in the Dutch realm of the Habsburgs, and from that time its history is shared with that of the Netherlands as a whole. In medieval times the Hanseatic towns of Kampen, Deventer and Zwolle were among the most important in the Netherlands. About 1500 the predominance passed to Holland (Amsterdam). Within the province the Twente area left behind the IJssel towns under the impact of the industrial revolution. In 1962 the Northeast polder was added administratively to the province. (H. J. KE.)

ØVERLAND, ARNULF (1889–), among the most notable of Norwegian poets who came to manhood after the death of Ibsen, achieved his widest recognition with some memorable poems written and clandestinely distributed in Norway after the German invasion in 1940. Born in Kristiansund on April 27, 1889, the son of a ship's engineer, he went to school in Bergen and studied philology briefly at Christiania university. His first verses (*Den ensomme fest*, 1911; *De hundrede violiner*, 1912) are tinged with bitter resignation, but the events of World War I (in which his sympathies lay with the central powers) fostered a radical opposition to bourgeois society and to Christianity, proclaimed in *Brød og vin* (1919). He joined Mot Dag, a group inspired by the Clarté socialism of Henri Barbusse (*q.v.*), and his political engagement is mirrored in *Berget det blå* (1927), *Hustavler* (1929), *Den røde front* (1937) and in stories, *e.g.*, *Gud plantet en have* (1931), and pamphlets, *e.g.*, *Det frie ord* (1935). His "illegal" poems directed against the German occupation, which led to his imprisonment in Sachsenhausen, are collected in *Vi overlever alt* (1945). Later verse includes *Sverdet bak døren* (1956), and he has also published political essays strongly critical of the Soviet Union, *e.g.*, *Nøitralitet eller vestblokk* (1948). Øverland's poetic style, marked by clarity, economy and polemic force, is in the tradition of Ibsen and Welhaven. He is a partisan of *riksmål*, *e.g.*, in *Riksmål, landsmål og slagsmål* (1956). *See* NORWEGIAN LANGUAGE.

OVER-THE-COUNTER MARKET. In the United States the over-the-counter market includes all trading in stocks and bonds that does not take place on the stock exchanges. It is often called the "off-board market," and sometimes the "unlisted market," though the latter term is misleading because some securities traded over-the-counter are listed on a stock exchange. Such trading rarely occurs at the place of business or "over the counter" of a dealer in securities but rather by telephone, telegraph or leased private wire. Thus the over-the-counter market has been described as "a market without a marketplace." In this market are dealers who buy and sell for their own account and who usually specialize in certain issues. The investor may deal directly with a dealer willing to sell stocks or bonds that he owns or through a broker who will search the market for the best price.

Bonds of the U.S. government (called "treasuries") are listed on the New York Stock exchange but most of the trading in them is carried on over-the-counter and is dominated by about a dozen bond dealers and a few large commercial banks. Other obligations of the federal government, as well as the bonds of the states and municipalities, are traded over-the-counter exclusively. Many other bond issues and preferred-stock issues are listed on the exchange but have their chief market over-the-counter. Members of a stock exchange are required to make their trades in listed common stocks on the exchange except occasionally when they sell a large block by special permission after trading hours, soliciting orders through both member and nonmember brokers.

A certain amount of off-board trading occurs in listed common stocks. It is handled by a few dealers and investment bankers who are not members of the New York Stock exchange. They either buy and sell for their own account or bring together buyer and seller, chiefly handling large blocks of well-known stocks mostly for institutional investors such as the mutual funds. They may

operate for profits or commissions that are less than standard exchange commissions and offer speedy execution for large blocks.

Prices at which transactions take place over-the-counter are not publicly reported as they are by the securities exchanges but the National Quotation bureau issues daily reports of prices to dealers who subscribe to its service. Prices are also indicated in the newspapers by daily "bid and asked" quotations for the more active issues. The "bid" quotations are the prices at which dealers are willing to buy; the "asked" quotations are the prices at which they are willing to sell. Sometimes these quotations are merely estimates or are good only for small amounts. They are subject to change and better prices may be found if the investor shops around. The difference (known as "spread") between bid and asked prices as supplied by a dealer indicates the gross profit he hopes to make. His actual profit will be affected by price changes that occur between the times of purchase and sale and by his costs of doing business.

Some corporations prefer to have their stocks and bonds sold over-the-counter rather than being listed on a stock exchange because the "spread" offers dealers more compensation than the ordinary brokerage commission. As a result, the dealers have an incentive to support and develop an otherwise limited market: that is, they will buy blocks for their own account and use selling effort to find buyers. As the size of the corporation increases and its stock is more widely held, listing becomes more desirable. Wider publication of price quotations and corporation news improves the market for the listed stock.

Much of the regulation of the over-the-counter market is effected through the National Association of Securities Dealers, Inc., the only organization of its kind registered with the Securities and Exchange commission. This association was created under an act of congress in 1939 to establish rules of conduct, to protect members and the investing public from possible excesses and abuses of associates, and to co-operate with government regulatory agencies.

See Irwin Friend *et al., The Over-the-Counter Securities Markets* (1958). (H. G. Gn.)

OVERTURE, a piece of music, originally serving as an introduction to an opera, later developed into an instrumental work associated with both the suite and the symphony, and ultimately into an independent piece for large orchestra.

The earliest operas usually opened with a trumpet fanfare (of which a surviving example is the short "toccata," three times repeated, in Monteverdi's *Orfeo*) or with a prologue sung in recitative. The first attempt to establish the form of an organized work that should serve as an appropriate introduction to the operatic entertainment is found in the overtures to the French operas of Lully. These, *e.g.*, the overture to *Thésée* (1675), open with a slow section in a pompous double-dotted rhythm followed by a quick section in a fugal, or imitative, style. The third section of the Lullyan, or French, overture was either a repetition of the opening slow section or a slow dance movement, sometimes a minuet or a gavotte. Another type of overture, the Italian opera overture, known also as the *sinfonia avanti l'opera*, was established after 1680 by Alessandro Scarlatti; it is also in three sections, the two outer sections being in quick time and the central section in slow time (allegro-adagio-allegro).

The form of the French overture was widely copied, and not only by opera composers. It appears also as an introduction to oratorios. Purcell's *Dido and Aeneas* and Handel's *Messiah* are among the many 17th- and 18th-century works provided with an overture on the Lullyan model. It was also adopted in purely instrumental music. Many German composers used the form for the opening movement of suites for harpsichord, the remaining movements consisting of dances. It was natural that the gavotte or the minuet, forming the final section of the Lullyan overture, should be followed by other dances, and it thus came about that this type of overture developed into the orchestral suite. Handel's seventh harpsichord suite, opening with a movement entitled Overture, and Bach's four orchestral "ouvertures," in which there is an extended first movement followed by a series of dances, are works of this kind. This form of the suite, based on the French overture, persisted until the middle of the 18th century. The form of the Italian opera overture, on the other hand, later served as a model for the three-movement form of the 18th-century symphony illustrated in works by J. G. Graun, C. P. E. Bach and G. Benda. This form was cultivated until Johann Stamitz added the minuet to the three movements of the symphony. The term overture, however, was used for the symphony in England until the end of the 18th century. It appears as a description of Haydn's symphonies performed in London in 1791.

A more modern form of the opera overture was established by Gluck. In his dedication of *Alceste* (1769) he declared that an overture should "prepare the audience for the plot of the play." Consequently instead of the overture being brought to a close before the rise of the curtain, it was designed to merge into the mood of the opening act. Gluck's overture to *Iphigénie en Tauride* contains an example of this device, foreshadowing a similar device used by Wagner in *Tristan und Isolde*. In the meantime Gluck's recommendation was followed by Mozart, notably in the overtures to *Don Giovanni* and *Die Zauberflöte*, where themes from the opera are alluded to; the allusions are in the former to the music of the Commendatore in the last scene and in the latter to the theme heard on the trombones associated with the Temple of Wisdom. The anticipation in an opera overture of themes to be heard later in the course of the opera is used with great dramatic effect in Beethoven's *Leonore* no. 2 and no. 3 overtures and with great evocative effect in Weber's *Der Freischütz* and Wagner's *Tannhäuser* overtures. The most highly developed opera overture of this kind is Wagner's overture to *Die Meistersinger*, in which the principal themes from the opera are contrapuntally combined.

Toward the end of the 19th century the opera overture was frequently replaced by a shorter introductory prelude, particularly in Wagner's *Lohengrin* and *Parsifal*. This was an entirely new conception. By quickly establishing the mood of the opening act such preludes were held to merge more effectively into the dramatic action. Following the Wagnerian model, introductions to later operas, among them those to Debussy's *Pelléas et Mélisande* and Benjamin Britten's *Peter Grimes*, consist only of a few bars. A successful experiment was made in Italian opera: the prologue to Leoncavallo's *Pagliacci* is an aria sung in front of the curtain.

Based on the style of the overtures to romantic operas, the concert overture became established in the 19th century as an independent work of a descriptive or programmatic nature. Mendelssohn's *Hebrides* overture, Dvorak's *Carnival* overture and Walton's *Portsmouth Point* overture are examples. Unity is achieved in these works by the development and contrast of themes, in the manner of thematic development in symphonic form, but the descriptive nature of their inspiration dictated a rhapsodic rather than a classical form. The concert overture thus took on the character of a symphonic poem. Another category belongs to incidental music or music for the spoken drama. Overtures to plays, such as Mendelssohn's *Midsummer Night's Dream* overture and Beethoven's *Coriolan* overture, though intended for occasions when a large orchestra was available at the performance of a stage play, are in modern times heard exclusively in the concert hall.

See H. Botsiber, *Geschichte der Ouvertüre* (1913).

OVID (in Latin, PUBLIUS OVIDIUS NASO) (43 B.C.–A.D. 18), Roman poet, who can be regarded either as the last of the Augustan poets or as the first poet of the Silver Age of Latin literature and whose work has had immense influence both for its imaginative interpretation of the classical world and as an example of supreme technical accomplishment, was born at Sulmo (modern Sulmona), in the country of the Paeligni, on March 20, 43 B.C., of an old middle-class family. The main events of his life are described in a famous autobiographical poem (*Tristia*, iv, 10). While still a boy he was sent to Rome to be educated, being intended by his father for the public service. He studied rhetoric under the best masters of the day and was thought to have the makings of a good orator, but in spite of his father's admonitions he neglected his studies for the verse making which came so naturally to him. After completing his education with travels in Greece, Asia Minor and Sicily, he held some minor official posts, but he finally abandoned his career to devote himself to poetry.

His first work, the *Amores* ("Loves"), had an immediate vogue and was followed, in rapid succession, by the *Heroides* ("Heroines"), the *Medicamina faciei* ("Cosmetics"), the *Ars amatoria* ("Art of Love") and the *Remedia amoris* ("Remedies of Love"), all reflecting the brilliant, sophisticated, pleasure-seeking society in which he moved. The common theme of these early poems is love and amorous intrigue, but it is unlikely that they mirror Ovid's own life very closely. Of his three marriages the first two were short-lived, but his third wife, of whom he speaks with respect and affection, remained constant to him until his death. (His one daughter was probably by his second wife.) At Rome he enjoyed the friendship and encouragement of M. Valerius Messalla, patron of a circle which included Tibullus, whom Ovid knew only for a short time before his untimely death; his other friends included Horace, Propertius and the grammarian Hyginus. Virgil, as he said, he had only seen. Having won an assured position among the poets of the day he turned to more ambitious projects, the *Metamorphoses* ("Transfigurations") and the *Fasti* ("Calendar"). The former of these was nearly complete, the latter half finished, when his life was shattered by a sudden and crushing blow. In A.D. 8 the emperor Augustus banished him to Tomis (or Tomi; near the modern Constanta) on the Black sea. The reasons for his exile will never be fully known; Ovid himself specifies two, his *Ars amatoria* and an offense which he does not describe beyond insisting that it was an indiscretion (*error*), not a crime (*scelus*). Of the many explanations which have been offered of this mysterious *error*, the most probable is that he had somehow become an accomplice in the adultery of Augustus' granddaughter, the younger Julia, who was also banished at the same time. In 2 B.C. her mother, the elder Julia, had similarly been banished for immorality, and the *Ars amatoria* had appeared while the scandal was still fresh in the public mind. These coincidences, together with the tone of Ovid's reference to his offense, suggest that he had acted in some way damaging both to Augustus' program of moral reform and to the honour of the imperial family. Since his punishment, which was the milder form of banishment called relegation, did not entail confiscation of property or loss of citizenship, his wife, who was well connected, remained in Rome to protect his interests and to intercede for him. Exile at Tomis, a half-Greek, half-barbarian port on the extreme confines of the Roman empire, was for a man of Ovid's temperament and habits perhaps the cruelest punishment that could be devised. He never ceased to hope, if not for pardon, at least for mitigation of sentence, keeping up in the *Tristia* ("Sorrows") and *Epistulae ex Ponto* ("Letters From the Black Sea") a ceaseless stream of pathetic pleas, chiefly through his wife and friends, to the emperor; but neither Augustus nor his successor Tiberius relented, and Ovid was even becoming reconciled to his fate when death released him.

WORKS

Ovid's extant poems, all written in elegiac couplets except the *Metamorphoses*, fall into three groups.

Early Works.—The chronology of the early works is obscure. The first edition of the *Amores*, in five books, was issued when Ovid was still very young; the edition that has survived, in three books, dates from a later revision. The *Amores* invite comparison with the poems of Tibullus and Propertius, but the resemblance is only superficial. Their keynote is not passion, but the witty and rhetorical exploitation of erotic commonplace: they chronicle, not a real relationship between Ovid and Corinna (who, unlike the Delia of Tibullus, or the Cynthia of Propertius, cannot be identified with a real woman and probably never existed), but all the phases of a typical affair with a demimondaine.

In the *Heroides* Ovid was developing an idea already used by Propertius (iv, 3) into something like a new literary genre. The first 15 of these letters from legendary ladies such as Penelope, Dido and Ariadne to absent husbands or lovers appeared between the two editions of the *Amores*. Their epistolary form hardly disguises the fact that they are really dramatic monologues, in which the influence of Ovid's rhetorical education, particularly the exercise called *ethopoeia* (character drawing), can be clearly seen. Unlike most ancient writers Ovid liked women as a sex; and though no doubt many of his shrewd touches reflect his reading rather than an intimate knowledge of "feminine psychology," the note of sympathy and understanding is unmistakable. But not all his skill can disguise the inherent monotony of subject and treatment, and there are many *longueurs* and lapses of taste. The six later epistles, the authenticity of which has been unjustly suspected, are on a different and more successful plan: they form three pairs, the lover addressing and being answered by the lady. The correspondence of Paris and Helen is one of antiquity's minor masterpieces.

In turning, as he next did, to didactic poetry, Ovid was following a popular fashion: his first attempt, the *Medicamina faciei*, of which only 100 lines survive, was typical of many such witty exercises. This frivolous but harmless poem was followed (1 B.C.) by the notorious *Ars amatoria*, a manual of seduction and intrigue for the man about town. The seducer's prey, in this work, is ostensibly the courtesan (which in Rome meant the freedwoman, the nearest equivalent to the Greek *hetaera*), and Ovid explicitly disclaims the intention of teaching adultery; but all his teaching could in fact be applied to the corruption of married women. Such a work constituted a direct challenge, no less effective for being flippant, to Augustus' cherished moral reforms, and it is part of Ovid's essential naïveté that he either could not or would not see the gravity of his offense in publishing it. The first two books, addressed to men, were the original extent of the work; a third, in response to popular demand, was added for women. For most modern readers, including Lord Macaulay, this is Ovid's masterpiece, a brilliant medley of social and personal satire, vignettes of Roman life and manners and charming mythological digressions. The veneer of didacticism is light but unmistakable, with deliberate echoes of Lucretius and of Virgil's *Georgica*, the traditional role of the poet as teacher being cleverly perverted in Venus' service. In the *Amores* he had presented love as a game to be played for enjoyment only; in the *Ars* he codified and illustrated the rules. In the social sense the *Ars* is an immoral poem, and the candid reader must recognize the justice if not the wisdom of Augustus' condemnation of it; but it is not pornographic, and it may be doubted whether many have been the worse for reading it. It was followed by a mock recantation, the *Remedia amoris*, also a burlesque of an established genre. Though amusing, this contains clear indications of flagging inspiration, and Ovid now turned to new types of poetry in which he could indulge to the full his supreme narrative and descriptive gifts.

Metamorphoses and Fasti.—The poems of the second group of Ovid's works were being written concurrently from *c.* A.D. 1 onward. The *Metamorphoses* represented for Ovid himself, as its concluding lines show, the masterpiece from which he hoped for immortality. Ostensibly it is a collection of stories depicting the transformations so frequent in classical legend, told in approximately chronological order from the creation of the world to the poet's own day; in fact his theme gave him an excuse to tell almost any story that took his fancy. The idea and its execution were Alexandrian, but Ovid's use of his Greek sources was free, and in the various devices and digressions that he employed for connecting and "framing" the stories he displayed a variety and ingenuity that outdid his models. The result is a long poem in 15 books of hexameters, with a total of nearly 12,000 lines; and the wonder is that it can be read through with so much pleasure and so little fatigue. Moreover, by his genius for narrative and vivid description, Ovid gave to scores of legends, some of them little known before, what was to be for many generations of poets and painters their definite form. No single work of literature has done more to transmit the riches of the Greek imagination to posterity. Though the poem is brought down to Augustus, the Roman legends in it are comparatively few.

The treatment of Roman legends was mostly reserved by Ovid for his *Fasti*. This work was originally planned to comprise 12 books, one for each month, but only the first 6, covering January–June, were finished at the time of Ovid's banishment. It recounts the Roman festivals as they occur and relates the myths appropriate to each; again an opportunity for storytelling. Ovid's chief Greek model was Callimachus' *Aetia*, but here again, as in the

Heroides, he was following a lead given by Propertius (iv). As a medium for narrative, the elegiac couplet in Ovid's hands rivals the hexameter, and as a collection of stories the *Fasti* ranks second only to the *Metamorphoses*. It was intended, however, as something more—as a national, specifically Roman, poem, a part in fact of the Augustan literary program. From the inevitable comparison with Virgil it emerges badly, especially in its perfunctory patriotism and gross adulation of the imperial family. The *Fasti* constitutes a unique source of information about Roman religion but must be used with extreme caution.

Poems of Exile.—The *Tristia* and the *Epistulae ex Ponto* were written and sent to Rome at the rate of about a book a year from A.D. 9 onward; they consist of letters to the emperor and to Ovid's wife and friends, describing his miseries and pleading for their alleviation. Book ii of the *Tristia*, a characteristic defense of the *Ars amatoria*, addressed to Augustus, is of particular interest to the literary historian, but its mixture of casuistry and something very near impudence can scarcely have helped its author. A few of the other poems stand apart because of their subjects (for example: *Tristia* i, 3, a moving description of Ovid's last night in Rome; and iv, 10, the autobiography), but most of both the *Tristia* and of the *Epistulae ex Ponto* exhibit a uniform tone of depression and self-pity. Ovid has been condemned for his lack of fortitude, but only the most self-righteous can fail to be moved as, remembering what he had been, they read of the terrible winters of Tomis, of barbarian incursions across the frozen Danube and of the aging poet taking his turn at sentry duty; or of his lack of books and of civilized company and of his wistful imaginings of life in Rome.

During his exile Ovid partially revised the *Fasti;* otherwise the only work of this time that has survived is the *Ibis*. This is a long curse directed at an unnamed enemy whom, following Callimachus in his attack on Apollonius, he called Ibis after the Egyptian bird (supposed to have filthy habits). Its amalgam of rhetorical abuse and curious learning is typically Alexandrian, and it may have been no more than a literary exercise. If Ibis was a real enemy, this poem was Ovid's only lapse from the high standard of fairness and benignity (*candor*) on which he prided himself.

Lost and Spurious Works.—The loss of Ovid's tragedy *Medea*, written at Rome, is particularly to be deplored; it was praised by Quintilian and Tacitus. Of the extant works sometimes attributed to Ovid, the best case can perhaps be made out for the *Nux* ("Nut-tree"), a pleasing little poem. The fragment of the *Halieutica* ("Sea-fishing") which has survived is certainly not his; nor, it is generally agreed, are the *Consolatio ad Liviam* and the *Elegia in Maecenatem*.

THE MAN AND THE POET

When the battle of Actium was fought in 31 B.C., Ovid was still a child. Older men, like Horace and Virgil, who had endured the anarchy and bloodshed of the declining Roman republic, were deeply thankful for the regime of Augustus, in whom they saw the saviour of civilization. Their beliefs and aspirations held little interest for the younger generation, for whom the peace and security of their environment formed merely the background to the private pursuit of pleasure. Ovid's early training encouraged his romantic and escapist bent. Rhetoric, still the staple of higher education though increasingly divorced from reality, had degenerated in the hands of many of its exponents into an elaborate game with words and ideas; and in Ovid can be seen the beginnings of the long domination of rhetoric over poetry. Latin elegiac poets regularly turned away from public life and responsibility, but Ovid was better fitted by temperament even than Tibullus and Propertius for escape to the poet's world of fantasy. His imagination was stirred not so much by his own experience (though the *Amores* and the *Ars amatoria* show him as an acute and witty observer of the contemporary scene) as by the riches of Greek legend.

From his boyhood Ovid venerated and cultivated the society of poets; few poets have read more poetry than he or remembered and reproduced more of what they read. In his exile poetry was his only solace. As its subject matter stimulated his imagination, so its technique fascinated his intellect. His astonishing dexterity is the response to the difficulty of adapting the intractable Latin tongue to dactylic Greek metres. The Roman elegiac couplet was already governed by stricter rules than its Greek model, and Ovid further refined these rules. He is the most Alexandrian of the Roman poets. His aims can be summed up in the one word point: point conveyed by smoothness, fluency and balance. To achieve this he shaped the already artificial poetic diction elaborated by his predecessors into an instrument which within its inherent limitations is nearly perfect. Its elegance masks its extreme artificiality, and the casual reader overlooks the quiet ruthlessness of Ovid's linguistic innovations, particularly in vocabulary. His hexameters in the *Metamorphoses* are a superb vehicle for rapid narrative and description.

To this technical facility was added an unrivaled power of invention which enabled Ovid to exploit ideas and situations to the utmost. This fertility, that "plenty of subjects and words" which was the goal of ancient rhetorical education, was not without dangers. The elder Seneca, who provides a valuable portrait of the young Ovid in his *Controversiae* (ii, 2, 8), remarks elsewhere (ix, 5, 17) that he could not let well alone; and the reader of the *Heroides* and *Metamorphoses* is alternately enchanted and repelled by his baroque exuberance. His undoubted rhetorical gifts have caused him to be dubbed insincere and even heartless, and he seems indeed to have lacked the capacity for strong emotion or religious feeling; but the *Heroides* and the poems of exile show that he was not without sensibility. When he offends, it is through his refusal (which Seneca tells us was deliberate) to control his genius: his wit leads him into outright frivolity, and the whole is forgotten in the pleasure of developing its parts. Classical perfection had no appeal for him; he was accustomed to say that a mole improved a beautiful face. Judged, however, by his gift for fantasy, Ovid is one of the great poets of the world. The *Metamorphoses*, formless as it is, shows him at his most characteristic. For him and for his readers the scenes of his poetry were full of the associations of history and legend, and he had a keen eye for natural beauty. His idealized landscapes are peopled, not by the gods, demigods and mortals of classical Greek mythology, but by what might almost be called fairy substitutes, creatures of the poet's fancy invested with some of their attributes. Ovid had few illusions about the historic past and did not share the fashionable nostalgia for a golden age; his escape was into the timeless and miraculous world of romance, and into his depiction of this unreal world he infused all the beauty and gaiety of which the world of the senses is capable. His talent is not of that highest order which can pierce the outward semblance of men and things and receive intimations of a deeper reality; but what he could do, few if any poets have ever done better.

INFLUENCE

The immense popularity that Ovid enjoyed during his lifetime continued after his death, being little affected by the action of Augustus, who banned his works from the public libraries. Virtually no Latin poet was thereafter immune from his influence. The elegiac couplet, in particular, remained substantially what he had made it.

From about 1100 onward Ovid's fame, which during late antiquity and the early middle ages had been to some extent eclipsed, began to rival and even at times to surpass Virgil's. The 12th and 13th centuries have with some justice been called "the age of Ovid." Surprisingly, he was esteemed in this period not only as entertaining but also as instructive: he was a "golden author" whose works, not even excluding the *Remedia amoris*, that "remedy worse than the disease," were read in schools. Not even he had been able to ignore the fundamentally moral orientation of ancient literature; his poetry is full of epigrammatic maxims and sententious utterances which, lifted from their contexts, make a respectable appearance in the excerpts in which medieval readers often studied their classics. He also provided rich material for a favoured exercise of the age, allegorical interpretation—a treatment which not even the *Ars amatoria* escaped. His popularity was part, however, of a general secularization and awakening to the beauties of profane literature: he was the poet of the wander-

ing scholars who were one of the scandals of the age as he was of the vernacular poets, the troubadours and minnesingers; and when the concept of romantic love, in its new chivalrous or "courtly" guise, was developed in France, it was Ovid's influence that dominated the book in which its philosophy was expounded, the *Roman de la rose*. His fame at this time was such that he was even translated into Greek by the monk Maximus Planudes, when interest in Latin literature had for centuries been dormant in the Byzantine empire. (Planudes' prose versions of the *Heroides* and *Metamorphoses* are still extant.) Ovid continued, then, to be one of the familiar poets of the middle ages, Dante and Chaucer, for instance, being much indebted to him; but some of the ways in which he influenced medieval literature and thought would undoubtedly have astonished him. Like Virgil, he survived in the memory of his native countryside as saint and wizard.

With the culmination of the Renaissance, Ovid may be said to have come into his own. While the middle ages had honoured him where he least deserved it, that is, for his morality, the humanists of the 15th century, striving to recreate ancient modes of thought and feeling, honoured him for his poetry (though it must also be remembered that Greek literature and thought were for many accessible only through the medium of Latin, so that the *Metamorphoses* was indispensable if only as a mythological handbook). His vivid and striking descriptions, the gaiety and free play of his fancy, the elegance and brilliance of his language, even his superficial hedonism, all combined to recommend him to the new spirit that was abroad. Printed editions of his works followed each other in an unending stream from 1471 onward. He continued to be read in schools, and when the composition of Latin verses was established as an integral part of the standard literary education, it was his verse, above all, that was imitated. A knowledge of his works was taken for granted in an educated man. In the 15th, 16th and 17th centuries it would be difficult to name a poet or painter of note who was not in some degree indebted to him. Of scores of names it suffices to mention Shakespeare and Milton in England.

The subsequent decline in Ovid's popularity is not wholly attributable to the decrease in the importance of the classics which followed the romantic movement at the end of the 18th century and the rise of scientific education in the 19th. As classical studies took their place as a discipline beside other disciplines, ancient authors came to be esteemed as they were original, informative or improving rather than for their power to delight and entertain. In the 20th century, however, reaction against Victorian rigidity brought signs that Ovid might be attaining in the opinion of contemporary critics the place to which, in Seneca's words his "cultivated, seemly and pleasing genius" entitles him.

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(E. J. Ky.)

OVIEDO, a city of northern Spain, capital of the province of Oviedo, is situated on the foothills of the Cantabrian mountains 212 km. (132 mi.) W. of Santander by road. Pop. (1960) 127,058. It lies between the valleys of the Ñora and the Nalón, at the foot of Mt. Naranco, near the mining centres of the province and 29 km. (18 mi.) from the port of Gijón. On the south slope of Naranco are two fine examples of 9th-century Christian art, the monuments of San Miguel del Lillo (or Linio) and Santa María. The city has many interesting buildings, of which the cathedral is outstanding. It dates from the 12th to the 16th century and contains the Cámara Santa, with many holy relics. The old convent of San Vicente (rebuilt 15th–18th centuries) contains the provincial museum and the tomb of Benito Jerónimo Feijóo y Montenegro, the 18th-century monk and scholar. There are other churches and convents of artistic interest and the pleasant San Francisco park. The city developed around a monastery built by Fruela I in the 8th century. It became capital of the Asturian kings but declined after García I transferred his seat to León (910). A bishopric was established in 812 and a university was founded in 1608. Oviedo was sacked by French forces in 1809 and was badly damaged in the siege (1936–37) during the Spanish civil war. A new quarter has since been built on its southwest side. Oviedo is an agricultural, mining and industrial centre and has light industries.

Oviedo Province is coextensive with the region of Asturias. Area 4,079 sq.mi. Pop. (1960) 989,344. The province is largely mountainous; the chief peaks are Torre de Cerredo (8,688 ft.), Torre de Llambrión (8,586 ft.), Peña Vieja (8,573 ft.), Naranjo de Bulnes (8,219 ft.) and the Picos de Europa (including Peña Ubiña and Peña Rubia). The main passes are Somiedo (4,521 ft.) and Pajares (4,475 ft.). Lake Enol in the peaks of Covadonga is picturesque, and the Santina sanctuary, a shrine to the Virgin Mary, is famous throughout Spain. The coastline is rugged: its natural features include (east to west) the Ribadesella estuaries; Ría de Villaviciosa; the bay and port of Gijón; Cape Peñas; Ría de Avilés and the Rías de Pravia, Muros y Noya and Navia. The country is one of mists, frequent rainfall and green pastures. The main river is the Nalón; other rivers are the Sella and the Navia. Oak, chestnut and, especially, apple trees abound; the apples are used for making cider, the typical drink of the region and one of its exports. Maize (corn) and rye are grown and the province is the largest producer of potatoes in Spain. It also has the highest number of cattle (more than 300,000), the basis of the dairy industry. The great wealth of the province is in its coal mines; the fields extend throughout the Nalón basin and cover 1,043 sq.mi. It is the most important mining and metallurgical province in Spain. A great industrial complex has been built up at Avilés and has resulted in a large increase in its population. Mieres is an important mining and smelting centre. Gijón's seaport, El Musel, is the foremost coal-exporting port in Spain. There is a national armaments factory at Trubia.

Avilés, Gijón and Oviedo are linked by rail with Madrid via León, and Oviedo with Santander. The main east-west road (La Coruña-Santander) passes through Oviedo, with a subsidiary road Luarca-Avilés-Gijón-Ribadesella; and Oviedo is linked by road with Madrid.

See also Asturias. (M. B. F.; X.)

OVOLO: *see* Molding.

OVULE, the organ or structure in plants which after fertilization develops into a seed. *See* Flower.

OWEN, JOHN (1563 or 1564–1622), Welsh epigrammatist whose mastery of the Latin epigram caused him to be called "the British Martial," was born at Llanarmon, Caernarvonshire, probably in 1563 or 1564. He was educated at Winchester, and at New college, Oxford, where he was elected fellow in 1584. In 1591 he became a schoolmaster at Trelleck, near Monmouth, and later taught at Warwick free grammar school. He died in London in 1622.

Owen's first collection of epigrams was published in 1606—

Epigrammatum . . . Liber Tres. A second volume followed in 1607 and two more in 1612, bringing the number of books up to ten (three volumes contained three books each, and one consisted of a single book). They achieved immediate popularity. Owen was highly praised by his contemporaries, both in England and abroad, for his readability, nimble wit, linguistic dexterity, and the skill with which he turned his verses. His epigrams are pointed rather than poetic: full of anagrams and near puns, they were appreciated particularly by a public brought up on Latin versification and accustomed to its use as a professional language. He incorporated many familiar Latin tags in his own work, sometimes with a skillful turn which added the shock of unexpectedness to the reader's pleasure in recognition. His works were frequently reprinted during the 17th and 18th centuries, both in England and abroad, and were translated into English, French, German and Spanish. The first English translation was by John Vicars (1619).

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OWEN, JOHN (1616–1683), took a prominent part in ecclesiastical and political life in England during the Commonwealth and Protectorate; both then and afterward he was the leading figure among the Independents, whose principles he, with others, expounded in the Savoy confession of 1658. He was born at Stadhampton, Oxfordshire, and was educated at Queen's college, Oxford. In 1643 he became rector of Fordham and in 1646 vicar of Coggeshall, both in Essex. Sermons preached by him before parliament led to his attachment to Oliver Cromwell, whom in 1649–50 he accompanied to Ireland and Scotland, and who in 1652, as chancellor of the University of Oxford, nominated him vice-chancellor. This office Owen held till 1657. From 1651 to 1660 he was also dean of Christ Church and in 1654 was elected to represent Oxford in parliament but was disqualified under the Clerical Disabilities act of 1642. Of republican sympathies, he opposed the offer of the crown to Cromwell and after Cromwell's death supported a military plot to reestablish the rule of "the Saints." After the Restoration he abandoned politics but remained loyal to the principles of Independency and issued a number of pleas for the toleration of Nonconformists. By means of anonymity, retirement and friends at court he succeeded in evading prosecution. Declining invitations to New England, he preached frequently in London, where from 1673 he ministered to an influential Independent (or Congregational) church in Leadenhall street. He died in London on Aug. 24, 1683. A writer both prolific and prolix and a vigorous controversialist, Owen was also devout and a man of deep learning. These latter aspects of his character find fullest expression in his books on the Holy Spirit; he here saw himself, justly, as a pioneer.

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OWEN, SIR RICHARD (1804–1892), British biologist, a pioneer in vertebrate paleontology and a prolific writer on many topics in comparative anatomy, was born at Lancaster on July 20, 1804. In 1820 he was apprenticed to a local surgeon and apothecary, and in 1824 he proceeded as a medical student to Edinburgh university. After completing his medical course at St. Bartholomew's hospital, London, he began a professional career; but, being induced by the eminent surgeon John Abernethy to accept the position of assistant to William Clift, conservator of the museum of the Royal College of Surgeons, he devoted himself to the more congenial work of scientific research. In 1831 Owen attended Georges Cuvier's lectures in Paris. He prepared a series of catalogues of the Hunterian collection in the Royal College of Surgeons, and, in the course of this work, acquired the knowledge of comparative anatomy that facilitated his researches on the remains of extinct animals. In 1836 he was appointed first Hunterian professor in the college; in 1849 he succeeded Clift as conservator and in 1856 became superintendent of the natural history departments of the British museum. He then devoted his energies to a scheme for a national museum of natural history, which eventually resulted in the removal of the natural history collections of the British museum to a new building at South Kensington, London. He retained office until the completion of this work in 1884, when he was created knight commander of the Bath, and thenceforward lived in retirement at Sheen lodge, in Richmond park, until his death on Dec. 18, 1892.

Owen's first notable publication, the *Memoir on the Pearly Nautilus* (1832), was soon recognized as a classic. Thereafter, for more than 50 years, he continued to make important contributions to comparative anatomy, devoting special attention to the remains of extinct groups, and published his work on *Odontography* (1840–45). His chief memoirs on British specimens were reprinted in his *History of British Fossil Reptiles*, 4 vol. (1849–84). He also wrote much on extinct birds. Sir Thomas Mitchell's discovery of fossil bones in New South Wales provided material for Owen's long series of papers on extinct mammals of Australia, which were eventually reprinted in book form in 1877. His industriousness placed him in the forefront of anatomists, but it is to be regretted that his work was not free from gross errors of observation and interpretation. His views on evolution were equivocal.

Besides those mentioned, Owen wrote: *A History of British Fossil Mammals and Birds* (1846); *The Archetype and Homologies of the Vertebrate Skeleton* (1848); *Comparative Anatomy and Physiology of Vertebrates*, 3 vol. (1866–68); *Monograph of the Fossil Mammalia of the Mesozoic Formations* (1871); *Antiquity of Man as Deduced From the Discovery of a Human Skeleton* (1884); and *Catalogue of the Fossil Reptilia of South Africa* (1876).

See R. S. Owen, *The Life of Richard Owen* (1894). (G. DE B.)

OWEN, ROBERT (1771–1858), British reformer and socialist, was born at Newtown, Montgomeryshire, Wales, on May 14, 1771. He attended local schools until he reached the age of nine. When only 19 he became manager of a large cotton mill in Manchester. Soon he had made it one of the best establishments of the kind in Great Britain. In this factory Owen used the first American sea-island cotton ever imported into the country and made improvements in the quality of the cotton spun. On becoming manager and partner in the Chorlton Twist company at Manchester, Owen induced his partners to purchase the New Lanark mills. Encouraged by his great success in Manchester, he had already formed the intention of conducting New Lanark on higher principles than the current commercial ones.

Connected with the mills were about 2,000 people, 500 of whom were young children from the poorhouses and charities of Edinburgh and Glasgow. The children especially had been well treated by the former proprietor, but the general condition of the people was unsatisfactory. Crime and vice bred by demoralizing conditions were common; education and sanitation were alike neglected; and housing conditions were intolerable. Owen greatly improved their houses, and mainly by his personal influence trained them to habits of order, cleanliness and thrift. He opened a store, where the people could buy goods of the soundest quality at little more than cost price; and the sale of liquor was placed under the strictest supervision. His greatest success, however, was in the education of the young, to which he devoted special attention. In 1816 Owen opened at the New Lanark mills the first infant school in Great Britain and thereafter gave it close personal supervision.

In all these plans Owen obtained success. Though at first regarded with suspicion as a stranger, he soon won the confidence of his people. The mills continued to be a commercial success, but some of Owen's schemes involved considerable expense, which was displeasing to his partners. Tired at last of the restrictions imposed on him by men who wished to conduct the business on the ordinary lines, Owen formed a new firm, the members of which, content with 5% of return for their capital, were ready to give freer scope to his philanthropy (1813). In this firm Jeremy Bentham and the well-known Quaker William Allen were partners. In the same year Owen published *A New View of Society, or Essays on the Principle of the Formation of the Human Character*, in which he expounded the principles on which his system of educational philanthropy was based. From an early age he had lost all belief in the prevailing forms of religion and

had thought out a creed for himself, which he considered an entirely new and original discovery.

The chief points in Owen's philosophy were that man's character is formed by circumstances over which he has no control and that he is not a proper subject either of praise or blame. These convictions led Owen to the conclusion that the great secret in the right formation of man's character is to place him under the proper influences from his earliest years. The irresponsibility of man and of the effect of early influences are the keynote of Owen's whole system of education and social amelioration.

For the next few years Owen's work in New Lanark had a national and even European significance. New Lanark itself became a much frequented place of pilgrimage for social reformers, statesmen and royal personages. According to the unanimous testimony of all who visited it, the results achieved by Owen were singularly good. The children brought up on his system were graceful, genial and unconstrained; health, plenty and contentment prevailed; and the business was a commercial success. In 1815 Owen started, apparently single-handed, an agitation for factory reform, with little effect. His work as a practical reformer gave way in 1817 to the ideas—still vital—which made him the forerunner of socialism and co-operation. Owen pointed out that the competition of human labour with machinery was a permanent cause of distress, and that the only effective remedy was the united action of men and the subordination of machinery. His proposals for the treatment of pauperism were based on these principles. He recommended that communities of about 1,200 persons each be settled on quantities of land from 1,000 to 1,500 ac., all living in one large building in the form of a square, with public kitchen and messrooms. Each family should have its own private apartments, and the entire care of the children till the age of three, after which they should be brought up by the community, their parents having access to them at meals and all other proper times. These communities might be established by individuals, by parishes, by counties or by the state; in every case there should be supervision by duly qualified persons. Work and the enjoyment of its results should be in common. The size of his community was no doubt suggested by his village of New Lanark; and he soon advocated such a scheme for the reorganization of society in general. In its fully developed form it was as follows. He desired that communities of from 500 to 3,000, mainly agricultural and possessing the best machinery, and being, as far as possible, self-contained, "should increase in number, unions of them federatively united shall be formed in circles of tens, hundreds and thousands," till they should embrace the whole world in a common interest.

His plans for the cure of pauperism were received at first with considerable favour. But at a large meeting in London, Owen declared his hostility to the received forms of religion. After this act of defiance his theories became suspect to the ruling classes, though he did not lose all support from them. To carry out his plan of self-contained communities in 1825 he bought 30,000 ac. of land in Indiana in the United States from the Rappite religious community, and renamed it New Harmony (*q.v.*). For a time the community life was well ordered and contented under Owen's practical guidance, but differences about the form of government and religion soon appeared, and all the numerous attempts at reconstruction failed to compose them, though there is a consensus of testimony to the admirable spirit which prevailed amid all the dissensions. Owen withdrew from the community in 1828, having lost £40,000—four-fifths of his fortune. The other chief Owenite community experiments were at Queenwood, Hants (1839–45), in which Owen took part for three years, and Orbiston near Glasgow (1826–27) and Ralahine in Ireland (1831–33), with neither of which he was directly concerned.

In his Report to the County of Lanark (a body of landowners) in 1820, Owen declared definitely that not reforms but a transformation of the social order was required. The appeal of such a doctrine to the workers is obvious. From 1820 his proposals for communities attracted the younger workers, brought up under the factory system, and between 1820 and 1830 numerous societies were formed and papers started to advocate his views. The growth of labour unionism and the emergence of a working-class point of view caused Owen's doctrines to be accepted as the expression of the workers' aspirations. When he returned to England in 1829 he found himself regarded as their leader. In the unions Owenism stimulated the formation of self-governing workshops, and their need for a market led to the formation of the Equitable Labour exchange in 1832, applying the principle that labour is the source of all wealth. The unprecedented growth of labour unions made it seem possible that the separate industries and eventually all industry might be organized by these bodies. Owen and his followers carried out an ardent propaganda all over the country, with the result that the new National Operative Builders union turned itself into a guild to carry on the building industry, and the Grand National Consolidated Trades union was formed (1833–34). The enthusiasm and the numbers joining were remarkable, but the determined opposition of the employers and the severe repression by the government and law courts ended the movement in a few months. It was two generations before socialism, first popularly discussed at this time, again influenced unionism. Throughout these years Owen's community ideas maintained a hold; ultimately they provided the basis for the worldwide Consumers' Co-operative movement which sprang from the Rochdale Pioneers Co-operative society founded in 1822. (*See* Co-operatives.) After 1834 Owen devoted himself to preaching his educational, moral, rationalist and marriage reform ideas. At the age of 82, he became a spiritualist. He died on Nov. 17, 1858, at Newtown.

Of Owen's numerous works in exposition of his system, the most important are the *New View of Society;* the *Report* communicated to the Committee on the Poor Law; *The Report to the County of Lanark;* the *Book of the New Moral World;* and *Revolution in the Mind and Practice of the Human Race.*

Robert Owen's four sons all became U.S. citizens. The eldest, Robert Dale Owen (1801–1877), sat in congress (1844–47), and drafted the bill founding the Smithsonian institution. In the Indiana house of representatives, 1836–39 and 1851–52, and constitutional convention, 1850, he was instrumental in securing a married woman's property law, a common free school system, and more freedom in divorce. From 1853 to 1858 he was United States ambassador to Naples. He was a strong believer in spiritualism. *See* Socialism: *Owenism; see* also references under "Owen, Robert" in the Index.

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(X.; D. F. Dd.)

OWEN, WILFRED (1893–1918), British poet, whose angry pity at the cruelty and waste of war received tragic confirmation in his own death in action, was born at Oswestry, Shropshire, March 18, 1893, and educated at the Birkenhead institute. A delicate, dreamy boy, he did not go to a university, although he matriculated at London in 1910; after an illness in 1913, he lived in France. He had already begun to write and, while working as a tutor near Bordeaux, was preparing a book of "Minor Poems—in Minor keys—by a Minor" which was never published, however. These early poems are consciously modeled on Keats: often ambitious, they show keen enjoyment of poetry as a craft.

In 1915, Owen enlisted in the Artist's Rifles. His experience of trench warfare brought him to rapid maturity; the poems written after Jan. 1917 are full of anger at its brutality and an elegiac pity for "those who die as cattle," as well as of rare descriptive power. In June 1917 he was invalided home and while in a hospital near Edinburgh met Siegfried Sassoon, who shared his feelings about the war and who became interested in his work. Reading Sassoon's poems, and discussing his own work with him, revolutionized Owen's style and his conception of poetry. Despite plans to find him a staff job, he returned to France in Aug. 1918 as a company commander. He was awarded the military cross in October, and was killed a week before Armistice day, on Nov. 4, 1918.

Published posthumously by Sassoon, his single volume of *Poems* contains the most poignant English poetry of the war. W. B.

Yeats, in his introduction to the *Oxford Book of Modern Verse,* criticized war poets like Owen for identifying themselves too much with the unhappiness of their men. To many this identification seemed a source of true poetic strength rather than weakness. The fragmentary preface to the poems contains a maxim much meditated by the poets of the 1930s: "All a poet can do to-day is to warn. That is why the true poets must be truthful." Apart from their moving content, Owen's poems are of great interest as technical experiments in assonance.

See *Poems* (1920), enlarged edition (1931). (S. H. Sr.)

OWENSBORO, a city of northwestern Kentucky, U.S., 29 mi. S.E. of Evansville, Ind., on the Ohio river, is the seat of Daviess county. It is an important market for tobacco, corn, wheat, dairy products and livestock. Owensboro is also the centre of a gas and oil field. Manufactures include electrical tubes and lamps, chemicals, steel, whisky, furniture, cigars, toys and building materials.

In 1815, it was officially named Rossborough after David Ross, a local landowner. The site of the town had been known to Ohio boatmen as Yellow Banks, because of the colour of riverside clay deposits, even before the erection of the first cabin in 1799. It was incorporated as a town and renamed Owensborough in 1817 after Col. Abraham Owen (1769–1811), an Indian fighter killed at the battle of Tippecanoe. The name was later changed to Owensboro. It received a city charter in 1866; a council-manager form of government came into effect in 1954. During the American Civil War, Owensboro was the scene of several minor skirmishes in 1862 and the victim of a Confederate guerrilla raid in 1864. Owensboro is the seat of Brescia college (Roman Catholic, 1925) and Kentucky Wesleyan college (Methodist, 1858). For comparative population figures *see* table in Kentucky: *Population.* (J. C. Cr.)

OWL, the common name for usually nocturnal birds of prey that form the order Strigiformes. Although they bear some likeness to both hawks and eagles (order Falconiformes), and were once placed with them in the same order, they are not closely related.

Because of their nocturnal habits and their ominous hooting sounds, owls early became associated with the occult and the otherworldly. They became symbolic of intelligence because it was thought they presaged events. One species, the barn owl of Europe (*Tyto alba*), was looked upon as a bird of ill omen, and subsequently became a symbol of disgrace. In the middle ages the common little owl of Europe was used as a symbol of the "darkness" before the coming of Christ; by further extension it was used to symbolize the nonbelievers who dwelt in this "darkness."

Owls, unlike other birds of prey, have virtually noiseless flight; the butterflylike flapping of wings is muffled by downy-fringed plumage. These seemingly neckless birds vary in length from five inches in the North American elf owl (*Micrathene whitneyi*) to more than two feet in the European eagle owl (*Bubo bubo*). On each side of the base of the beak are several rows of small, curved, stiff-shafted feathers, which form a ruff to support the long feathers of the disc, or space around the eyes. The ear openings, hidden by bristlelike hairs, are large, with well-developed and often asymmetrical folds of skin, so that each ear may be shaped differently. Some species have hornlike tufts near the ears. Many species of owl show two phases of coloration—one in which the brown tends toward red, the other in which it tends toward gray. The outer toes of all owls are reversible. Unlike most birds, owls incubate from the laying of the first egg.

Owls are grouped in two families, Tytonidae, the barn owls or "monkey-faced" owls, so called from their heart-shaped facial discs and the absence of ear tufts, and Strigidae, the typical owls, many of which have conspicuous ear tufts. The Tytonidae comprises 11 species found all over the world except in the polar regions, New Zealand, Hawaii and some islands of the Malay archipelago. The Strigidae includes 123 species and is similarly worldwide in its range, except for a few oceanic islands and the south polar areas. One species, the snowy owl (*Nyctea scandiaca*), inhabits the northern circumpolar belt as far as northern Scandinavia, northern U.S.S.R., northern Alaska, Ellesmereland and northern Greenland, and wanders south during severe winters when food becomes scarce in the snow-covered lands.

Representative of the Tytonidae is the common barn owl (*Tyto alba*) widespread in tropical and temperate zones. It is about 18 in. long, with a white face, cinnamon-dappled white breast and buffy wings and back. A notable member of the Strigidae in America, Europe, Africa and Asia is the tawny owl (*Strix aluco*), a woodland bird that feeds largely on rats, mice, voles and shrews.

The eagle owl (*Bubo bubo*) ranges over most of Europe and Asia north of the Himalayas. The allied great horned owl (*B. virginianus*) extends over all North and South America from the northern limit of trees in the arctic to the Straits of Magellan but is absent in the West Indies. They are sombre-coloured birds and among the largest species. Equally large is the snowy owl, a circumpolar species with white plumage flecked with brown. In winter it migrates southward. The long- and short-eared owls (*Asio otus* and *A. flammeus*) are common to the northern parts of Europe and America. The short-eared owl, often seen abroad in the daytime, prefers open country. The long-eared owl is a woodland bird. Both possess erectile tufts on the side of the head. The burrowing owl (*Speotyto cunicularia*) of America lives in excavations, frequently sharing those of the prairie dog and vizcacha. The bird of the Greek goddess Athena is *Athene noctua,* the little owl of Europe, which was introduced into Great Britain, where it spread rapidly. *A. brama* replaces it in India. The American screech owl (*Otus asio*), in its numerous varieties, is found practically throughout North America except at the far north. It varies much in colour and size. It can be distinguished at night by its peculiar whistles, snarls and hisses.

W SUSCHITZKY

SNOWY OWL (NYCTEA SCANDIACA), OF ARCTIC REGIONS

Owls, as might be expected of nocturnal hunters, have very large eyes, which gather more light in dim nocturnal illumination, enabling these predators to see better in the dark. The orbs are directed forward, giving owls binocular vision; they are thus able to perceive the whereabouts of their prey in a three-dimensional manner. Their eyes absorb light to such an extent that most owls are quite uncomfortable in broad daylight. They become dazzled by bright light. Despite this fact there are some owls that are diurnal. The snowy owl sees very little darkness during the arctic summer when there is daylight for most of the 24-hour-day.

A few tropical African and Asian owls are fish eaters, such as *Scotopelia* and *Ketupa,* but most of these birds live on small mammals and small birds, which they kill after the manner of hawks. They usually tear the larger prey to pieces and then swallow the parts, fur, feathers and bones included. Smaller prey is often gulped down whole. A little later, after the prey has been digested, the bones, fur and feathers are coughed up in small pellets. Examination of these owl pellets has produced knowledge as to the feeding habits of the several species of owl. These data have shown clearly that owls are very beneficial to the agriculture of their areas, for while they consume large numbers of destructive or harmful rodents, they destroy few beneficial insect or weed-seed-eating birds.

JOHN MARKHAM

TAWNY OWL (STRIX ALUCO) OF OLD WORLD WOODS

See also Bird. (Ht. Fn.)

OWYHEE, a river draining portions of north-central Nevada, southwestern Idaho and southeastern Oregon. Rising in the mountains of Nevada, it flows northwesterly across the southwest corner of Idaho to the mouth of Jordan creek in Oregon where it swings north and empties into the Snake river near Adrian, Ore. Falling 3,500 ft. in 277 mi., it drains 11,340 sq.mi. of sagebrush-covered watershed. River flow is primarily from snow melt and annual runoff fluctuates widely. Key storage structure for irrigation of over 118,000 ac. of lower valley farmland is Owyhee dam, in Oregon, with a reservoir capacity of 1,120,000 ac.ft.

The name (an old form for Hawaii) derives from the disappearance of two Hawaiians who ran away from a fur trading party in the area in the early 1800s. (G. V. SK.)

OX, strictly speaking, the Saxon name for the males of domesticated cattle (*Bos taurus*), but in a zoological sense employed so as to include not only the extinct wild ox of Europe but likewise bovine animals of every description; that is to say, true oxen, bison and buffaloes. They typify the subfamily Bovinae, family Bovidae, in being large and heavy bodied and in having smooth horns usually in both sexes, placed well behind the eyes. For the systematic position of Bovidae, *see* ARTIODACTYL. For the typical oxen, as represented by the existing domesticated breeds, *see* CATTLE. *See* also references under "Ox" in the Index.

OXALIC ACID, the simplest dibasic organic acid, and one of the strongest organic acids. Industrially, it is widely used as an acid rinse in laundries, where it also is unusually effective in removing rust and ink stains since it forms a complex ferrioxalate ion with iron. Oxalic acid together with a small amount of added corrosion inhibitor is the chief constituent of the many automobile radiator scale removers. These two uses consume a large part of the oxalic acid of commerce. It is also employed as an electrolyte in the anodic oxidation of aluminum, as a bleaching agent for straw, cork and rosin, as a wash for anthracite coal which has been too long in storage and as a precipitant for rare earths. It is often used where an acid in solid, water-soluble, nonhygroscopic form is desired, as in printing of cloth, photography, etc. The sodium salt is used in pyrotechnics, as an antiflash agent in artillery ammunition and in chrome tanning to increase the amount of chromium taken up by the hide. The iron salt is used in the manufacture of blueprint paper, the tin and antimonyl salts in printing and dyeing. The laboratory applications of oxalic acid are discussed below.

The formula of oxalic acid is $(COOH)_2$, or, in its usual form of crystalline hydrate $(COOH)_2{\cdot}2H_2O$. Its occurrence in wood sorrel (*Oxalis acetosella*, hence the name) and in sour dock (*Rumex acetosa*) in the form of its potassium salt was known at the beginning of the 17th century. Carl W. Scheele in 1776 prepared the acid by oxidizing sugar with nitric acid and showed this acid to be identical with the one derived from sorrel. The existence of oxalates in nature is widespread in both plant and animal kingdoms.

There are four industrial methods for the manufacture of oxalic acid: (1) Synthetic sodium formate is heated to 360° C. in the presence of an alkali catalyst to yield hydrogen and sodium oxalate, from which oxalic acid is obtained. (2) Carbohydrates, such as sugar, starch or cellulose, are oxidized with concentrated nitric acid in the presence of a vanadium catalyst to give oxalic acid. The oxides of nitrogen are recovered and reoxidized. (3) Wood waste, such as sawdust, is treated with fused sodium hydroxide to give sodium oxalate. This process became obsolete at the end of the 19th century, but in 1942 a procedure for carrying out this reaction continuously, thereby lowering the cost, was described. (4) Fermentation of sugar solutions by molds was later developed.

Oxalic acid crystallizes from water as a dihydrate in monoclinic prisms melting at 101.5° C. Heated at 100° C. it readily loses its water of crystallization. The anhydrous acid begins to sublime below 100° C. and sublimes rapidly above 125° C. The anhydrous acid may be recrystallized from glacial acetic acid and melts at 189.5° C. It has been used as a condensing agent. When heated more strongly, oxalic acid decomposes into carbon dioxide, carbon monoxide and water. The decomposition to carbon dioxide and formic acid is an intermediate stage in this reaction. Dehydrating agents such as sulfuric acid accelerate the thermal decomposition of oxalic acid. Oxalic acid heated with glycerol at 100° C. gives formic acid and carbon dioxide. At higher temperatures allyl alcohol is formed. Electrolytic reduction of oxalic acid at lead or mercury cathodes yields glycolic acid. At low temperatures glyoxylic acid may be obtained as an intermediate stage. Permanganates in acid solution oxidize oxalic acid to carbon dioxide and water. The reaction is autocatalytic. It is of great importance in analytical chemistry. In the presence of uranyl salts, oxalic acid undergoes photochemical decomposition. This reaction has found application in actinometry. Oxalic acid may be characterized by the following spot test: a fragment, melted with a little diphenylamine in a micro test tube, is heated over a free flame. The melt is then dissolved in a drop of alcohol. Formation of aniline blue shows the presence of an oxalate. Deutero-oxalic acid and its deuterate have been prepared and studied.

Oxalic acid is poisonous. The antidotes for oxalic acid poisoning are milk of lime, chalk, whiting or even wall plaster, followed by evacuation brought about by an enema or castor oil. Only the salts of the alkali metals are soluble in water. Besides the ordinary acid and neutral salts, a series of salts called tetraoxalates is known, these being salts containing one molecule of acid salt, in combination with one molecule of acid; one of the most common is "salt of sorrel," $KHC_2O_4{\cdot}H_2C_2O_4{\cdot}2H_2O$. The oxalates are readily decomposed when heated, leaving a residue of carbonate or oxide of the metal. The silver salt decomposes with explosive violence, leaving a residue of the metal.

Ethyl oxalate $(CO{\cdot}OC_2H_5)_2$, prepared by boiling anhydrous oxalic acid with absolute alcohol, is a colourless liquid which boils at 186° C. Methyl oxalate $(CO{\cdot}OCH_3)_2$, which is prepared in a similar manner, is a solid melting at 54° C. It is used in the preparation of pure methyl alcohol. Oxalyl chloride, a liquid boiling at 64° C. (melting point −12° C.), has been obtained by the action of phosphorus pentachloride on anhydrous oxalic acid. Oxamic acid, $HO_2C{\cdot}CONH_2$, is obtained by heating acid ammonium oxalate or by boiling oxamide with ammonia; it is among the products produced when amino acids are oxidized with potassium permanganate. It is a crystalline powder sparingly soluble in water and melting at 210° C. (with decomposition). Its ethyl ester, known as oxamethane, crystallizes in rhombic plates which melt at 114°–115° C. Oxamide $(CONH_2)_2$ is best prepared by the action of ammonia on the esters of oxalic acid. It is also obtained by the action of hydrogen peroxide on hydrocyanic acid, or of manganese dioxide and sulfuric acid on potassium cyanide. It is a white crystalline powder which is almost insoluble in cold water. When heated with phosphorus pentoxide it yields cyanogen. It is readily hydrolyzed by hot solutions of the caustic alkalies. Substituted oxamides are produced by the action of primary amines on ethyl oxalate.

OXALIS, a large genus of small herbaceous plants, comprising, with a few small allied genera, the family Oxalidaceae; except for a few South American species that provide edible tubers or roots, the genus is known for those forms cultivated as ornamentals indoors and in the garden. The name is derived from the Greek *oxalis* ("acid"), the plants being highly acid to the taste. The genus contains about 800 species, chiefly south African and tropical and South American. It is represented in eastern North America and Great Britain by the common wood sorrel (*O. acetosella*), a small, stemless plant with cloverlike three-parted leaves growing from a creeping, scaly rootstock, and the flowers borne singly on an axillary stalk. The flowers have five white, purple-veined, petals. The fruit is a capsule, splitting by valves, the seeds have a fleshy coat, which curls back elastically, ejecting the true seed. The leaflets, as in other species of the genus, fold back and droop at night.

JOHN H. GERARD

VIOLET WOOD SORREL (OXALIS VIOLACEA)

Besides the wood sorrel, about 20 other species occur in North America, among which are the yellow wood sorrel (*O. stricta*), of the eastern United States and Canada, with yellow flowers; the violet wood sorrel (*O. violacea*), of the eastern United States, with rose-purple flowers; the redwood wood sorrel (*O. oregana*), of the coast redwood belt from California to Oregon, with pink to white flowers; and *O. cernua,* known as Bermuda buttercups, with showy yellow flowers, native to south Africa and naturalized in Florida and the Bermudas. Another yellow-flowered kind is the weedy, creeping oxalis (*O. corniculata*). Both *O. stricta* and *O. corniculata* are widely naturalized in the old world. *O. tuberosa,* the oca of South America, is a tuberous-rooted half-hardy perennial, native of Peru; its small, slightly acid tubers are edible only after having been mellowed in the sun for 6–10 days. *O. deppei,* a bulbous perennial of Mexico, has scaly bulbs, from which are produced fleshy, tapering, white, semitransparent, edible roots, about four inches in length and three to four inches in diameter.

OXENSTIERNA (Oxenstjerna), **AXEL GUSTAFSSON,** Count (1583–1654), Swedish statesman, chancellor for 42 years and one of his country's greatest public servants, was born near Uppsala on June 16, 1583, of a noble family which had played a considerable part in Sweden's history. After education at Rostock and other German universities he was in 1605 appointed to a post in the exchequer; in June 1609, at the early age of 24, he was made a member of the council of state. He soon established an ascendancy in that body, and on the death of Charles IX in 1611 it was he who extorted from the new king, Gustavus II Adolphus (*q.v.*), a charter guaranteeing the nation against the abuses which had latterly prevailed. One of Gustavus' first acts was to appoint Oxenstierna chancellor (Jan. 1612).

Oxenstierna had emerged as the champion of the aristocracy against the violence of the monarchy; and the charter might well have initiated a constitutional struggle if strong ties of respect and affection had not soon developed between king and chancellor. They became, indeed, ideal collaborators and share the credit for the achievements of the reign. Oxenstierna's contributions were in the spheres of administrative reform and diplomacy. He drafted the *Riksdagsordning* of 1617, which stabilized the constitution of the diet; he drew up the ordinance of 1619 on the development of the towns; he carried through a reform in local government in 1623; and he issued a chancery ordinance in 1626 which organized the business of that office. He was mainly responsible for the building of the house of the nobility in Stockholm, and for the *Riddarhusordning* (1626), which divided the nobility into three classes and specified the members of each. As a diplomat he was entrusted with a long succession of major negotiations: the peace of Knäred (with Denmark, 1613), the truce of Ogra (with Poland, 1622), the negotiations with Denmark at Sjöaryd (1624). When Gustavus transferred his war against Poland to Prussia in 1626, Oxenstierna was brought over and installed as governor general, and it was he who negotiated the advantageous truce of Altmark with Poland in 1629. In Nov. 1631 the king called him to Germany. (*See* Thirty Years' War.)

Oxenstierna had been more reluctant than his master to intervene in Germany and would probably have preferred, in the first instance, a final settlement with Denmark—always, in his view, Sweden's main enemy. Moreover he disliked the French alliance; considered that Gustavus made a capital error in not marching on Vienna after the battle of Breitenfeld; disapproved the king's candidature for the Polish throne in 1632; and tacitly opposed the project for marrying Christina (*q.v.*) to the electoral prince of Brandenburg, Frederick William. His removal to Germany placed the main burden of Swedish diplomacy again on his shoulders; but the king also now entrusted him with military commands, such as the formation and leadership of the army which relieved Gustavus at Nürnberg in Aug. 1632.

The death of Gustavus, in Nov. 1632, put the supreme direction of the Swedish cause in Germany into Oxenstierna's hands. Preserving to himself much of the king's authority and prestige, he negotiated with electors as an equal; and the project of making him elector of Mainz was canvassed. In the League of Heilbronn (1633) he created a *corpus evangelicorum* of the kind that Gustavus had planned, with himself as its director; but he never managed to persuade the North German princes to join it. The disaster at Nördlingen (1634) destroyed his hopes of keeping Sweden's allies loyal, and many of them made peace at Prague in 1635. In the same year the renewal of the truce with Poland was purchased (to Oxenstierna's indignation) only by sacrificing the tolls which the Swedes had been levying in the Prussian harbours from 1627. Faced with overwhelming difficulties, he was for a time the virtual prisoner of his mutinous unpaid soldiery. He hesitated long between buying a peace on the best terms that he could get, and accepting a French alliance and indefinite continuation of the war: it was not until 1638 that the Holy Roman emperor Ferdinand III's intransigence forced him to the second alternative. Thenceforward he was the strongest advocate of fighting on until peace could be had on really favourable terms. Political enemies at home accused him of prolonging the war for his own ends; but the terms obtained by Sweden under the peace of Westphalia in 1648 justified his obstinacy. Meanwhile, he had launched the sudden attack on Denmark in 1643: the morality of it was dubious, but at Brömsebro in 1645 he could dictate a peace which wiped out the humiliations suffered at Knäred in 1613.

As chancellor, Oxenstierna was one of the five regents who were to govern Sweden during Christina's minority; and it was he who drew up (probably with Gustavus' approval) the *Form of Government* accepted by the diet in 1634. It was not until his return to Sweden in 1636 that he participated in the regency's government; but for the next eight years or so he was the real ruler of the country. His relations with the queen, after she attained her majority (1644), were never as cordial as with her father: she saw in him the leader of an aristocracy anxious to limit the crown's powers and perhaps even to set up a republic. Others disliked him as the defender of noble privileges and noble encroachments on the liberties of the peasantry, though he repeatedly urged moderation on his colleagues in this regard. He had to face the intrigues of a hostile party at court; and he clashed with Christina on foreign policy, on the question of the succession and on her proposal to abdicate.

After 1650, however, relations improved, and he was as firmly established in office as at any time in his career when he died, in Stockholm, on Aug. 28, 1654.

Sagacious, imperturbable, courageous and industrious, copious in speech and writing, unhurried in negotiation and not without a pungent humour, Oxenstierna felt the service of the state to be equally congenial and obligatory. His single-minded patriotism transcended the interests of his class—though he never forgot them. Publication of his correspondence began in 1888.

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OXENSTIERNA (Oxenstjerna), **BENGT GABRIELSSON,** Count (1623–1702), Swedish statesman chiefly important for his reorientation of foreign policy, was born at Morby castle on July 16, 1623, the son of a first cousin of the great Axel Oxenstierna. He began his career as a diplomat in 1647, took part in the congress at Osnabrück for the peace of Westphalia and in the congress at Nürnberg for the execution of the treaty, and was entrusted with a mission to Vienna before being appointed president (1653) of the tribunal at Wismar, one of Sweden's German acquisitions. A councilor of state from 1654, he was summoned to join Charles X Gustavus (*q.v.*) on the opening of the war against Poland in 1655, distinguished himself militarily in the defense of Torun (1658) and, as Swedish representative in the peace negotiations (1659–60), was instrumental in achieving the satisfactory treaty of Oliva.

After being governor general of Livonia (1662–66), he returned to Wismar and began also to act as permanent Swedish minister in Germany. Having served in the Stockholm chancellery from 1671 to 1673, he went again to Germany and was ambassador to Vienna in 1674. He was Sweden's negotiator at Nijmegen from 1676 to 1679.

In 1680 Oxenstierna was appointed head of the chancellery

board in succession to Johan Gyllenstierna; from 1685 he had the title president of the chancellery. Virtually in control of foreign affairs, he reversed the policy of alliance with France that had prevailed since the 1630s. Seeking a rapprochement with Great Britain, Holland and the Holy Roman emperor, he concluded the treaty of the The Hague with the Dutch in 1681 (to guarantee the settlement of 1648) and pursued the new line even when Sweden's interests conflicted with those of the maritime powers. The acceptance of Swedish mediation for the peace of Rijswijk in 1697 was an important success for him. Mistrusting Denmark, he favoured alliance with Holstein-Gottorp. (*See* RIJSWIJK, TREATIES OF.)

A member of the regency for Charles XII (*q.v.*) in 1697, Oxenstierna was opposed by his more francophile colleagues in it. His influence declined and from the outbreak of the Northern War (1700) Charles XII took his decisions in the field, bypassing the chancellery and perhaps resenting Oxenstierna's failure to predict the alliance of Denmark, Russia and Saxony against Sweden. Oxenstierna died in Stockholm on July 12, 1702.

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(N. G. R.)

OXENSTIERNA, JOHAN GABRIEL, COUNT (1750–1818), Swedish poet, diplomat and civil servant whose writings reflect the classical tendencies of the Gustavian period in Swedish literature, was born at Skenäs, Södermanland, the family seat and the "Eden" of his poetry, on July 19, 1750. He studied at Uppsala and entered the diplomatic service, being secretary at the embassy in Vienna from 1770 to 1774. In 1786 he was appointed head of the government offices by Gustavus III and became a founder member of the Swedish academy. From 1789 to 1801 he held various offices at court. He died at Stockholm on July 29, 1818.

Oxenstierna knew much of Virgil by heart and took him as his model in his descriptive nature poems. His best poems were written as a young man, but he revised them extensively before publication. The final form of his most important work, *Skördarne* ("Harvests"), first written in 1773, had grown from three cantos to nine by the time it was published in 1796. It thus illustrates the development of his style, from rococo to empire, and reflects the experiences of a lifetime. The original version was first published in 1957. His underlying melancholy is shown especially in his elegiac poem *Netten* ("The Night," 1785).

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(S. E.)

OXFORD, EARLS OF, an English title held by the De Vere, Harley and Asquith families. The earldom was first created for AUBREY III DE VERE (*c.* 1110–1194) by the empress Matilda in 1142 and was later recognized by King Stephen. The three most important De Vere earls are noticed separately. On the death of AUBREY (1627–1703), 20th earl, the title lapsed. ROBERT HARLEY (1661–1724; *see* OXFORD, ROBERT HARLEY, 1st Earl of) assumed the title in 1711 but contemporary objections to his assumption of the ancient earldom, and doubts about the existence of a possible heir male, led him to take the modified title of earl of Oxford and Mortimer. EDWARD (1689–1741), 2nd Harley earl of Oxford, increased his father's collection of books and manuscripts, part of which was sold by auction in March 1742 and another part of which was sold to the nation for £10,000 by his widow in 1753. The Harleian manuscripts formed an important part of the later British museum collection.

The title lapsed again on the death of ALFRED (1809–1853), 6th earl, but was revived in 1925 for H. H. ASQUITH (1852–1928; *see* OXFORD AND ASQUITH, HERBERT HENRY ASQUITH, 1st Earl of), the Liberal prime minister, who, to avoid objections from both De Vere and Harley descendants, took the title of Oxford and Asquith. JULIAN (1916–), 2nd earl, succeeded to the title in 1928.

OXFORD, EDWARD DE VERE, 17TH EARL OF, in the Vere line (1550–1604), a lyric poet and dramatist, considered by some to have been the author of Shakespeare's works. He was born on April 12, 1550, at Castle Hedingham, Essex, and studied at Cambridge. Succeeding to the earldom as a minor in 1562, he lived for eight years as a royal ward under the care of William Cecil (later Lord Burghley), and in Dec. 1571 married Burghley's daughter, Ann Cecil. He visited the Netherlands in 1574 and France and Italy in 1575–76. On his return he became estranged from his wife and Burghley until 1582. In 1579 he quarreled with Sir Philip Sidney, who challenged him and fell into disgrace for refusing to apologize, as Elizabeth I commanded. In 1581 Oxford himself fell into disgrace, but was restored to favour in 1583. By then his financial position had become very straitened, perhaps chiefly through his lack of financial sense. His younger children were provided for by Burghley, with whom he remained friendly even after Ann's death (June 1588) and his own remarriage in 1591 or 1592. In 1586 the queen granted him an annuity of £1,000. He died at Newington, Middlesex, on June 24, 1604.

He was never appointed to any important office or command, though he was named on the commissions for the trials of Mary, queen of Scots (1586), the earl of Arundel (1589) and the earls of Essex and Southampton (1601); and was said to have been made a privy councilor by James I. It has therefore been suggested that the annuity may have been granted for his services in maintaining the company of actors which he had taken over from the earl of Warwick in 1580; and that the obscurity of his later life is to be explained by his immersion in literary pursuits. He was indeed a notable patron of writers. He employed John Lyly, the author of *Euphues*, as his secretary for many years. Along with Francis Bacon, Christopher Marlowe, the 5th earl of Rutland, the 6th earl of Derby and others, Oxford has been seen as the putative author of Shakespeare's works (*see* SHAKESPEARE, WILLIAM).

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OXFORD, JOHN DE VERE, 13TH EARL OF (1442–1513), a prominent supporter first of the Lancastrian cause in the Wars of the Roses, and then of the Tudors. He was the second son of John (?1408–62), 12th earl, who with his eldest son Aubrey was executed in 1462 for Lancastrian conspiracy. The younger John de Vere was restored as 13th earl in 1464, but in 1468 he was suspected of plotting with the Lancastrians and was thrown into the Tower of London. He was released before Jan. 1469, probably owing to Richard, earl of Warwick's influence; he certainly accompanied Warwick when he fled to France in 1470 and, returning with him to restore Henry VI, was made constable of England. At Barnet (April 14, 1471), he led the van of Warwick's force and although personally successful at first, he was involved in the general rout and again had to flee to France. In 1473 he organized a Lancastrian expedition which seized St. Michael's mount in Cornwall. After a siege of four and a half months he surrendered and was imprisoned at Hammes near Calais. Thence he escaped, probably in Aug. 1484, and joined Henry Tudor, returning to England with him in 1485 to command the right wing at the battle of Bosworth Field. For this service he was restored to his title and estates and made chamberlain and admiral of England. He led the van of the royal army at Stoke in 1487, commanded an expedition to Flanders in 1492, and defeated the Cornish rebels at Blackheath in 1497. He was high steward for the trial of Edward, earl of Warwick, in 1499. He died on March 10, 1513. (A. R. M.)

OXFORD, ROBERT DE VERE, 9TH EARL OF (1362–1392), English courtier and leader of Richard II's supporters until 1387, was the only son of Thomas, the 8th earl and Maud de Ufford, a descendant of Henry III. Robert succeeded his father in 1371 and in 1378 married Philippa de Coucy, daughter of his guardian, the earl of Bedford, a son-in-law of Edward III. Already great chamberlain of England, he was made privy councilor and knight of the Garter by Richard II. Constantly in the young king's company, he was given large grants of estates and castles and was created marquess of Dublin in 1385 (the first use of this title in England) and duke of Ireland in 1386. His elevation caused much resentment especially among the older nobility and

the king's more ambitious uncles such as Thomas of Woodstock, duke of Gloucester. His reputation was not enhanced by his role in the Scottish expedition (1385), which was a fiasco, and by his divorce (1387) and marriage to the Bohemian Agnes Lancecrona. Although he was appointed chief governor of Ireland from Dec. 1385 to 1387, he remained in England.

In the 1380s he was constantly under attack by the nobility and commons for leading the king astray, but there is no evidence that his influence was vicious; he merely lacked ability and judgment, which, in the circumstances of the day, was disastrous. Oxford witnessed Richard II's questions to the judges in 1387 and was appealled by Gloucester and his supporters on Nov. 17. Fleeing to the northwest to gather supporters for the king, he was routed on his return at Radcot bridge in Oxfordshire (Dec. 19). Oxford escaped in disguise to the Netherlands and died at Louvain in 1392. Oxford's defeat brought disaster to the king's party; Richard had to submit to the "merciless parliament" and the lords appellant who dominated England for two years.

See M. McKisack, *The Fourteenth Century, 1307–1399* (1959).

OXFORD, ROBERT HARLEY, 1st Earl of (1661–1724), English statesman prominent in Queen Anne's reign. He was born in London on Dec. 5, 1661, the eldest son of Sir Edward Harley (1624–1700), a Herefordshire landowner, who opposed legislation against Nonconformists in the parliaments of Charles II. Bred in an atmosphere of political and religious opposition to the established order, Harley eventually changed his political connections, but never abandoned his early Presbyterian piety. In 1688 he and his father occupied Worcester in the interest of William III. Harley was made sheriff of Herefordshire in 1689, entered parliament for Tregony, 1689–90, and sat for New Radnor, 1690–1711.

Harley owed much of his electoral influence to political and marriage connections with the Foley family, which was deeply rooted in Staffordshire, Herefordshire and Worcestershire. In parliament he combined with Paul Foley to maintain the "country" traditions of the Harleys, directing his group of 10 to 20 members in attacks on the weight and misapplications of taxes, the influence in parliament of placemen (persons holding office under the crown), the suspension of habeas corpus, the ruin of trade, and demanding that privy councilors sign any advice given to the king and so make it possible that they could be impeached successfully. By 1693 Harley and his father were recognized as leaders of the new country party, and in 1694 he introduced the triennial bill.

Unable to stem this combined opposition of Whigs and Tories, the Danby ministry (*see* Leeds, Thomas Osborne, 1st Duke of) was gradually supplanted by the Whig junto. The Foley-Harley group, despite its former Whig connections, was no longer amenable to court measures and in 1695, supported by a solid Worcestershire and Herefordshire vote, carried Foley's election as speaker against the government candidate. Its influence was again underlined in 1696 when Harley and Foley headed the ballot for the powerful commission of accounts, and it was Harley who by family background was fitted to establish links with the Tories. Until the fall of the junto in 1698 Harley continued in constant opposition; with Foley he promoted the Land Bank act in 1696 and, after the peace of Rijswijk (1697), carried reductions in the army in 1697 and 1698.

Much remains obscure about the years 1698 to 1702, which saw Harley converted from a country to a court politician. But his maneuvers were not without consistency, for to him as to his later colleague Henry St. John (afterward earl of Bolingbroke) the Revolution seemed final. To defend this settlement he sought to wean the country Tories from their high-flying leaders, and also to thwart what he regarded as the king's campaign against the ancient constitution. His great victory in this struggle came in 1700 with the passing of the forfeitures bill. The government was compelled to seek support from Harley's opposition in the summer of 1700, and he was elected speaker in 1701 as a ministerial candidate. The deaths of Foley (1699) and Sir Edward Harley (1700) further weakened his ties with the opposition. Nevertheless the constitutional clauses of the Act of Settlement (1701) which he helped to carry embodied the doctrines he had always proclaimed.

From 1702 the policies of Anne (*q.v.*) proved decisive for Harley and his political following. The central core of Anne's government till 1708 consisted of John Churchill, duke of Marlborough, and Sidney, earl of Godolphin, court politicians both, and Harley, a leader of the country party and master of parliamentary procedure who was still determined to keep royal government free from the party managers whether Whig or high church. On these three the conduct of the War of the Spanish Succession (*q.v.*) in the field, in finance and in the lobby, largely depended, and of the three, Harley became the favourite with Anne, herself resolved to avoid the shackles of party. The high Tories expected to come into their own in the new reign but had to accept the triumvirate of nonparty men in influential places; finding that the three usually settled important business together, that the main war effort was to be on the continent, and that centre politics triumphed in the government even against the project of an occasional conformity bill, they resigned, and met disaster in opposing the ministry at the election of 1705. Harley meanwhile had become northern secretary of state (1704) and turned the influence of the Whig, John Holles, 1st duke of Newcastle, and the propaganda of Daniel Defoe to electoral profit.

Soon after the election, however, friction developed between Harley and Godolphin. The latter had been an especial butt of Tory propaganda, and now looked for protection from the Whig junto; moreover, since the court party was in a minority, he argued that support must come from one of the party corps, that is, in the circumstances, from the Whig junto. Knowing that the queen supported his traditional policy, Harley replied that the known determination of the queen to remain above party would rally sufficient support for the government from court and independent country members, for the party corps were also minority groups. Godolphin and Marlborough had now come to distrust both Harley's intrigues in the house, and his success in displacing the duchess of Marlborough in Anne's affections by his cousin, Abigail Masham (*q.v.*), and, defeated on a war issue by Tory votes, they insisted on the resignation of Harley and his friends in Feb. 1708. Harley, already widely distrusted as an intriguer, was thrust into an alliance with the Tories, evidenced by his willingness to support William Bromley for the speakership. His policy now was to rely on the queen's favour, and to exploit her detestation of the new ministers forced on her, the animosities of the ministers among themselves and their blunders in domestic and foreign affairs.

In 1710 Anne restored Harley to office as chancellor of the exchequer at the head of another coalition. Although he secured a great majority at the general election his new ministry was more radically Tory than Harley wished. He now reached the peak of his career, and after surviving a murderous assault by the marquis de Guiscard, a French spy who had been arrested and was being interrogated at a privy council meeting, was created earl of Oxford and made lord treasurer and knight of the Garter in 1711. By funding the most pressing portion of the national debt in the South Sea company stock (1711), and by securing a reasonable peace at Utrecht (1713), Oxford dealt with two crucial issues, but was now threatened by the intrigues of his protégé and colleague, Bolingbroke. Avid for power, Bolingbroke, like Godolphin earlier, could argue the need for an alliance with a party, and the Schism act (1714), abolishing the Dissenting academies in one of which Oxford himself had been educated, was his pledge to the Tory highfliers. The struggle between them became the more desperate, for both had been discountenanced by George, the Hanoverian heir to the throne, for making peace at Utrecht; both engaged in treasonable correspondence with James, the Old Pretender, with whom the relations of both were shattered by his refusal to change or dissemble his religion, finally announced in March 1714. Oxford, now preoccupied with nepotism, was in physical and mental decline, but Anne stubbornly kept him in office till July 27, 1714, five days before her death.

Permanently exiled from power by the Hanoverian succession, Oxford was imprisoned in 1715; an impeachment, among the managers of which was his Herefordshire enemy Lord Coningsby, collapsed in 1717 because of differences between the two houses and

within the Whig party itself, but Oxford played no further part of importance in parliamentary politics or Jacobite conspiracy. He died in London on May 21, 1724.

Oxford formed a great library and collection of manuscripts, both of which were enlarged by the second earl. In 1753 the manuscripts were bought by the nation to form the Harleian collection in the British museum.

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OXFORD, the county town of Oxfordshire, Eng., a county and parliamentary borough, a cathedral city and seat of a university, is 57 mi. W.N.W. of London by road. Pop. (1961) 106,124, including nearly 9,000 university students.

The ancient city of Oxford was wholly confined, except northward, by the rivers Thames (known in Oxford as the Isis) and Cherwell and its shape was dictated by the need for bridging these waterways at the easiest points. The Cherwell flows from the north to join the Thames, which comes from the northwest, just south of the old city. The earliest bridge, Magdalen bridge, was built over the Cherwell in the 11th century where the gravels on either side of the river are nearest to one another, the river banks being generally marshy and liable to flood. In the 12th century a causeway called Grandpont was built entering the city from the south and crossing the Thames at Grandpont (now called Folly) bridge. This road follows a gravel terrace between the two rivers and branches north of Carfax (Lat. *quadrifurcus* = with four forks; *cf.* Fr. *carrefour*), which was at the centre of the medieval walled city, one branch going to Woodstock and one to Banbury. Carfax is the meeting point of Cornmarket street from the north, St. Aldate's from the south, High street from the east and Queen street from the west. In the 16th century the Botley causeway from the west was built, crossing the seven channels of the Thames at Osney, Hythe and other bridges. The northward expansion of the city has followed the Woodstock and Banbury roads, and Summertown (now completely suburban) and Wolvercote (still a village) are now part of Oxford. The earliest outward sprawl, however, was east of Magdalen bridge toward the villages of Headington, Cowley and Iffley, all now engulfed. Development has also spread west of the railway stations and Osney bridge on to the slopes of Hinksey hill. The 20th-century growth of industry and population have posed traffic problems which by the mid-1960s were still unsolved—a new road to relieve the High street of local traffic was agreed to be necessary but its route was still a subject of controversy. Much relief has meanwhile been given by bypasses for through traffic.

Oxford is known as the "City of Spires" because of the beautiful skyline of its Gothic towers and spires as seen from any of the nearby hills. The old university and college buildings are almost all east of the main north-south road (St. Giles-Cornmarket-Carfax-St. Aldate's), in the High, the Broad, the Turl, Merton streets, etc. The buildings were mostly put up in the 15th, 16th and 17th centuries. Each college is built around two or three quadrangles, with a chapel, hall, library, and walled gardens—some of which, such as those of St. John's and Wadham, are particularly beautiful. Christ Church, whose chapel is now the cathedral and whose Tom Quad is the biggest college quadrangle, lies farthest south and the Christ Church meadows run down to where the Cherwell joins the Isis. Tom tower, built by Sir Christopher Wren in 1682 over the main entrance (Wolsey's gateway), houses "Great Tom," the seven-ton bell that sounds 101 strokes (one for each member of the foundation) each evening at 9:05. St. Mary the Virgin, the university church, is in the High street and has a 13th–14th-century tower and spire and curious twisted pillars (1637) in the porch. North of High street, between it and Broad street, are the Bodleian library and Divinity school, the Radcliffe camera, the Sheldonian theatre designed by Sir Christopher Wren, and the Old Ashmolean building (now the Museum of the History of Science). The Ashmolean museum is at the corner of St. Giles and Beaumont streets. In the northeast of Oxford are the parks, with the University museum (now largely a laboratory), the Pitt-Rivers Anthropological museum and the science buildings; Rhodes house, founded in 1929 as a meeting place for Rhodes scholars and a library of imperial history; and Keble college.

History.—Oxford first appears in history when Edward the Elder in A.D. 912 "held Lundenbryg (London) and Oxnaford (Oxonia in its latinized form) and all the lands that were pertaining thereto." It became one of the trading centres of the upper Thames district. It was attacked by the Danes during the 10th and 11th centuries and "councils" or "national assemblies" were held there in 1036 and 1065. The first Norman governor was Robert D'Oili, who built the castle and the earliest bridges (Magdalen, Folly and Hythe). Of the castle only the Mound, which once bore the keep, and the crypt and tower of the church of St. George-in-the-Castle survive, now being part of the prison.

The first parish church, which survived until the 19th century, was St. Martin's. Only its tower, known as Carfax tower, remains, the rest having been demolished in 1896 to widen the area around Carfax. Other churches surviving from Norman times are St. Michael's at the North gate, the Saxon tower of which was part of the defenses of the North gate, later to become famous as Bocardo, the university prison, where bishops Latimer, Ridley and Cranmer were confined before being martyred; St. Peter-in-the-East; St. Mary the Virgin; St. Mary Magdalen; and St. Ebbe's.

Portions of the medieval walls (13th century) can be seen in New college and on the north side of Christ Church meadow and elsewhere. They enclosed an area of about 95 ac. The wool fair and strangers' market were outside the North gate and had, about 1200, their own church of St. Giles. The merchant class originally brought prosperity to Oxford and assumed control of municipal affairs. Probably before the Domesday Book the burgess and the guild merchant became identical. In 1199 the guild merchant bought the feefarm of the city from the king for 200 marks down and an annual payment of £63 0*s*. 5*d*., which continued to be paid until 1787.

The medieval city differed in no way from any other provincial market town with great abbeys in its neighbourhood, but in the second half of the 12th century the university began and in the following century the first colleges were built (*see* OXFORD UNIVERSITY). Though parliaments were still often held in Oxford in the 13th century, the growth of the university restricted normal development and by 1248 it had become necessary to define the liberties of the university in relation to the city. This was done by a charter which in consequence of increasing tension between the citizens and the scholars was revised from time to time, and always in favour of the university, notably after the "town and gown" riots of St. Scholastica's day in 1355. (The annual penance at St. Mary's required from the city was not waived until 1825.)

Oxford remained a market town but it declined economically from the 13th to the 16th century, and its history became the history of the university which by the mid-14th century had usurped, or at least acquired, control. Its "privileged persons" operated in the city without having to be freemen, side-stepping the established jurisdiction of the guild merchant. In 1348, for instance, the university "incorporated" barbers and in 1480, cooks. These privileged persons were exempt from local taxation and in other ways formed a community in competition with the freemen. Friction naturally resulted and whenever there was a trial of strength the central government favoured the university. Nevertheless, the city developed a civic consciousness and by the 16th century had evolved a hierarchy of officials. In 1605 a charter, granted by James I, made Oxford a free city on condition of its not using its freedom to prejudice the university's privileges and liberties.

In the English Civil War its strategic importance made Oxford the royalist headquarters, to which the king retired after his defeats at Edgehill, Newbury and Naseby. In May 1646, when all other strongholds were lost and Charles himself had escaped in disguise, Lord Fairfax besieged the city, which finally surrendered on June 24. Though Charles II held a parliament there in 1681, the city as such passed out of national politics after the Civil War,

BY COURTESY OF BRITISH TRAVEL ASSOCIATION PHOTO

HIGH STREET, THE MAIN THOROUGHFARE, OXFORD. IN THE CENTRE RISES THE SPIRE OF ST. MARY'S, THE "UNIVERSITY CHURCH"

though the university maintained its status as a national institution by getting at cross-purposes with the restored Stuarts.

In 1771 deplorable sanitary conditions and other inconveniences in the city called for drastic remedies: the first of five Oxford Mileway acts was passed. This provided for widening and rebuilding bridges and streets, removed the market from the streets and empowered colleges to dispose of land within the city. Commissioners were appointed by the university and by the city. In the same year a Poor Law act established one of the earliest boards of guardians, with a workhouse on the site of Wellington square, but exempted all university and college property from payment of the poor rate. This exemption ended in 1854 but the university and colleges were compensated by the right of appointing 11 guardians, the city council and the parishes also electing 11 each.

In 1835 the Municipal Corporations act, based on the report of the Royal commission, repealed all the existing charters and substituted a democratically elected council for the close corporation of co-opted freemen. The act reserved to the university its part in the government of the city; but the chief authority for local government continued to be the Mileways commissioners whose position was preserved by the Public Health act, 1848. The Oxford order of 1889 constituted Oxford a county borough and vested all local government functions in the city council and the board of guardians. Oxford is now governed by a council of 68 members, 12 of whom are elected by the university. In 1955 the cordiality between the university and city was recognized by the mayor's being made an honorary doctor of civil law and the vice-chancellor an honorary freeman of the city. In 1962 the office of mayor was raised to that of lord mayor; and in 1964 proposals were made for reducing the number of university members of the city council.

Communications and Industry.—Oxford is more or less equidistant from the ports of London, Bristol and Southampton and from the industrial area around Birmingham. The Thames, which was navigable for barges from London only as far as Burcot, was the most important traffic route for heavy goods until the 18th century. When the river was obstructed, the price of commodities in Oxford used to rise. Traffic by road kept either to the gravel terraces stretching northward from the city to Woodstock and Banbury, or to the Oxford heights. Stagecoaches for passengers first ran between Oxford and London in 1667 or thereabouts and in the 19th century Oxford became an important stagecoach junction. The first revolutionary improvement in traffic routes for heavy merchandise was the development in the 18th century of the canals linking Oxford with the ports and with the Midlands. In 1835 the Great Western railway (G.W.R.) from London to Bristol was begun. The company intended it to pass through Oxford but the university resisted the proposal. The branch Great Western line to Oxford from Didcot was built in 1844, thus linking Oxford and London. The city airport at Kidlington is used only for charter services and by flying clubs.

In 1801 Oxford was still a small market town, with only 12,279 inhabitants, but by 1851 the population had more than doubled and the city was expanding northward. By 1901 there were nearly 50,000 people living in Oxford. By 1912 printing was already established and was the one big industry, although preserves (chiefly marmalade) were also being made and in that year the first Morris car was built at Cowley by William Morris (afterward Lord Nuffield). As the automobile and associated industries expanded so the population increased. In 1926 a pressed steel factory was built at Cowley. In 1929 the city's boundaries were extended on the east and north, taking in the new industrial quarter and increasing the area of the city from 4,719 ac. to 8,416 ac. and the population (1931) to 80,539. Oxford is now a great industrial city with heavy and electrical engineering largely connected with the motor vehicle industry; pressed steel works; the university's printing and publishing works; and factories for preserves and other goods. (D. V.)

OXFORD, PROVISIONS OF (1258). The Provisions of Oxford, which can be regarded as the first written constitution in English history, were formulated during the political crisis of 1258 when King Henry III (*q.v.*), bankrupted by the foolish project of making his younger son Edmund king of Sicily, and threatened with immediate papal excommunication, appealed to his barons for financial help. In return for their promise to induce the great council to grant him an aid, Henry swore to reform the state of the realm in accordance with the report of a royal commission of 24, chosen half by the king and half by the council. The report of this commission to the king and parliament at Oxford (*c.* June 10, 1258) is known as the Provisions of Oxford. Its foundation was the oath of the "community" of magnates to uphold the plan of reform, to act justly toward all men, and to treat as mortal enemies all who opposed the plan, a clause aimed primarily at Henry's Lusignan half brothers, who, although among Henry's nominees to the 24, resisted and were immediately exiled (July 1258). The Provisions laid down that Henry must govern solely on the advice of a privy council of 15, nominated by a subcommittee of four of the commission (two selected by each half from the other half); after deliberating in sworn secrecy, the subcommittee reported its nominations to the whole 24, who then included the names of the privy councilors in their report for parliament's approval. The council of 15 were to advise Henry on all matters, and to devise reforms necessary for the common good. All officials, from the justiciar, chancellor and treasurer down to the humblest local official, were placed under their authority: the great officers swore to obey king and council jointly (not Henry alone), never to infringe the Provisions, and to govern honestly and impartially for the public good. Appointed initially for one year only, they must render account at the year's end to king and council for their conduct in office. The sheriffs were to be of the knightly class and had to hold lands in the shires which they administered. They too were appointed for one year only and were to be paid adequate salaries. The council's future reform proposals were to be submitted for discussion and joint approval to parliaments meeting thrice yearly (Oct. 6, Feb. 3, June 1); and to ensure a quorum, 12 other magnates, chosen by the barons were designated to attend all three parliaments. The justiciar would redress all complaints against local officials reported by anyone to a special tribunal of four knights elected in each shire. As security for good faith Henry surrendered 21 royal castles to constables chosen by the commission of 24; these constables were responsible to king and council jointly and could not be dismissed without the council's consent. The provisions were to remain valid for 12 years, to enable the council to plan and establish the necessary reforms. Annulled by papal bulls in 1261 and 1262, and by King Louis IX of France in the Mise of Amiens (Jan. 1264), the provisions were restored by baronial action in July 1263 and, in modified form, in May 1264, but finally annulled by the *Dictum de Kenilworth* (Oct. 1266).

See W. Stubbs (ed.), *Select Charters*, 9th ed. (1913); R. F. Treharne, *The Baronial Plan of Reform, 1258–1263* (1932). (R. F. T.)

OXFORD AND ASQUITH, HERBERT HENRY ASQUITH, 1st Earl of (1852–1928), prime minister of Great Britain from 1908 to 1916 and leader of the Liberal party, was born at Morley, Lancashire, on Sept. 12, 1852. He was the second son of Joseph Asquith, a small businessman in the wool trade and an ardent Congregationalist, who died in 1860. The family then depended on the bounty of relatives and the moral influence of their strong-minded mother. Asquith was educated by his uncle at the City of London school from 1863 till 1870 when he won a classical scholarship at Balliol college, Oxford. He obtained the highest academic honours, became president of the Union in 1874 and in the same year a fellow of his college. He then decided upon a legal career and entered Lincoln's Inn, being called to the bar in 1876. The following year he married Helen Melland, daughter of a Manchester doctor, by whom he had four sons and a daughter. His early days at the bar were difficult but from about 1883 onward he became highly successful. A keen Liberal, he entered the house of commons for East Fife in 1886 and remained its member for 32 years. He commanded the attention of the house from the first, concentrating particularly upon the Irish question. Two years later he achieved celebrity as junior counsel for Charles Stewart Parnell before the commission which adjudicated upon Richard Pigott's forgeries published by *The Times*. (*See* Parnell, Charles Stewart.) Asquith's cross-examination of *The Times* manager was devastating. His practice at the bar greatly increased, and he became queen's counsel in 1890. In 1892 Gladstone made him home secretary. Before this, in Sept. 1891, his wife died of typhoid fever and he was left with a family of young children. Less than three years later he astounded the social and political world by marrying Margot Tennant who was 12 years younger and the centre of a social and intellectual beau monde far removed from the circles in which Asquith and his first wife had moved. Society from Queen Victoria downward regarded the match with apprehension. Undoubtedly his marriage tended to remove Asquith from the solid Nonconformist middle-class friends who had supported him. But it gave him great personal happiness, even if it was to produce some embarrassments. They had two children who survived infancy.

His three years as home secretary, though in general an unhappy period for the Liberals, established Asquith's reputation as an administrator and a debater. By 1895 he was one of the leading figures of his party. The ensuing 11 years were spent in opposition. He earned during this time a large income at the bar, but absence of any private means obliged him to refuse the party leadership offered to him after Sir William Harcourt's resignation in 1898 and Sir Henry Campbell-Bannerman succeeded instead. Although Asquith welcomed the appointment, he did not see eye to eye with the new leader on all questions of foreign and imperial policy. Their divergence became open and public during the South African War. Asquith, along with Lord Rosebery, Sir Edward Grey and R. B. Haldane, considered that the government ought to be supported without too much argument about past misdeeds. In 1902 they formed the Liberal league to advocate an imperial policy well to the right of traditional Gladstonianism. Campbell-Bannerman, while avoiding the extremism of the "pro-Boers," was ready to criticize the government freely both for its part in originating and its method of conducting the war. This conflict was temporarily healed after the end of the war and all elements of the Liberal party united in opposing the tariff reform policy of Joseph Chamberlain. Asquith was particularly vigorous, following in Chamberlain's heels up and down the country and replying to his speeches with great effect.

Arthur Balfour resigned in Dec. 1905. Asquith reluctantly gave up a brief marked 10,000 guineas and became chancellor of the exchequer. But his attempt in conjunction with Haldane and Grey to persuade Campbell-Bannerman to conduct the premiership from the house of lords did not succeed. The ensuing general election resulted in an overwhelming Liberal victory. Asquith introduced three budgets. On the whole they followed orthodox lines, although his second in 1907 was responsible for first establishing a distinction for tax purposes between earned and unearned income. For the government the years from 1906 to 1908 were frustrating: the Conservatives used their majority in the house of lords to defeat all the principal Liberal measures.

Prime Minister.—In Feb. 1908 Campbell-Bannerman became dangerously ill. Early in April he resigned, and died some days later. Asquith, generally regarded as his inevitable successor, became prime minister. He was to hold the office for nearly nine years, the longest continuous period since the death of Lord Liverpool. He made few cabinet changes, the principal ones being the appointment of Lloyd George to the exchequer, Reginald McKenna to the admiralty, and Winston Churchill to the board of trade. The chief problems confronting him at home were the obduracy of the house of lords and the danger of a rebellion in his own party from the frustrated radicals; abroad there was the threat of a great German navy. Lloyd George endeavoured to meet all these difficulties in 1909 by a radical budget that raised money both for naval increases and social services by methods of taxation particularly offensive to the Conservatives. Neither he nor Asquith believed that the peers would dare to reject it. When they did so at the end of November the game was truly in the Liberals' hands.

At this stage Lloyd George went into the background and Asquith took over the conduct of a constitutional struggle for which his talents were especially suited. He and his party were determined to secure a mandate to curb the powers of the upper house. The general election of Jan. 1910 gave the government a majority of 124, so long as they could depend on the 82 Irish and the 40 Labour members. The budget now passed the lords without a division. At the same time Asquith announced a plan to limit the powers of the upper house. Under this plan the peers could only delay a measure, not veto it; and their delaying power was limited. This parliament bill could only be passed if the king was willing to create enough peers to swamp the opposition. Edward VII made it clear that he would not consider doing so until a second general election fought on this issue had given a verdict in favour of the government. He died in May 1910 but his death did not basically alter the situation. The summer was spent on vain efforts at compromise. In the late autumn, having persuaded George V to promise reluctantly in advance to create the necessary peers, Asquith dissolved parliament again. The election held in December left the balance of parties virtually unaltered. After a series of scenes almost unparalleled in parliamentary history, the lords passed the bill by 17 votes on Aug. 10, 1911.

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ASQUITH

The three years between the end of this episode and the outbreak of World War I were extremely harassing for the prime minister. At home militant woman suffragists, aggressive trades unionists and rebellious Ulstermen caused much trouble. Another contentious matter was the disestablishment of the Welsh church, which was carried in 1914 despite the house of lords veto. Abroad the international situation rapidly deteriorated and the danger of war became imminent. Of the domestic difficulties the Irish question was by far the most acute. With the removal of the barrier of the house of lords and with the Irish party holding the parliamentary balance the Liberals were bound to attempt to carry Home Rule. But Asquith showed less than his usual acumen in overruling those members of his cabinet who wished to exclude the Protestant Ulstermen from its scope. He underestimated the genuine passion raised by this issue and the situation was exploited to the full by Unionist leaders. In 1914 grave errors on the part of the war office resulted in the famous Curragh incident when a

number of officers stationed near Dublin stated in answer to a question (which should never have been put to them) that they would rather be dismissed than march against Ulster. A major political crisis followed and Asquith took over the war office himself. It is probable that the outbreak of hostilities with Germany alone prevented a civil war in Ireland.

World War I.—In the negotiations which preceded World War I Asquith displayed an imperturbable common sense and a clarity of mind which mark him as a great statesman. Himself convinced that a German victory over France would be disastrous to the British empire, he nonetheless saw that to some of his colleagues mere strategic considerations were not enough. Premature declaration of his hand might well have broken up the cabinet. Adroitly waiting until the moral conscience of the whole country had been outraged by the German attack on Belgium, he succeeded in steering an almost unanimous government into the war.

There was at first no question of a coalition. The principal change was the appointment of Lord Kitchener to the war office. Asquith himself did not pretend to be a strategic genius. He trusted the military experts and in general, with the exception of the Dardanelles expedition, favoured the school which maintained that victory could only be won on the western front. Here he differed from Lloyd George, who was an eloquent advocate of the so-called "eastern" strategy. The Conservatives were content to play a passive role in the first nine months of the war, but in May 1915 the first sea lord, Admiral Lord Fisher, suddenly resigned as a result of differences with Winston Churchill. Bonar Law could no longer hold his followers in check and to avoid public recrimination Asquith had to reconstruct the cabinet on a coalition basis. He dropped Churchill from the admiralty and Haldane from the lord chancellorship; Lloyd George became minister of munitions; Bonar Law and the leading Unionists entered the cabinet. The new cabinet was no more successful than the old. The Dardanelles expedition failed and no sign occurred of a breakthrough in the west. At the end of 1915 Asquith substituted Sir Douglas Haig for Sir John French as British commander in chief in France, and Sir William Robertson as the new chief of the imperial general staff acquired many of Kitchener's powers. But 1916 was an even unhappier year: the Easter rebellion in Dublin caused a grave domestic crisis and the battle of the Somme led to a complete impasse on the western front and after a protracted struggle conscription was belatedly introduced. But there was a general aura of dissatisfaction by the autumn, and Asquith was assailed by a strident press campaign led by Lord Northcliffe. He treated this with silent contempt, well merited but perhaps imprudent. He was by now becoming a little weary. In December a series of complicated maneuvers, in which Lloyd George, Carson, Bonar Law and Sir William Maxwell Aitken (afterward Lord Beaverbrook) played parts that are the subject of controversy even today, resulted in Asquith's resignation and his replacement by Lloyd George. He never held office again.

For the rest of the war he led a "patriotic opposition" and only once divided the house against Lloyd George. This was in May 1918 when Lloyd George proposed that certain allegations made by Gen. Sir Frederick Maurice against the government should be investigated by three judges—a procedure of which Asquith disapproved. At the end of the war he declined an offer to join Lloyd George's government and in the general election that followed he and his supporters in the Maurice debate did not receive from Lloyd George and Bonar Law the joint letter of approval (dubbed by Asquith "the coupon") which went to recognized Conservative and Liberal supporters of the coalition. As a result the Asquithian Liberals were almost swept out of existence, Asquith losing his seat and not returning till a by-election for Paisley in 1920.

Last Years.—Asquith was never really reconciled with Lloyd George. He surveyed with satisfaction the latter's downfall after the breakup of the coalition in 1922. In the election of that year the Lloyd George and Asquithian Liberals fought in bitter opposition. It is true that in the following year a formula was found for a temporary truce and in the election of 1923 the Liberals under the joint leadership of the two men won 150 seats. But in 1924 they slumped to 40. Asquith again lost his seat. He accepted a peerage in 1925 as earl of Oxford and Asquith, being created a knight of the Garter shortly afterward. In the same year he had a disappointing experience when he was defeated by Lord Cave, a relatively insignificant figure, for the chancellorship of Oxford university. It was a sorry example of conservative and clerical prejudice against the author of Welsh disestablishment. In 1926 he finally broke with Lloyd George and resigned the leadership. The public issue was the latter's equivocal attitude to the general strike. Underlying it was a quarrel about Lloyd George's inordinate influence on the party, thanks to the huge fund that he had acquired by the sale of honours. In the last years of his life Asquith was relatively impoverished and wrote a number of books to make money, the best known being *The Genesis of the War* (1923), *Fifty Years of British Parliament* (1926) and *Memories and Reflections* (1928). He died at his country house in Sutton Courtenay on Feb. 15, 1928, and was buried at his own wish in the graveyard of the parish church.

Described once as "the last of the Romans," Asquith had a love of scholarship, a gravity of demeanour, a clarity of mind and a strength of character which go far to justify the epithet. He guided the country through a series of dangers such as rarely confront a prime minister. In peacetime his serenity and *sangfroid* were great assets; in wartime his very virtues perhaps put him at a disadvantage: a sense of decorum and a hatred of showmanship were defects in the heyday of Lord Northcliffe. But the notion that he was not a fighter, or lacked determination, is a myth; on the contrary, he displayed throughout his career not only a high sense of honour and devotion to duty but a steely determination in the pursuit of what he believed to be the right course. *See* also ENGLISH HISTORY.

See J. A. Spender and Cyril Asquith, *Life of Herbert Henry Asquith, Lord Oxford and Asquith*, 2 vol. (1932). (R. N. W. B.)

OXFORD MOVEMENT, the movement, centred at Oxford university, which sought to bring about a return of the Church of England to the high-church ideals of the later 17th century. It derived its immediate impetus from the revolution of 1828–32 in the relations between church and state, when the abolition of the Test and Corporation acts and the emancipation of the Roman Catholics were followed by the widening of the franchise in the Reform act of 1832. For a short time there was a threat of disestablishment and disendowment. Many loyal Anglicans therefore wished to assert that the claim of the church upon the allegiance of Englishmen rested upon a commission independent of the state's patronage, on its ministerial authority (episcopal succession from the apostles) and its teaching of truth (Catholic orthodoxy). Consequently, while the Oxford movement gathered into itself the remnants of the old party of high-church Tories, whose chief aim was to maintain the privileges of the establishment against dissenters, it rapidly became a movement of far wider interests—theological, pastoral and devotional. The problem was no longer to maintain the political privileges of the establishment but to justify the intellectual and pastoral claims of the Church of England while many of those privileges were disappearing. The presentation of signed addresses to the archbishop, the agitation against the suggested appropriation by parliament of church funds, the attack upon government for interference with church property (as in the 1833 assize sermon of John Keble against the Irish Church bill) were but a small part of its activities.

The movement was directed away from a mere participation in the Tory program toward the theological basis of church authority by its publication of the *Tracts for the Times*, intended to rouse the clergy to action; the first (1833) and 23 others were written by J. H. Newman (*q.v.*), who edited the whole series. Against any theory of individualism in religion or control of the church by the state, the Tractarians asserted the doctrinal authority of the Catholic Church to be absolute, and by "catholic" they understood that which was faithful to the teaching of the early and undivided church. Besides Newman, the leaders were Richard Hurrell Froude (*q.v.*), who died of tuberculosis in 1836; John Keble (*q.v.*), whose *Christian Year* (1827) had introduced a new, partly romantic, partly evangelical note into the poetry and hymnody of churchmen, but who, by temperament and by employment as a

country vicar at Hursley, was for the most part a figurehead; and Edward Bouverie Pusey (*q.v.*), professor of Hebrew and canon of Christ Church, Oxford, who provided solid erudition and a rare, sometimes strange, patristic sanctity, as well as the backing of his public position. Under Pusey's influence the tracts ceased to be pamphlets and became learned. They did not sell widely until public controversy made them notorious.

The Tractarians, who looked back to those high-church thinkers of the 17th century known as the Caroline divines, argued that although all things necessary for salvation are contained in the Scriptures, the Scriptures were written for a living community. The understanding of the Scriptures by the early church in its teaching and worshiping life was therefore the authoritative understanding; and thus the Catholic faith condemned on the one side "additions" to ancient doctrine (as by the Council of Trent) and on the other side "subtractions" from ancient doctrine (as by the "popular Protestants" who taught the Bible alone as the religion of Protestants in such a sense as to neglect the historical community of Christians). The Tractarians therefore encouraged the study of the early Fathers, edited their works and arranged for their translation. Since this idea of authority was reacting against an excessive application of reason (common sense) to the dogmas of religion as shallow and detached, the Tractarians had affinities with other writers such as S. T. Coleridge, Walter Scott and the leaders of the romantic movement, and with the evangelicals who represented the contemporary critique against "mere" prosaic reason. Faith, argued Newman, was not an assent given at the conclusion of logical arguments for belief in God. It was a reaching out of the heart, based upon moral conviction, in response to God's revelation presented to it. The logical arguments of common sense about the external world were needed afterward to confirm and adjust, but they were not the foundation or origin of the act of faith. These views of faith and authority were expressed in a measure by all the leaders, but the idea of authority is best found in Newman's *Lectures on the Prophetical Office of the Church* (1837) and the idea of faith in his *University Sermons* (1843). There are many illuminating passages scattered among his *Parochial and Plain Sermons*, preached as vicar of St. Mary's, Oxford (1834–42), perhaps the most influential publication of the movement. The emphasis upon the importance of the moral judgment for faith led the Tractarians to controvert the common evangelical understanding of justification by faith alone and hold to a moderate or Arminian statement of the doctrine (*see* especially Newman's *Lectures on Justification*, 1838).

The Tractarians' first public opposition to the establishment occurred in 1836 over the appointment by Lord Melbourne of the liberal R. D. Hampden to the regius professorship of divinity at Oxford. Hampden was known to favour the admission of dissenters to the university, and his theology minimized the authority of the church in doctrine. The Tractarians were in the van of a much wider, though unsuccessful, opposition to Hampden's appointment. But after Keble and Newman had edited Froude's *Remains* (1838–39), which disclosed how suspect was the Reformation to some of the Tractarians, their whole attitude to the Reformation came under fire. Moreover an extreme wing of Newman's disciples, led by W. G. Ward (*q.v.*) of Balliol college, exposed the appeal to the ancient and undivided church as in part encouraging the liberal spirit by an implicit appeal to free historical inquiry and therefore pressed Newman toward the doctrines of a living and infallible authority in the Roman Catholic Church. While Protestant churchmen were arguing that Tractarian doctrines of tradition and church authority were not compatible with the reformed status of the Church of England, as expressed in the Thirty-Nine Articles, Ward and the extremists argued that the Thirty-Nine Articles were incompatible with the catholic status of the Church of England. To satisfy these pressures Newman published *Tract 90* (1841), an attempt to show that the articles could be understood in the sense of Catholic antiquity. There was nothing new about a lax interpretation of the articles; what was new was their interpretation in a sense which seemed to break down the barriers they appeared to erect against Roman Catholic doctrines. And although Newman intended to show the articles to be compatible with antiquity, Ward claimed that he was making them compatible with the Council of Trent. The other Tractarians decisively approved *Tract 90*, but public confidence in Newman was gone. Four Oxford tutors, including the future archbishop of Canterbury, A. C. Tait, made a public protest, and Bishop Richard Bagot of Oxford requested that the tracts be discontinued. Newman consented, but the storm of obloquy shattered his confidence and forced him to reconsider his doctrinal position. He withdrew from Oxford to Littlemore (1842) and from further effective participation in the movement; he was received into the Roman Catholic Church in 1845. In that year the University of Oxford condemned a book in praise of the Roman Catholic Church by Ward (*The Ideal of a Christian Church*, 1844) and stripped him of his degrees, but a further attempt to condemn *Tract 90* was frustrated.

Newman's secession was a severe blow to the aims and influence of the movement. A number of men and women, including Ward, F. Oakeley and F. W. Faber, joined the Roman Catholic Church. In 1850 the Gorham judgment, whereby the judicial committee of the privy council concluded that a man who rejected the doctrine of regeneration of all baptized infants could be an incumbent in the Church of England, seemed to some Tractarians a final disclosure of naked Erastianism and a proof of faithlessness to Catholic antiquity; and more Tractarians joined the Roman Catholic Church, notably H. E. Manning, J. R. Hope-Scott, R. I. Wilberforce and Henry Wilberforce.

Keble, Pusey, R. W. Church and others, however, stood by the main principles of the movement, and its influence began again to spread, more quietly, in the vicarages and congregations of the country. After 1850 it began to be associated with the quest (which had existed apart from it but with which Newman and Pusey had been deeply concerned) for more reverent worship and ceremonial in churches, and its concern for Catholic antiquity and for the historical continuity of Christendom helped churchmen to lift their eyes to the treasures of the Christian centuries, especially in hymnody and modes of prayer. The increasing effect of these ideals, despite controversies over ritualism in London parishes, was especially marked by the revival of religious communities for nuns, and later by the institution of communities for men, especially the Society of St. John the Evangelist at Cowley, founded by R. M. Benson in 1866 (*see* MONASTICISM; WOMEN'S RELIGIOUS ORDERS). The sign of the Oxford movement's success was the rapid acceptance of such communities as no foreign element in the Church of England. Its ideals of worship reached out beyond the Church of England into the free churches and its ideals of priestly life affected the training of the clergy (especially by the foundation of theological colleges) and the practice of pastoral care (*e.g.*, by the use of auricular confession and retreats).

The movement inspired little historical writing of the first rank. Students of the Reformation period such as J. S. Brewer, S. R. Maitland, and R. W. Dixon wrote under its influence, but J. A. Froude's reaction against it was visible in his history of England. Among the poets, it inspired F. W. Faber, Christina Rossetti, and Gerard Manley Hopkins. Several good writers set forth its ideals in their novels, especially E. M. Sewell and Charlotte M. Yonge, a disciple of Keble who in *The Heir of Redclyffe* (1853) produced the best Tractarian novel of the century. *John Inglesant* by J. H. Shorthouse (1881) also owed much to its ideals. Its poets and translators produced some of the best hymns and carols of the Victorian age. Two translations (Bishop J. R. Woodford's "Thee we adore" and R. F. Littledale's "Come down, O love divine") were confessed to be better than their originals. *Hymns for Little Children* (1848) by Mrs. C. F. Alexander, another disciple of Keble, included "There is a green hill" and other verses which became a permanent part of the English heritage (*see* also HYMN: *Anglican Hymnody*). Among theologians (after the first leaders) only J. B. Mozley, R. W. Church, and H. P. Liddon were of the first rank, but the divinity of the movement became more widely influential when after the publication of *Lux mundi* in 1889 it accepted the historical criticism of the Bible; and with Charles Gore, H. Scott Holland, and R. C. Moberly it guided the English religious thought of a generation. *See* also ENGLAND, CHURCH OF.

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OXFORDSHIRE (abbreviated OXON), a southern midland county of England, bounded north by Northamptonshire and Warwickshire, west by Gloucestershire, south by Berkshire and east by Buckinghamshire. The geographical boundaries since 1911 enclose an area of 749 sq.mi. The 14 Oxfordshire hundreds include five of the Chiltern hundreds, the jurisdiction over which belonged to the manor of Benson and, in 1199, to Robert de Harecourt.

Physical Features.—The county lies across the central portion of the Jurassic and Cretaceous outcrops. The strike of the strata is in each case from northeast to southwest, for Tertiary movements have tilted them gently down to the southeast from the northwest of the county. In the northwest the marlstone of the Middle Lias and the limestones of the oölitic series are permeable and relatively resistant, and stand out as a sharp edge, continuing the line of the Cotswolds at a lower level (average 500 ft.) but rising to 700 ft. in Edgehill in the northeast of the county. In the southeast the chalk is also permeable and resistant, and the hard chalk-with-flints crowning the Chilterns presents a sharp edge to the northwest.

Between these two upland regions the intermediate geological series floors a broad vale (about 10 mi. wide) of alternating clays and calcareous, sandy beds. The Upper Greensand forms a low bench at the foot of the chalk hills, succeeded northward by the Gault, with width of outcrop varying from 4 mi. to $1\frac{1}{2}$ mi. The Lower Greensand appears from beneath the Gault at Culham and Nuneham Courtenay and in outliers north of Cuddesdon; Portland Limestone, Portland Sands and Purbeck beds lie between it and the Kimeridge Clays, which outcrop between Sandford and Waterperry. Coral Rag is traceable from Sandford to Wheatley and beyond this comes a broad outcrop of Oxford Clay followed by the Cornbrash (a brownish rubbly limestone). This develops a belt of variable width between Broughton Poggs and Chesterton but forms a wide plateau near Bicester. It also occurs as small isolated inliers between Islip, Blackthorn hill and Marsh Gibbon (Bucks).

The county lies almost wholly in the basin of the Upper Thames, in which the significant drainage is that of the Cherwell-Thames (*see* also THAMES). The drainage pattern as a whole consists of numerous consequent streams from the scarplands (Evenlode, Windrush, etc.) which have been captured and diverted into the Cherwell-Thames by powerful subsequent streams (Ock, Upper Thames, Ray, Thame), working along lines of weakness in the strike of the rocks, obsequent streams flowing down the scarp edge often being a further result of the capturing. The Cherwell occupies a broad sag between Edgehill and the Northampton uplands. It flows south-southeast, joins the Thames coming from the west at Oxford, after which the combined stream continues the southeast direction, passing by the Goring gap through the chalk between Wallingford and Reading. That the gap originated northwest of its present position is argued from the fact that the level of the riverbed at this point is 100 ft. while that of the hills on either side is 700–800 ft. It is an old but rejuvenated drainage system, which, working upon calcareous rocks, has given rise to a characteristic topography. There is little glacial drift except in the northeast of the county. Gravel deposits, both plateau (North Leigh, Combe, Tiddington, etc.) and flood plain (Bampton, Oxford, Dorchester, etc.), are very important; tracts of clay-with-flints, brick earth and gravel, as well as outliers of the London Clay (Nettlebed, Caversham, etc.) occur on the dip slope of the chalk. (R. P. BE.)

History.—The gravels and sands near the Chilterns and gravels near Wolvercote have yielded Lower Palaeolithic flint tools. Some Mesolithic flints have been found. There is ample evidence for the settlement of Neolithic farmers, *e.g.*, at Dorchester, Abingdon, Eynsham and other places; the Beaker people have left many traces especially between the Evenlode and the Windrush. The Rollright stone circle (probably built by the Beaker people) on the Oölite scarp needs special mention. Settlement on the dip slope of the Chilterns was debarred by forests, as also in the forested northeastern portion of the county; but the Icknield way, generally on the Greensand, and the Ridgeway, on the Chalk above, followed the scarp face to the Thames crossing. The Bronze Age period was a trading time for the area. Iron Age invaders had begun to arrive by the early 3rd century B.C. There are plentiful Iron Age finds in the valleys of the Oxford heights, and especially near the Thames crossing at Dorchester. During the Roman period the area was thickly populated and a road was made through Dorchester-on-Thames from Silchester (Hants) near Reading to Towcester (Northants) on Watling street. Alchester was built where this road cuts Akeman street linking Verulamium (St. Albans) on the east and Corinium (Cirencester) on the west. The Saxon settlements are noticeably on valley sites, occupied in pre-Roman times, and these have continued as nucleated settlements to the present day; isolated farms are mainly on plateau or vale from which forest was cleared comparatively late. In the 6th century the West Saxons under Cuthwulf took Benson and Eynsham. (*See* the *Anglo-Saxon Chronicle* for 571.)

In the 7th century the Mercians held all the northern border of the Thames, and during the 8th century this district fell to Wessex after the battle of Burford, and to Mercia after a battle at Benson, when it was included in the diocese of Lincoln. The bishopric at Dorchester, given to Birinus (the apostle of Wessex) in 634, temporally ended on the establishment of the see of Winchester. Before the Mercian conquest in 777 Oxfordshire was in the diocese of Sherborne. In 873 the jurisdiction of Dorchester reached to the Humber, and when the Danes were converted it extended over Leicestershire and Lincolnshire, Oxfordshire forming about an eighth of the diocese. In 1092 the seat was transferred to Lincoln. In 1542 a bishopric at Osney and Thame was established taking its title from Oxford, the last abbot of Osney being appointed to it. In 1546 the existing bishopric of Oxford was created by Henry VIII.

The Danes overran the county during the 10th and 11th centuries; the shire moot at Oxford is mentioned in Canute's Oxford Laws and it was at Oxford that Harold II allowed Tostig to be outlawed and Morcar (Morkere) to be chosen earl in his place, thus preparing the way for his own downfall and for the Norman Conquest. Under the later Saxon and Norman kings Oxford was of greater importance in national politics than before or since, but the rise of the university made it an intellectual capital during the 13th and 14th centuries. It was the seat of the county court from the first, the castle being the county jail. The bishops of Winchester and Lincoln and many religious houses (*e.g.*, Abingdon, Osney and Godstow) held much land in the county. The dissolution of the monasteries, though it affected the county greatly, caused no general disturbance.

After the battle of Edgehill (Oct. 23, 1642), Oxford became the headquarters of the royalist cause. More than once, notably at Chalgrove Field (June 18, 1643), Prince Rupert's cavalry struck hard and successfully. In the campaign of Newbury, skirmishes took place as the parliamentary troops under the earl of Essex passed through north Oxfordshire on their way to the relief of Gloucester, and at the close of the campaign the fortresses of the county offered the defeated royalists a refuge which Essex was powerless to disturb. In the following campaign King Charles I abandoned the idea of an envelopment and decided to use Oxfordshire as the stronghold from which to strike in all directions. Ma-

terial wants made it impossible for Charles to maintain permanently his central position, and eventually Essex headed for the southwest leaving Sir William Waller to face the king alone. The battle of Cropredy Bridge followed (Jan. 29, 1644), and the victorious king turned south to pursue and capture Essex at Lostwithiel in Cornwall. In the operations of 1644 (Newbury and Donnington) Oxfordshire again served as a refuge and base.

On the appearance of Oliver Cromwell and the "New Model army" a fresh interest arose. Leaving Windsor (April 20, 1645), the future Protector carried out a daring cavalry raid. He caught the royalists unaware at Islip, pursued the fugitives to Bletchington and forced the governor to surrender. He swept round Oxford, fought again at Bampton, and rejoined Fairfax, in Berkshire. A few days later Charles again marched northward, while Fairfax was ordered to besiege Oxford. Charles was compelled to turn back to relieve the city, and the consequent delay led to the campaign and disaster of Naseby. Yet even after Naseby, Oxfordshire still retained its importance, but in 1646 the Roundheads closed in from all sides and Stow-on-the-Wold (Glos.) witnessed the final battle of the first war. On May 9 Banbury surrendered, on June 24 Oxford capitulated, and three days later Wallingford, the last place to give in, followed its example. (*See* also CIVIL WAR, ENGLISH.)

By the middle of the 17th century the great Cotswold wool industry was dying out, though it persisted at Burford until the 19th century. The forests also were diminishing as a result of the Civil War and of enclosures, but there are still extensive woods where once were the forests of Shotover, Bernwood, Woodstock and Wychwood. The building of canals and turnpike roads in the 18th century altered the status of many towns which, by the mid-19th century had been further changed by the setting up of new industries.

Architecture.—The limestone of the oölitic series has provided splendid material for both ecclesiastical and domestic architecture. Considerable portions of the Norman Oxford castle survive, and slighter remains of the castle at Bampton, the seat of Aymer de Valence in 1313.

Notable remains of former mansions include Greys court (13th century) near Henley-on-Thames (*q.v.*), Minster Lovell on the Windrush above Witney, and Rycote between Thame and Oxford. Minster Lovell was the seat of Francis, Lord Lovell (*q.v.*), the son of a Lancastrian who incurred the hatred of that party by serving Richard III; he afterward aided Lambert Simnel and mysteriously disappeared after the battle of Stoke (1487). Rycote (where Elizabeth I resided both before and after her accession) is of fine Elizabethan brick, and in the chapel attached to the manor there is remarkable Jacobean woodwork, the entire fittings being of this period. Broughton castle (14th century) near Banbury, Stonor park (with early 14th-century brickwork) near Henley, Shirburn castle (mainly 15th-century), Stanton Harcourt (1450, with a gatehouse of 1540, a vast kitchen and "Pope's tower") and Chastleton have been inhabited by the same families for generations. Mapledurham house on the Thames above Reading is a fine Tudor mansion of brick, and Water Eaton on the Cherwell is a singularly perfect Jacobean house of stone. Rousham house (17th century) has a landscape garden by William Kent. Blenheim palace, near the little town of Woodstock (*q.v.*), was designed by Sir John Vanbrugh and is the seat of the dukes of Marlborough.

A large number of monastic foundations arose in the neighbourhood of the university: Augustinian at Bicester (*q.v.*), Caversham, Cold Norton, Dorchester-on-Thames (*q.v.*), Osney and Wroxton; Cistercian at Bruern and Thame; Benedictine at Cogges, Eynsham and Milton; Mathurin (Trinitarian) at Nuffield; Gilbertine at Clattercote; and Templar at Sandford-on-Thames. Gosford possessed one of the only two preceptories of female Templars in England. Of all these, excepting the abbey church at Dorchester, remains are scanty. Still standing are the boundary walls of Godstow nunnery, on the Thames, the retreat and burial place of Rosamund Clifford, or "Fair Rosamond," the object of Henry II's passion.

In ecclesiastical architecture Oxfordshire, as well as Oxford itself, is remarkably rich, but nearly all the churches are of mixed dates. Iffley, Adderbury and Minster Lovell are types of a single style. Iffley, 1 mi. south of Oxford, is one of the finest examples of pure Romanesque in England, with a highly ornate west front. Adderbury, 4 mi. south of Banbury, is a great cruciform Decorated church with a massive central tower and spire. Minster Lovell, also cruciform, is pure Perpendicular; its central tower is supported on four detached piers.

What is now Oxford cathedral dates from the 12th century. There are splendid central spires to the great churches at Witney (*q.v.*), Bampton, Shipton-under-Wychwood and Bradwell and a fine spire at Bloxham, one of the largest and finest churches in the county. Burford (*q.v.*) and Langford have particularly fine large early Norman churches. At South Leigh, Beckley and Swinbrook are remarkable medieval mural paintings, while at Caversfield there is what is probably the oldest church bell in England—cast before 1219. About 5 mi. north of Oxford there are Kidlington (Decorated), with a beautiful needlelike Perpendicular spire, and Islip, the birthplace of Edward the Confessor. Ewelme church (Perpendicular) is remarkable for the tomb of Alice, duchess of Suffolk (d. 1475), gorgeous with tracery and gilded canopy, and that of Sir Thomas Chaucer (d. 1434) and his wife, with enamelled coats of arms. There William de la Pole, duke of Suffolk, founded in 1436 the picturesque hospital and free school, still occupied.

The Economy.—A large proportion of the county (about 80%) is under cultivation. The Cornbrash is especially good for grain growing. Stock are raised on the clay lowlands, and dairying (Shorthorns, Friesians, Channel Island and Ayrshire cows) is carried on. Sheep (Oxford Downs, Hampshire Downs and crossbred) are reared.

Ironstone is obtained from the Middle Lias round Banbury; limestone (from the Great Oölite) is still quarried in small quantities at Bladon and Burford, but the preparation of stone slates for which Stonesfield was noted has now ceased. Clay and gravel are dug and there are cement works at Chinnor and Shipton. The National trust owned 584 ac. in 1963 and protected 464 ac.

The largest centre of industry is at Cowley, a suburb of Oxford (Nuffield industries and pressed steel). There are also considerable aluminum and engineering works at Banbury. Blankets have long been made at Witney, and tweeds at Chipping Norton since 1835. There are paper mills at Wolvercote, Shiplake, Sandford and Eynsham, using pure stream water. The making of leather gloves has been established in Woodstock, Charlbury and Didcot since the 16th century. Banbury has long been celebrated for a currant cake; Oxford makes marmalade and about 1,000 people are employed by the Oxford University press.

Oxford is a road centre not only for the county but also for the midlands; it was not so in prehistoric or Roman times, though many of the roads are ancient routes on the plateau or following the strike of the rocks. The main railways are markedly transverse, linking London with the industrial northwest.

Population and Administration.—The area of the administrative county, excluding the county borough of Oxford, is 735.2 sq.mi. with a population (1961) of 203,161. Wartime evacuees between Sept. 1939 and Feb. 1941 raised the population by 21%. The municipal boroughs are Banbury (pop., 21,004), Chipping Norton (4,245), Henley-on-Thames (9,144), Oxford (106,291), a cathedral city and the county town, and Woodstock (1,818) (*qq.v.*). There are 3 urban and 6 rural districts and 232 civil parishes. The county is in the Oxford circuit and assizes are held at Oxford. It has one court of quarter sessions and is divided into 11 petty sessional divisions. The borough of Banbury and the city of Oxford have separate courts of quarter sessions and commissions of the peace, and the borough of Henley-on-Thames has a separate commission of the peace. The ancient county (which in 1289 sent two members to parliament) was divided in 1918 into two parliamentary divisions, Banbury and Henley, each returning one member; the parliamentary borough of Oxford also returns one member. Oxfordshire is within the diocese of Oxford.

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(X; W. O. H.)

OXFORD UNIVERSITY. The stories connecting Oxford university with Brut the Trojan, with King Mempeic (1009 B.C.) and with the Druids cannot be traced back beyond the 14th century. Authentic history appears to begin in 1133 with the arrival from Paris of the theologian Robert Pullen who lectured there. There is, however, little evidence that Oxford was regarded as a fully equipped university before 1163—allusions to its being a *studium generale* (*see* UNIVERSITY) occur only after that date and even these are held by some to be inconclusive. Subsequent progress must, however, have been rapid as, about 100 years later, the deputies of Oxford, in an appeal to the king, described the university as *schola secunda ecclesiae* or second to Paris. The coming of the religious communities, the Dominicans, Franciscans and Carmelites in the 13th century and the Benedictines a little later, profoundly affected the advancement of learning. The names of Roger Bacon, John Duns Scotus and John Wycliffe are sufficient to indicate the prominence of Oxford in the middle ages. The earliest colleges to be founded were University college (1249; the mythical foundation by Alfred in 872 is no longer accepted) and Balliol (about 1263). Merton was established in 1264 to provide a collegiate discipline for the secular clergy; its statutes served as a model for subsequent creations, not only at Oxford but at Cambridge.

From the 13th century onward a succession of royal charters strengthened the position of the university at the expense of the town. At the Renaissance the new learning found its leading exponents in Erasmus, who lectured there, and in such famous scholars as William Grocyn, John Colet and Sir Thomas More. The old Scholasticism received its deathblow from the royal injunctions of 1535. Oxford, as well as Cambridge, suffered from numerous confiscations of land and revenues during the Reformation period. In 1571 the Act of Elizabeth incorporated and reorganized the two universities. The statutes of the university were codified in 1636 by the chancellor Archbishop William Laud. With certain modifications, they formed the official code of the university until 1858. During the Civil War the university sided with the king while the town sympathized with the parliament, but no open breach between the two occurred. Under Oliver Cromwell, who acted as chancellor from 1651 to 1657, an effort was made to restore the standards in work and discipline which had suffered from the civil wars. During the reign of James II the university acquired popularity by its successful resistance to James's effort to open the university to Catholics, even to the extent of imposing his own Catholic nominee on the fellows of Magdalen. The university, however, soon returned to its Jacobite allegiance and at the coming of the Georges was definitely anti-Hanoverian, a phase that came to an end after the visit of George III in 1785. In the latter half of the 18th century the influence of the Wesleys on Oxford was far less than on the country at large; on the other hand the Tractarian movement (*see* NEWMAN, JOHN HENRY), at the beginning of the 19th century, had a most profound and lasting effect on the Church of England. There was a general rise in the level of studies toward the end of the 18th century as written examinations gradually supplemented the old oral examinations, often merely formal, and henceforth the range of studies themselves extended. By the reform of 1858 the professoriate was increased, reorganized and re-endowed, and dissenters were admitted to entrance to the bachelor of arts (B.A.) —the master of arts (M.A.) being thrown open in 1871.

The reforms of 1877 directed a certain proportion of the college revenues to the use of the university (especially for the encouragement of natural science) and improved the position of professors and lecturers, thus leading to the growth of a regular resident professoriate. Schools and degrees alike multiplied (*see* UNIVERSITY) and the history of the university was one of general progress and expansion. From 1900 university history entered a new phase, marked by the rise of scientific disciplines and greater specialization in all studies.

In the 19th century annual matriculations increased steadily (except for a check between 1812 and 1849), from 240 in 1800 to 840 in 1900. College fellows retained almost all instruction and administration. In spite of their other tasks they were able to improve the quality of teaching, so long as science spread slowly. In 1900 there were only seven readers and lecturers in the faculty of natural sciences, of whom four were college fellows. By 1940 the faculty had been divided into physical and biological sciences, with 91 readers and lecturers, of whom 41 were fellows. By 1960 a faculty of agriculture and forestry had been added. There then were 168 readers and lecturers, 82 of them fellows. Between 1900 and 1960 the number of departments in these faculties went up from 9 to 24. In the same period there was a shift of interest among undergraduates: in 1900, out of a total of 469 candidates, only 47 sat for final honour science examinations, a mere 10%; by 1939 this had risen to 252 out of 1,305, or nearly 19%; and by 1960 to 755 out of 2,438, or just over 30%.

Meanwhile the humane studies also changed greatly. English and modern language faculties were set up and honours examinations instituted in philosophy, politics and economics, and in music.

The swing to science, with its special emphasis on demonstration and experiment, brought far-reaching changes in the responsibilities and the budget of the university. Though five colleges had provided science laboratories, the study of science was never seriously entertained as a college activity. Laboratories on the scale required could be provided only by the university. Annual expenditure on the science departments was £24,177 in 1900, £186,942 in 1939 and £1,846,742 in 1960.

After 1900 postgraduate studies expanded greatly. The degrees of bachelor of letters (B.Litt.) and bachelor of science (B.Sc.) were established in 1895 and that of doctor of philosophy (D.Phil.) in 1917. For these degrees candidates must submit a thesis embodying the results of research; D.Phil. theses must be "an original contribution to knowledge." In 1947 the university instituted the degree of bachelor of philosophy (B.Phil.), obtained partly by examination and partly by thesis, after a course of advanced study less highly specialized than that for the other degrees. In 1939, 440 students were registered for these degrees (212 D.Phil., 89 B.Sc., 139 B.Litt.); in 1960 there were 1,373 (787 D.Phil., 89 B.Sc., 417 B.Litt. and 80 B.Phil.). Nuffield college (mainly social studies), St. Antony's college (mainly modern subjects) and Linacre house, a new society, are exclusively postgraduate; but most postgraduate students belong to the various colleges. This influx of new members, with special needs both for instruction and for other facilities, into primarily undergraduate institutions produced new problems of integration.

From 1900 to 1950 university finance underwent radical change; until the 1920s the university depended on endowments (£19,000 net in 1900) and on fees and dues (£30,488 in 1900). Major developments required private benefactions. After World War I these sources became inadequate. On the recommendation of a royal commission, and against much opposition within the university, a government grant was introduced. In 1927–28 this covered 21% of the total expenditure. The same proportion still held in 1938–39, but the amount had gone up by about one-third. By 1947–48 the share had risen to 49% and by 1959–60 to 68%. At the same time more and more students were subsidized from public funds: in 1959 more than eight in ten received some form of financial assistance.

The control of these growing resources, however, never passed into the hands of a body separate and distinct from the colleges. What the framers of the Oxford constitution aimed at was to ensure that the university's business, being for the benefit of scholars, should be controlled by scholars. The effective power was thus vested in the university at large. Naturally it was primarily in the hands of those holding academic positions ("congregation"), but as late as 1919 the nonresident masters of arts were able to defeat a proposal for the abolition of compulsory Greek. In 1926 the nonresident masters were finally relieved of

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HALL QUADRANGLE, ORIEL COLLEGE. ORIEL WAS FOUNDED IN 1326

all but revising functions exercised if the university was internally divided; and since the nonresident masters number about 25,000 they could not in any case be an effective body. Power, therefore, rests with congregation (about 1,350 M.A.'s), all members of the separate colleges. The fact that all decisions affecting policy must be passed by congregation, in which it is always easy to stir up opposition, has prevented the university from imposing anything like bureaucratic control upon the colleges. Congregation has, indeed, only a limited power of initiation, its function being to pass judgment on proposals submitted to it by the Hebdomadal council, a body containing 6 ex-officio members (the chancellor, vice-chancellor, the 2 proctors, the assessor and a pro-vice-chancellor, who is either the outgoing or the incoming vice-chancellor) and 18 M.A.'s elected by congregation. The council is thus a body which exercises a great influence; but it is the influence of a leader in a free community.

Benefactions.—The university used to depend for developments almost wholly on private benefactors. The Bodleian library, the Sheldonian theatre, the Ashmolean museum, the Dyson Perrins laboratory and the Serena professorship of Italian commemorate the names of some of them. The rise of taxation and the increase in government support for the university after World War I did not, as was feared, put a stop to the flow of private benefactions. More than £3,300,000 was contributed by Lord Nuffield just before World War II for the medical school and the establishment of Nuffield college, and in 1949 M. Antonin Besse gave £1,250,000 for the foundation of a new college, St. Antony's, and £250,000 for the expansion of existing colleges. Professorships were founded by Montague Burton, Henry Spalding and Isaac Wolfson. New sources of support for university development arose in the form of foundations (the Rockefeller foundation, for example, gave £586,000 in the 1930s for the extension of the Bodleian library and £150,000 in 1960 for a new law library) and industry (Imperial Chemical Industries and the Pressed Steel company, for example, gave £180,000 for the maintenance of research fellowships between 1952 and 1960). An appeal for £1,750,000 for the restoration of university and college historic buildings launched in June 1957 reached its target by Aug. 1958: more than £1,700,000 was raised for the foundation of a new college (St. Catherine's); and benefactions and bequests, large and small, continue to accrue both to individual colleges and to the university.

Colleges and Halls.—After University, Balliol and Merton the other colleges, in order of foundation, are: Exeter (1314), Oriel (1326), Queen's (1340), New (1379), Lincoln (1427), All Souls (1438), Magdalen (1458), Brasenose (1509), Corpus Christi (1517), Christ Church (begun by Cardinal Wolsey in 1525, final foundation by Henry VIII, 1546), St. John's (1555), Trinity (1555), Jesus (1571), Wadham (1612), Pembroke (1624), Worcester (1714), Hertford (1874), Keble (founded in 1868 and made a full college in 1952) and St. Edmund hall (reputed foundation as an academic hall, 1226; incorporated as a college in 1957). There are also five women's colleges: Lady Margaret hall (1878), Somerville (1879), St. Hugh's (1886), St. Hilda's (1893) and St. Anne's (1952); since 1960 these have had the same status as the men's colleges. St. Peter's hall, which became a private hall in 1929 and a new foundation in 1947, in 1961 was incorporated as St. Peter's college. Other new foundations are St. Antony's (1950) and Nuffield college (founded in 1937 as a university institution and incorporated as a new foundation in 1958). There are also five permanent private halls: Campion hall (1896), St. Benet's hall (1897), Mansfield college (1955), Regent's Park college (1957) and Greyfriars (1957).

Noncollegiate students were admitted as members of St. Catherine's society in 1868, but in 1956 it was agreed that the undergraduates of this body should form the nucleus of a new college, St. Catherine's college, while the postgraduates would be absorbed into a new postgraduate society, Linacre house, both institutions opening in 1962.

Academic Buildings of Note.—The main group of historic university buildings consists of the Bodleian library, the divinity school, the Convocation house, the Sheldonian theatre, the Clarendon building and the old Ashmolean museum, with the Radcliffe Camera and the university church of St. Mary's to the south. Another later group comprises the Ashmolean Museum of Art and Archaeology, the Taylor Institution for Modern Languages and the Oriental institute. The science laboratories surround the University museum (1855), and it is here that most of the post-World War II university buildings have been erected: new buildings or important extensions for geology, botany, forestry, physiology, chemistry, metallurgy, pharmacology, engineering and physics.

University Constitution.—"The chancellor, masters and scholars of the University of Oxford" form a corporate body, within which the colleges are individual corporations. The highest officer of the university is the chancellor, who is elected by the members of convocation, holds office for life and is generally a distinguished member of the university. The vice-chancellor is in practice the head. He is nominated annually by the chancellor and must by convention be the senior head of a college who has not yet held this post, who is not more than 63 years old and who is willing to accept the office. Each vice-chancellor is nominated for two years in all. Two proctors are appointed annually by two of the colleges in rotation. Until 1948, when the privilege dating from 1603 was abolished, the university returned two members to

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TOM TOWER, CHRIST CHURCH COLLEGE, DESIGNED BY SIR CHRISTOPHER WREN. CHRIST CHURCH WAS FOUNDED IN 1546

parliament under a system of proportional representation.

The Hebdomadal council initiates and congregation decides the business of the university, but there is a considerable delegation of executive functions. The administrative work is assigned sparingly so that scholars can do it without affecting their scholarly work. The delegation ranges from such bodies as the curators of the Bodleian library, who spend about £250,000 a year, to such as the committee for comparative philology, which spends about £10.

The delegate bodies fall into two groups: (1) those (*e.g.*, faculty boards) dealing with academic questions, which maintain academic standards both by supervising the selection of the teaching and research staffs and their work and by determining the content and standard of examinations—such bodies are supervised by the general board of the faculties; and (2) those which provide services not regarded as academic. To these, the curators of the university chest bear much the same relation as the general board does to academic delegacies. But the curators are also responsible for advising the Hebdomadal council on financial matters, for managing the real property and other investments of the university and for ensuring that accounts are so kept as to form a trustworthy basis for estimating future expenditure and detecting waste.

Degrees.—Nobody can study for a degree or be a member of the university unless he is a member of a college. The examinations for the B.A. (the title of the first degree, no matter in what subject it is taken) are: (1) the first public examination which may be an honours examination as in Greek and Latin literature or a pass examination designed as a preliminary to one of the final honour schools; (2) the second public examination which may be either an honours examination in a single subject or in two or three closely related subjects (a final honour school) or a pass examination in three unrelated subjects. In addition there are examinations in theology (for the bachelor of divinity [B.D.] degree), law (for the bachelor of civil law [B.C.L.]), medicine (for the bachelor of medicine [B.M.] and bachelor of surgery [B.Ch.]), music (for the bachelor of music [B.Mus.]) and in eight other subjects (for the B.Phil.) which are normally taken after the B.A. Degrees of B.Litt., B.Sc. and D.Phil. are awarded for original research undertaken under supervision, and the higher doctorates for published work containing an original contribution to the advancement of learning.

See also references under "Oxford University" in the Index.

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(C. BR.; J. WS.; D. V.; F. H. SA.)

OXIDATION AND REDUCTION are chemical terms applied to changes in the electrical charge of an element in the course of a chemical reaction. For example, the combination of sodium and chlorine involves the transfer of an electron from a sodium atom to a chlorine atom and the formation of a sodium-chloride molecule in which the sodium is charged positively and the chlorine negatively, (Na^+) (Cl^-). The element which has lost electrons and thus acquired positive charges is said to be oxidized and the process is called oxidation. The element which gained electrons is reduced and the process is one of reduction. Thus, the combination of sodium and chlorine is an oxidation-reduction reaction resulting in the oxidation of the sodium and the reduction of the chlorine. In this reaction the chlorine is the oxidizing agent and the sodium the reducing agent.

Before the introduction of the electron concept, the term oxidation was applied to reactions in which an element gained oxygen as in the burning of carbon, $C + O_2 \rightarrow CO_2$, or the rusting of iron, $4Fe + 3O_2 \rightarrow 2Fe_2O_3$; the term reduction designated a reaction by which an element lost oxygen, such as the reduction of copper oxide by hydrogen, $CuO + H_2 \rightarrow Cu + H_2O$.

In all oxides, the oxygen atom has a charge of $2-$ (or oxidation number of $2-$); hence, when free oxygen gas combines with another element to form an oxide, it gains electrons from that element. In the generalized concept the term oxidation has been extended to include all similar reactions.

Many substances in water solution ionize (that is, dissociate into their charged constituents; *e.g.*, $NiCl_2 \rightarrow Ni^{2+} + 2Cl^-$), and the electrolysis of such solutions results in an oxidation process at the anode and a reduction at the cathode. For the electrolysis of $NiCl_2$ the anode reaction is $2Cl^- \rightarrow Cl_2 + 2e^-$ and the cathode reaction $Ni^{2+} + 2e^- \rightarrow Ni$. These reactions involving the electrons are called half reactions or oxidation-reduction couples. Each couple has the reduced state of the element as one half and the oxidized state plus electrons as the other half. In theory, every oxidation-reduction reaction may be broken up into two couples that indicate the mechanism by which electrons are transferred. $Ag + 2HNO_3 \rightarrow AgNO_3 + NO_2 + H_2O$; couples, $Ag + NO_3^- \rightarrow AgNO_3 + e^-$ and $e^- + 2HNO_3 \rightarrow NO_2 + NO_3^- + H_2O$. From this mechanism it is evident that oxidation and reduction occur simultaneously and in equivalent amounts; *i.e.*, the number of electrons lost is equal to the number gained. The relative potentials of the two couples determine the direction in which the reaction will proceed (*see* THERMODYNAMICS).

The most powerful reducing agents are the electropositive metals such as sodium. These readily reduce the compounds of the noble metals and also liberate hydrogen from water: $AgCl + Na \rightarrow Ag + NaCl$ and $2Na + 2H_2O \rightarrow 2NaOH + H_2$. The noble metals are poor reducing agents but their compounds are good oxidizing agents. Among the most powerful oxidizing agents are fluorine, ozone and cobaltic ion. These readily liberate oxygen from water, $2F_2 + 2H_2O \rightarrow O_2 + 4HF$. Hydrogen peroxide, potassium permanganate and ceric compounds are examples of powerful oxidizing agents which are used extensively in analytical and industrial chemistry.

See also references under "Oxidation and Reduction" in the Index. (W. M. LA.)

OXIDE, in chemistry, a binary compound of oxygen and another element. Oxides are the most plentiful and characteristic components of the earth's hydrosphere and lithosphere: the hydrosphere consists essentially of water, the commoner oxide of hydrogen; and the lithosphere of simple oxides of the general formula A_mO_n and complex oxides of the type $A_xB_yC_z \ldots O_n$. The complex oxides are more abundant, and the study of them forms the greater part of mineralogy, since they include many important rock-forming materials. Work on the structure of crystals has shown that the former inclusion of carbonates, aluminates and alumino-silicates among the complex oxides was not strictly correct (*see* below), though their empirical formulas are often given as though they consisted of oxides; *e.g.*, beryl, $Be_3Al_2Si_6O_{18}$, which is a silicate, may be written incorrectly as $3BeO{\cdot}Al_2O_3{\cdot}6SiO_2$. The ordinary ingredients of soil, subsoil and rocks are partly composed of oxides in either anhydrous or hydrated forms.

Oxygen can be made to combine directly with most elements, although sometimes it will not do so in the entire absence of water vapour; in a few cases in which direct methods are unavailing, as, for example, in the case of noble metals such as gold or platinum, which remain unaffected in air even at very high temperatures, indirect methods can be used and oxides can be prepared from the salts of the metals.

Oxides of some of the noble gases (*see,* for example, XENON) have been formed in the laboratory under exceptional conditions. Fluorine and bromine, too, have been oxidized by special methods, though for a long time their oxidation was considered impossible.

Many elements form a series of several oxides. Thus nitrogen yields six: N_2O, NO, N_2O_3, NO_2 (N_2O_4 at lower temperatures), N_2O_5 and possibly NO_3. In general, the acidic character of the oxide increases with increase in the oxygen content. For purposes of classification it is usual to assign a typical oxide to each element; usually this oxide is the highest having acidic or basic properties and is related to the position of the element in the periodic classification (*see* PERIODIC LAW) as follows: the typical oxides of Group I are of the form M_2O[I] (roman numeral in

brackets indicates periodic group), of Group II those of the form MO[II], of Group III those of the form M_2O_3[III], and so on, Group VI being those of the form MO_3[VI]. The oxides of typical metals (*e.g.*, MgO) are known to be aggregates of oxygen ions (O″) and positive metal ions held together by electrostatic forces in certain geometrical arrangements, while oxides of nonmetals (*e.g.*, CO_2) are usually volatile compounds, the constituent atoms being held together by covalent bonds. Less electropositive metals will form chemical bonds with oxygen that will have considerable covalent nature; *e.g.*, PtO.

Oxides are often classified by type as (1) acidic oxides; (2) basic oxides; (3) amphoteric oxides; (4) neutral oxides; (5) suboxides; (6) higher oxides including peroxides, superoxides and dioxides or polyoxides; (7) mixed oxides; and (8) complex oxides. An oxide may not fall clearly into any one of these classes but have the characteristics of two.

1. Acidic oxides are those that combine with bases or basic oxides to form salts. Many of the oxides of nonmetals (*e.g.*, carbon, nitrogen, phosphorus and sulfur) are of this type. Some acidic oxides are "mixed" anhydrides: thus nitrogen peroxide reacts with water to give two acids, nitrous and nitric, and with bases to form nitrites and nitrates.

2. Basic oxides similarly react with acids or acidic oxides to form salts, and many of the oxides of metals fall into this class.

3. Amphoteric oxides behave as acidic oxides toward bases and as basic oxides toward acids: thus zinc and aluminum oxides dissolve in acids or bases to give salts of the acid or zincates (aluminates) of the base, respectively.

4. Neutral oxides are those that neither react to form salts nor combine with water to give acids or bases: carbon monoxide and nitrous oxide are examples, for although they result from formic and hyponitrous acids, respectively, by loss of water, they do not combine with water to give these acids and are therefore not acidic anhydrides.

5. Suboxides have less oxygen than the common lowest stable oxide, but the term is often loosely used. Carbon suboxide (C_3O_2) is one of the few true suboxides and is obtained by the dehydration of malonic acid, into which it can be converted again by water. At 200° C. carbon suboxide can be changed into a lower oxide, pentacarbon dioxide, C_5O_2. Some so-called suboxides (*e.g.*, lead suboxide, Pb_2O) are now considered to be mixtures (in this case, of lead and lead monoxide). Certain metals, particularly titanium, will yield solid oxides slightly deficient in oxygen or metal and are therefore nonstoichiometric; *i.e.*, they do not obey the law of constant composition. Such "deficient" oxides often show special electrical conductivity properties.

6. Higher oxides have more oxygen than the typical oxide as determined by the periodic classification and can be divided mainly into three groups: (*a*) peroxides, (*b*) superoxides and (*c*) dioxides.

a. Peroxides contain two oxygen atoms linked together to form the grouping —O—O— and usually occur in solid oxides as O_2^{2-} ions. They are closely related to hydrogen peroxide (a neutral oxide), and the latter is formed when peroxides are treated with water or dilute acid. True peroxides are formed by metals such as sodium and barium (*e.g.*, Na_2O_2 and BaO_2). The peroxide link is also found in certain peracids (*e.g.*, persulfuric acid, $H_2S_2O_8$) and their salts. Many organic compounds can have the oxygen atom replaced by the —O—O— group, and these are known as organic peroxides (*e.g.*, diethyl peroxide, $C_2H_5—O—O—C_2H_5$). They are not very stable and can be used, like other peroxides, as powerful oxidizing agents. The formation of peroxides in the oxidation of gasoline in the internal combustion engine is well known, and diethyl peroxide is a "pro-knocking" agent.

b. The final oxidation products (KO_2) of potassium are known to contain the superoxide ion $(—O—O—)^-$; such compounds, formerly known as tetroxides and written as M_2O_4[I], are called superoxides.

c. Certain other oxides, often termed peroxides, are of an entirely different type from true peroxides and contain the ordinary oxygen ion (O^{2-}) linked to the metal ion. Thus lead peroxide is now called lead dioxide since it shows no structural similarity with a true peroxide, but it is, of course, a strong oxidizing agent. Like manganese dioxide it reacts with an acid to give a salt of lower valency, *e.g.*, $MnO_2[IV] + 4HCl \rightarrow MnCl_2[II] + Cl_2 + 2H_2O$, but not hydrogen peroxide.

The typical oxides of Group VII elements, Cl_2O_7 and Mn_2O_7, are not peroxides, but S_2O_7 (if it exists) would have more oxygen than the typical oxide of sulfur (SO_3 in Group VI) and might be expected to have some of the properties of a peroxide.

7. Metals that have two valencies can form oxides containing the metal in its two different valencies (*e.g.*, Pb_3O_4 and Fe_3O_4), and these mixed oxides will have some resemblance to complex oxides (*see* below). Thus Pb_3O_4 has been shown to have a crystal structure consisting of chains of tetravalent lead ions surrounded octahedrally by oxygen ions with divalent lead ions linking the chains together. The action of acids upon such an oxide will yield a mixture of compounds derived from Pb[II] and Pb[IV]; *e.g.*, $PbO_2[IV] + Pb(NO_3)_2[II]$.

8. Complex oxides can be divided into two large groups: (*a*) those that contain oxyions (CO_3^{2-}, SiO_3^{2-}, etc.) and are more strictly known as oxysalts rather than oxides; and (*b*) those that consist of aggregates of oxygen ions (O^{2-}) and positive metallic ions and are true complex oxides. The latter will have different geometrical arrangements in their crystal form according to the relative sizes and numerical proportions of the constituents. As the oxygen ion is usually much larger than the metallic ion, there will be a close packing of the negative oxygen ions with the positive ion or ions occupying the interstices between the oxygen ions.

Metals of the same size will yield complex oxides of similar crystal structure, since it is possible to replace one metal by another of a similar size: thus, in the spinels of general formula MAl_2O_4, the metal M can be Fe, Co, Ni, Mn or Zn, yielding a whole series of spinels. Where the metallic ion approaches the size of the oxygen ion a new geometrical arrangement will be necessary, and there are a number of possible structures; typical of these is the perovskite structure of the so-called titanates, $SrTiO_3$, etc., in which the large Sr^{2+} or Ba^{2+} ions are closely packed with oxygen ions, and the smaller Ti^{4+} occupies the interstitial positions. The study of such structures is an important aspect of inorganic chemistry (for fuller details *see* A. F. Wells, ***Structural Inorganic Chemistry***, 1951). The production of artificial minerals such as sapphires for use as bearings is an interesting industrial process. Mixtures of metallic oxides and oxides of metals with variable valency such as vanadium are of great importance in modern catalytical chemistry, for example, in the manufacture of sulfuric acid.

Many oxides combine with water to form hydroxides (*see* HYDROXIDE), and all hydroxides lose water on heating to give the corresponding oxide. The chemical properties of a hydroxide are almost identical with those of the corresponding oxide, but the latter is somewhat more inert, especially if it has been very strongly heated. *See* also OXIDATION AND REDUCTION; and references under "Oxide" in the Index.

See H. B. Weiser, *The Hydrous Oxides*, "International Chemical Series" (1926). (A. D. M.; F. H. P.)

OXIMES are organic compounds containing the group >C:NOH. They are obtained either by the action of hydroxylamine on an aldehyde or ketone (I), or by the action of nitrous acid or its esters on a compound containing a reactive methyl or methylene group (II). The products of the latter type of reaction are sometimes called isonitroso compounds, but they are all true oximes and the prefix oximino is better than isonitroso.

$$>C{:}O + H_2NOH \underset{\text{I}}{\rightarrow} >C{:}NOH + H_2O$$

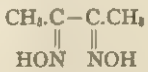
$$>CH_2 + O{:}NOH \underset{\text{II}}{\rightarrow} >C{:}NOH + H_2O$$

Viktor Meyer prepared the first oxime in 1878 and since that date the compounds have been of continued interest to organic chemists because of their value in identification and synthesis and still more so because of the stereoisomerism which occurs in certain classes of oximes (*see* STEREOCHEMISTRY: *The Stereochemistry of Nitrogen*).

Oximes are usually regarded as derivatives of aldehydes and

ketones and thus are divided into aldoximes and ketoximes. Since they are solids which, apart from the simplest members, are insoluble in water and crystallize well, they are used to some extent for isolating and identifying aldehydes and ketones. The rate of oxime formation, however, is often somewhat slow, so that it is frequently more convenient to use derivatives of hydrazine. The oximes behave as weak acids and also as weak bases. They are reduced to primary amines, and this is a useful method for effecting the change $>CO \rightarrow >CHNH_2$. The aldoximes are dehydrated to nitriles by acid chlorides or anhydrides, $-CH{:}NOH \rightarrow -CN + H_2O$, a reaction which was of value in the early study of the structures of the simpler sugars. All oximes can be hydrolyzed by aqueous mineral acids, with varying ease, to the parent aldehyde or ketone and hydroxylamine, but they are stable to aqueous alkalies. The characteristic reaction of ketoximes, the Beckmann transformation, is discussed below.

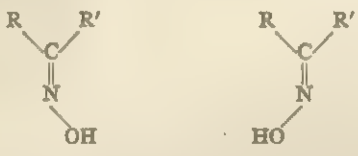
Certain oximes form stable co-ordination compounds with metals and since there are marked differences in the solubilities of the oxime complexes of closely related metals, these oximes are valuable quantitative reagents in analytical chemistry. Only one example will be given here. Dimethylglyoxime (III), the dioxime of a diketone, forms a series of complexes with metals of which only those with nickel and palladium are insoluble in dilute alkalies and weak acids. It is, therefore, the standard reagent for determining these metals and, in particular, gives a quantitative separation of nickel from cobalt.



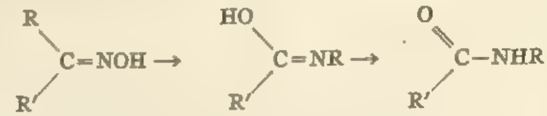
III

From the point of view of the development of stereochemistry, the oximes are of great interest. In 1883 Hans Goldschmidt found that benzildioxime ($C_6H_5.CN.OH.CN.OH.C_6H_5$) existed in two forms, and a third form was obtained by Viktor Meyer in 1889. In 1886 Ernst Beckmann found that an aldoxime, that of benzaldehyde, existed in two forms. Geometrical isomerism in unsaturated carbon compounds had already been recognized by J. H. van't Hoff and generally accepted, and in 1890 Arthur Hantzsch and Alfred Werner extended this conception to compounds containing the group $>C{:}N-$ and advanced the view that these isomeric oximes were geometrical isomers. This view is now known to be true, but it was not accepted by all at first and the ensuing controversy led to much experimental work which laid a solid foundation for fundamental knowledge in a wide field of stereochemical problems.

The Hantzsch-Werner hypothesis was that the oxime of an unsymmetrical ketone or of an aldehyde can exist in two forms which may be written:



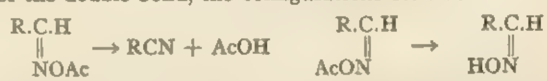
The isomerism was held to be similar to that of compounds containing the group $>C{:}C<$, as with maleic and fumaric acids. The hypothesis implies two postulates: (1) that the hydroxl group is not placed symmetrically with respect to the carbon and nitrogen atoms, but lies to one side of the line joining them; (2) that there is no "free rotation" about the double bond between the carbon and nitrogen atoms, so that the two forms are not readily interconvertible. There were several weighty reasons for the hypothesis. First, isomeric oximes should, and in fact do, occur only when the groups R and R′ are different; *i.e.*, in aldoximes and oximes of unsymmetrical ketones. If R and R′ are alike, the two configurations are identical. Still another argument was based on the Beckmann transformation of the ketoximes. This occurs when a ketoxime is treated with certain acidic reagents, notably phosphorus pentachloride in dry ether. The product obtained after treatment with water is a substituted acid amide. There must be an exchange of groups, one originally attached to the carbon atom having changed places with that attached to nitrogen (*see* MOLECULAR REARRANGEMENTS).



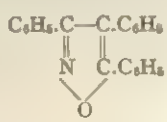
It was pointed out that with two isomeric oximes of formula RR′C:NOH, the main product obtained from one isomer is the amide R′CO.NHR, whereas the other gives the isomeric amide R.CO.NHR′. This is strong evidence that the isomeric oximes have the same structure but a different space arrangement.

Many more facts later accumulated to support the view of Hantzsch and Werner and show that geometrical isomerism occurs in the oximes. Reference can be made to only a few. The truth of postulate (1), the unsymmetrical position of the hydroxyl group, was established by the experiments of W. H. Mills in 1910–31. In this work the aim was to prepare a compound which, if the postulate is correct, has a space configuration not superposable on its mirror image, so that it should exist in optically active forms, whereas, if the postulate is incorrect, resolution into optically active forms is impossible. Several such compounds have been resolved, and in one of them (Mills and B. C. Saunders, 1931) the molecule is such that the optical activity cannot arise from any known cause, probable or improbable, other than the unsymmetrical position of the group attached to nitrogen in $>C{:}N-$. A final argument which should be given is that if the isomerism is geometrical, it should occur in compounds containing this group other than the oximes. It does occur, since isomeric hydrazones containing the group $>C{:}N.NHR$ or $>C{:}N.NR_2$ are known.

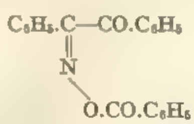
The remaining point of interest is the question of the methods available for allotting configurations to a set of isomeric oximes. Such methods must clearly be based on reactions in which the isomers differ. Hantzsch and Werner pointed out that such reactions are known and applied them to this purpose. With aldoximes the acetyl derivatives of an isomeric pair differ in that one, when treated with aqueous sodium carbonate, is hydrolyzed to the oxime, whereas the other eliminates acetic acid and gives a nitrile. If it is assumed that this elimination of acetic acid takes place with the oxime in which the acetyl and hydroxyl groups are on the same side of the double bond, the configurations follow:



Similarly with the ketoximes, they pointed to the two products of the Beckmann transformation mentioned above and allotted configurations on the assumption that groups situated on the same side of the double bond (often described as in the syn-position) exchange places. Doubts as to the validity of the two assumptions made in these arguments were expressed as early as 1904 (P. Pfeiffer), but the matter came to a head in 1921 when J. Meisenheimer published results showing that the oxidation with ozone of the compound shown in (IV) gives a derivative of β-benzilmonoxime and the latter must thus have the configuration corresponding to (V). On the assumption of Hantzsch and Werner, however, this is the configuration of the α-monoxime.



IV



V

This discovery led to an extended series of investigations both in Germany and England, the aim being to establish the configuration of an oxime by some indisputable method, so that the validity of the original assumptions could be settled. All results tended to show that the original assumption was wrong and that groups in the anti-position, and not the syn-, are involved in the Beckmann change. Similarly the configurations of the aldoximes have also been settled, and it has been shown that elimination of acetic acid

in an acetyl derivative involves the groups lying across, and not on the same side of, the double bond. (T. W. J. T.; G. W. WD.)

OXNARD, a city of Ventura county in southern California, U.S., is midway between Santa Barbara and Los Angeles, and about 4 mi. from the Pacific coast. Oxnard is the centre of a rich agricultural area noted for the production of lemons, avocados, strawberries, sugar beets, lima beans, walnuts and other vegetable crops. Industries include sugar processing, fish and vegetable canning, citrus packing, vegetable processing, oil refining and paper making. Harbour facilities have been developed at Port Hueneme, a deep water port 4 mi. S. of Oxnard. Port Hueneme is also the site of a U.S. naval station. A naval air missile test centre is located at Point Mugu, 6 mi. S.E. of the city.

In 1898 the Oxnard brothers from Louisiana constructed a large sugar-beet factory around which the town developed. Oxnard was incorporated in 1903 and in 1947 adopted a council-manager form of government. Population (1964) 58,269; Oxford-Ventura standard metropolitan statistical area (Ventura county) (1960) 199,138. For comparative population figures *see* table in CALIFORNIA: *Population.* (R. H. BI.)

OXUS: *see* AMU-DAR'YA.

OXYACETYLENE TORCH: *see* WELDING.

OXYGEN is the most abundant of the elements, but its nature eluded the investigation of the early chemists. It was first produced about 1772 by C. W. Scheele, who obtained it by heating certain metal oxides, including mercuric oxide, and described it as "empyreal air." It was discovered independently in 1774 by Joseph Priestley, who also obtained it by heating mercuric oxide, and called it "dephlogisticated air," to denote that it had been separated from "phlogiston," the imaginary substance that was supposed to be the raw material of fire. It was first recognized as a chemical element by A. L. Lavoisier, in his 1775–77 experiments. He named it *oxygine*, later *oxygène*, from the Greek for "acid maker," explaining in his *Elements of Chemistry* that "one of the most general properties of this base is to form acids by combining with many different substances."

Lavoisier, however, subscribed to another scientific fiction of the era—"caloric," an intangible and weightless substance that was supposedly the cause of heat. He wrote that the union of oxygen and "caloric" produced "oxygen gas, which is the same with what was formerly called pure or vital air."

Occurrence and Properties.—The atmosphere contains 21% by volume and 23.2% by weight of oxygen. Water contains 88.8% by weight, and there is about 50% of combined oxygen in the earth's crust. Oxygen is taken in from the atmosphere by plants and animals during respiration and given off as carbon dioxide. This process is counterbalanced in nature by the assimilation of carbon dioxide by green foliage and by the evolution of free oxygen (*see* CARBON, OXIDES OF).

The chemical symbol of oxygen is O, the atomic number 8 and the atomic weight of the lightest isotope occurring in nature is 15.9994, or approximately 16. Natural oxygen contains two other isotopes, O^{17} and O^{18}, the relative abundance being $O^{16}:O^{17}:O^{18} = 99.76:0.04:0.20$. Three radioactive isotopes are known, O^{14}, O^{15} and O^{19}, but they are very short lived.

Oxygen is somewhat soluble in water (about 2.8 ml. per 100 ml. of water at 20° C.) and the solubility in sea water is only a little less. This dissolved oxygen is essential to fish.

Ozone (*q.v.*), with the chemical formula O_3, is an allotropic form of oxygen.

Oxygen forms a pale blue liquid (b.p. −182° C.). The critical temperature and pressure are −118.8° C. and 49.7 atm., respectively. Solid oxygen melts at −218.4° C. and exists in two crystalline modifications. Oxygen is paramagnetic in all its physical states. It behaves chemically as a bivalent element, forming a large range of compounds in which it is covalently bonded to other elements. These include the oxides of a number of nonmetallic elements (*e.g.*, H_2O, SO_2, SO_3, CO_2). In the lattices of many solid ionic oxides the element is present as the ion O^{2-} (*e.g.*, ZnO). Metallic superoxides and peroxides contain one or other of the ions O_2^- (as in KO_2) or O_2^{2-} (as in BaO_2). (*See* also OXIDE.) Oxygen is also a constituent of the molecules of a large number of chemical compounds of the most varied types. It combines directly with most other elements, either at ordinary temperatures or on the application of heat. This process is known as oxidation: when oxidation is accompanied by the evolution of light as well as of heat it is termed combustion. (It should be noted that the chemist also uses the term oxidation in a wider sense; *see* OXIDATION AND REDUCTION.) Oxygen is estimated in a gas sample by absorbing it in an alkaline solution of pyrogallol and observing the diminution in volume. Alternative absorbents suitable for the quantitative estimation of oxygen are ammoniacal solutions of cuprous salts, alkaline solutions of sodium hydrosulfite, or yellow phosphorus.

Preparation.—In the laboratory, oxygen is commonly prepared by heating a mixture of potassium chlorate with about a third of its weight of manganese dioxide at 240° C. The manganese dioxide facilitates the decomposition. Various oxides, peroxides and oxygen-rich compounds such as mercuric oxide, barium peroxide and potassium permanganate also evolve oxygen when heated. The obsolete Brin process for obtaining oxygen from the air was based on converting barium monoxide to peroxide by heating it in compressed air and then raising the temperature and reducing the pressure to bring about the reversion of barium peroxide to the monoxide and oxygen.

The chief commercial source of oxygen is the atmosphere. Air freed from carbon dioxide is liquefied by compressing it and allowing it to expand through a nozzle. In this expansion, work is done, heat is lost and the temperature of the issuing gas falls. By a system of heat exchange the cooled gas, which has been expanded, is made to cool the air still under pressure and the cumulative cooling effect thus obtained leads to liquefaction of the air. The chief components of liquid air, oxygen (boiling point −182° C.), argon (b.p. −185.8° C.) and nitrogen (b.p. −195.8° C.), are separated by rectification of the liquid mixture. The principle is the same as that employed in the fractionating columns used in separating petroleum products. The liquid air is passed down a column fitted with numerous plates so designed as to give intimate contact between the gas ascending the column (produced by the evaporation of liquid air at the bottom) and the descending liquid. The result is that the more volatile nitrogen and argon are evaporated from the liquid and the less volatile oxygen enriched in it. After a period of operation liquid oxygen is obtained at the bottom of the column and nitrogen at the top. There are many modifications of this general process in commercial practice. They yield both oxygen and nitrogen of purity exceeding 99%.

A certain amount of oxygen is obtained as a by-product in the manufacture of hydrogen by electrolysis; *e.g.*, in the electrolysis of aqueous caustic soda.

For many purposes oxygen is stored and transported as gas under pressure in steel cylinders, but the storage and transport of the liquid is also common. This is done in double-walled spherical Dewar vessels of spun copper with long narrow necks. The space between the walls is highly evacuated to prevent heat reaching the liquefied gas and may also contain absorptive charcoal. The latter, when cooled by contact with the cold surface, has the property of absorbing residual gas and so maintaining the vacuum. High polish on the metal surfaces also helps to prevent evaporation of the liquid oxygen. A 25-l. container loses by evaporation only about 5% of its full charge per day.

Uses.—The chief industrial use of oxygen is for the fusion welding of metals; *e.g.*, steel, cast iron or aluminum, and for the cutting of steel. Welding is done with an oxyacetylene flame, the two gases being supplied to a special blowpipe in which they are mixed before combustion. The temperature of the inner core of the flame may reach about 4,000° C. and suffices to melt locally the metal surfaces to be joined. The exact procedure and the fluxing materials used depend on the metal to be welded. For cutting metal an oxyacetylene flame is again used but, whereas in welding it is important to minimize oxidation, it now becomes important to oxidize away a certain amount of the metal. To accomplish this the cutting blowpipe is so designed that an auxiliary jet of oxygen is directed onto the heated metal. The oxyacetylene flame is also used in the descaling of steel billets and in the surface hardening of steel

components. Oxygen or oxygen-enriched air is being increasingly used in place of air in steelmaking operations. Liquid oxygen is also finding more and more technical applications. Porous charcoal or other absorptive and readily oxidizable material which has been impregnated with liquid oxygen forms a powerful explosive. The impregnation is done just before use. The explosive has the advantages that it automatically becomes dead through evaporation if it is not fired, and also gives rise to no harmful gases. Liquid oxygen is used as an oxidizing agent in rockets using liquid fuel. The German V-2 rocket used liquid oxygen in conjunction with alcohol.

Gaseous oxygen is often used to enrich the air breathed in the treatment of cases of pneumonia, gas poisoning, etc., and for admixture with nitrous oxide, ether and other anesthetics. It also finds a limited use as an oxidant in the chemical industry, and is used, too, in the continuous gasification of solid fuel. Oxygen admixed with steam is passed into the fuel bed and maintains a sufficiently high temperature to allow the water-gas reaction to proceed smoothly.

See also references under "Oxygen" in the Index. (H. J. Es.)

OXYGEN STEEL: *see* CONVERTER STEEL.

OXYRHYNCHUS, modern BEHNESA, now an inconsiderable village in Egypt watered by the Bahr Yusuf on the western edge of the Nile valley, about 115 mi. S.S.W. of Cairo, was formerly the capital of the 19th nome or district of upper Egypt. Its Greek name derives from the sacred sharp-nosed fish. Recorded history begins with its capture *c.* 715 B.C. by King Piankhi (*see* EGYPT: *History*). But its best-known period lies between *c.* 250 B.C. and A.D. 700, owing to the finding of innumerable papyri written especially in Greek and Latin but also in demotic Egyptian, Coptic, Hebrew, Syriac and Arabic. Excavations for papyri were first made by B. P. Grenfell and A. S. Hunt (1897–1907), and continued by Italian scholars in 1910, 1914, 1927 and 1932–34. Most museums and papyrus collections possess texts from this site.

The Greco-Roman city, a district metropolis, was walled and gated and its main streets arcaded. A temple of Sarapis and public buildings (theatre, hippodrome, gymnasium, baths, and in the 6th century 26 Christian churches) are mentioned in the papyri, which enable the historian to follow its inhabitants into the schoolroom, the poetry competitions, the council chamber and marketplace, the race course, or on army service abroad. These finds include religious texts (*e.g.*, miracles of Sarapis, early copies of the New Testament, and apocryphal books such as the Gospel of Thomas and the so-called *Logia Iesu*) and also masterpieces of Greek classical literature. The works of Greek authors found at Oxyrhynchus have restored to the world lost texts of early Greek lyric poetry, Pindar, the dramatists including Menander, Callimachus, and innumerable prose works of oratory or history, such as those of the Oxyrhynchus historian (*q.v.*). Book catalogues and payments to scribes show that books were copied in the town as well as imported. A papyrus letter mentions among the writer's friends Valerius Pollio, Diodorus and Harpocration (professors at the Alexandrian museum resident in Oxyrhynchus). Satyrus, historian of Alexandria, and Theon probably also lived there.

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OXYRHYNCHUS HISTORIAN is the name now generally given to the author of a well-informed and conscientious history of Greece, continuing the work of Thucydides, and covering events between 409 and 394 B.C., contained in two fragmentary papyrus rolls found at Oxyrhynchus. Scholars have suggested identifications (none cogent) with Cratippus, Theopompus, Ephorus, Androtion and Daimachus.

See V. Bartoletti, *Hellenica Oxyrynchia* (1959). (E. G. T.)

OYAPOCK (Port. OIAPOQUE) is the river that forms the boundary between the Brazilian territory of Amapá and French Guiana. The river rises in the Guiana highlands and flows northeast for 311 mi. to empty into the Atlantic near Cape Orange. It is navigable only for canoes. The country through which it passes is very thinly populated, and mostly covered by an unbroken tropical rain forest. (P. E. J.)

OYER AND TERMINER, the Anglo-French name, meaning "to hear and determine," applied in England to one of the commissions by which a judge of assize sits (*see* ASSIZE). By the commission of oyer and terminer the commissioners (in practice primarily the judges of assize, though others are named with them) are commanded to make diligent inquiry into all treasons, felonies and misdemeanours committed in the counties specified in the commission, and to hear and determine the same according to law. By the Treason act of 1708 the crown may issue commissions of oyer and terminer in Scotland for the trial of treason and misprision of treason. In the United States oyer and terminer is the name given to several state courts of criminal jurisdiction.

OYO, the chief town of the Oyo province of Western Nigeria, Federation of Nigeria, lies 33 mi. N. of Ibadan. Pop. (1963) 112,349. Atiba hall in the Akesan market was opened in 1941 and St. Andrew's college, which is the premier teachers' training college in Nigeria and is run by the Anglican mission, was founded in 1897. The Shango shrine at Koso is a ceremonial place for Shango worshipers and plays a principal part in the installation of a new *alafin* of Oyo. Shango was a mythical early king of the Yoruba (*q.v.*), later deified as the god of thunder and lightning. Oyo is on the main road from Ibadan to Ilorin and the north. Agriculture is the chief occupation of the people but there are local crafts of leatherworking and wood carving.

The Oyo kingdom was the most important and authoritative of all the early Yoruba principalities. It broke up at the end of the peaceful reign of Alafin Abiodun in 1839. The site of the former centre, now known as Old Oyo, was about 115 mi. N. of the present town. Though Oyo retains some of its traditional pomp, the *alafin* has only nominal secular suzerainty over the Yoruba chiefs, the spiritual head being the *oni* of Ife (*q.v.*), from where is taken to Oyo the sword of state through which the *alafin* receives authority at his coronation. (S. A. Y.)

OYSTER. Oysters belong to a large class of mollusks called Bivalvia in reference to their hinged double shells or valves. Two other names of this class frequently found in the textbooks of zoology are Lamellibranchia, meaning platelike gills, and Pelecypoda, meaning hatchet-shaped foot. In the course of evolution certain bivalves lost their foot and some of them, including all oysters, lost the ability to move. A relatively large foot, used in swimming and crawling, is present in oyster larvae but disappears after the larvae attach to submerged objects (set). Bivalves without the foot have only one muscle, which they use for closing the valves, while all others have two muscles, one anterior and one posterior.

The distribution of oysters is limited by the latitudes 64° N. and 44° S. Within this broad belt they occur in shallow inshore waters of all the continents. The adults rest on bottom or are attached by their left valves to rocks or submerged objects.

BY COURTESY OF THE U.S. BUREAU OF FISHERIES

A NATURAL SET OF OYSTERS ON A PILING

In the 18th and 19th centuries all oysters were considered belonging to one genus *Ostrea*. On the basis of shell structure, anatomy and their mode of living, oysters are now separated into three genera, *Ostrea*, *Crassostrea* and *Pycnodonte*. *Ostrea* is represented by the circular, flat oysters of the type of European edible oyster (*O. edulis*) and small Olympia oyster (*O. lurida*) of the Pacific coast of the U.S. These species prefer clear, relatively cool water; their eggs and sperm are produced by the same individual (hermaphrodite); and the eggs are incubated inside the brood chambers of the gills (lar-

viparous). The genus *Crassostrea* comprises many species characterized by a deep, left valve and the presence of a promyal chamber, an irregularly-shaped space on the right side of the body. The sexes are separate but may change. These oysters are oviparous, *i.e.*, they discharge unfertilized eggs that develop in the sea. The typical representatives of the genus are *Crassostrea virginica* of the Atlantic coast of North America; *C. angulata*, the Portuguese oyster of the western coast of Europe; *C. gigas*, the large rapid-growing oyster of Japan; *C. cucullata* of India; *C. commercialis* of Australia and New Zealand; and *C. chilensis* of the Pacific coast of Central and South America. The genus *Pycnodonte*, native to Australian coasts, is an oviparous oyster with large and heavy shells and an internal anatomy that differs from the other genera—the heart surrounds the rectum.

Structure and Functions of the Oyster.—The shell completely surrounds the soft body of the oyster. Its hinged narrow part marks the dorsal end; the shells are broad and rounded where they open ventrally. The shell, secreted by the mantle, a soft membrane underlying the valves, consists primarily of calcium carbonate laid between the thin layers of an organic substance known as conchiolin. The two flaps of the mantle are joined together and embrace the body on the anterior and dorsal sides but leave the ventral edges free. Two rows of tentacles along each free border of the mantle guard the body. Mechanical disturbance, change in illumination or presence of irritating substances are sensed by the tentacles; the stimulus is conveyed through the nerves of the mantle to the muscle, which closes the shell.

The adductor muscle is the most conspicuous organ of the oyster. It occupies a slightly asymmetrical position and its place of attachment to the shell is often dark coloured. This muscle consists of a crescent-shaped, white posterior part and slightly darker, translucent anterior part. The latter is made of fibres that contract more rapidly than the fibres of the opaque portion of the muscle and hold the valves in any position to which they are brought by the contraction of the posterior part. The maintenance of the muscle tonus at any particular level of contraction is attributed to the so-called locking mechanism of the adductor. When the muscle relaxes, the springlike action of the elastic ligament at the narrow end of the shell forces the valves apart. Observations show that in the presence of harmful substances in the water those oysters that remain closed for a longer time have better chance to survive than those that open more frequently. *C. virginica* may remain in good condition for about four months if kept in air at a temperature a few degrees above freezing. Warming, shaking or rough handling causes the adductor to relax; the valves gap, the water retained inside the shell is lost and the oyster soon dies.

The power of the adductor muscle varies with the size and condition of the oyster. Continuous pull equal to 22 lb. applied to the shell proved to fatigue the muscle of an adult American or Japanese oyster in less than an hour, but at least 17 days were needed to attain the same effect with the pulling force of 2.2 lb. A force of from 26 to 33 lb. is required to tear off the muscle of these oysters.

A pair of gills (branchiae) is located under the mantle on the ventral side of the oyster. They are attached by their bases to the body (visceral mass), while their distal edges are free. Each gill consists of two plates (lamellae), V-shaped in a cross section. Space between the plates is called the interlamellar cavity. In a cross section of the body each gill appears as a W joined by the right and left limbs. Each gill plate is formed by many tubular filaments arranged in a series of folds (plicae) which give the gill a pleated appearance. The filaments are kept together by a series of horizontal shelves which form interfilamentar junctions. The outer and inner lamellae of each plate are joined together by partitions (septae) which divide the interlamellar cavity into a series of water channels opening into a wide passage known as the suprabranchial chamber. The latter leads to the cloaca through which the water is discharged to the outside. In *Crassostrea* the water from the anterior half of the right gill is discharged through a space known as promyal chamber. This asymmetrical chamber is not found in the oysters of other genera. Free spaces between the filaments form oval-shaped openings, ostia, surrounded by powerful cilia which beat inward and force the water to enter the gill. Filaments supported by an inside framework of chitinous rods contain blood vessels, muscle fibres, connective tissue and nerves. The surface of the gill is covered with ciliated epithelium and mucous cells. The entire gill can be compared to a folded sieve through which the water is strained. A complex system of currents along the gill surface carries the food particles toward the terminal grooves at the free edge of gill lamellae and in the opposite direction to the base of the gills. In both places they are picked up by the currents which transport them along the length of the gill to the mouth. Water pumped by the gills provides food and oxygen. This vital function is regulated by changing the rate of ciliary motion of gill epithelium and by increasing or reducing the space between the valves through which the water is sucked in.

The rate of pumping of water or ventilation of the gill can be accurately measured and recorded by the methods developed in U.S. laboratories. Large *C. virginica* were reported to pump as much as 37 qt. (35 l.) per hour at temperatures of 71.6°–78.8° F. (about 22°–26° C.); the average rate at this temperature is about 15–16 l. With the onset of the cold season the pumping slows down and ceases at about 42.8° F. (hibernation).

Oxygen consumption by *C. virginica* kept at 77° F. is low; in an oyster about 4 in. long (10 cm.), it varies from 2 to 6 ml. of O_2 per hour. The food consists of minute algae and other microorganisms. In feeding, the oyster rejects the particles of unsuitable size or shape and those otherwise undesirable. Sorting begins on the surface of the gills and is finally accomplished on the folded inner surfaces of labial palps which border the mouth.

Gills play an important role in the female spawning of oviparous oysters. Violent shell movements which accompany female spawning force the eggs, discharged from the ovary, to pass through the channels of the gill and ostia and accumulate in the mantle cavity. Ensuing sharp movements of the valves eject and disperse them in the water and also draw in water containing sperm. In this way the chance for fertilization of eggs is greatly enhanced.

The alimentary canal begins with the mouth, which is situated at the dorso-anterior part of the body and surrounded by two pairs of triangular palps. A narrow esophagus opens into the stomach, a large, saclike structure with several pouches or outgrowths protruding from its sides. A finger-shaped posterior outgrowth contains the crystalline style, a gelatinous rod about one-half inch long with a broad head projecting into the stomach. The crystalline style is not a permanent structure; it is always present in the actively feeding oysters but disappears shortly after their removal from water. The style rotates in its sack, mixing and grinding small food particles caught between its head and the gastric shield—a cuticular structure that lines the left side of the inner wall of the stomach. The style contains amylase, the enzyme that digests starch and glycogen, and several oxidases.

A short mid-gut leads from the stomach into the intestine; after making a forward loop, it continues backward into the rectum, which opens into the cloaca. Feces discharged through a narrow anus are washed away by the outgoing current running through the cloaca. Time needed for food to pass through the entire alimentary canal of an adult *C. virginica* varies from 90 to 150 min. (at 68° F.).

A large brownish mass of digestive gland surrounds the stomach. It consists of numerous blind tubules (diverticula) kept together by connective tissue and lined by irregularly shaped epithelial cells.

Blood cells (phagocytes), always present in the tubules, engulf the food and digest it inside their bodies. Proteolytic enzyme and lipase have been extracted from digestive organs of oysters, but the question of whether these enzymes are secreted by the gland itself or are liberated from the phagocytes has not been settled.

The circulatory system consists of the heart, arteries, sinuses and veins. The heart has one ventricle and two auricles. The

rate of pulsation varies in *C. virginica* from 15 to 24 beats per minute at 64.4°–68° F. and decreases as the temperature drops. When the oyster closes its shell, the heart beat slows to two or three times per minute regardless of temperature. Through the arteries blood enters the irregular spaces in the tissues (sinuses) from which it flows into veins and back to the heart. An accessory heart, a large vessel at the base of the right and left halves of the mantle, beats independently of the heart and agitates the blood within the mantle.

C. virginica contains no hemocyanin or other blood pigment. The blood cells (amoebocytes and phagocytes) are capable of amoeboid movement and often aggregate on the outer surfaces of gills and mantle (diapedesis) and are discarded.

One pair of visceral ganglia and a smaller pair of cerebral ganglia, with the connecting commissures and branches, constitute the nervous system. A large circumpallial nerve runs along the free edge of the mantle. The structure of commissures and circumpallial nerve resembles that of the ganglia. They consist of numerous nerve cells located mostly along the periphery and of nerve fibres occupying a more central position. Sense organs consist of a series of tentacles which readily respond to various stimuli and of a pallial organ, a small bulge on the side of the adductor muscle inside the cloaca and covered by tall ciliated cells. Its function is not known.

The excretory system is formed by a pair of nephridia situated close to the adductor muscle and to the pericardium with which they communicate. They open into the suprabranchial chamber.

The sex organs (gonads) are made of many branching follicles forming a creamy layer around the visceral mass. Each follicle is lined with germinal epithelium from which the sex cells develop. The degree of gonad development varies greatly, depending on the environment. Sexes in the oyster are not stable, and changes of sex occur in all the species studied. In flat oysters of *O. edulis* type this change is rapid, the sperm beginning to develop a few days after the egg spawning so that cells of both sexes are present simultaneously (hermaphroditism). In cuplike oysters the change of sex in either direction takes place during the winter resting phase. Observations conducted by P. S. Galtsoff showed that in New England waters about 10% of adult oysters change their sex annually. Young *C. virginica* are predominantly males, but toward the end of the first year some of them change into females and a 1:1 ratio is established.

Larvae swim freely in water for 2 to 3 weeks (*C. virginica, C. gigas*). At the end of this period they cement themselves (set) on rocks, piles or on clean surfaces of shells or other material (cultch) spread over oyster grounds by oyster farmers. Those that fail to set perish.

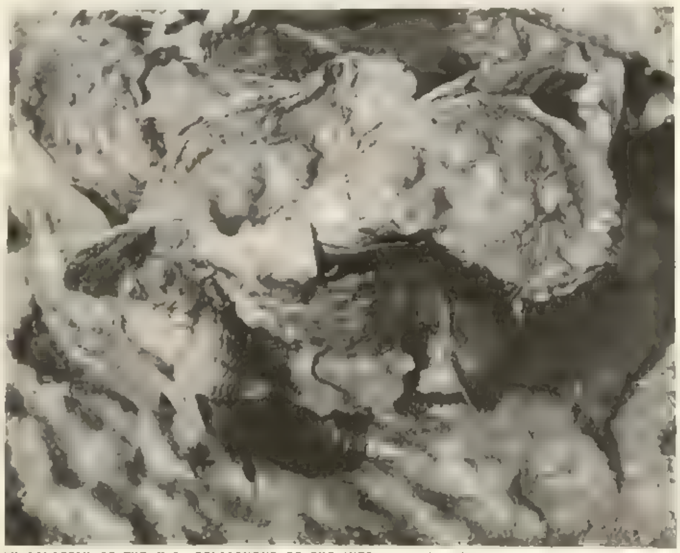
Chemical Composition.—The meat of the oyster consists of proteins (8%–11%), carbohydrates (3.7%–9.6%), glycogen (0.4%–9.5%), fat (1.2%–2.5%), mineral salts (ash, 0.9%–3.0%) and large quantities of water (76%–89%). Paramyosin, a muscle protein found only in bivalves, composes the bulk of the adductor muscle; actinomyosin, the contracting muscle protein, forms only a minor fraction of it. Paramyosin is primarily concerned with the locking mechanism of the muscle. The following inorganic constituents are usually present: sodium, potassium, calcium, magnesium, chlorine, bromine, phosphorus and sulfur.

Many of the heavy metals such as iron, copper, zinc, manganese and iodine are always present in variable quantities, and oysters grown in water contaminated by industrial wastes may accumulate large amounts of iron and copper and appreciable quantities of arsenic and lead. Excessive accumulation of copper produces a green discoloration and renders oysters unpalatable. The green colour of the European oyster, however, is caused by the absorption of a bluish-green pigment of a diatom, *Nitzschia,* which abounds in oyster grounds and is eaten by the oyster.

The chemical composition of the meat changes from season to season and varies somewhat in oysters from different localities. Oysters may be eaten at any season of the year. The so-called "r" rule (that oysters should be eaten only during months in which the letter "r" occurs) probably originated from the observations that during the summer oysters are watery and contain only little glycogen. They can be eaten, however, without any danger to human health. Oyster meat is a low source of energy; an average serving of six raw *C. virginica* yields only about 60 calories.

Parasites and Commensals.—Oysters harbour many parasites. The most dangerous among them is *Dermocystidium marinum,* a funguslike microorganism that attacks the internal organs and may cause death. Trematode worms *Bucephalus haimeanus* and *B. cucullus* infest oysters and destroy their gonads. A parasitic copepod, *Mytilicola orientalis,* sometimes attacks *O. lurida* of the Pacific coast without causing serious injury to the host. The common oyster or pea crab (*Pinnotheres ostreum*), for a long time considered a harmless commensal living on the gills of *C. virginica,* may inflict serious damage to the oyster and even cause its death. Many other invertebrates such as several species of boring sponge (*Cliona*) and boring clam (*Martesia*) damage the oyster shell and are thus injurious. The mud worms *Polydora websteri* and *P. ligni* settle on the inner side of the shell, collect mud and cause the formation of mud blisters. The slipper shell (*Crepidula fornicata*) and jingle shell (*Anomia* species) settle sometimes in very large numbers on the shells of oysters and become a great nuisance to oyster growers. Many Bryozoa, barnacles, ascidians and other invertebrates grow on oyster shells and occupy all the space that could have been available for the attachment of oyster larvae. *Eliminius modestus,* a barnacle incidentally introduced to British waters from the southern hemisphere, is particularly troublesome in this respect.

Predators.—Among the enemies preying on oysters the most destructive are the various species of snails which bore through the shell by the use of a rasplike radula (*Urosalpinx, Tritonalia, Thais* and other snails commonly known as screw borers, or drills) or break the valves by inserting between them a sharp edge of their own shell (whelks of the genus *Busycon*). Pyramidellid snails, *Odostomia* (*Menestho*) in America and *Chrysallida* in Europe, settle at the very edge of the shell, wait for the oyster to open, insert their proboscis and suck its blood. In spite of their small size, not exceeding about .2 in. (5 mm.), *Chrysallida* seriously damages European oysters and *Odostomia bisuturalis* interferes with the growth of young American oysters. Polyclad worms such as *Stylochus frontalis, S. ellipticus* and *Pseudostylochus ostreophagus* (on the Pacific coast of the U.S.) destroy large numbers of adult and young oysters. New England oystermen wage continuous warfare against the starfish *Asterias forbesi* by removing it from the bottom with tangle mops and suction dredges. Skates and drumfish are kept away from oyster grounds by fences.



BY COURTESY OF THE U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE

THE OYSTER DRILL, A SNAIL (UROSALPINX CINEREA) (LOWER LEFT) PREYING ON A CLUSTER OF OYSTERS

Pollution and Sanitary Control.—The discharge of industrial wastes into coastal waters often causes the destruction or poor

growth of oysters. The discharge of untreated domestic sewage into natural waters rarely kills the oysters, but it renders them unmarketable. The suitability of grounds for harvesting shellfish for human consumption is determined by a bacteriological examination of water. No shellfish is permitted to be taken from any area that contains more than 70 *Escherichia coli* in each 100-c.c. sample of water. This harmless bacterium flourishes in human intestines and is therefore a reliable indicator of pollution. Oysters from moderately polluted areas may be purified by chlorination, a process used in the U.S. and England. It consists in washing and disinfecting the outside surfaces of the shells with chlorinated sea water, then placing the oysters for self-purification in sterile water containing no residual chlorine. The disposal of radioactive waste from nuclear reactors presents a serious problem because some of the radioisotopes of metals are readily accumulated by the tissues of mollusks and may render them dangerous for human consumption.

Oyster Farming.—Long before the Christian era, the Chinese were cultivating oysters, and Romans successfully used artificial methods of growing them to satisfy the refined tastes of their epicures.

During the 20th century the progress of biological research and food technology made possible rapid advancement in oyster farming. Many thousands of acres of barren sea bottom were converted into fertile farms under water; the quality of oysters was

BY COURTESY OF THE AUSTRALIAN NEWS AND INFORMATION BUREAU

OYSTER FARMING IN AUSTRALIA: (LEFT) OYSTERS ARE CULTIVATED ON SUBMERGED STICKS TO INSURE PROPER SPACING AND EASE IN COLLECTING: (RIGHT) HARVESTING MATURE OYSTERS

improved, new harvesting implements were invented, and reliable methods were developed for the preservation of oyster meat by canning, freezing and smoking.

Oyster farming consists of the following operations: (1) selection of suitable bottoms, clearing them of debris and predators and, if necessary, reinforcing them with shells or gravel; (2) planting a sufficient number of adult oysters (spawners) for breeding; (3) scattering clean shells (cultch) or collectors over the bottom or on tidal flats for the attachment of oyster larvae; (4) transplanting young oysters (seed) to growing and maturing grounds; (5) protecting the oysters against predators; and (6) harvesting. Grounds upon which larval oysters set in great abundance may not be suitable for the growth and fattening of market stock and vice versa. These peculiarities of oyster habitat must be studied and determined by field tests.

A crucial problem of oyster farming is the scarcity of seed oysters aggravated by extensive mortalities. Seed oysters are harvested from natural oyster beds or are obtained by scattering clean oyster or clam shells for the attachment of larvae. In the state of Washington the producers of the Pacific oyster depend on the import of large quantities of seed of *C. gigas* from Japan. European oyster growers developed elaborate methods of obtaining seed on tile or brush collectors set on tidal flats. In Japan young oysters are collected on garlands of shells strung on wire and suspended from poles exposed at low water.

Several empirical methods of predicting time of setting have been suggested. For instance, in the Netherlands the breeding of *Ostrea edulis* may be expected to begin when water temperatures reach 59° F. and the release of larvae to occur periodically in June and July, ten days after the full and new moon.

No lunar periodicity in breeding was observed in *C. virginica*. Spawning of this oyster in Long Island sound usually begins between June 1 and 8, and setting may be expected about 18 days later. Deviations from normal air temperatures through Jan.–April along the Pacific coast of the U.S. determine the time of setting of the native oyster, *O. lurida*.

Artificial Raising of Larvae.—Larvae of *C. virginica*, *C. gigas* and *O. edulis* have been artificially raised in laboratories. Fertilized eggs of the first two species may be obtained by stimulating spawning in ripe females by adding sperm to the water and increasing the temperature. In a few hours, fertilized eggs develop into minute larvae which hatch out and swim in water. They are given food which consists of various small flagellates and unicellular algae. Cultures of these microorganisms must be prepared in advance. Laboratory methods of artificial raising of larvae were so perfected by the early 1960s that experimental breeding of oysters became possible.

Introduction of Foreign Species.—The American oyster, *C. virginica*, was planted in northern Europe, and unsuccessful attempts were made to establish this species in the waters of the Pacific coast. The Portuguese oyster, *C. angulata*, was accidentally introduced into the waters of the west coast of France and established itself in the area formerly occupied by *O. edulis*. *O. edulis* raised from fertilized eggs in the laboratory of the Bureau of Commercial Fisheries in Connecticut was planted and established itself in the coastal waters of Maine. Most spectacular was the case of the introduction of the Japanese species, *C. gigas*, into Puget sound and adjacent bays of the American coast where this oyster is successfully cultivated on a large scale. *C. gigas* was planted with fair success in Australia. In several instances the introduction of a foreign oyster was followed by a spread of new predators, which became destructive to local shellfish.

The Japanese snail *Tritonalia japonica*, brought into Puget sound with the first shipments of seed oysters from Japan, became a serious pest; and the American oyster drill *Urosalpinx cinerea*, brought into England, became a serious menace to native *O. edulis*. Introduction of any foreign species of oyster must be carefully supervised to avoid such dangers.

Further physiological studies of food and feeding, fattening, respiration and growth are needed to place oyster farming on a sound scientific basis. These problems are studied in numerous oyster laboratories established in western European countries, Japan, Australia, the Philippines, the U.S. and Canada.

Marketing.—Oysters sold in their shells are usually consumed raw (half shell trade). In the U.S. a considerable portion of raw oysters are opened at the oyster houses; the meats are thoroughly washed in water and packed in cardboard containers which may be kept on ice for several days (shucked oysters). Canned oysters are produced by steaming the oysters in large vats, removing the meats, packing and sealing them in metal cans and cooking them under ten pound pressure (240° F.) for 30 or 40 minutes. Some companies specialize in producing smoked oysters packed in oil. Small quantities of oysters are frozen.

Pearls.—Edible oysters occasionally produce round calcareous concretions; they have no lustre and are worthless. True pearl oysters inhabit warm waters of the tropics. They differ from the edible oysters by the presence of a tuft of filaments (byssus) by which they attach themselves to the substratum, and by a number of other characters. The inside of their shell is lined with layers of an iridescent nacreous substance absent in the shells of edible oysters (*see* PEARL).

See also MOLLUSK; BIVALVE.

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OYSTER BAY, a village of Nassau county, New York, U.S., situated at the foot of Oyster Bay harbour on the north shore of central Long Island. The village of Oyster Bay was first settled in 1653 by a group of English families from Connecticut and Massachusetts. The land was bought from the Matinecock Indians and the only battle between colonists and Indians in the history of Long Island took place within the village area during the first years of settlement.

In the early 19th century Oyster Bay was essentially a rural village, although its harbour was used extensively by the whaling industry which flourished in that section of Long Island during the period. A significant change in the character of the community occurred during the late 19th and early 20th centuries when the land surrounding the village was developed into great estates by industrial and financial leaders. Estates owned by Louis Tiffany, Arthur Weeks, Charles Theirot, William Coe, John Schiff, George Maxwell, F. W. Woolworth and others gave Oyster Bay a "Gold Coast" reputation. In addition, "Sagamore Hill," the three-story home and summer White House of Pres. Theodore Roosevelt, contributed to Oyster Bay's fame.

Later in the 20th century the era of the great estates began to pass, particularly after the depression decade of the 1930s. The area continued to be essentially residential and resisted all attempts to increase industrialization or even to extensively settle the village with smaller homes. Shipbuilding, oystering, oil distribution, sand and gravel excavation and plastics were the only industries carried on within the village area.

Places of interest in Oyster Bay include Sagamore Hill, made a national historic site in 1963; Raynham Hall, the white salt box home of Sally Townsend who helped save West Point from the British during the American Revolution; the Roosevelt bird sanctuary; and Wisteria house, which was built in 1660. The population is about 5,000. (Wl. M. D.)

OYSTER CATCHER (Mussel Picker), a large, thickset shore bird, allied to the plovers and composing the family Haematopodidae, members of which are scattered on the seacoasts from Iceland to the Red sea. The common European oyster catcher (*Haematopus ostralegus*) is conspicuous in both sexes by its black and white plumage, pinkish legs and long orange-red beak. It feeds largely on marine worms, crustaceans and mollusks and is very wary. The hen lays three clay-coloured eggs blotched with black, usually on a shingle bank near the sea. The young are at first clothed in protectively coloured down and can run at once.

ERIC HOSKING

COMMON OYSTER CATCHER (HAEMATOPUS OSTRALEGUS) OF EUROPE

Usually seen in pairs, oyster catchers sometimes congregate in large flocks. The courtship consists of a dance in which one or both birds run around piping. Sometimes this dance, losing its original significance, is performed as a social function by a number of birds.

The American oyster catcher (*H. palliatus*) has a longer bill and less white on the back, and its piercing call note differs from the musical trill of the European bird. Various other species occur, some of which are entirely black: *H. bachmani* is the black oyster catcher of the western coast of North America and *H. fuliginosus* is the sooty oyster catcher of Australia.

OYSTER PLANT (Vegetable Oyster): *see* Salsify.

OZANAM, ANTOINE FRÉDÉRIC (1813–1853), French historian, a leading figure in the Catholic revival in France in the first half of the 19th century, and founder of the Society of St. Vincent de Paul, was born at Milan on April 23, 1813. He was educated at the Lycée Royale at Lyons, where his parents had settled in 1816. In 1831 he went to Paris to study law, and during this period met Chateaubriand, Montalembert, Lacordaire and other leaders of the Catholic revival. In 1839 he returned to Lyons as professor of commercial law, but his enthusiasm had always been for literary and historical studies and in 1840 he was appointed assistant professor of foreign literature at the Sorbonne, becoming full professor in 1844. Meanwhile, he had founded, in 1833, with seven fellow Catholic students, the lay Society of St. Vincent de Paul for work among the poor; before his death this numbered about 2,000 centres (or *conférences*, as they were called) in 29 countries. He died at Marseilles on Sept. 8, 1853.

Among his writings those that broke new ground were *Dante et la philosophie catholique au XIII^e^ siècle* (1845); *Les Poètes franciscains en Italie au XIII^e^ siècle* (1852; Eng. trans. 1914), an edition of early Franciscan poetry; and *La Civilisation chrétienne chez les Francs* (1849). In journalism, politics and social action he argued that French Catholics should play their part in the evolution of the democratic state. He opposed the abuses of laissez-faire economic liberalism and also any form of socialism, while being one of the most clear-sighted theorists and practitioners of social reform. His brilliant exposition of Catholic social doctrine in the 24th lecture of his course in commercial law at Lyons foreshadowed by its authoritative orthodoxy Pope Leo XIII's encyclical *Rerum Novarum* of 1891.

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OZARKS. The Ozark highlands are a moderately rugged, heavily forested group of highlands extending southwestward from St. Louis, Mo., to the Arkansas river. Their total area is estimated at 50,000 sq.mi., of which 33,000 sq.mi. are in southern Missouri, 13,000 in northern Arkansas, 3,000 in northeastern Oklahoma and the remainder in southern Illinois and southeastern Kansas. The Ozarks and the adjacent Ouachita mountains (*q.v.*) comprise the only large area of rugged topography between the Appalachians and the Rockies; however, transition from plain to highland is very gradual except on the south and southeast.

The highland is a domal structure composed of an igneous core and gently tilted sediments, primarily limestones. The granites and porphyries of the core are exposed only near the eastern edge, where they form the isolated peaks and knobs of the St. Francois mountains. One knob, Taum Sauk in Iron county, is the highest elevation, 1,772 ft., in Missouri. The domed sediments have been elevated irregularly and have been subjected to varying degrees of weathering, erosion and underground solution. To the west, the Springfield plateau has undergone little erosion; to the east, the plateau surface has been maturely dissected, forming a rough hilly region, the Salem upland. To the south, the Boston mountains, the highest of the Ozarks, have been magnificently sculptured by the White and Arkansas rivers into a bold, mountainous escarpment with many elevations over 2,250 ft.

The Ozarks have a smaller population and less wealth than the surrounding lowlands. However, its natural beauty is the basis for a substantial summer tourist trade, as, for example, at Big Spring and Lake of the Ozarks state parks in Missouri (*q.v.*), and the lead and zinc mines in the tri-state district and southeastern Missouri are leading U.S. producers.

See C. O. Sauer, *The Geography of the Ozark Highland of Missouri* (1920); Wallace W. Atwood, *The Physiographic Provinces of North America*, pp. 235–250 (1940). (A. W. Sm.)

OZD, a new industrial settlement of northern Hungary in Borsod-Abáuj-Zemplén *megye* (county), lies 23 mi. W.N.W. of Miskolc in the hill country to the north of the Bükk highland close

to the frontier with Slovakia. Pop. (1960) 34,155 (mun.). Formerly a small village on the south bank of Hangony stream, just above its confluence with the Sajó river, Ozd has developed rapidly as an iron and steel producing centre. There are limited supplies of iron ore and lignite in northern Hungary, and heavy industry is more widely distributed according to available resources; *e.g.*, iron and steel at Salgótarján west of Ozd and at Miskolc to the east. The growth of settlement at Ozd is more conspicuous because of its previous village character. (H. G. S.)

OZOCERITE (Ozokerite), from the Greek meaning "odoriferous wax," is a native wax composed chiefly of solid paraffinic and cycloparaffinic hydrocarbons. Large deposits of ozocerite occur in Galicia, Rumania, Russia and Utah; specimens are found in many other localities. The Galicia and Utah deposits have been mined; peak production of the Galicia mines was about 20,000 tons annually. Production dropped far below this figure after 1940 because of competition from paraffin wax prepared by cooling high-temperature distillation fractions of petroleum.

Ozocerite usually occurs as thin stringers and veins that fill rock fractures in tectonically disturbed areas. It is believed to have separated from paraffin base petroleums which percolated through the rock fissures. In Utah, ozocerite is still being deposited from liquids exuding from fissures exposed in mine drifts. In many respects the paraffin "scale" deposited on borehole walls of oil wells resembles ozocerite. (*See* also Geochemistry: *Bioliths.*)

Native ozocerite is light yellow to dark brown in colour. It ranges in hardness from less than 1 to 2 on Mohs' scale (*q.v.*); specific gravity varies from 0.85 to 0.95 and the melting point from 58° to 100° C. It is soluble in turpentine, toluene, benzene, carbon disulfide, chloroform and ethyl ether.

Mineral impurities are separated by boiling mined ozocerite in water; the wax rises to the surface and is refined by treatment with sulfuric acid and decolorized with charcoal. Ozocerite has a higher melting temperature than typical synthetic petroleum wax, a desirable property in the manufacture of carbon paper, leather polishes, cosmetics, electrical insulators and candles. (S. R. Sn.)

OZONE is a bluish gas with a distinctive, penetrating odour. An allotropic form of oxygen, it has the chemical symbol O_3. Ozone is a powerful oxidizer, and is used commercially as an antiseptic and bleaching agent. In the earth's atmosphere, where it occurs naturally in very small amounts, ozone plays a crucial geophysical role because of its intense absorption of solar ultraviolet radiation.

M. van Marum in 1785 noted and reported a peculiar smell in the vicinity of electrical machines. However, it was not until 1840 that C. F. Schönbein recognized clearly that the odour signaled the presence of a new gas to which he gave the name ozone, after the Greek *ozein,* meaning "to smell." The chemical composition of this gas was uncertain until the definitive work of B. Brodie in 1872 established it as the triatomic molecule of oxygen.

Ozone finds limited commercial use in a variety of applications. As a water-purification process, ozonization is less prevalent than the cheaper chlorination method; however, its superior ability to eliminate objectionable tastes and odours has led to its adoption in some locations, for example, Philadelphia and Paris. Ozone is used as an oxidant in certain chemical processes: to bleach oils, fats and textiles; to eliminate harmful compounds in industrial wastes; and to control bacteria in cold-storage rooms. In air-conditioning systems, the use of ozone permits a reduction of the amount of outside air needed for recirculation.

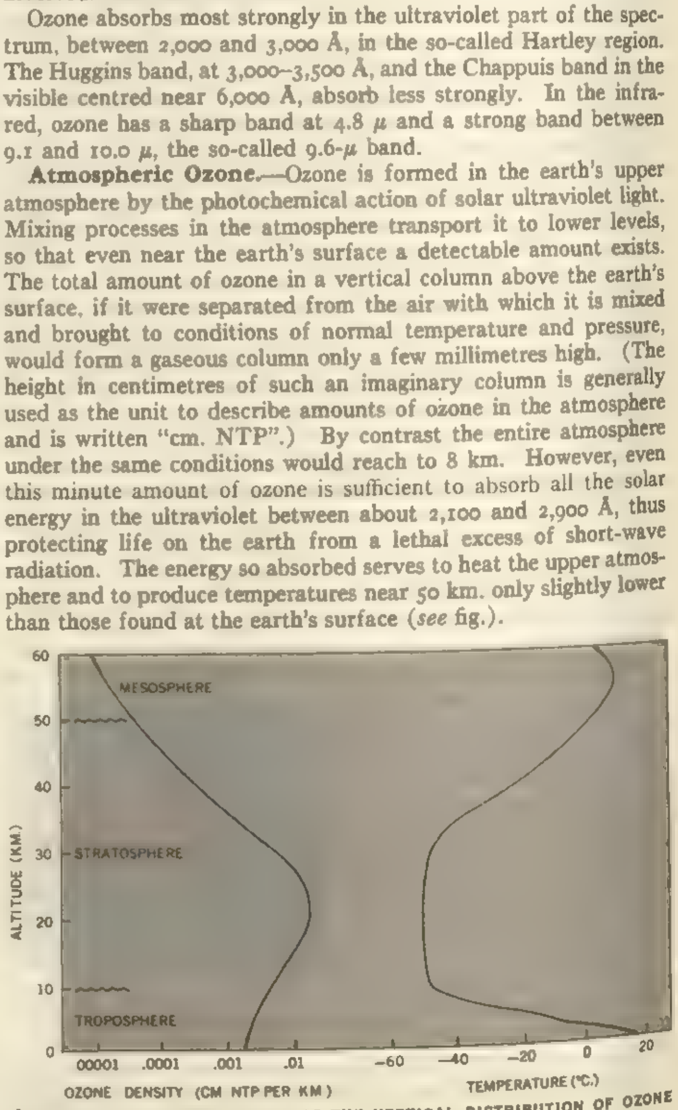
In sufficient concentration, ozone corrodes organic matter, such as rubber and cork. Continued human exposure to concentrations greater than 1 part per 1,000,000 (by volume) is considered hazardous, and irritation to the respiratory tract may follow from smaller dosages. The natural concentration of ozone near the earth's surface, while highly variable, does not reach dangerous levels. However, abnormally high concentrations have been noted in some areas, presumably as a result of combustion products of industry and automobiles. For this reason, the U.S. public health service constantly monitors the ozone concentration in these areas, for example, Los Angeles.

Ozone has a molecular weight of 48.000, a specific gravity (air = 1) of 1.658, and a boiling point of −112° C. It is slightly soluble in water, more so in oil of cinnamon and oil of turpentine. In liquid form, it is dark blue in colour and highly explosive. The usual commercial technique of producing ozone involves a silent electrical discharge through oxygen or dry air; this forms a dilute mixture of ozone and the parent gas. In some commercial applications, oxygen or air is exposed to ultraviolet light, usually from a quartz lamp, to form ozone. Ozone may also be formed by the electrolysis of acidulated water, by some chemical reactions, and by the slow oxidation of many substances.

In the usual method of detecting and measuring ozone, the oxygen-ozone mixture is passed through a neutral solution of potassium iodide. Unlike oxygen, ozone reacts with the potassium iodide to form iodine. The amount of liberated iodine is then measured amperometrically; this gives a measure of the amount of ozone in the sample. Ozone concentration may also be measured photometrically, as a consequence of ozone's intense absorptivity near 2,500 Å (*see* below); the photometric method is used commercially when small or variable ozone amounts are involved.

Ozone absorbs most strongly in the ultraviolet part of the spectrum, between 2,000 and 3,000 Å, in the so-called Hartley region. The Huggins band, at 3,000–3,500 Å, and the Chappuis band in the visible centred near 6,000 Å, absorb less strongly. In the infrared, ozone has a sharp band at 4.8 μ and a strong band between 9.1 and 10.0 μ, the so-called 9.6-μ band.

Atmospheric Ozone.—Ozone is formed in the earth's upper atmosphere by the photochemical action of solar ultraviolet light. Mixing processes in the atmosphere transport it to lower levels, so that even near the earth's surface a detectable amount exists. The total amount of ozone in a vertical column above the earth's surface, if it were separated from the air with which it is mixed and brought to conditions of normal temperature and pressure, would form a gaseous column only a few millimetres high. (The height in centimetres of such an imaginary column is generally used as the unit to describe amounts of ozone in the atmosphere and is written "cm. NTP".) By contrast the entire atmosphere under the same conditions would reach to 8 km. However, even this minute amount of ozone is sufficient to absorb all the solar energy in the ultraviolet between about 2,100 and 2,900 Å, thus protecting life on the earth from a lethal excess of short-wave radiation. The energy so absorbed serves to heat the upper atmosphere and to produce temperatures near 50 km. only slightly lower than those found at the earth's surface (*see* fig.).



A SCHEMATIC REPRESENTATION OF THE VERTICAL DISTRIBUTION OF OZONE AND TEMPERATURE. BOTH VARY IN DETAIL FROM TIME TO TIME AND PLACE TO PLACE

A few direct and many indirect (but crude) measurements of the distribution of ozone in the vertical have been made. The maximum density of ozone (mass of ozone per unit volume) in the vertical occurs near 22 km., although at times it may be as low as 15 km. or as high as 30 km. The ozone density at the maximum is also variable, perhaps as low as .008 or as high as .030 cm.

NTP per kilometre. The maximum *concentration* (volume of ozone per unit volume of air) is believed to be near 35 km. and to have a value of about 10 parts per 1,000,000, although very few direct measurements have reached so high. The figure shows schematically the vertical distribution of ozone and temperature.

The total amount of ozone (in a vertical column above the earth's surface) has been determined many times by a spectrophotometric technique developed by G. M. B. Dobson. Northern hemisphere observations show a marked latitudinal variation, the minimum amount occurring near the equator. Except near the equator, where there is little annual variation, the maximum amount of ozone occurs in the spring, the minimum amount in the autumn. In addition, except in equatorial regions, there is marked variability from day to day that is correlated with meteorological conditions: ozone excesses usually occur a bit west of the centres of cyclones, deficits a bit west of the centres of anticyclones. A few observations in the southern hemisphere indicate the same over-all pattern of variability.

Ozone is constantly created and destroyed by photochemical processes in the atmosphere. The rates of creation and destruction depend on air density, air temperature, absorbed solar energy and ozone density. For specified values of the first three, one may calculate a value of ozone density for which these rates exactly balance one another. This is called the "photochemical-equilibrium" amount of ozone, which, of course, varies with altitude, latitude and season. Such calculations agree well with measurements of ozone density above 25–30 km. They predict much less ozone than is observed in the lower stratosphere and troposphere, particularly at high latitudes in spring. Ozone is transported to these lower levels from above by meteorological processes that are as yet poorly understood. Net photochemical destruction then proceeds at such a slow rate that, for practical purposes, the ozone content of an air parcel is unchanging. Detailed observations of ozone density would assist the meteorologist to trace air motions in the lower stratosphere and upper troposphere.

Ozone is also created in relatively small amounts by lightning, and destroyed near ground level by contact with various atmospheric contaminants with which it is chemically active.

See ATMOSPHERE; *see* also references under "Ozone" in the Index.

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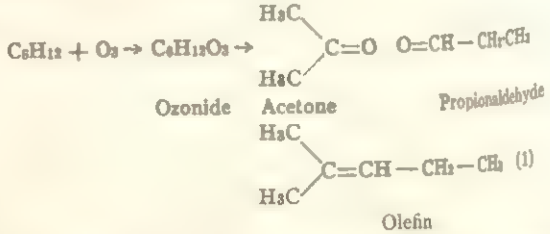
(R. A. Cg.)

OZONOLYSIS is a reaction used in organic chemistry to determine the position of a carbon-carbon double bond in unsaturated compounds. It involves the reaction of the compound with ozone leading to the formation of an ozonide and the ozonide yields on hydrogenation or treatment with acid a mixture containing aldehydes, ketones or carboxylic acids. From the determination of the structure of the aldehydes and ketones so produced, it is possible to determine the position of the double bond in the original unsaturated compound. For example, if ozonolysis of an olefin, C_6H_{12}, yielded acetone and propionaldehyde, it could be deduced that the olefin had the structure (1) as indicated in the following scheme:



Ozonolysis has been used very extensively in the determination of the structure of natural products, particularly the terpenes (*q.v.*). It has also been used in the study of the structure of rare aromatic compounds (*see* BENZENE) and for the synthesis of rare aldehydes and ketones. Thus oleic acid on ozonolysis yields *n*-nonanal (pelargonic aldehyde) and azelaic semialdehyde:

$$CH_3(CH_2)_7CH{=}CH{\cdot}(CH_2)_7{\cdot}CO_2H \rightarrow CH_3(CH_2)_7CHO + OCH(CH_2)_7{\cdot}CO_2H$$

The detailed structure of the ozonides is still under examination and researches (L. Long, *Chem. Rev.*, 27:437; (1940); P. S. Bailey, *Chem. Rev.* 58:925 (1958)) indicate that a much greater variety of structure than that shown by the pioneering studies of H. Staudinger is possible for the ozonides.

(W. D. Os.)

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